SURVEY OF WARREN'S ROOT COLLAR WEEVIL IN THE KISPIOX FOREST DISTRICT SUMMER 1989

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
R. White Woods inc.

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EXECUTIVE SUMMARY

Thirty pine plantations were surveyed in the Kispiox Forest District for the incidence of Warren's root collar weevil, *Hylobius warreni* Wood. The plantations ranged in age from five to 10 years old. The percentage of sampled lodgepole pine trees attacked ranged from zero to 100%. Average tree mortality ranged from zero to 8.8%, with most mortality occurring in plantations less than 10 years of age. Mortality was often clumped in distribution. The average amount of root collar girdling in 15 plantations was 50% (S.D. = 32%). Twenty of the 30 surveyed plantations met minimum stocking standards, while six of the remaining 10 had more than 600 stems per ha. The major impact associated with weevil damage will likely be losses in annual increment rather than understocking of plantations. The percentage of sample pine attacked was related to plantation age and tree height. No relationship could be demonstrated between percentage attack and LFH depth or tree density. There was no apparent relationship between weevil damage and site preparation method, ecosystem association, elevation, slope or aspect. Plantations with high weevil incidence generally occurred on sites which originally had a pine component. A survey of root collars of trees in adjacent mature stands showed a high incidence of low level endemic weevil infestations. The weevil appears to survive best on moist, well-drained sites, and is less abundant on the more hygric and xeric sites. Weevil incidence was highest in the Suskwa and Salmon River areas and least in the Kispiox River area. This may be related to the age of the plantations within these areas.

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1 INTRODUCTION

Warren's root collar weevil, *Hylobius warreni*, is an insect whose larvae feed in the root collar region of a number of conifer tree species (Furniss & Carolin 1977). In British Columbia the major host is lodgepole pine (Pl), *Pinus contorta* var. *latifolia*, while the spruce hybrid (Sx) *Picea glauca* x *engelmanni* is a minor host (Herring & Coates 1981). Infestations generally begin in stands about six years of age and continue through to maturity (Cerezke 1970a). Larval feeding in the cambial layer of the root collar results in wounding, resinosis and, in some cases, complete stem girdling of the tree (Cerezke 1974). The effects of damage range from growth losses in larger trees to mortality in younger trees, however mortality seldom reaches five percent within natural pine stands (Cerezke 1974). Growth losses include decreases in both radial and height increment, the magnitude of which depends on the percentage of the root collar which has been girdled (Cerezke 1969, 1974). Height growth losses were estimated to be between 11% and 16% for two years following 50% girdling of the tree stem (Cerezke 1970a), while radial growth increment does not generally decline until after 50% of the root collar has been girdled (Cerezke 1974).

Much of the research carried out on Warren's root collar weevil, in relation to lodgepole pine, has been carried out in natural stands in the Alberta foothills (Cerezke 1969). In British Columbia the damage caused by *Hylobius* has been reported mainly in plantations (Herring & Coates 1981; Garbutt 1988), and there is now some concern that it is causing higher mortality in young pine than previously reported (Cerezke 1969, 1974). This is especially true in the Prince Rupert Forest Region. Garbutt (1988) found an average of 76% of pine sampled in plantations, ranging from four to 20 years old, had been attacked by the weevil in the Kispiox Forest District, Hazelton, B.C. This is of some concern as approximately 70% of planted trees within this district are lodgepole pine (George Burns, personal communication[1]). As a result of Garbutt's initial survey, Prince Rupert Regional MoF staff decided to conduct a more intensive survey of pine plantations within the Kispiox Forest District to determine the incidence and severity of root collar weevil attacks.

The objective of this survey was to sample a minimum of 30 pine plantations throughout the forest district and to assess the damage caused by *Hylobius warreni*. The distribution of weevil incidence within the district as well as perceived relationships between various site factors such as duff depth, site preparation method, original mature stand type, ecosystem association, plantation age, average tree height, slope, aspect and elevation were also examined.

[1] Resource Officer Silviculture, Kispiox Forest District.

2 METHODS

2.1 Survey Area

All surveys were conducted in the Kispiox Forest District in northwestern British Columbia. This forest district is considered to be in a transition zone between coastal and interior climates (Haeussler *et al.* 1985). All plantations surveyed were within the Interior Cedar-Hemlock, Northwest transitional sub-zone (ICHg).

2.2 Selection of Sampling Method and Plot Type

Two plot types were selected for evaluation: a two metre by 25m strip plot adapted from Fletcher (1986) and a 3.99m radius circular plot. Both plot types had areas of $50m^2$ for easy comparison and conversion to plantation areas on a per hectare basis. A four-hectare area in a Date Creek plantation (Opening # 93M042-026)(Figure 1), which was previously known to be infested (Garbutt 1988) was selected for comparison testing of the two plot types. Alternate transects of strip and circular plots were oriented in an East - West direction. Circular plot centres were placed at 25m intervals, while strip plots were oriented sequentially with a two metre by 25m strip constituting one plot. The distance between transects was also 25m. The percentage of sample trees attacked was then determined for each plot type, tallying dominant/ co-dominant lodgepole pine trees with old and current attacks as positive weevil attack. The percentage of sample trees attacked was then pooled for each plot type and compared using a Z statistic (Zar 1984).

2.3 Sampling Intensity and Maximum Survey Area

It was desired to maximize both the number and area of plantations surveyed in the time allotted for completion of the project (approximately 16 weeks). Based only on logistical considerations, it was decided by the contractor and the regional entomologist[2] that a sampling intensity of one percent of the total plantation area would be used (two plots/hectare). Additionally, due to the large size of some plantations in the forest district, it was decided that the maximum area covered on any plantation would be 50 hectares. For plantations greater than 50 hectares an arbitrary 50-hectare area was delineated for surveying, with consideration given to ease of location of the point-of-commencement. Approximately half way through the project it became apparent that the minimum number of plantations would not be surveyed, and so it was mutually decided that the sampling intensity would be reduced to 0.5% of the plantation area. This sampling intensity was used on the final 15 plantations.

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[2] Tim Ebata, Prince Rupert Forest Region, Smithers, B.C.

2.4 Plantation Selection

Thirty plantations were selected randomly from a pool of plantations meeting the following criteria: the plantations had to be predominantly lodgepole pine; a minimum of six years old and had to meet the MoF minimum stocking standards of 800 well-spaced stems/hectare (or 700 stems/hectare for plantations surveyed prior to the new stocking requirements). The age category was revised for eight plantations to address the concern of weevil caused mortality in younger plantations. In these cases, five-year-old plantations were surveyed.

2.5 Plot Information

The following information was collected from within each plot:

1. **Total number of trees within the plot, broken down by species and age class**, where two broad age classes were established; layer 1 and layer 2 trees. Layer 1 trees were those that had seeded in naturally since the time of planting, while layer 2 trees were composed of the dominant/co-dominant trees. The latter are described in the average height and dbh values given for each plantation.

2. **The number of dead Pl and Sx and the cause of death from visible symptoms.**

3. **The number of dying or chlorotic Pl and the cause of stress from visible symptoms.**

4. **The number of green, healthy-looking Pl with root collar weevil damage.**

5. **The number of healthy trees examined.**

6. **The number of well-spaced trees per plot based on stem form and spacing** (an arbitrary minimum of two metres distance from competing conifers). The maximum number of well-spaced trees per plot was six.

7. **The number of weevil-affected, potential, well-spaced stems** (i.e., meeting all requirements of 6 above), but have evidence of weevil damage.

8. **Average LFH depth** (calculated by taking four depth samples every fourth plot). The plot was divided into four equal quadrants and a central measurement of the LFH layer was taken from each. Sample depths were pooled and the average calculated for each plantation. LFH, as defined in this study, includes all organic matter above mineral soil, including the moss layer, if present.

A positive score for weevil damage was given if a tree had evidence of new or old attacks. New attacks were distinguished from old attacks by the presence of fresh pitch exudation and the presence of larvae.

For the final 15 plantations it was decided to determine the average percentage of girdling caused by weevil larvae and the average number of larvae present per tree for each plantation. This was done by randomly selecting one weevil-attacked tree per plot and excavating the root collar and larger lateral roots. The percentage of the stem girdled was estimated to the nearest 10%. The total number of larvae per tree was also counted.

2.6 Plantation Summary

2.6.1 Plot summaries

Each plantation was summarized in terms of the following attributes:

1. total trees per hectare;
2. total well-spaced trees/hectare;
3. total weevil-attacked trees/hectare;
4. weevil-attacked, well-spaced trees/hectare[3];
5. percentage of weevil-caused mortality to layer 2 lodgepole pine;
6. total number of chlorotic and dead trees due to agents other than weevil;
7. average tree height;
8. average diameter at breast height (dbh), where trees were at least three metres in height.

Age was initially measured using either whorl counts or an increment bore; however this was omitted as preliminary results were extremely variable. The age of the dominant/co-dominant trees was taken as roughly the same as the plantation age. It was felt this gave a more accurate estimation of tree age.

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[3] Well-spaced and weevil-attacked, well-spaced trees are not necessarily additive as a smaller, non-weevil-attacked tree would be tallied as a well-spaced tree, even if it was within two metres of a taller, weevil-attacked tree. The weevil-attacked tree would then be tallied as a weevil-attacked, well-spaced tree. In the absence of weevil, only one well-spaced tree would have been tallied.

2.6.2 Within plantation distribution

A 1:10 000 (or 1:20 000) scale plot map was constructed for each plantation showing the distribution of plots with and without weevil-attacked trees. This was done to determine if there was any apparent stratification of weevil damage. Maps were then compared with field information (i.e., plot notes) to assess the predictability of weevil habitat.

2.7 Historical Information

The MoF history record system provided historical background information on surveyed plantations. This included information on original stand type, site preparation method, plantation establishment and, in some cases, ecosystem classification. Ecosystem classification follows Haeussler *et al.* (1985).

2.8 Survey Summary

After data compilation was completed for all plantations, a simple linear regression (Zar 1984) was used to determine the relationship between percentage of sample pine attacked and plantation age, tree height, tree density and LFH depth. Regression analysis was done using MIDAS (Fox & Guire 1976) on the University of British Columbia computing services network.

The data were also examined to determine if trends existed between the percentage of weevil-attacked pine and site preparation technique, ecosystem classification, original stand type, elevation, slope and aspect.

3 RESULTS AND DISCUSSION

3.1 Selection of Plot Type

There was no significant difference in the percentage of sampled trees with weevil damage between the two plot types ($Z = 0.176$; $p > 0.05$). Therefore it was decided to use the 3.99m radius circular plot in the survey for a number of reasons. Circular plots were easily established by one person. The time required to establish a circular plot was generally less than that required for a strip plot (this is dependent on tree density). The shorter perimeter of the circular plot (25m vs 54m for strip plot) resulted in less judgement calls as to whether a tree is in or out of the plot, and thus minimized bias. Circular plots are commonly used in other silviculture assessments, such as regeneration and free-growing surveys.

The survey method used in this study could be integrated with present free-growing surveys to assess the impact of the weevil. It appears to be quite sensitive to assessing weevil damage. In only one case, the Seven-Sisters plantation in the SW region of the forest district, did our plots fail to contain weevil-attacked trees when there was evidence of weevil damage within the plantation.

3.2 Plantation Distribution

Figure 2 shows the distribution of surveyed pine plantations within the forest district. Plantations ranged in age from five to 16 years. Plantation size ranged from four to 107 hectares. As would be expected, most plantations within a given drainage were of a similar age. This made it difficult to estimate the effect time would have on weevil incidence within a given area. For example, the Upper Kispiox River (Figure 2) had a relatively low incidence of weevil damage, but the plantations were relatively young (five to seven years). Without having an older pine plantation in the area for comparison, it is difficult to speculate as to how weevil incidence will change as the plantations get older. The plantations surveyed were distributed throughout most areas in the forest district (Figure 2).

3.3 Plantation Summaries

Data summaries and plot location maps for all surveyed plantations (Appendix A) are not reproduced with this report but are available from the MoF, Forest Health Section, Protection Branch, Victoria. The percentage of sampled pine with attacks ranged from zero to 100% for all plantations (Table 1), with the average being 29% (S.D. = 26%). Weevil-caused mortality was low in most plantations, ranging from zero to eight percent, averaging 1.5 (S.D. = 1.9). Mortality was generally higher in the younger plantations (i.e., <10 years).

The average percentage girdling of sampled trees for the final 15 plantations was 50% (S.D. = 32, n = 107), and the average number of larvae per girdled tree was 0.33 (S.D. = 0.49, n = 107). If Cerezke's (1970a) estimates are valid for the Kispiox Forest District, growth losses of 17% and 12% in radial and height growth, respectively, in the two years following partial girdling could be expected. The prolonged effects of this damage are not known. The average number of weevils per attacked tree was relatively low. This may have occurred for two reasons. It may have been that there was a high proportion of old attacks or that there were a number of fresh attacks, on previously attacked trees, with early instar larvae. In the latter case, it is quite difficult to see the larvae and they may have been overlooked in the sample.

In most cases there were sufficient non-attacked, well-spaced trees to maintain plantations at minimum stocking (20 of 31 plantations >700 stems/ha)(Table 1). Only four of the remaining plantations were below 600 stems/ha. In these four plantations, the primary reason for their NSR status was weevil damage. It is difficult to speculate as to whether weevil-attacked trees will produce merchantable volumes. In most plantations weevil-attacked trees appeared healthy and did not seem to be suffering ill effects. It therefore appears that the primary impact of *Hylobius warreni* will be growth losses in weevil-attacked trees, resulting from chronic infestations, and not plantation failure, as originally feared. The magnitude of these growth losses in the long term (i.e., over a rotation), is not presently known.

3.4 Weevil Incidence in Relation to Site and Stand Factors

3.4.1 Plantation age

The percentage of sampled pine with weevil attacks was related to plantation age (Table 1, Figure 3). This relates to work done by Cerezke (1970b), indicating that weevil attack incidence will increase with increasing stand age. It is therefore probable that young plantations with low weevil attack rates will gradually increase in the percentage of stems attacked.

3.4.2 Tree height

The percentage of sampled pine with weevil attacks was also related to tree height (Figure 4). The percentage of trees with weevil attacks increased with increasing tree height, which was expected to be based on the adult weevil's preference for larger, dominant and co-dominant trees (Cerezke 1969).

3.4.3 Plantation density

There was no apparent relationship between the percentage of weevil-attacked trees and the total number of stems/ha (Figure 5). Cerezke (1970c) reported that there was some evidence that excessively stocked stands provided poor weevil habitat, however, it is clear that none of the plantations were excessively stocked with dominant/ co-dominant pine, as is found in some natural stands. Therefore, it was not expected to see a large effect of density on percentage of trees attacked.

3.4.4 LFH depth

There was not a good relationship between LFH layer depth and the percentage of attacked pine (Figure 6). Cerezke (1970c), however, found that the duff depth (LFH) gave an indication of the quality of habitat, with the thicker, moister duff depths being the most suitable for survival. Cerezke measured the duff depth in the root collar region of host trees, however, while the duff depths in this project were measured in the open. It appears that the method used in this report is inadequate for assessing sites which are conducive to weevil development. It was initially hoped that this method would allow a "quick" assessment of the probability of a site becoming infested, but it is apparent that the important factor is LFH layer depth at the base of trees.

3.4.5 Site preparation method

Burning or scarifying had no apparent effect on the abundance of weevils (Table 1). Average percentage weevil attacks on broadcast burn blocks was 55.7%, spotburned blocks 26%, scarified blocks 15.8%, and for blocks with no treatment 13%. This is somewhat unexpected since burning or scarifying is thought to reduce weevil survival by reducing the LFH layer, which is important to weevil survival (Cerezke 1973). However, if we look at the average age of the plantations with each treatment type, we see that the average age is 16 years for broadcast burned blocks, eight years for spot-burn blocks, six years for no treatment, and five years for scarified blocks. It is likely that enough time has elapsed to allow for sufficient build-up of organic material in the burned blocks to support weevil re-invasion. Of the scarified blocks, only two had high weevil incidence (Table 1). The method of site preparation may delay the onset of an infestation. This would allow trees to reach a size that was capable of sustaining weevil damage without causing mortality.

3.4.6 Ecosystem classification

There was no apparent relationship between ecosystem and percentage of sampled trees weevil-attacked (Table 1). The majority of plantations were in the ICHg3.01, and it is clear that there is a wide range of weevil incidence, even within this association. At present, ecosystem association does not provide a reliable indication of the risk of a plantation becoming infested.

3.4.7 Original stand type

Plantations on sites which had a pine component prior to harvest, or are adjacent to standing mature pine, appear to be most susceptible to weevil damage. Such sites are prone to weevil re-invasion in the years following harvest (Cerezke 1973). In some cases, weevil damage was present in plantations which were previously spruce, hemlock, balsam, cedar or some combination thereof, however, this appears to be the exception rather than the rule.

3.4.8 Elevation, slope and aspect

There was no indication that elevation, slope or aspect had an impact on weevil abundance. The elevational range of the plantations varied from 300 - 884m (Table 1), which is well within reported limits of weevil damage (Cerezke 1970b). Surveyed plantations were all on moderate slopes, with the exception of the Shandilla plantation (Table 1).

3.5 Within Plantation Distribution

There was no evidence suggesting weevil attack was stratified within a plantation (see plot maps in Appendix A). It appears the weevil disperses quite randomly, selecting trees considered suitable for oviposition. The predominance of weevil damage did occur in areas with a relatively moist LFH and heavy moss layers. In some cases, damage also occurred along plantation perimeters adjacent to surrounding mature pine. This supports Cerezke's (1969) work on dispersal of weevils from residual trees into younger clearcuts.

3.6 Within Forest District Distribution

High weevil attack rates were found in all older pine plantations within the forest district, while younger plantations generally had lower rates of attack (Figure 3, Table 1). High levels of infestation were found in the Suskwa River, Nash Y and Shandilla plantations. Salmon River plantations, which are considerably younger, were also heavily infested, possibly because the previous Pl stands had chronic, endemic infestations of root collar weevil.

4 CONCLUSIONS

1. The 3.99m radius circular plot survey method proved to be efficient. Circular plots were favoured over strip plots because they minimize edge calls; are more familiar to field workers; and are easier to make decisions on tree spacing when determining stocking levels.

2. Warren's root collar weevil was found throughout the Kispiox Forest District, with weevil incidence increasing with plantation age (and height).

3. The major effects of the weevil are:

a) spot mortality in young stands (<10 years);

b) growth losses resulting from partial girdling effects in stands older than 10 years.

5 REFERENCES

Cerezke, H.F. 1969. The distribution and abundance of the root weevil, *Hylobius warreni* Wood, in relation to pine stand conditions in Alberta. Ph.D. thesis, University of British Columbia, xvii + 221pp.

Cerezke, H.F. 1970a. A method for estimating abundance of the weevil, *Hylobius warreni* Wood, and its damage in lodgepole pine stands. For. Chron. 46: 92-396.

Cerezke, H.F. 1970b. Survey report of the weevil, *Hylobius warreni* Wood, in the foothills of Alberta. Can. For. Serv., For. Res. Lab., Edmonton, AB. Int. Rep. A-38. 40pp.

Cerezke, H.F. 1970c. Biology and control of Warren's collar weevil, *Hylobius warreni* Wood, in Alberta. Can. For. Serv., For. Res. Lab., Edmonton, AB. Int. Rep. A-27. 28pp.

Cerezke, H.F. 1973. Survival of the weevil, *Hylobius warreni* Wood, in lodgepole pine stumps. Can. J. For. Res. 3:367-372.

Cerezke, H.F. 1974. Effects of partial girdling on growth in lodgepole pine with application to the weevil *Hylobius warreni* Wood. Can. J. For. Res. 4:312-320.

Fletcher, V.M. 1986. Development of sampling guidelines for estimating the proportion of weeviled trees on a plantation. For. Serv. Inter. Rep. PM-PB-18, Brit. Colum. Min. For. 19pp.

Fox, D.J. and K.E. Guire. 1976. Documentation for MIDAS. 3rd Ed. Univ. Mich. 203pp.

Furniss, R.L. and V.M. Carolin. 1977. Western Forest Insects. USDA For. Serv. Misc. Publ. No. 1339.

Garbutt, R. 1988. Pine root weevil in the coast transition zone in the Prince Rupert Forest Region. Can. For. Serv. Special report. 3pp.

Haeussler, S., J. Pojar, B.M. Geisler, D. Yole and R.M. Annas. 1985. A guide to the interior Cedar - Hemlock zone, Northwest transitional sub-zone (ICHg), in the Prince Rupert Forest Region, British Columbia. Min. For. Land Manage. Rep. No. 25.

Herring, L.J. and H.G. Coates. 1981. Warren's collar weevil: The underground plantation menace. Prince George Forest Region unpublished Report. 8pp.

Zar, J.H. 1984. Biostatistical Analysis. 2nd Ed. Prentice-Hall Inc. 718pp.

TABLE 1 SUMMARY DATA FOR PLANTATIONS SURVEYED FOR WARREN'S ROOT COLLAR WEEVIL IN THE KISPIOX FOREST DISTRICT, HAZELTON, B.C., SUMMER 1989

Location	Opening No.	Plantation Age	Site Preparation	Ecosystem Classification	Original Stand Type	Elevation (m)	Slope (%)	Aspect	Soil Texture	LFH (cm)	Area Surveyed (ha)	Sampling Intensity (%)	%[1] Weevil-Attacked	% Weevil Mortality	Well-Spaced Stems/ha	Weevil-Attacked[2] Well-Spaced/ha	Total Trees/ha	Tree Height (m)	DBH (cm)
Shandilla	93M001-009	16	Broadcast burn	ICHg3.01/09	HSx	381	50	N	SL	7	50	1	55	1.1	608	492	3 095	7.04	10.1
W. of Skeenax	93M001-013	16	Broadcast burn	ICHg2.01	HCw	457	20	N	-	7	50	1	34	0.5	614	214	2 894	6.46	8.1
Nash Y	93M011-041	16	Broadcast burn	ICHg3.01/.09	PlH	549	10	SE	SL	4	30	1	75	1.0	240	540	2 860	7.32	10.5
Suskwa R	93M024-007	13	Broadcast burn	ICHg2-3	CwB	610	15	S	-	15	50	1	27	0.3	726	202	1 750	6.37	9.3
Suskwa R	93M024-018	16	Broadcast burn	ICHg3.01	HCw	457	20	N	-	12	46	1	71	1.1	428	405	2 959	7.45	9.5
Mosquito Flat	93M024-025	16	Broadcast burn	ICHg3.01	HPl	487	10	W	-	6	38	1	84	1.3	177	564	1 054	5.07	10.3
Robinson Lk.	93M033-005	16	Broadcast burn	ICHg3.03a	HB	884	20	N	-	11	14	1	43	0.0	600	250	1 864	6.89	10.1
Nash Y	93M011-047	10	Spotburn	ICHg3.01	PlSx	549	10	SE	SL	8	33	1	23	1.2	1 030	272	6 520	3.60	4.7
Seely Lk.	93MO22-019	13	Spotburn	ICHg3	PlSx	450	20	S	-	5	50	0.5	35	0.1	440	464	6 944	4.09	4.5
Suskwa R.	93M024-005	10	Spotburn	ICHg3.01	PlH	762	10	S	SiL	8	43	1	34	2.2	825	138	2 666	4.16	5.7
N. Salmon R.	93M032-005	8	Spotburn	ICHg3.06	Pl	305	0	F	SiL	7	58	1	42	1.4	361	357	2 730	4.08	4.3
Utsun Cr.	93M042-007	7	Spotburn	ICHg3.01	HCw	534	10	V	SL/LS	7	50	1	6	6.3	1 024	28	9 132	3.31	4.4
Date Cr.	93M042-026	13	Spotburn	ICHg3.01	SxHw	457	20	S	-	5	4	8	45	2.4	710	-	5 455	-	-
N. Kline Lk.	93M051-002	7	Spotburn	ICHg3.01/02/03	SxPl	390	0	F	-	8	50	0.5	19	0.0	712	12	1 920	2.57	-
Murder Cr.	93M051-006	6	Spotburn	ICHg3.01a	HB	580	15	SW	-	7	42	0.5	12	1.6	812	76	3 468	2.47	-

Location	Opening No.	Plantation Age	Site Preparation	Ecosystem Classification	Original Stand Type	Elevation (m)	Slope (%)	Aspect	Soil Texture	LFH (cm)	Area Surveyed (ha)	Sampling Intensity (%)	%[1] Weevil-Attacked	% Weevil Mortality	Well-Spaced Stems/ha	Weevil-Attacked[2] Well-Spaced/ha	Total Trees/ha	Tree Height (m)	DBH (cm)
LOT 3020	93M051-014	12	Spotburn	ICHg3.01	PlAt	549	30	W	SL	4	50	0.5	23	0.3	648	316	6 208	3.86	5.4
Cullon Cr.	93M061-016	6	Spotburn	ICHg3.01	HPl	500	10	F	CL	7	50	0.5	6	0.7	688	24	1 500	2.08	-
Cullon Cr.	93M061-030	6	Spotburn	ICHg2.01	HSx	450	20	S	L/CL	7	30	0.5	5	0.0	900	17	2 550	2.14	-
Ironside Cr.	103P060-002	5	Spotburn	ICHg3.09b	SxPl	450	10	SW	L	5	17	0.5	100[3]	2.0	829	14	1 856	1.64	-
Ironside Cr.	103P070-010	6	Spotburn	ICHg3.01/03	SxB	450	15	SE	SiCL	7	50	0.5	8	3.6	896	28	2 688	1.86	-
Ironside Cr.	103P070-023	6	Spotburn	ICHg3.01/03	PlSx	425	20	V	SL	4	50	0.5	6	0.0	1 012	36	3 484	2.01	-
Sterritt Cr.	93M052.023	5	Scarified	ICHg3.01/03	H	450	15	SW	L	7	36	0.5	4	1.4	971	5	5 060	1.97	-
Salmon R.	93M032-011	5	Scarified	ICHg3.01/09	SxPl	300	0	F	LS	5	28	0.5	22	8.8	856	0	2 471	2.16	-
Salmon R.	93M032-014	5	Scarified	ICHg3.09	PlSx	300	15	NW	SiCL	8	47	1	34	6.0	763	167	4 637	1.67	-
Natlan Cr.	93M034-005	5	Scarified	ICHg2.04	HB	762	20	S	C	13	50	1	3	0.0	888	2	2 984	0.95	-
5m Nash Y	93M011-045	9	Nil	ICHg3.01/02	PlSx	450	10	SW	-	6	50	1	12	0.3	902	180	7 740	-	-
Luno Cr.	93M014-062	5	Nil	ICHg3.01/03	SPl	400	20	W	Cl/SL	7	22	1	17	4.0	823	45	2 173	1.74	-
Swan Rd.	93M032-007	5	Nil	ICHg3.01/03	PlAt	275	15	V	SL-L	6	4	0.5	31	0.0	800	400	2 850	1.75	-
Sterritt Cr.	93M052-010	5	Nil	ICHg3.01	SxCw	450	5	F	C/LS	8	49	0.5	3	1.0	778	5	1 454	2.00	-
Seven Sisters	103P009-011	6	Nil	ICHg2.01/04	HSx	460	15	N	SL	8	39	0.5	0	0.0	856	0	3 959	1.59	-
Nangeese R.	103P079-005	6	Nil	ICHg3.01	SB	550	0	F	LS	6	14	0.5	8	0.0	814	143	1 700	1.85	-

[1] Expressed as percentage of weevil-attacked layer 2 (characterized by average height and dbh values).

[2] Meet all requirements of a well-spaced tree with the exception of weevil damage (i.e., good form and spacing).

[3] n = 3 trees.

FIGURE 1 SCHEMATIC REPRESENTATION OF LAYOUT OF TWO PLOT TYPES TESTED FOR ASSESSING THE INCIDENCE OF HYLOBIUS WARRENI DAMAGE IN THE KISPIOX FOREST DISTRICT, HAZELTON, B.C., SUMMER 1989

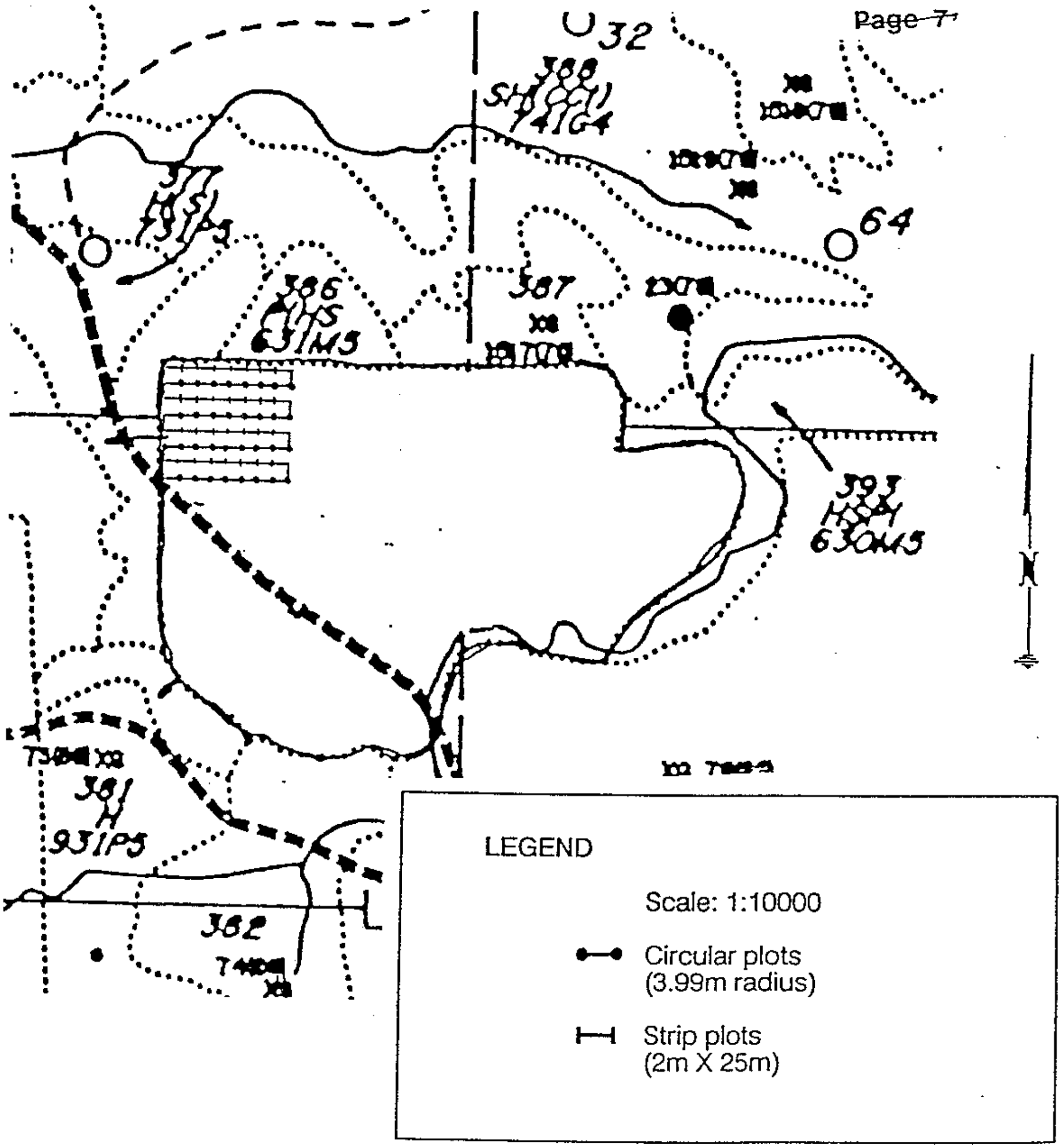

FIGURE 2 THE DISTRIBUTION OF LODGEPOLE PINE PLANTATIONS SURVEYED FOR HYLOBIUS WARRENI DAMAGE IN THE KISPIOX FOREST DISTRICT, HAZELTON, B.C., SUMMER 1989

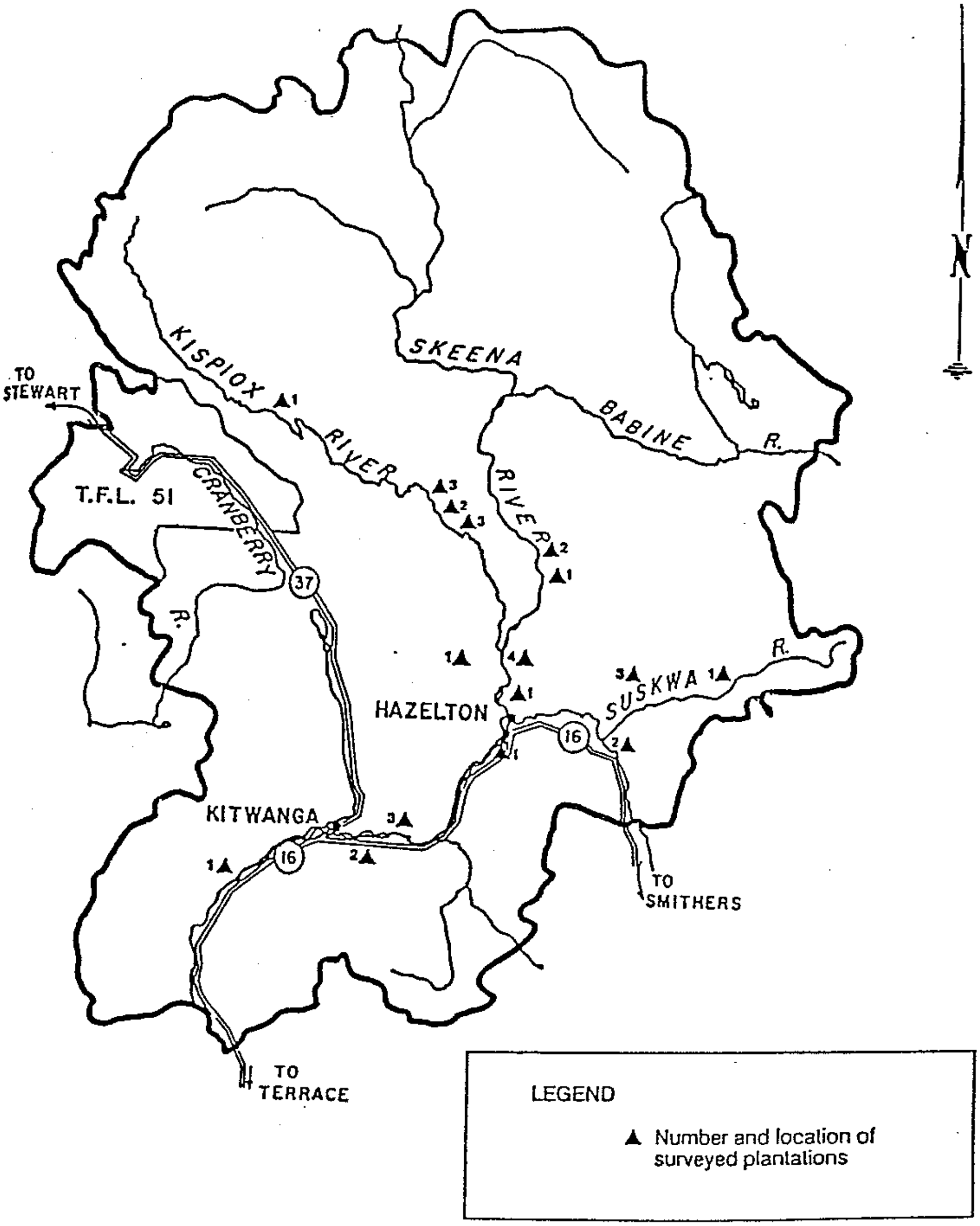

FIGURE 3 PERCENTAGE OF SAMPLED PINE WITH HYLOBIUS WARRENI DAMAGE IN RELATION TO PLANTATION AGE IN THE KISPIOX FOREST DISTRICT, HAZELTON, B.C., SUMMER 1989

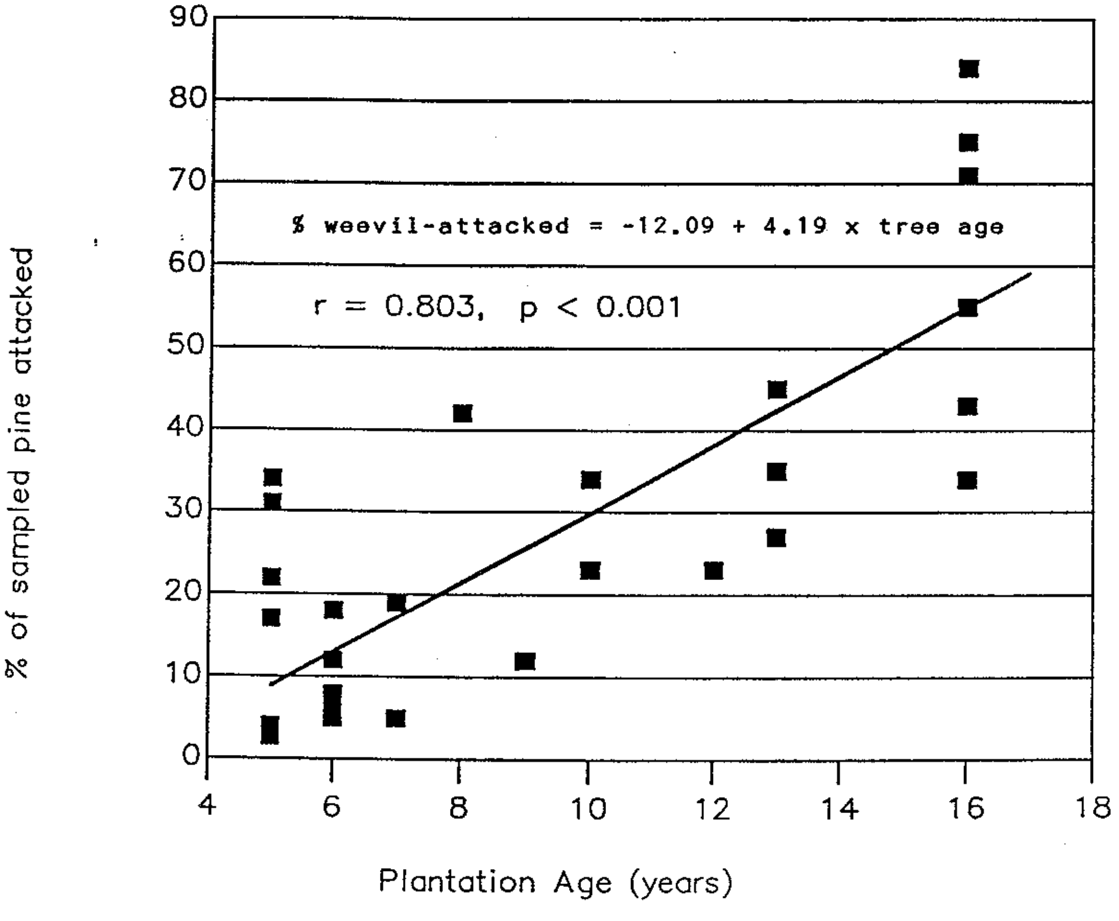

FIGURE 4 PERCENTAGE OF SAMPLED LODGEPOLE PINE WITH HYLOBIUS WARRENI DAMAGE IN RELATION TO AVERAGE TREE HEIGHT IN THE KISPIOX FOREST DISTRICT, HAZELTON, B.C., SUMMER 1989

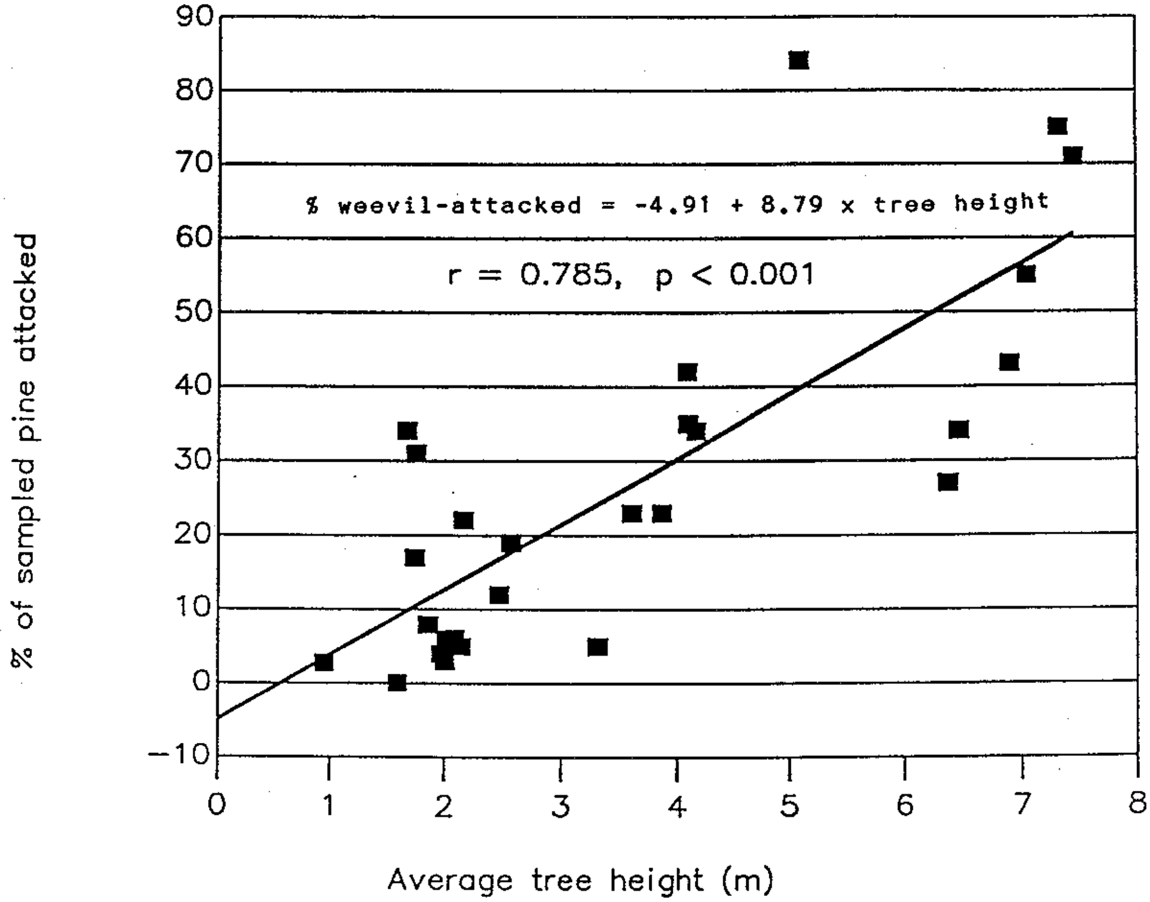

FIGURE 5 PERCENTAGE OF SAMPLED LODGEPOLE PINE WITH HYLOBIUS WARRENI DAMAGE IN RELATION TO PLANTATION DENSITY IN THE KISPIOX FOREST DISTRICT, HAZELTON, B.C., SUMMER 1989

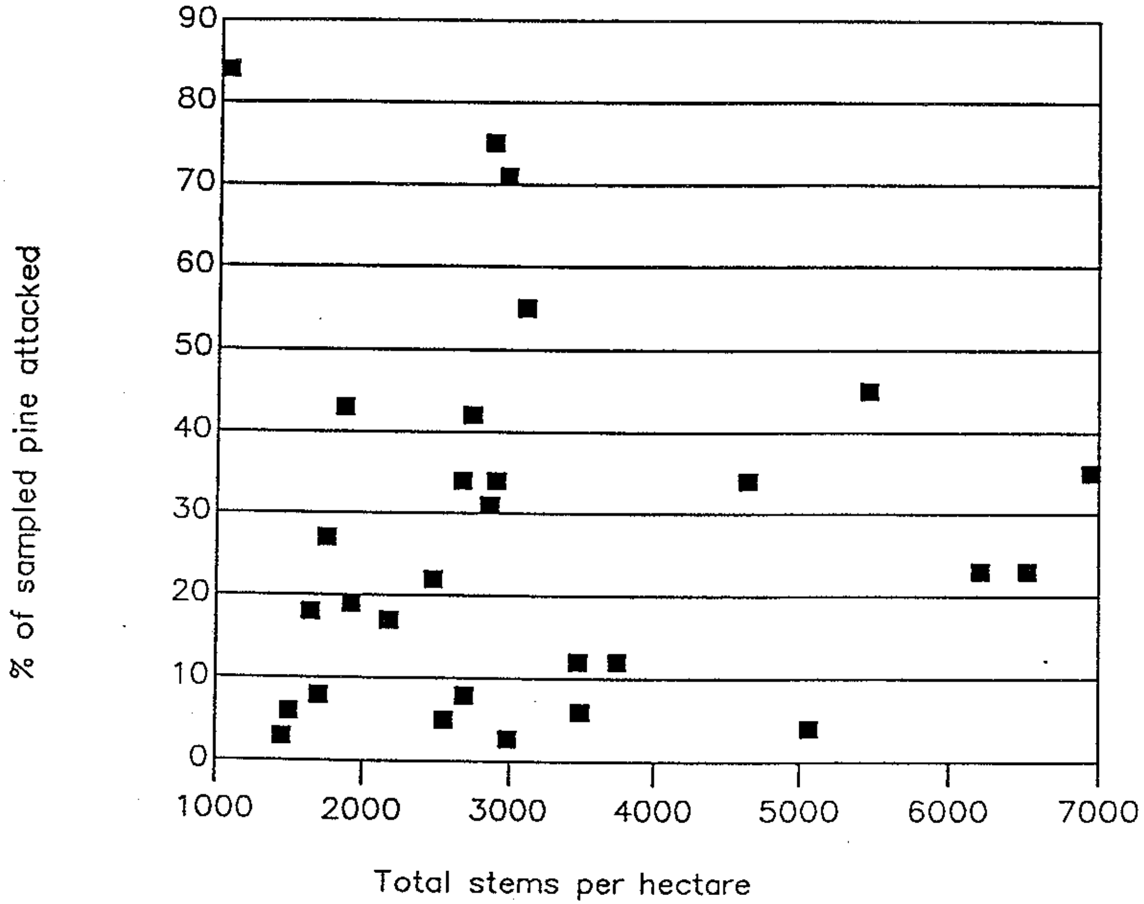

FIGURE 6 PERCENTAGE OF SAMPLED LODGEPOLE PINE WITH HYLOBIUS WARRENI DAMAGE IN RELATION TO AVERAGE ORGANIC MATTER LAYER DEPTH IN THE KISPIOX FOREST DISTRICT, HAZELTON, B.C., SUMMER 1989