Factors affecting the incidence of white pine weevil damage to white spruce in the Prince George Region of British Columbia

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ABSTRACT

A survey was conducted to study the incidence of attack by the white pine weevil, *Pissodes strobi* (Peck) on white spruce, *Picea glauca* (Moench) Voss., in the Prince George Region of British Columbia, in relation to biogeoclimatic subzone, site quality class and plantation age. The average percentage attack on the spruce component was 3.2% (range 0 to 26.6%). A general trend of increasing attack with increasing biogeoclimatic subzone moisture was found. No correlation was found between percentage attack and site quality or age. The implications of this survey for the Prince George Region are discussed.

INTRODUCTION

In British Columbia, the white pine weevil, *Pissodes strobi* (Peck) (Coleoptera; Curculionidae), causes serious damage to Sitka spruce, *Picea sitchensis* (Bong) Carr., white spruce, *Picea glauca* (Moench) Voss., and Engelmann spruce, *Picea engelmannii* Parry ex Engelm. (Alfaro 1982, Cozens 1983, McMullen 1976, McMullen and Condrashoff 1973, Stevenson 1967). Adult weevils overwinter in the duff and emerge in the spring to oviposit in year-old spruce leaders (Wood and McMullen 1971). Within about 10 days, the eggs hatch and the larvae begin to mine downward feeding on the phloem. The year-old leader is eventually killed through girdling which results in height growth loss. Greater losses occur if larvae mine past the year-old leader into the previous year's growth or if re-attack occurs below an attacked leader (Cozens 1987). Most adults emerge in late summer and fall, and, after feeding for a while, go to their overwintering sites. Depending on local climate, a portion of the larval population remains to overwinter within the leaders. Attacked trees usually develop stem defects (Alfaro 1989a) which affect the value of the logs obtained from the trees. Repeated attacks produce stunted and deformed trees.

McMullen (1976) studied the ecological factors which affect the distribution of *P. strobi* on Vancouver Island. Based on the minimum requirement for accumulated heat needed for brood development, McMullen concluded that low weevil hazard zones would occur on Northern Vancouver Island and along its extreme Western coastline. These findings were confirmed by Heppner and Wood (1984) who examined Sitka spruce plantations within the coastal Vancouver Forest Region of B.C., and concluded that these low hazard zones coincide closely with the Southern Hypermaritime Coastal Western Hemlock Biogeoclimatic Subzone Variant CWHvh. Past incidence surveys in the interior of B.C. (Lewis 1988) have yielded some results, but have never been stratified by biogeoclimatic units. This is important because ecological factors may influence the susceptibility of stands to weevil attack. In this study we report the results of a survey conducted in the Prince George Forest Region of B.C. to determine the incidence of *P. strobi* damage in white spruce in relation to biogeoclimatic zone, site quality and plantation age.

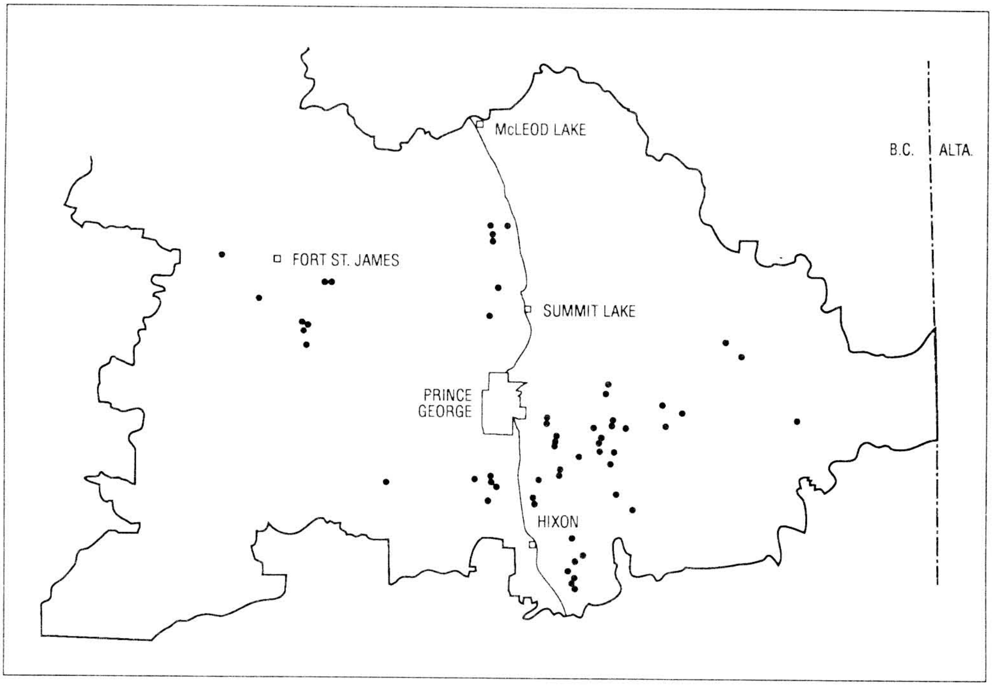

Figure 1. Location of the spruce plantations surveyed for *Pissodes strobi* incidence in the Prince George, Vanderhoof and Fort St. James Forest Districts, of the Prince George Timber Supply Area, in the Prince George Forest Region of British Columbia.

METHODS

Plantation selection

The survey was conducted in the Prince George Timber Supply Area (T.S.A.) of the Prince George Forest Region, which includes the Prince George, Vanderhoof and Fort St. James Forest Districts. A computer printout list of all second growth spruce plantations established in the T.S.A. since the 1960's was obtained from the B.C. Ministry of Forests Silviculture Branch. The plantation list included, among other attributes, the establishment date, site quality classification, and the biogeoclimatic zone and subzone of each plantation. Only plantations in which spruce was the dominant species and only those in the Sub-Boreal Spruce (SBS) biogeoclimatic zone (predominant in the Prince George T.S.A) were considered for examination of white pine weevil damage. The plantations were stratified based on biogeoclimatic subzone into groups which differed in soil moisture availability (Meidinger in press) as follows: DRY which included subzones dk, dw_2 and dw_3; MOIST, including subzones mw, mc_2, and mk1; and WET including subzones vk and wk1. The plantations were further stratified by site quality classification into good and medium sites, and by plantation age into three classes: 11-15, 16-20 and 21-25 years old.

Plantations which did not fall into one of these classes, were not considered in the study. No plantations were located in the SBS dry/good site 21-25 age class. Therefore, only 17 different categories were surveyed. The total number of plantations which fell into each category ranged from 1 to 200. In the categories which contained more than five plantations, five were randomly selected to be surveyed. If the category had five plantations or less, all plantations in that class were chosen. In all, 58 plantations were surveyed (Fig. 1).

Each plantation was identified on a 1:15,840 scale forest cover map provided by the forest district and on aerial photos. To estimate the percentage of *P. strobi* attack in a plantation, we used the systematic strip sampling method recommended by Fletcher (1986), who concluded that reasonably accurate estimates of weevil incidence could be obtained from sampling as few as five strips per plantation. In each plantation, a point of origin was established at random along the perimeter of the plantation. Then, starting at this point, five strips of equal length were established. The strips usually ran the approximate width of the plantation and were evenly spaced so that maximum coverage of the plantation was achieved. The length of each strip was determined using a topofil measuring meter. All planted spruce trees within 5.0 m of either side of the strip were examined for 1988 white pine weevil attack. Also recorded was the number of trees from species other than spruce which occurred as ingrowth on the plantation. For each plantation the percentage of spruce trees attacked was calculated with respect to the total number of trees and with respect to the spruce component.

The data were subjected to analysis of variance/covariance to test for significant differences in the percentage of white spruce trees attacked based on biogeoclimatic subzone, site quality and age. Stand density was used as a covariate. Attack percentages were transformed by the arcsin transformation before the analysis. The ANOVA procedures for unequal numbers of samples were used. Means were separated using the Student Newman-Keúls test.

RESULTS

The mean percent attack in the spruce component over all plantations was 3.2% (range 0 to 26.6%). The percentage spruce attacked with respect to all the trees in a stand averaged 2.5% (range of 0 to 23.7%) over all plantations.

The percentages of the spruce component attacked were sorted into 5% attack classes (Table 1). Nine of the 58 plots surveyed, or 15.5%, were free from weevil attack. Most plots (65.5%) had attack percentages of 0.1 to 5% (38% had 0.1 to 1% attack). Approximately 10 and 5% of the plots had attack intensities in the 5.1 to 10 and 10.1 to 15% classes, respectively. Only 2 plots (3.4%) had attack intensities higher than 15%.

A general trend to increasing attack with increasing site moisture (biogeoclimatic subzone class) was detected for both the percentage attack on the spruce component and the percentage attack on the total stand (Table 2). This relationship, however, was statistically significant only when percentage attack was calculated as a proportion of all trees in the plantation (ANOVA, $F = 4.5$, $P < 0.05$). The percentage of the spruce attacked was nearly three times higher on the Wet than on the Dry sites; similarly, the percentage of all plantation trees attacked was nearly 10 times higher on Wet than on Dry sites (Table 2). None of the other variables tested (site quality, plantation age or plantation density) had a significant relationship with the percentage of spruce trees attacked. This was true for the percentage calculated in relation to the spruce component or for the total number of trees in the stand.

DISCUSSION

Most reports of *P. strobi* damage come from the Sitka spruce literature where incidences of more than 50% trees attacked/year have been reported (Alfaro and Omule 1990). The incidence of *P. strobi* in the Prince George T.S.A. was generally low. However, the fact that individual plantations in this study had attack intensities as high as 26.6% indicates that white spruce is also highly susceptible to attack. The generally low incidence is probably due to the fact that most plantations in the Prince George area are young and are just entering their most susceptible stage. However, the lack of correlation of attack intensity with age may appear to contradict this statement. If plantations are more susceptible as they get older, a positive correlation of the attack with age was expected. The low correlation with age could be due to the fact that the older plantations are rare in this Region and

Table 1
Plantations surveyed in the Prince George Timber Supply Area tabulated by percentage attack by *P. strobi*.

Percentage* attack class	No. of plantations	Percentage of plantations
0	9	15.5
0.1- 5	38	65.5
5.1-10	6	10.3
10.1-15	3	5.3
15.1-20	0	0.0
20.1-25	1	1.7
25.1-30	1	1.7

* Percentage attack on the spruce component of the plantations.

Table 2
Mean percentage attack by *P. strobi* in 58 spruce plantations surveyed in the Prince George Forest Region, tabulated by moisture code, site and age class.

		Spruce trees attacked		Extent of total plantation attacked	
Code/Class	No. of plantations	%	Standard Deviation	%	Standard Deviation
Moisture					
Dry	13	1.7a	3.9	0.4ab	0.6
Moist	19	2.5a	4.1	2.0bc	3.7
Wet	26	4.6a	6.8	3.8c	5.9
Site					
Medium	31	3.4a	6.4	2.6a	5.6
Good	27	3.1a	3.9	2.3a	3.3
Age					
11-15 yrs	25	3.0a	5.7	2.3a	5.3
16-20 yrs	19	4.4a	6.3	3.3a	5.1
21-25 yrs	14	2.1a	2.9	1.6a	2.3

Means followed by the same letter were not statistically different (ANOVA and Student Newman-Keuls test $P>0.05$).

have until now escaped attack. Late invasion of older plantations after the weevil population reaches epidemic levels has been observed in the field by the authors. Whether interior spruce will ever show the elevated levels of attack reported for Sitka spruce (Alfaro 1982, Alfaro and Omule 1990) remains to be seen.

The high incidence of weevil damage in the wet habitats is probably due to fast growth in the spruces in response to high available moisture which produce long leaders and so favour weevil survival. In coastal Sitka spruce, *P. strobi* prefers to attack the trees with the longest leaders (Alfaro 1989b).

The results of this survey indicate that the white pine weevil has a generally low incidence in this Region and that, because a potential for higher populations does exist, foresters should continue to monitor this problem.

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REFERENCES

Alfaro, R.I. 1982. Fifty-year-old Sitka spruce plantations with a history of intense weevil attack. J. Entomol. Soc. Brit. Columbia 79: 62-65.

Alfaro, R.I. 1989a. Stem defects in Sitka spruce induced by Sitka spruce weevil, *Pissodes strobi* (Peck.), Pp. 177-185 in Alfaro, R.I. and S. Glover (editors). Insects affecting reforestation: biology and damage. Proceedings of a IUFRO symposium held on July 3-9, 1988, in Vancouver, B.C. Canada, under the auspices of the XVIII International Congress of Entomology. Forestry Canada, Victoria, B.C.

Alfaro, R.I. 1989b. Probability of damage to Sitka spruce by the Sitka spruce weevil, *Pissodes strobi* (Peck). J. Ent. Soc. Brit. Columbia 86: 48-54.

Alfaro, R.I. and S.A.Y. Omule. 1990. The effects of spacing on Sitka spruce weevil damage to Sitka spruce. Can. J. For. Res. 20: 179-184.

Cozens, R.D. 1983. The spruce weevil, *Pissodes strobi* Peck, (Coleoptera: Curculionidae). A review of its biology, damage and control techniques with reference to the Prince George Timber Supply Area. B.C. Min of For. Int. Rep. PM-PG-3.

Cozens, R.D. 1987. Second broods of *Pissodes strobi* (Coleoptera: Curculionidae) in previously attacked leaders of interior spruce. J. Entomol. Soc. Brit. Columbia 84: 46-49.

Fletcher, V.E. 1986. Development of sampling guidelines for estimating the proportion of weeviled trees on a plantation. B.C. Min. of For. Int. Rep. PM-PB-18.

Heppner, D.G. and P.M. Wood. 1984. Vancouver Region Sitka spruce weevil survey results (1982-1983), with recommendations for planting Sitka spruce, B.C. Min. of For. Int. Rep. PM-V-5.

Lewis, K.G. 1988. Spruce weevil in spruce plantations in the Cariboo Forest Region B.C. Min. of For. Cariboo For. Reg. Williams Lake, B.C. Unpublished report. 35 pp.

Meidinger, D., J. Pojar and W.L. Harper. In press. Sub-boreal spruce zone. In D. Meidinger, and J. Pojar (eds.), "Ecology of British Columbia". B.C. Min. of Forests, Special Report Series.

McMullen, L.H. 1976. Spruce weevil damage. Ecological basis and hazard rating for Vancouver Island. Can. For. Serv. Pac. For. Res. Cent. Inf. Rep. BC-X-141. Victoria, B.C. 7p.

McMullen, L.H. and S.F. Condrashoff. 1973. Notes on dispersal, longevity and overwintering of adult *Pissodes strobi* (Peck) (Coleoptera: Curculionidae) on Vancouver Island. J. Entomol. Soc. Brit. Columbia 70: 22-26.

Stevenson, R.E. 1967. Notes on the biology of the Engelmann spruce weevil, *Pissodes engelmanni* (Curculionidae: Coleoptera) and its parasites and predators. Can. Entomol. 99: 201-213.

Wood, R.O. and L.H. McMullen. 1971. Spruce weevil in British Columbia. Can. Dept. For. Can. For. Ser. Pac. For. Res. Cent. Pest Leaflet.

The Aphids (Homoptera:Aphididae) of British Columbia 20. Further additions

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ABSTRACT

Five species are added to the aphid fauna of British Columbia. Fifty-four of the 88 new aphid-host plant associations of plant species are new host plants.

INTRODUCTION

Four hundred species of aphids collected from 1124 hosts or in traps, and 2233 aphid-host plant associations were recorded in fifteen previous lists of the aphids of British Columbia (Forbes, Frazer and MacCarthy 1973; Forbes, Frazer and Chan 1974; Forbes and Chan 1976, 1978, 1980, 1981, 1983, 1984, 1985, 1986a, 1986b, 1987, 1988, 1989; Forbes, Chan and Foottit 1982). The present list adds 5 aphid species (indicated with an asterisk in the list) and 88 aphid-host plant associations to the previous lists. Fifty-four of the new aphid-host plant associations of plant species have not been recorded before. The additions bring the number of known aphid species in British Columbia to 405. Aphids have now been collected from 1178 different host plants and the total number of aphid-host plant associations is 2321.