DISTRIBUTION AND INCIDENCE OF WHITE PINE WEEVIL IN THE PRINCE GEORGE TIMBER SUPPLY AREA

by

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ABSTRACT

The distribution and incidence of white pine weevil, ***Pissodes strobi***, (Peck) (Coleoptera: Curculionidae) has been investigated in the Vancouver, Cariboo and Prince Rupert Forest Regions. These surveys have never been stratified by biogeoclimatic units, nor extrapolated for analysis at a Timber Supply Area level. Therefore, a ***Pissodes strobi*** distribution and incidence survey, stratified by biogeoclimatic subzones, site class and age, was conducted in the Prince George Timber Supply Area. Fifty-eight second growth, spruce plantations were randomly chosen to be surveyed for attack damage from white pine weevil. In each plantation, systematic strip sampling was performed. The grand mean proportion of spruce stems attacked was 0.0325 with a range of 0 to 0.266. A general trend of increasing site moisture was observed. An analysis of variance which tested the main effects of moisture, site class and age class, and their interactions on weevil incidence showed that none of these were statistically significant. The data collected from this study must be analyzed by the computer simulation model Spruce Weevil Attack Trial to determine the yield enhancement opportunities due to ***Pissodes strobi*** attack in the Prince George Timber Supply Area.

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1. INTRODUCTION

In coastal British Columbia, Sitka spruce, ***Picea sitchensis*** (Bong) Carr show severe damage from larval feeding by the white pine weevil, ***Pissodes strobi*** (Peck) (Coleoptera; Curculionidae) (Alfaro 1982, Berry and Stiell 1976). Adult weevils overwinter in the duff and emerge in the spring to oviposit in year-old spruce leaders (Wood and McMullen 1971). Within 10 days, the eggs hatch and the larvae begin to mine downward. The year-old leader is eventually killed through girdling. Since the growth of the current year dies as well (McMullen 1976), larval feeding results in a minimum growth loss of two years. Greater losses occur if larvae mine past the year-old leader into previous years growth (Alfaro, pers. comm. 1989). This may result when larval densities are very high.

Attack from white pine weevil causes retarded growth, crooked trunks and forked tops (Alfaro 1989). Repeated attacks produce stunted and deformed stems, severely reducing the quality and the amount of merchantable timber for harvest.

McMullen (1976) studied the ecological factors which affect the distribution of ***P. strobi*** on Vancouver Island. Based on the minimum requirement of accumulated heat needed for brood development, McMullen predicted that low weevil hazard zones would occur on northern Vancouver Island and along its extreme western coastline. This prediction was confirmed by Heppner and Wood (1984) who examined all Sitka spruce plantations five years and older within the Vancouver Forest Region. They (ibid) state that these low hazard zones coincide closely with the Southern Hypermaritime Coastal Western Hemlock Biogeoclimatic Subzone Variant (CHWDI). Past interior incidence surveys (Ebata 1989, Lewis 1988) have yielded some results, but have never been stratified by biogeoclimatic units nor analyzed at the Timber Supply Area (T.S.A.) level. The importance of stratifying surveys by biogeoclimatic zones (geographic areas influenced by similar climate (Doliner and Borden 1984) must be stressed since ecological factors may influence the susceptibility of stands to pest attack. Therefore, a ***P. Strobi*** distribution and incidence survey was conducted in the Prince George t.S.A. which addressed both of the above points. The results of this study, presented in this paper, can be combined with the Canadian Forestry Service (C.F.S.) damage appraisal model (Spruce Weevil Attack Trial = S.W.A.T.) (Alfaro 1988) to estimate the impact of ***P. Strobi*** at the forest and stand levels.

2. METHODS

2.1 Plantation Selection

A computer printout of all second growth spruce plantations established in the Prince George T.S.A. since the 1960's was obtained from the M.O.F. Silviculture Branch. Plantations were listed by establishment date, site, opening number and forest district. The Prince George T.S.A. includes the Prince George, Vanderhoof and Fort St. James Forest Districts. First and second tree species reforested were shown on the printout. Also, the biogeoclimatic zone and subzone, of each plantation were listed. Only spruce leading plantations which had been established in the Sub-Boreal Spruce (SBS) biogeoclimatic zone were considered for examination of white pine weevil infestation. The SBS plantations listed were stratified based on:

- biogeoclimatic subzones which were grouped together by soil moisture and vegetation association (Hamilton 1989); subzones D, K2 and K3 were classified as dry SBS; subzones C, E, E1 and E2 were classified as moist SBS; subzones F and J1 were classified as wet SBS;
- medium and good site classes; and
- 11-15 years old, 16-20 years old and 21-25 years old age ranges.

Plantations which did not fall int one of these classes, were not considered in the study. As well, there were no plantations located in the SBS dry/good site, 21-25 age class. Therefore, surveys were conducted in plantations which had been classified into one of 17 different categories. Figure 1 shows the stratification and number of plantations surveyed in each of these categories.

The total number of plantations which fell into each category ranged from approximately 1 to 200. If the category had less than four plantations, all plantations in that class were chosen to be surveyed. In the categories which contained greater than four plantations, either four or five plantations were randomly selected (using the random number tables in Zar 1984) to be surveyed.

A total of 58 stands were surveyed for white pine weevil infestation: 49 in the Prince George Forest District, six in the Vanderhoof Forest District and three in the Fort St. James Forest District.

A contractor surveyed 43 of the stands and Ministry of Forests employees surveyed the remainder. The general location of the stands are shown in Appendix I.

Figure 1. Stratification design of plantations surveyed for *Pissodes strobi* incidence in the Prince George T.S.A.

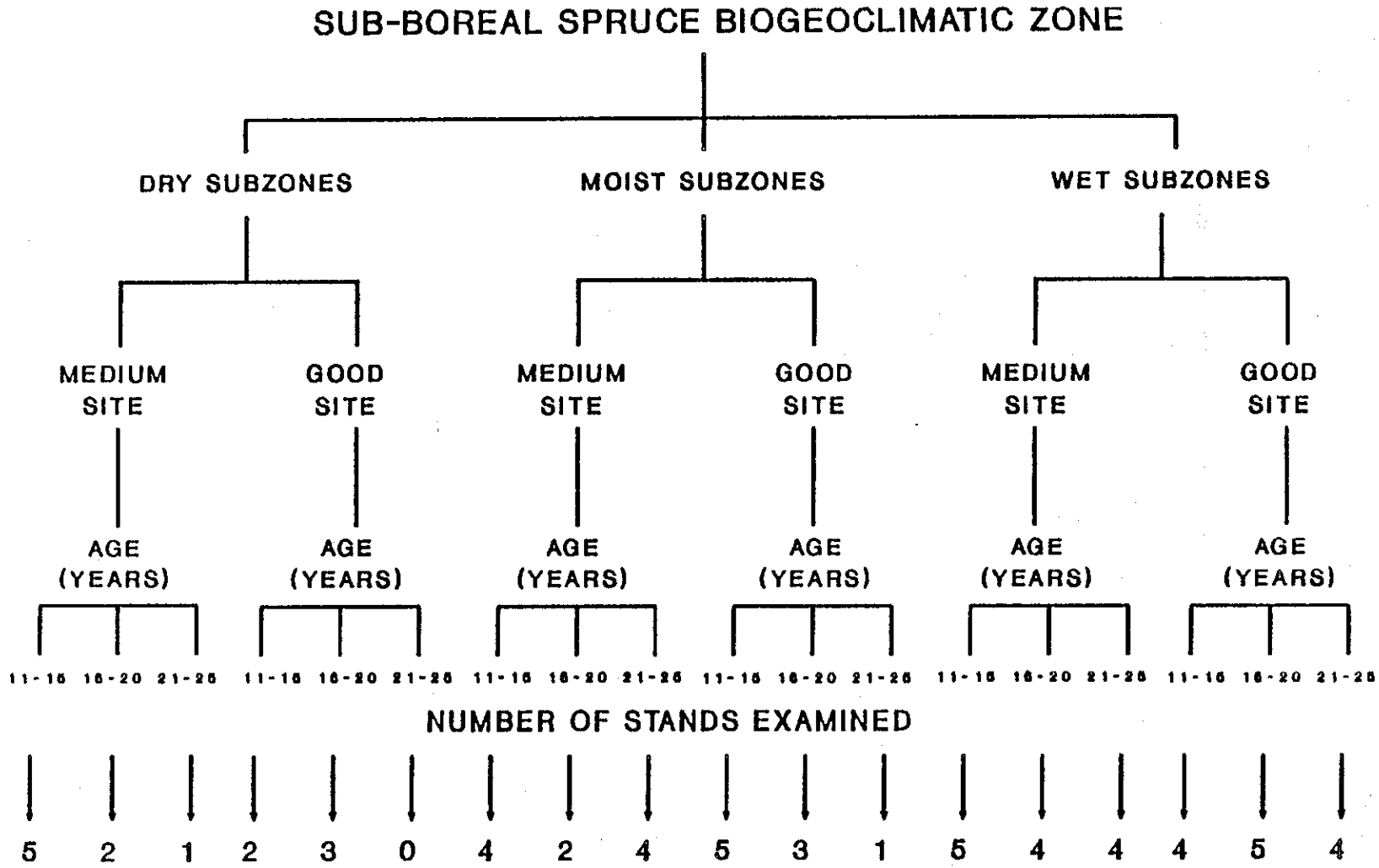

Figure 1. Stratification design of plantations surveyed for Pissodes strobi incidence in the Prince George T.S.A.

2.2 Incidence Survey

Each selected plantation was identified on a 1:15 840 scale forest cover map provided by the forest district. silviculture history records were used so that plantations would be accurately marked on the maps. Aerial photos and 1:50 000 scale maps were also used to aid in plantation location.

In each stand, a Point of Commencement (P.O.C.) was established. The randomly chosen P.O.C. was referenced to some identifiable feature (road junction, swamp, etc.) and marked with labelled pink flagging tape. To estimate the proportion of *P. strobi* in a plantation, systematic strip sampling was performed. Carlson and Churcher (1984) stated that cluster/strip sampling would provide a suitable estimate of the proportion of stems attacked by *P. strobi* in a stand, provided that the starting point was chosen randomly.

Fletcher (1986) concluded that reasonably accurate sample estimates could be obtained from sampling as few as five strips. Therefore, five strips were established in each plantation. The strips usually ran the approximate width of the plantation and were evenly spaced so that maximum coverage of the plantation was achieved (i.e. discrete corners or sections of the plantation were not omitted). The start and end of each strip was marked with labelled pink flagging tape. Each strip was marked at 10 m intervals with blue-flagging tape.

The length or each strip was determined using a topofil measuring meter. The P.O.C., bearing the length of each transect was plotted on the 1:15 840 scale forest cover map (Figure 2).

All planted second growth spruce trees within 5.0 m of either side of the strip were examined for 1988 white pine weevil attack damage (Figure 3). Weevil damage was recorded according to the number of whorls killed due to weevil feeding: one whorl killed = 1; two whorls killed = 2, three whorls killed =3 (Figure 4). Data was recorded on FS 375 forms. The total number of trees examined and the number of trees in each attack code, for each strip and for each plantation were tallied. For each plantation the proportion of 1988 weevil attack was calculated as follows:

$$\frac{\text{total trees attacked (all codes)}}{\text{total trees observed}}$$

General site features were noted for each plantation. These included:

- general type of terrain
- slope, aspect
- proportion of conifer species present
- deciduous overstory present: yes or no
- presence or absence of previous spruce weevil; and damage in plantation.

Figure 2. Illustration of placement of five transects within a plantation to survey for *Pissodes strobi* incidence (P.O.C. = Point of Commencement).

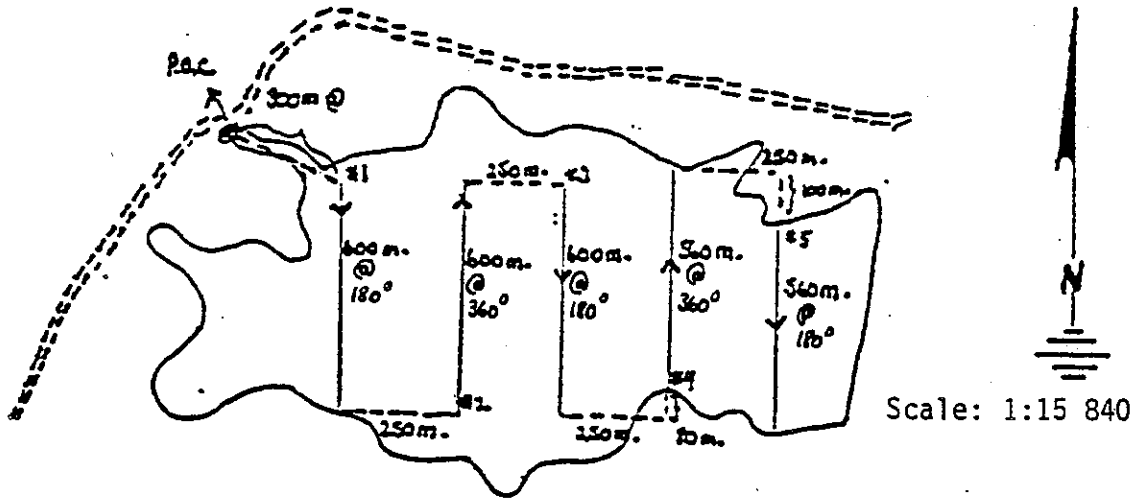

Figure 2. Illustration of placement of five transects within a plantation to survey for Pissodes strobi incidence (P.O.C.= Point of Commencement).

Figure 3. Attack damage caused by *Pissodes strobi* on 1987 (old) and 1988 (new) leaders (courtesy of T. Ebata, Prince Rupert For. Reg.).

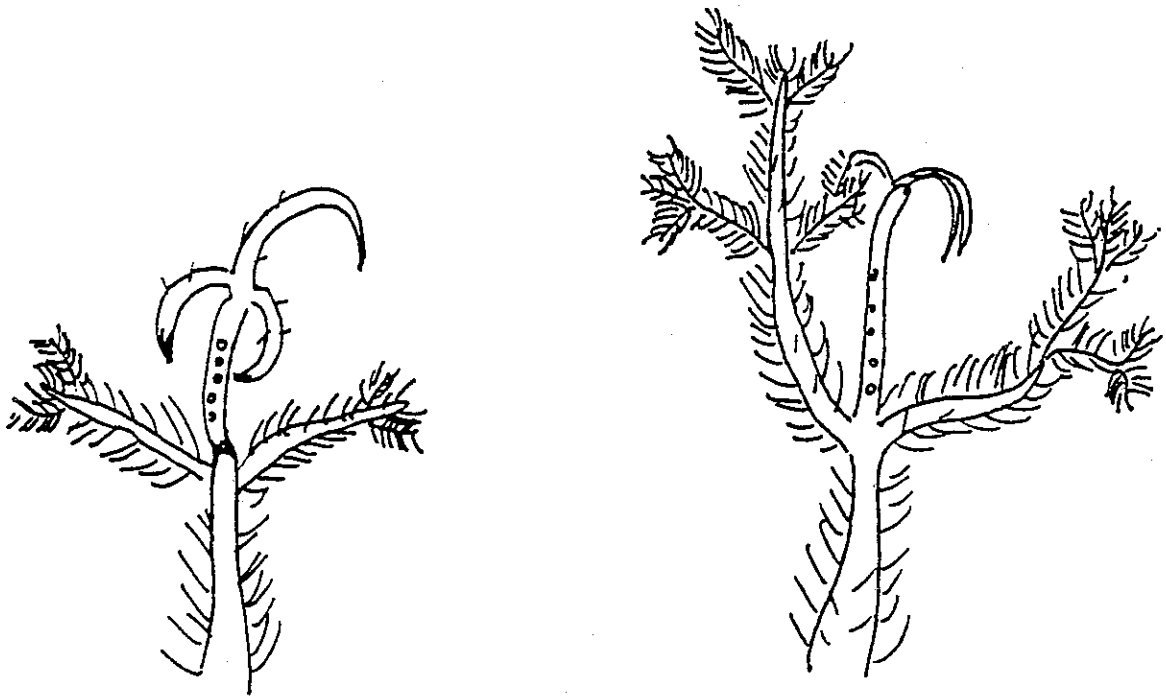

Figure 3. Attack damage caused by Pissodes strobi on 1987 (old) and 1988 (new) leaders (courtesy of T.Ebata, Prince Rupert For. Reg.).

Figure 4. Illustration of one versus two whorls killed from feeding by larvae of *Pissodes strobi* (courtesy of T. Ebata, Prince Rupert For. Reg.).

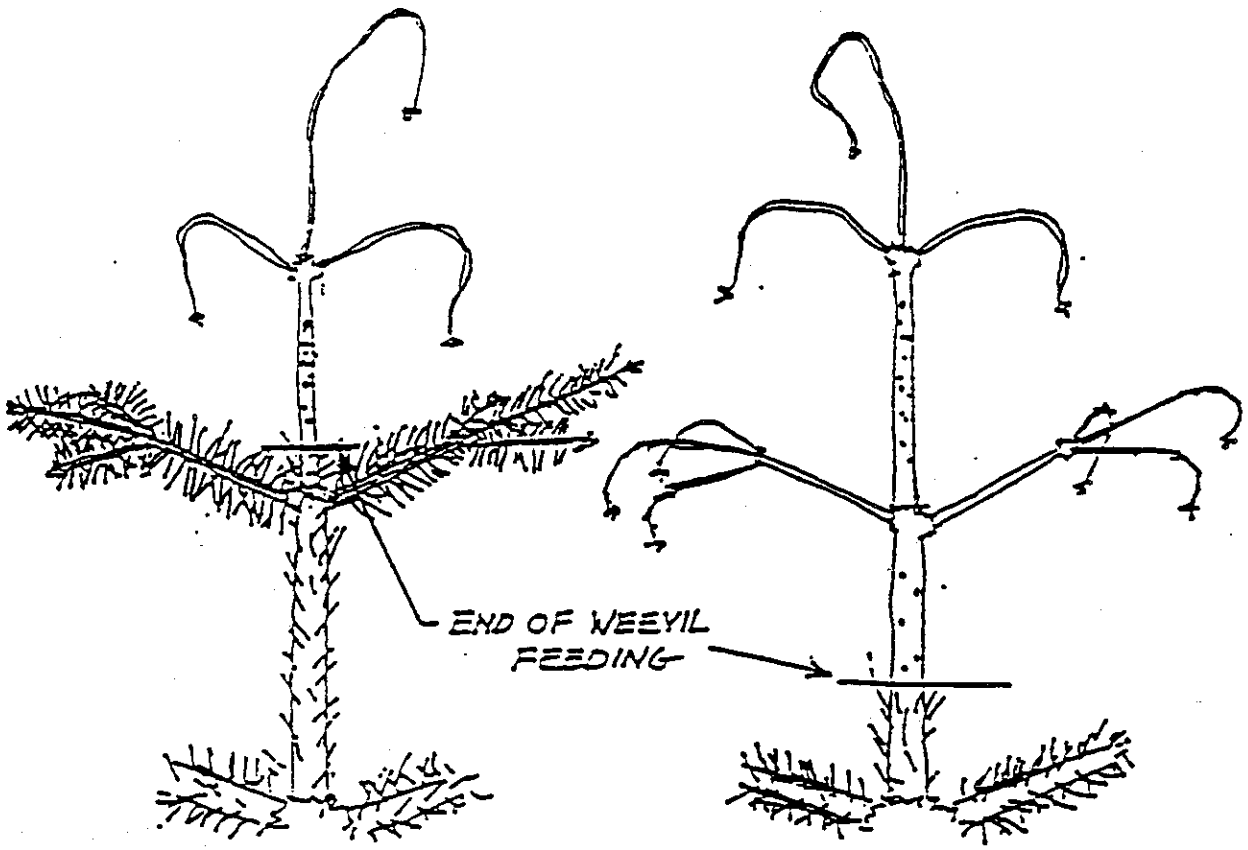

Figure 4. Illustration of one versus two whorls killed from feeding by larvae of Pissodes strobi (courtesy of T.Ebata, Prince Rupert For. Reg.).

3. RESULTS

The grand mean proportion attack (of all 58 plantations) was 0.0325 (Table 1) and had a range of 0.2660 to zero. a weighted value was calculated by multiplying the proportion of spruce attacked by the proportion of spruce present in the stand. The weighted value expresses *P. strobi* attack in terms of the total stems attacked in the stand rather than in terms of the spruce stems attacked in the stand (as does the unweighted variable). The grand mean proportion attack of the weighted variable was 0.0245 (Table 1) with a range of 0 to .2367. The mean proportion attack observed in each of the 17 different survey categories is shown in Appendix II.

The proportion of attack was divided into four different attack intensities, nil = .000 to less than .001; low = .001 to less than .10; medium = .10 to less than .25; and heavy = greater than .25. Table 2 shows the distribution of the 58 stands based on these intensities. While the majority of the stands (41 of the 58) showed low weevil intensities, only 1 stand showed heavy attack intensity.

A general trend of increasing attack with increasing site moisture was observed for both mean proportion of spruce stems and total stems attacked (Table 3). The mean proportion of spruce stems attacked was: wet sites = 0.0461; moist sites = 0.0246; and dry sites = 0.0170. Perhaps more importantly, Figure 5 shows (value of proportion spruce stems attacked were plotted) that this trend is also seen in the maximum value of attack observed in each of the moisture codes (maximum values of proportion spruce stems attacked were dry = 0.099, moist = 0.125 and wet = 0.266) (Table 3).

The mean proportion spruce stems attacked by site class were 0.0307 in the good sites and 0.034 in the medium sites.

Analyzed by age, the 16-20 year old stands showed the largest mean proportion attack values, both in terms of total stems and spruce stems only (Table 3). As with the moisture codes and site classes, only the values for the proportion spruce stems attacked are plotted (Figure 6).

Table 1. Grand mean values of ***Pissodes strobi*** attack calculated from the 58 spruce plantations surveyed in the Prince George Timber Supply Area.

	Grand Mean	Standard Deviation	Minimum Value	Maximum Value
*Unweighted [a]	0.0325	0.0535	0	0.2660
**Weighted [b]	0.0245	0.0464	0	0.2367

a Unweighted = proportion of spruce stems attacked
b Weighted = proportion of total stems attacked

Table 2. Distribution of attack intensities for the 58 spruce plantations surveyed in the Prince George Timber Supply Area.

Attack Intensity	Proportion of Spruce Stems Attacked	Number of Stands
Nil	.000 < .001	12
Low	.001 < .10	41
Medium	.10 < .25	4
Heavy	> .25	1

Table 3. Mean values by moisture code, site class and age class, of ***Pissodes strobi*** attack calculated from the 58 spruce plantations surveyed in the Prince George Timber Supply Area.

MOISTURE CODE

Code/Class	Proportions of Spruce Stems Mean	Standard Deviation	Min. Value	Max. Value	Proportion of Total Stems Mean	Standard Deviation	Min. Value	Max. Value
Dry	0.0170	0.0289	0	0.099	0.0037	0.0061	0	0.0199
Moist	0.0246	0.0406	0	0.125	0.0202	0.0369	0	0.1213
Wet	0.0460	0.0676	0	0.266	0.0380	0.0589	0	0.2367
			SITE	**CLASS**				
Medium	0.0340	0.0641	0	0.2660	0.0262	0.0557	0	0.2367
Good	0.0308	0.0391	0	0.1250	0.0226	0.0335	0	0.1213
			AGE	**CLASS**				
11-15 yrs	0.0304	0.0566	0	0.2440	0.0227	0.0527	0	0.2367
16-20 yrs	0.0436	0.0628	0	0.2660	0.0334	0.0506	0	0.1995
21-25 yrs	0.0211	0.0291	0	0.1084	0.0156	0.0234	0	0.0867

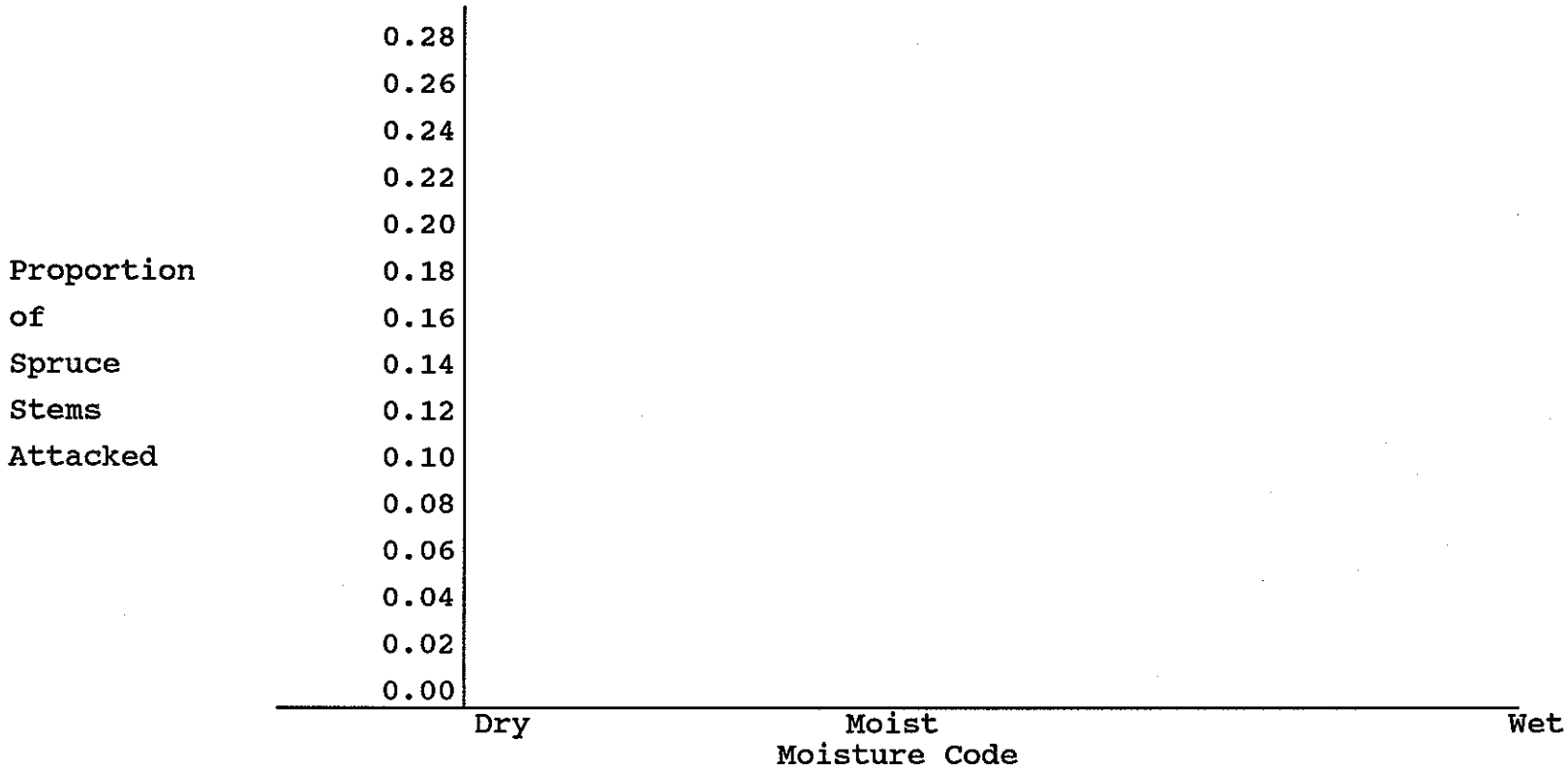

Figure 5. Proportion ***Pissodes strobi*** attack by moisture code from each plantation ( ) surveyed in the Prince George Timber Supply Area. The horizontal line connects the means and the vertical lines represent the standard deviations.

An analysis of variance was performed (general linear model using the computer package SAS) on transformed data. The Shapiro-Wilk test for normality indicated that some of the data was not normally distributed. Therefore, the rank transformation was employed. The analysis tested the main effects of moisture code, site class and age class, and their interactions. None of these were significant at the 95% confidence level. The results of the test are shown in Appendix III. Similar results were shown when an analysis of variance was performed on the data transformed by the arc sine.

Table 4 shows the mean values obtained when proportion attack was based on stocking (spruce stems per ha). The mean proportion attack values ranged from a low of 0.0297 when stocking was between 200 and 400 stem/ha to a high of 0.0411 when the stocking was greater than 600 stem/ha (the most dense stocking).

Appendix IV summarizes the site notes recorded as well as map sheet, opening number, area surveyed and proportion of attacked spruce stems from each plantation.

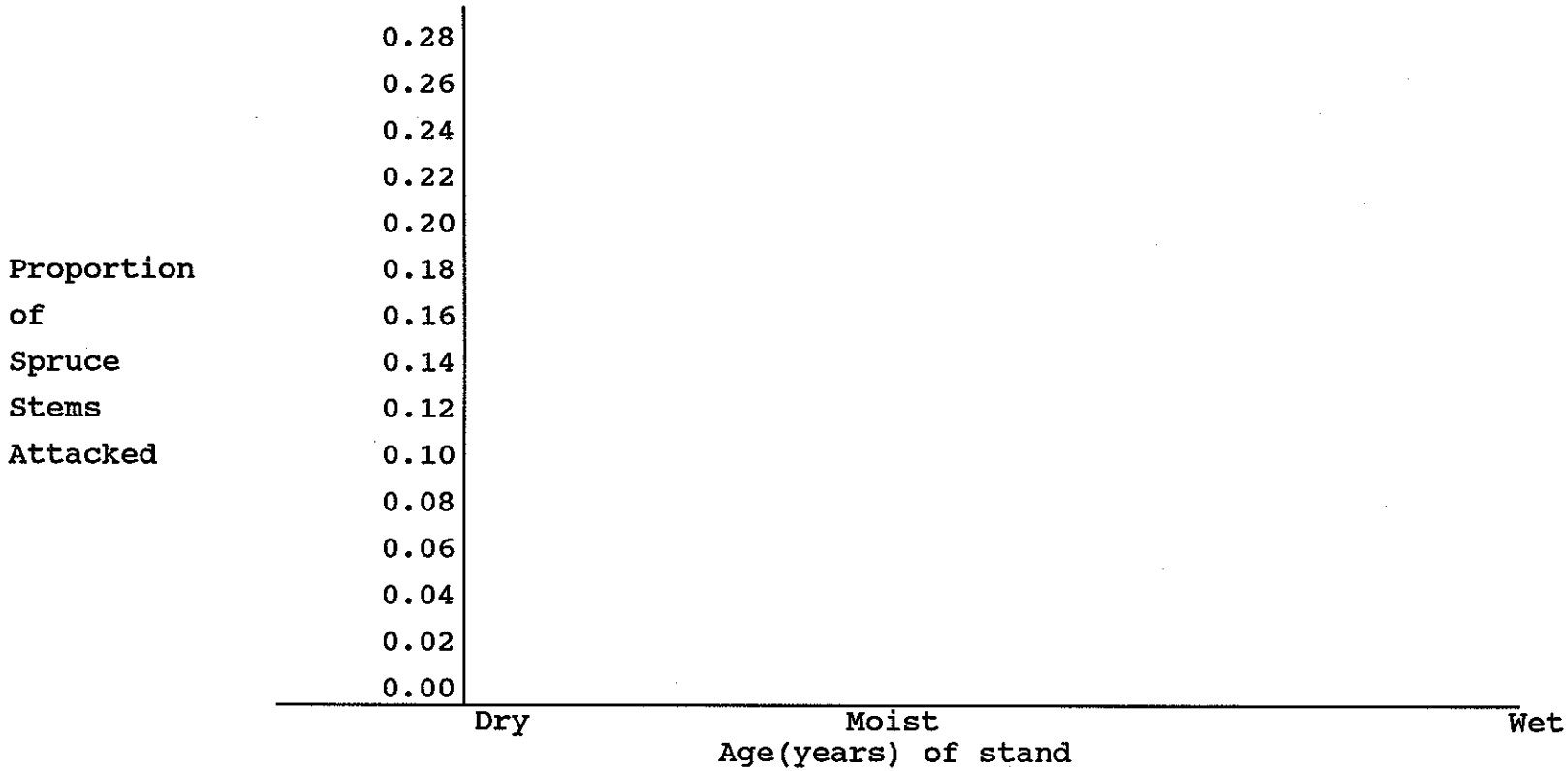

Figure 6. Proportion ***Pissodes strobi*** attack by age from each plantation ( ) surveyed in the Prince George Timber Supply Area. The horizontal line connects the means and the vertical lines represent the standard deviations.

Table 4. Mean values, when plantations were sorted by stocking (spruce stems per hectare), of *Pissodes strobi* attack calculated from the 58 spruce plantations surveyed in the Prince George Timber Supply Area.

Proportion of Spruce Stems

Stocking (spruce stems/ha)		Mean	Standard Deviation	Minimum Value	Maximum Value
0	200	0.03052	0.0376	0	0.099
200	400	0.0297	0.0576	0	0.266
400	600	0.0316	0.0417	0	0.125
	600	0.0411	0.0713	0	0.244

4. DISCUSSION

Forest planning techniques and wood-supply projections combined with stocking standards and growth and yield information usually consider the stand as the elemental unit (Errico, pers. comm.). For these purposes, it is the proportion of total stems attacked per stand which is important. The computer simulation model SWAT assumes the stand to be 100% spruce. For SWAT purposes, it is the proportion of spruce stems attacked which is of concern. For this reason the discussion will focus on proportions of spruce stems attacked for a stand. To determine whether an overall white pine weevil intensity of 0.0325 should concern foresters in the Prince George T.S.A. two points should be considered.

First, the population dynamics of the white pine weevil in the Prince George T.S.A. should be considered. Is the population in an early or advanced stage of development? Does the white pine weevil, as previously seen (DeBoo, pers. comm.) exhibit exponential growth when it affects between 2.5% and 5.0% of a stand (perhaps eventually attacking 50% of the spruce component yearly)? To address these questions, the 58 stands surveyed in this study should be re-examined in five years and a comparison made.

Second, what in terms of future volume loss does a weevil attack intensity of 0.0325 represent? To answer this, the survey results must be analyzed via SWAT.

Although site moisture was not a statistically significant factor in influencing the proportion of white pine weevil attack present in a stand, this result may be attributed to the small sample sizes in each of the classes. Observations in the field suggest that the weevil prefers (perhaps initially) the wetter locations. Within a plantation the weevil appeared to be most abundant around the swamps, creek or small lakes. This behaviour has also been observed in the Prince Rupert Region (Ebata, pers. comm.).

The maximum value of attack observed in each of the moisture codes, also suggests that moisture is a factor which influences the proportion of white pine weevil attack. What these extreme values represent in terms of volume loss, should be quantified via SWAT, since theoretically every stand at par could eventually exhibit these maximum levels of damage.

The trend of increasing attack with increasing site moisture was much more pronounced when expressed in terms of total stems than in terms of only the spruce component. This is because, in the drier sites the spruce component was generally less than 50% of the stand, while in the wetter sites the spruce component was usually greater than fifty per cent.

The data suggests that site class (good or medium) does not influence the proportion of white pine weevil attack in a stand.

Although differences in attack level for age classes were not statistically significant, the plantations which had the most white pine weevil attacks were in the 16-20 years age class. Similar results were seen in the Cariboo Forest Region (Lewis 1988) where heavy weevil populations were found in stands 18 - 20 years of age, and low weevil populations in stands greater than 20 years of age. Both this study and the Cariboo study tend to support Wood and McMullen's (1971) hypothesis that spruce trees greater than 9.0 m tall are less susceptible to white pine weevil attack.

This study did not quantify the amount of deciduous overstory in a stand. Therefore, statistical analysis which tested the factor of deciduous shading on proportion of weevil attack was not performed. General observations in the field, however, do suggest that sites with heavy deciduous overstory show less attack. Therefore, if it is true that age, site moisture and deciduous overstory limit white pine weevil attack, spruce stands located in the wet sites should not be brushed until past the susceptible age/height. The timber volumes gained by this procedure (through less weevil damage) should be weighed against the losses incurred through suppression or mortality of spruce by early competition with the deciduous species.

This study showed that the greatest proportion attack occurred in the most dense stands. This is not in agreement with a recent analysis by Alfaro (pers. comm.). Alfaro analyzed weevil populations, stratified by plantation density, over a number of years. It must be recognized that the results from the Prince George study only represent the white pine weevils status in one year. With Alfaro's study, fluctuations did occur (in certain years the weevil population was greatest in the densest stands) but overall results showed that the white pine weevil preferred the least dense stands. If the 58 plantations in Prince George were surveyed over a number of years, the trend found by Alfaro could surface.

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APPENDIX I

General locations of the spruce plantations surveyed for Pissodes strobi incidence in the Prince George, Vanderhoof and Fort St. James Forest Districts. The numbers on the maps refer to the assigned numbers in Appendix III.

Appendix 1.1 Plantations surveyed in the Prince George Forest District.

Appendix 1.2 Plantations surveyed in the Vancouver Forest District.

Appendix 1.3 Plantations surveyed in the Fort St. James Forest District.

APPENDIX II

Mean proportion of spruce stems attacked
by *P. strobi*
in the 17 different classes surveyed.

Moist Code[a]	Site Class[b]	Age Class[c]	Number of Plantations Surveyed	Mean Attack	Standard Deviation
D	G	3	2	0.0495	0.070
D	G	4	3	0.0027	0.0038
D	M	3	5	0.0077	0.0136
D	M	4	2	0.021	0.030
D	M	5	1	0.0331	
M	G	3	5	0.0278	0.0544
M	G	4	3	0.0287	0.0263
M	G	5	1	0.108	
M	M	3	4	0.0022	0.002
M	M	4	2	0.0585	0.0544
M	M	5	4	0.0020	0.0039
W	G	3	4	0.0245	0.026
W	G	4	5	0.0494	0.0407
W	G	5	4	0.0114	0.0107
W	M	3	5	0.0756	0.101
W	M	4	4	0.0823	0.123
W	M	5	4	0.0251	0.0176

[a] D = Dry; M = Moist; W = Wet

[b] G = Good; M = Medium

[c] 3 = 11 - 15 years old
4 = 16 - 20 years old
5 = 21 - 25 years old

APPENDIX III

Results of analysis of variance performed on data collected from P.G. T.S.A. white pine weevil survey.

Source	Degrees of Freedom	Sum of Squares	F Value	* Probability F
Moist Code	2	243.90746	0.49	0.6158
Site Class	1	315.96866	1.27	0.2661
Age Class	2	668.63625	1.34	0.2718
Moist Code				
Site Class	2	984.23888	1.98	0.1511
Moist Code				
Age Class	4	1477.87923	1.49	0.2240
Site Class				
Age C;ass	2	878.04477	1.77	0.1838
Moist Class				
Site Class				
Age Class	3	1046.78980	1.40	0.2554

* To be significant the Probability > F $\leq$ .05.

APPENDIX IV

Site notes from plantations in the Prince George T.S.A. surveyed for incidence of *P. strobi*

Assigned Number	Map Sheet followed by Opening Number	Year Plantation Established	Area Surveyed (Ha)	*Proportion of Spruce Stems Attacked
2bi	93G029-2	1968	91	0.059
				- moist areas throughout - gentle north and east slope - 0 - 15° - 69% Sx, 12% PL, 20% B - deciduous overstory only in SE corner - previous damage throughout
2bii	93G029-2	1967	88	0.1084
				- quite a dry site: excellent stand to survey - in southern portion 2 - 3° SE slope - 80% Sx, 10% PL; 10% B - no deciduous overstory - heavy previous damage in southern portion
2c	93G029-26	1964	33	0.000
				- very moist site: lots of different types of mushrooms - quite level terrain - 55% Sx, 10% PL, 35% B - heavy deciduous overstory - no previous damage

* Proportions can be converted to percentage by multiplying by 100.

Assigned Number	Map Sheet followed by Opening Number	Year Plantation Established	Area Surveyed (Ha)	*Proportion of Spruce Stems Attacked
4a	93G039-29	1975	9	0.000
			- quite a dry site - moderate eastern slope 0-5° - 2% Sx, 95% PL, 3% B - deciduous overstory throughout - no previous damage	
7a	93G049-21	1976	18	0.004
			- moist, marshy section - gentle eastern slope 5-10° - 95% Sx. 5% B - deciduous overstory throughout - no previous damage	
7b	93G049-34	1975	49	0.006
			- variable terrain: some marshy areas - western slope 15-20° - 68% Sx, 2% PL, 30% B - deciduous overstory throughout - no previous damage	
7c	93G049-59	1975	59	0.002
			- swamps common - variable slope and aspect - 58% Sx, 10% PL, 22% B - no deciduous overstory - no previous damage	

Assigned Number	Map Sheet followed by Opening Number	Year Plantation Established	Area Surveyed (Ha)	*Proportion of Spruce Stems Attacked
8	93G050-17	1967	200	0.0083
			- very rugged terrain with extremely dense under brush in portions - southwest slope 5-10° - 30% Sx, 10% PL, 50% B, 10% residual Sx - very little deciduous overstory - no previous damage	
10a	93G056-29	1970	7	0.000
			- drainages common - various slopes and aspect - 7% Sx, 55% PL, 33% B, 5% F - light deciduous overstory - no previous damage	
11a	93G058-10	1970	86	0.015
			- swamp, creeks and drainage in northern section - steep northwest slope 20-50° - deciduous overstory throughout - previous damage in southern portion	
11b	93G058-10	1970	65	0.012
			- quite rugged terrain - generally eastern with variable slopes 10-30° - 46% Sx; 4% PL; 50% B - deciduous overstory throughout - no previous damage	

Assigned Number	Map Sheet followed by Opening Number	Year Plantation Established	Area Surveyed (Ha)	*Proportion of Spruce Stems Attacked
12b	93G060-13	1974	77	0.040
			- ravines occurring in southern section - southern slope 5-15° - 50% Sx, 27% PL, 23% B - deciduous overstory primarily in centre - minor previous damage	
14a	93G066-29	1969	21	0.000
			- plateau in middle of block - steep slopes eastern 2-60°; milder western slope 5-20° - 1% Sx; 93% PL; 6% B - deciduous overstory throughout - no previous damage	
14b	93G066-29	1970	15	0.042
			- generally level terrain - gentle northern slope 0-5° - 5% Sx; 83% PL, 12% B - minor deciduous overstory - no previous damage	
14c	93G066-34	1966	35	0.0331
			- quite moist with swampy areas - fairly level SE 2-3° - 60% Sx; 40% PL - very little deciduous overstory - previous damage present	

Assigned Number	Map Sheet followed by Opening Number	Year Plantation Established	Area Surveyed (Ha)	*Proportion of Spruce Stems Attacked
14d	93G066-37	1977	48	0.099
			- quite dry site - gentle western slope 10-40° - steep eastern slope 10-40° - 13% Sx; 81% PL; 4% B; 2% F - deciduous overstory only in eastern section - minor previous damage	
15a	93G068-1	1969	16	0.020
			- swamp section in northern section - northern slope 5-10° - 49% Sx; 28% PL; 23% B - deciduous overstory throughout - no previous damage	
15b	93G068-34	1965	98	0.016
			- very rough terrain due to recent brushing - steep western slope and 5° northern slope - 80% Sx; 5% PL; 15% B - deciduous overstory throughout - no previous damage	
15c	93G068-34	1965	63	0.0337
			- eastern section swampy - 5° western slope - 80% Sx; 20% B - deciduous overstory throughout - previous damage heavy in NE	

Assigned Number	Map Sheet followed by Opening Number	Year Plantation Established	Area Surveyed (Ha)	*Proportion of Spruce Stems Attacked
17a	93G078-6	1966	42	0.000
			- quite dry site - southern slope 10° - 75% Sx; 25% PL - deciduous overstory throughout - no previous damage	
17b	93G078-6	1965	11	0.000
			- excellent easy terrain - fairly level - 60% Sx; 40% PL - deciduous overstory throughout - no previous damage	
17c	93G078-6	1965	53	0.0078
			- gully in western section - NW slope 5° - 70% Sx; 30% PL - deciduous overstory throughout - previous damage in northern portion	
18	93G079-38	1975	10	0.004
			- quite rugged terrain - western slope 5-15°; steep northern slope - 70% Sx; 14% PL; 16% B - deciduous overstory in eastern section - no previous damage	

Assigned Number	Map Sheet followed by Opening Number	Year Plantation Established	Area Surveyed (Ha)	*Proportion of Spruce Stems Attacked
19b	93G080-34	1971	13	0.1082
			- drainage in southern section - variable slope and aspect - 93% Sx; 1% PL; 6% B - no deciduous overstory - heavy previous damage	
19c	93G080-31	1963	15	0.0089
			- quite dry - generally level terrain - 50% Sx; 50% PL - no deciduous overstory - no previous damage	
19d	93G080-31	1964	36	0.0267
			- moist to dry site - eastern slope 2-3° - 70% Sx; 30% PL - deciduous overstory - no previous damage	
19e	93G080-31	1965	47	0.0016
			- quite varied terrain - eastern slope 20-30° in north and 5° eastern slope in south - 30% Sx; 50% PL; 10% B; 10% residual Sx - no deciduous overstory - minor previous damage	

Assigned Number	Map Sheet followed by Opening Number	Year Plantation Established	Area Surveyed (Ha)	*Proportion of Spruce Stems Attacked
20a	93G088-6	1967	35	0.0225
			- heavy weed component - fairly level - 80% Sx, 10% PL; 10% B - no deciduous overstory - minor previous damage	
20b	93G088-8	1967	50	0.0424
			- quite swampy - generally level - 80% Sx; 20% B - very little deciduous overstory - previous damage present	
21ai	93G090-24	1971	77	0.044
			- quite moist site - northwestern slope 5-10° - 90% Sx; PL 10% - deciduous overstory in southern section - heavy previous damage	
21aii	93G090-24	1971	39	0.066
			- swamp at northern boundary - variable slope and aspect - 52% Sx; 40% PL; 6% B - deciduous overstory throughout - moderate previous damage	

Assigned Number	Map Sheet followed by Opening Number	Year Plantation Established	Area Surveyed (Ha)	*Proportion of Spruce Stems Attacked
21b	93G090-15	1970	100	0.009
			- quite dry site - variable slope and aspect - 52% Sx; 40% PL; 6% B - deciduous overstory throughout - moderate previous damage	
22a	93G100-2	1974	16	0.244
			- very moist area - northeast slope 0-15° - 97% Sx; 3% B - deciduous overstory only in western section - previous damage throughout	
22b	93G100-5	1969	37	0.266
			- eastern portion wet and marshy - flat to northwestern slope 0-5° - 75% Sx; 25% B - deciduous overstory throughout - heavy previous damage	
25	93HO51-5	1976	25	0.003
			- creek in northeast corner - stand located on hill top - 60% Sx; 25% DL; 15% B - scattered patches of deciduous overstory - no previous damage	

Assigned Number	Map Sheet followed by Opening Number	Year Plantation Established	Area Surveyed (Ha)	*Proportion of Spruce Stems Attacked
27a	93HO81-29	1976	53	0.041
			- very open in northwest corner - northwest slope 0-10° - 61% Sx, 35% PL; 4% B - deciduous overstory throughout - moderate previous damage	
28	93HO82-29	1973	68	0.053
			- gullies and depressions - variable slope and aspect - 81% Sx; 11% PL; 5% C - deciduous overstory throughout - moderate previous damage	
30b	93HO91-34	1971	25	0.029
			- rock and boulders prevalent in southern section - eastern slope 0-15° - 95% Sx; 2% PL; 2% B - deciduous overstory throughout - moderate previous damage	
31a	93GO90-1	1971	157	0.011
			- quite moist - eastern slope 30° in eastern section - 90% Sx; 3% PL; 7% B - deciduous overstory in patches - moderate previous damage	

Assigned Number	Map Sheet followed by Opening Number	Year Plantation Established	Area Surveyed (Ha)	*Proportion of Spruce Stems Attacked
31b	93HO92-14	1970	39	0.043
			- drain in southeast section - variable aspect, slope 0-15° - 78% Sx; 10% PL; 12% B - deciduous overstory throughout - previous damage throughout	
32	93HO86-3	1976	77	0.089
			- excellent growing site; heavy fireweed; bordered by creeks - quite flat - 85% Sx; 15% B - no deciduous overstory - moderate previous damage in southern section where current damage is concentrated	
33b	931014-13	1974	86	0.000
			- moderate to heavy underbrush - gentle northeast slope with steep southwest slope in southern section - 90% Sx; 3% PL; 7% B - deciduous overstory throughout - no previous damage	
34	931014-5	1972	166	0.000
			- extremely rugged conditions - aspect is northeast with slopes ranging from 5-80° - 90% Sw; 10% B - no deciduous overstory - no previous damage	

Assigned Number	Map Sheet followed by Opening Number	Year Plantation Established	Area Surveyed (Ha)	*Proportion of Spruce Stems Attacked
35	93JO26-44	1972	51	0.097
			- large swampy areas in central section - generally flat throughout - 93% Sx; 1% PL; 6% B - no deciduous overstory - previous damage throughout	
37b	93JO37-30	1976	79	0.004
			- swamp in eastern section - gently sloping to the northwest - 85% Sx; 10% PL; 5% B - deciduous overstory present but treated with vision - previous damage present near swamp	
39b	93JO56-9	1976	68	0.002
			- quite rugged terrain - northern section 45° north; southern section 10-15° north - 70% Sx; 15% PL; 15% B - deciduous overstory light throughout - no previous damage	
39c	93JO56-16	1977	79	0.001
			- light brush in southern portion - variable slope and aspect with steep western slope in southeast section - 80% Sx; 13% PL, 7% B - deciduous overstory in western half - no previous damage	

Assigned Number	Map Sheet followed by Opening Number	Year Plantation Established	Area Surveyed (Ha)	*Proportion of Spruce Stems Attacked
39d	93JO56-19	1976	12	0.005
			- swampy depressions and ponds throughout - variable slope and aspect - 85% Sx; 10% PL; 5% B - no deciduous overstory - minor previous damage	
40	93JO57-8	1976	14	0.125
			- some open areas - eastern slope 5-10° - 97% Sx; 3% B - deciduous overstory present in northern section - no previous attack	
41	93K7H-9	1974	68	0.000
			- ridges run east-west through block - variable slopes and aspect - 42% Sx; 34% PL; 24% F - no deciduous overstory - no previous damage	
42	93J5D-3	1970	65	0.007
			- quite swampy - southern slope 0-10° - 38% Sx, 62% PL - minor deciduous overstory - minor previous damage	

Assigned Number	Map Sheet followed by Opening Number	Year Plantation Established	Area Surveyed (Ha)	*Proportion of Spruce Stems Attacked
43	93J5D-3	1971	80	0.001
			- large drainage in northwest section - southern slope 0-10° - no deciduous overstory; eastern portion thinned - very minor previous damage	
44	93K8D-509	1975	171	0.006
			- swampy section in south otherwise dry - variable but quite flat - 16% Sx; 74% PL; 10% F - deciduous overstory only in southern section - no previous damage	
45	93K1G-6	1976	116	0.008
			- southern section has swamps and small lake - deep drainage through centre of stand - 35% Sx; 64% PL; 190 B - minor deciduous overstory - no previous damage	
46	93K1H-501	1977	131	0.007
			- heavy brush throughout stand - steep ridge running SW to Ne - 65% Sx; 25% Pl; 10% B - deciduous overstory throughout - no previous damage	

Assigned Number	Map Sheet followed by Opening Number	Year Plantation Established	Area Surveyed (Ha)	*Proportion of Spruce Stems Attacked
47	93K1G-527	1979	59	0.004
			- heavy brush throughout - northern slope 0-15° - 70% Sx; 24% PL; 6% B - deciduous overstory throughout - minor previous damage	
48	93G12H-508	1976	80	0.001
			- active bear cave in southern section - northern slope 5-20° - 65% Sx; 26% PL; 9% B - deciduous overstory throughout - minor previous damage in central portion	
49	93J3D-4	1976	59	0.0318
			- juvenile spaced 1989 - generally quite flat - 20% Sx; 80% PL - deciduous overstory throughout - no previous damage	