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FOREST RESEARCH LABORATORY
VICTORIA, BRITISH COLUMBIA
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FORESTRY BRANCH
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## INTRODUCTION

The Sitka spruce weevil, Pissodes sitchensis Hopkins (Coleoptera: Curculionidae), is a pest throughout most of the range of its host, Sitka spruce (Picea sitchensis (Bong.) Carr.). It has periodically caused significant damage in localized areas with the result that considerable concern has been expressed recently by foresters about the desirability of growing spruce at some localities.

Sitka spruce occurs in a narrow strip along the west coast of North America from northwestern California to southern Alaska (Fowells, 1965). Sites where it grows most successfully are those influenced by the prevailing westerly winds blowing inland from the Pacific Ocean. High precipitation, cloud-cover averaging 200 days per year, and an absence of temperature extremes mark the typical Sitka spruce region climate. Soils range from those with heavy accumulations of humus near tidewater to alluvial stream bottoms at higher elevations. However, Sitka spruce seldom occurs above 1,000 feet elevation and grows best on Vancouver Island up to about 400 feet.

The Sitka spruce weevil lays its eggs in the spring just below the terminal buds of the main leader and the larvae feed down the year-old terminals during the summer. The new adults emerge in the fall, overwinter in the duff, and attack other trees in the following spring.

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1/ Respectively, Insect Survey Officer, Forest Research Technician and Survey Head, Forest Insect and Disease Survey, Victoria.

Feeding by the larvae damages the previous year's leader and deforms or prevents the development of the current year's leader and adjacent laterals. Often only one year's growth is lost, however, because one of the previous year's laterals assumes dominance to form a new leader. Trees repeatedly attacked develop poor form with multiple leaders and crooked boles. Weevil damage reduces the rate of height growth and lengthens the time until the tree becomes merchantable.

Weevil damage is evidenced by the presence of deformed, dying or dead leaders showing boring damage in the bark or wood. Past attack is evidenced by the stubs of old leaders protruding from branch whorls at intervals along the main stem.

The weevil is susceptible to killing by known insecticides as shown experimentally (Silver, 1968) but economically feasible methods still await development. The end product in view, sawlogs affected by both deformity and volume loss, or pulp affected only by volume loss, will have an important bearing on the control decision.

Expanding reforestation in the Province, involving a decision for accelerated planting of Sitka spruce on suitable sites, has recently caused foresters to consider seriously the damage caused by the weevil. A meeting of foresters concerned with the problem was held at the Forest Research Laboratory, Victoria, in October, 1966, when it was decided that more information was needed on this pest. To that date, Dr. G. T. Silver had been studying the biology of the weevil in the Province (Silver, 1968) and Mr. S. F. Condrashoff and Mr. D. N. Smith are continuing this work. It was recognized, however, that there was an immediate need for additional information on the distribution and impact of the weevil and to determine

the feasibility of hazard-rating prospective plantation sites.

Delineation of infested areas and assessment of attack intensity was begun in 1967. A wide variety of land ownership, complicated by access difficulties and varied terrain, resulted in a decision to restrict the survey initially to the area of highest concern, Vancouver Island. The scope of the survey was made possible through the co-operation and active assistance of field foresters and the Pest Control Committee, British Columbia Logger's Division, Council of the Forest Industries of British Columbia. This report presents the results of this survey.

## METHODS

A survey of spruce plantations and natural stands on Vancouver Island was begun in early spring, 1967, and continued through the summer. Field observations, supported by collections of weevilled leaders to confirm the identity of the insect, were made by foresters of four co-operating companies and by a Forest Insect and Disease Survey Appraisal Crew (Table 1).

Table 1. Sitka Spruce Assessed for Weevil Infestation on Vancouver Island, 1967

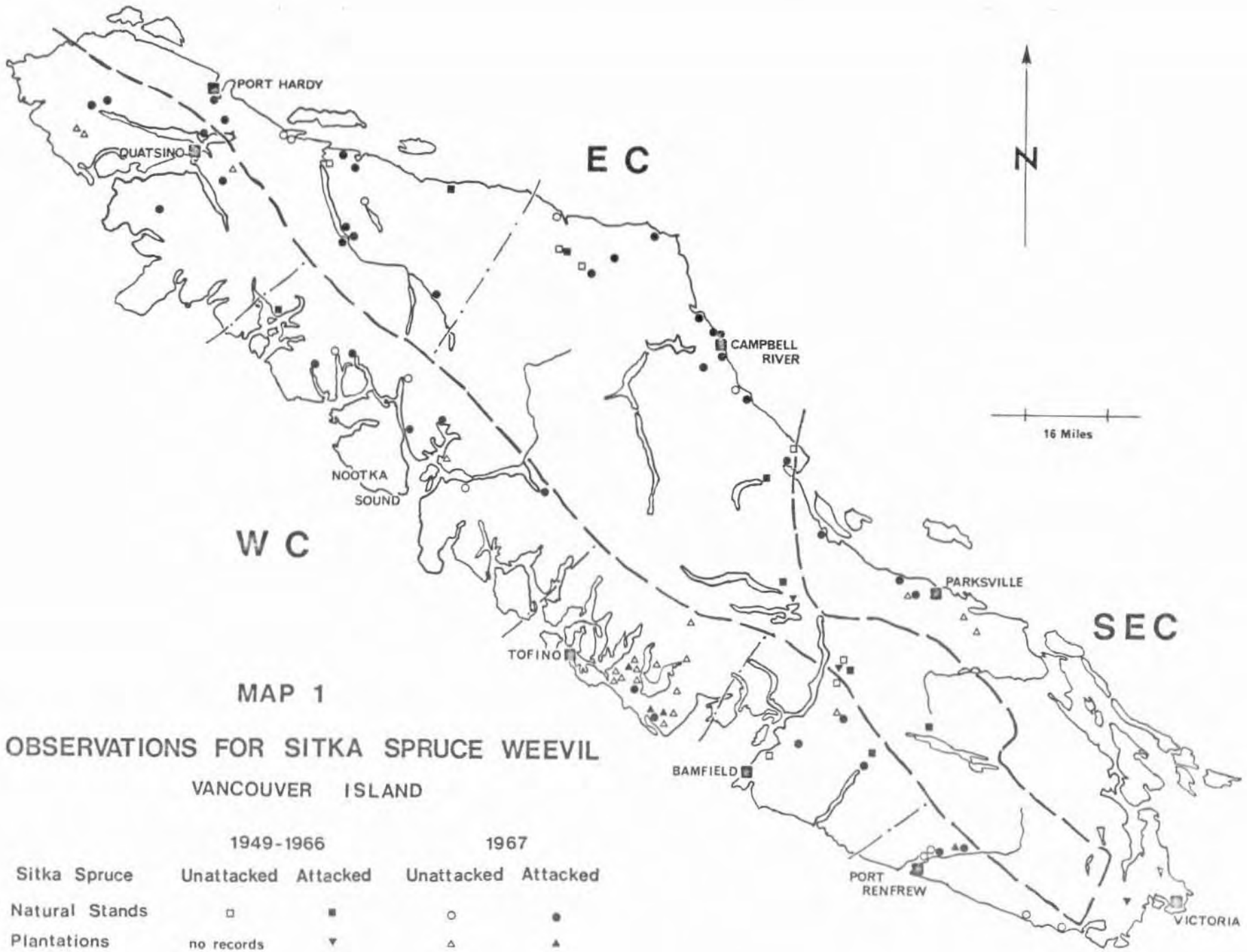
| Agency[1] | Natural stands | | Plantations | |
|---|---|---|---|---|
| | No. of Examinations | Total Trees Examined | No. of Examinations | Total Trees Examined |
| MacMillan Bloedel Ltd. | 7 | 512 | 20 | 1,704 |
| Canadian Forest Products Ltd. | 5 | 583 | 0 | 0 |
| Rayonier Canada (B.C.) Ltd. | 3 | 225 | 1 | 0 |
| B.C. Forest Products Ltd. | 1 | 108 | 1 | 173 |
| Dept. of Forestry and Rural Dev. (F.I.D.S.) | 34 | 2,041 | 5 | 283 |

[1] Some irregular observations not backed by standard data forms provided were also made by Tahsis Co. Ltd., Pacific Logging Co. Ltd., and several B.C.F.S. Rangers.

Data were collected on incidence of attack by height classes at different localities and records of existing spruce plantations were assembled to demonstrate the importance of possible weevil damage on Vancouver Island. Examinations of 5,629 naturally growing and planted trees were made at 76 sample points (Map 1). Fifty samples were made in natural stands and 26 in plantations. There was an average of 74 trees per sample plot.

The recorded incidence of infestation was measured as per cent trees infested and, because the examination period extended over the whole summer, probably included both 1966 and 1967 attack. Examinations were segregated by 10-foot height classes; trees below 3 feet were considered non-susceptible but the upper height limit of susceptibility, if it exists, is not known or assumed. Both natural stands and plantations were examined but few plantations above 20 feet in height occur on Vancouver Island and none were examined.

Since success of weevil attack may be influenced by climatically conditioned factors, data were segregated by bioclimatic zones, geographic areas and site type. The major divisions selected were the three climatic zones described by the B. C. Natural Resources Conference (1956). These zones represent various climatic factors which affect the biotic community such as precipitation and temperature. As far as spruce is concerned only two of these major subdivisions of Vancouver Island appear to be of real interest: "Outer West Coast" and "Inner West Coast". The former represents the part of Vancouver Island west of the main mountain ranges and is referred to in this report as "west coast". It receives the greatest amount of precipitation (100 to over 150 inches in most areas). The latter represents most of the eastern portion of Vancouver Island and is referred to as "east




MAP 1

# OBSERVATIONS FOR SITKA SPRUCE WEEVIL

VANCOUVER ISLAND

| | 1949-1966 | | 1967 | |
|---|---|---|---|---|
| Sitka Spruce | Unattacked | Attacked | Unattacked | Attacked |
| Natural Stands | □ | ■ | ○ | ● |
| Plantations | no records | ▼ | △ | ▲ |

coast". It includes the northeast coast and the central part of the southern portion, receiving 60-100 inches inland and 40-60 inches along the coast. The spruce-site areas of the "Outer West Coast Zone" and most of the "Inner West Coast Zone" are included in Krajina's (1965) "Coastal Western Hemlock Biogeoclimatic Zone". The third subdivision or "Southwest Coast Zone" includes the east coast of the Island south of Courtenay, where 30-40 inches or less of precipitation is experienced each year and commercial spruce is not abundant. This zone falls in Krajina's "Coastal Douglas-fir Zone" and is referred to in this report as "southeast coast". Samples were grouped into eight regions within the three climatic zones for further study.

Samples were also segregated by topographic position and broad site quality class to check the possibility of their correlation with severity of attack. The suitability of each sample area for growing spruce (site quality) was rated by examining foresters as high, medium or low. Samples were described further according to topographic position as valley bottom, where the trees were growing at the bottom of rather narrow valleys; flat, in wide, open valleys with no appreciable slope; and tidal, near sea level and often at river mouths where the site was directly influenced by the nearby ocean. A more finite evaluation of site was not possible within the scope of this survey but this does not rule out the existence of less obvious but nevertheless important controlling influences.

## RESULTS

### Geographic Distribution of Weevil Attack

Over one-half of the sample points examined, distributed over the spruce types of Vancouver Island, were infested by the Sitka spruce weevil (Table 2). The incidence of infested sample points in the eight regions

ranged from 29% to 83% (Map 1). Frequency of infested sample points was the highest at Campbell River and Port Hardy (east coast) and Bamfield (inland west coast). Fewer, but still over 50%, of the points examined at Quatsino and Nootka were infested; these were along the northwest coast of the Island and most were in valleys at the head of long inlets. Sample points containing attacked trees at Parksville, along the southeast coast, and at Renfrew, along the southwest coast of the Island, were less frequent, and the lowest frequency of attack was in the vicinity of Tofino, along the central west coast of Vancouver Island.

Table 2. Geographic Distribution of Attack by Sitka Spruce Weevil on Natural Growing and Planted Sitka Spruce by Climatic Zone and Region, Vancouver Island, 1967

| Climatic Zone | Region | No. Sample Points | Av. Ht. of Trees Sampld. (ft.) | No. Weevilled Plots | % Weevilled Plots |
|---|---|---|---|---|---|
| West Coast | Renfrew | 7 | 11 | 3 | 43 |
| " " | Bamfield | 4[1/] | 13 | 3 | 75 |
| " " | Tofino | 17[1/] | 5 | 5 | 29 |
| " " | Nootka | 9 | 15 | 5 | 56 |
| " " | Quatsino | 8 | 15 | 5 | 63 |
| " " | All | 45 | | 21 | 48 |
| East Coast | Port Hardy | 11 | 15 | 8 | 73 |
| " " | Campbell R. | 12 | 19 | 10 | 83 |
| " " | All | 25 | | 19 | 76 |
| Southeast Coast | Parksville | 6 | 14 | 3 | 50 |
| All Vancouver Island | | 76 | | 43 | 58 |

[1/] One plot in each in East Coast Zone.

## Intensity of Weevil Attack

### By Height

Incidence of attack, expressed as percent trees weevilled, was examined first to determine the relationship, in any, of attack incidence to tree height. The most consistently high attack was in the 11-20 foot height class (Table 3). Data from this class, therefore, were most useful in pointing out other trends.

Trees above 20 feet, and at least up to 50 feet, were also quite susceptible, although the sample of trees in these upper height classes was small. Only 10 (30%) of the sample points averaging over 10 feet in height were unattacked. Attacks in the 1-10 foot class, however, were very low; trees down to about 2 feet high were very occasionally attacked. Of 33 sample points free from attack, 19 or 56% averaged 5 feet or less in height; only one plantation averaging below 5 feet was attacked, and on this only 1% attack was noted.

### By Climatic Zone

Attack intensity by climatic zone varied considerably (Table 3). Considering the 11-20 foot height class, the highest attack was on the east coast of Vancouver Island at Campbell River and Parksville (42%); in other areas, particularly on the west coast, attack was much lower. The region with the lowest attack was at Bamfield; attack in other areas ranged from 13 to 22%.

### By Site and Topographic Position

Most of the sample point locations were rated as either high or medium sites for spruce and attack intensity on both situations was about the same (Table 4). However, infestation was highest in valley bottoms, next highest in flat, open situations, and lowest in tidal localities.

Table 3. Incidence of Attack by Sitka Spruce Weevil on Sitka Spruce[1/] by Climatic Zone, Region and Height Class, Vancouver Island, 1967

| Climatic Zone | Region | Total Trees Exam. | % Trees Att. | Trees Examined and Attacked by Height Class (ft.) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1-10 | | 11-20 | | 21-30 | | 31-40 | | 41-50 | | 50+ | |
| | | | | No. Ex. | % Att. | No. Ex. | % Att. | No. Ex. | % Att. | No. Ex. | % Att. | No. Ex. | % Att. | No. Ex. | % Att. |
| West Coast | Renfrew | 785 | 15 | 482 | 15 | 243 | 18 | 50 | 8 | 7 | 0 | 2 | 0 | 1 | 0 |
| " | Bamfield | 312 | 2 | 115 | 0 | 115 | 3 | 60 | 3 | 14 | 7 | 3 | 0 | 1 | 0 |
| " | Tofino | 1,700 | 1 | 1,556 | 0 | 134 | 13 | 0 | — | 0 | — | 0 | — | 0 | — |
| " | Nootka | 296 | 11 | 167 | 4 | 76 | 22 | 0 | — | 0 | — | 0 | — | 0 | — |
| " | Quatsino | 454 | 9 | 181 | 0 | 149 | 18 | 75 | 19 | 37 | 0 | 7 | 0 | 5 | 20 |
| " | All | 3,547 | 6 | 2,511 | 3 | 717 | 15 | 212 | 13 | 71 | 4 | 18 | 0 | 10 | 2 |
| East Coast | Port Hardy | 991 | 18 | 438 | 11 | 366 | 13 | 109 | 46 | 49 | 45 | 19 | 47 | 10 | 20 |
| " | Campbell River | 753 | 34 | 390 | 16 | 365 | 42 | 135 | 40 | 40 | 37 | 17 | 0 | 5 | 20 |
| " | All | 1,944 | 24 | 828 | 14 | 731 | 27 | 244 | 43 | 89 | 42 | 36 | 28 | 15 | 13 |
| Southeast Coast | Parksville | 138 | 13 | 79 | 0 | 24 | 42 | 21 | 19 | 10 | 30 | 4 | 25 | 0 | — |
| All Vancouver Island | | 5,629 | 13 | 3,418 | 6 | 1,472 | 22 | 477 | 30 | 170 | 25 | 58 | 19 | 25 | 16 |

[1/] In plantations and natural stands.

Table 4. Incidence of Attack by Sitka Spruce Weevil on Sitka Spruce by Site and Topographic Position, Vancouver Island, 1967

| Climatic Zone | Site or Topog. Position | No. Trees Exam. 1/ | % Trees Attack. | Trees Examined and Attacked by Height Class (ft.) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1-10 | | 11-20 | | 21-30 | | 31-40 | | 41-50 | | 50+ | |
| | | | | No. Ex. | % Att. | No. Ex. | % Att. | No. Ex. | % Att. | No. Ex. | % Att. | No. Ex. | % Att. | No. Ex. | % Att. |
| West Coast | High | 1,389 | 4 | 908 | 1 | 314 | 11 | 115 | 14 | 32 | 9 | 9 | 0 | 5 | 20 |
| " | Medium | 1,885 | 6 | 1,359 | 3 | 374 | 17 | 98 | 11 | 40 | 0 | 9 | 0 | 5 | 20 |
| East Coast | High | 1,299 | 24 | 532 | 13 | 458 | 27 | 193 | 42 | 101 | 30 | 46 | 20 | 10 | 20 |
| " | Medium | 445 | 27 | 158 | 25 | 209 | 24 | 51 | 45 | 15 | 47 | 7 | 14 | 5 | 20 |
| West Coast | Valley Bottom | 999 | 13 | 653 | 11 | 251 | 19 | 71 | 8 | 14 | 7 | 3 | 0 | 1 | 0 |
| " | Flat | 1,834 | 4 | 1,445 | 0 | 278 | 16 | 70 | 20 | 32 | 0 | 5 | 0 | 4 | 25 |
| " | Tidal | 483 | 7 | 217 | 3 | 154 | 12 | 71 | 10 | 26 | 8 | 10 | 0 | 5 | 20 |
| East Coast | Valley Bottom | 200 | 16 | 136 | 2 | 64 | 44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| " | Flat | 1,062 | 32 | 493 | 20 | 337 | 39 | 139 | 52 | 54 | 46 | 28 | 32 | 10 | 30 |
| " | Tidal | 418 | 23 | 129 | 4 | 175 | 15 | 82 | 30 | 26 | 31 | 5 | 0 | 1 | 0 |

1/ Trees are considered separately in both site and topographic categories and do not include all trees examined.

Natural Stands and Plantations

Intensity of attack, considering all trees in all zones, was 4% in plantations and 16% in natural stands (Table 5). However, many of these trees were small, and in the most susceptible height class, 11-20 feet, 33% of the trees in plantations were infested, compared with 21% in natural stands.

## Spruce Plantations on Vancouver Island

Forest Industry co-operators reported 181 Sitka spruce plantations: 138 on the west coast, 42 on the east coast and 3 on the southeast coast (Map 2). About one-half of these, however, contained trees which averaged less than 3 feet in height and were not yet susceptible to attack. Plantations averaged over 8,000 trees each; 500,000 trees of susceptible height (averaging between 6 and 7 feet) were growing on about 3,000 acres and another 1,000,000 trees (averaging between $1\frac{1}{2}$ and 2 feet) had been recently planted (Table 6.) . Norway spruce (Picea abies (Linnaeus) Karst) was planted at 6 locations on 51 acres. In 1966 and 1967, almost 11,000 trees of this exotic species were planted but they currently averaged only one foot high and were not yet susceptible to weevil damage.

Ten Divisional forestry offices responded to a questionnaire inquiring about concern over spruce weevil attack. Only two recognized this pest as creating a problem but nearly all indicated that they planned further plantings.

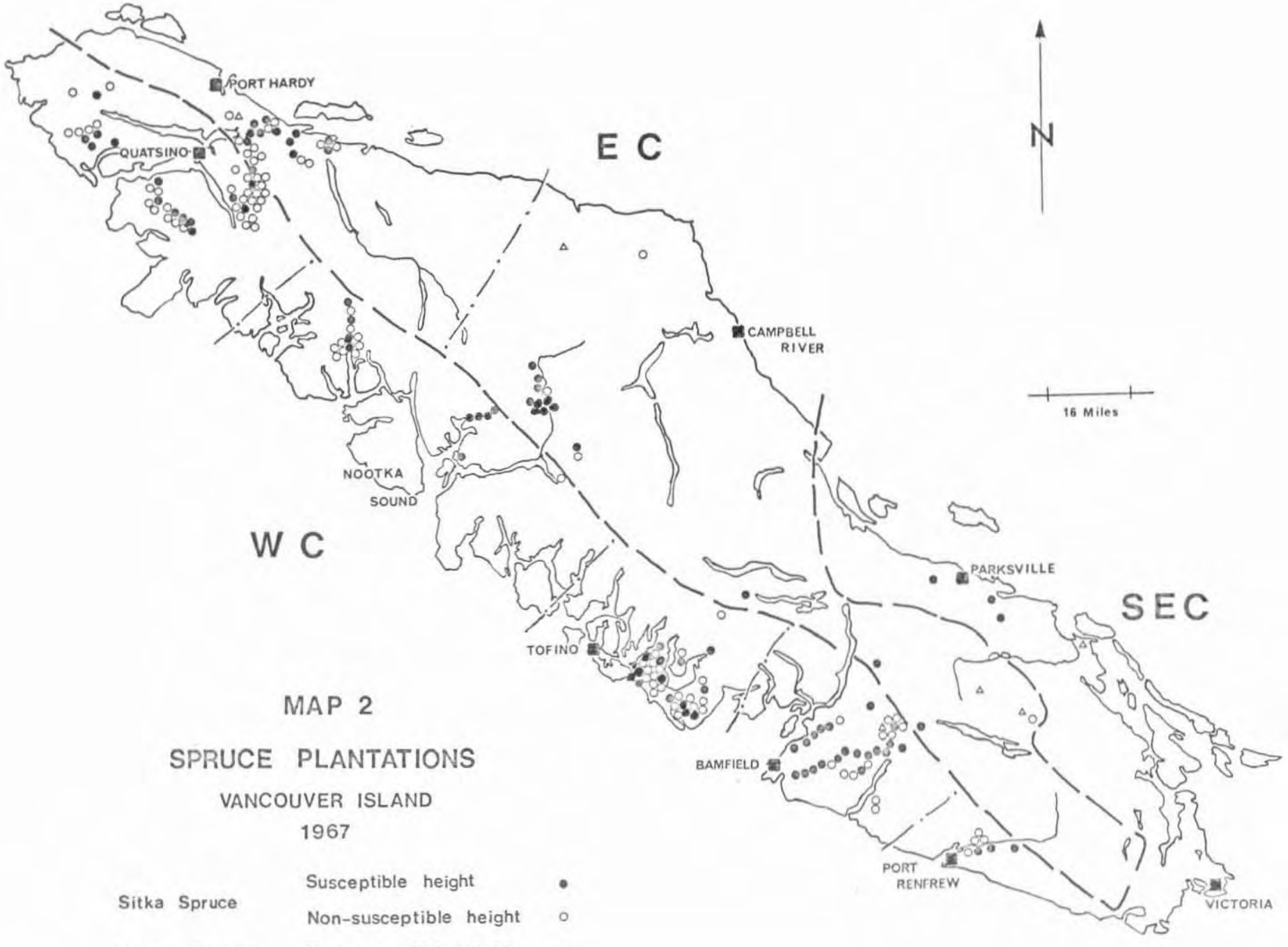
Table 5. Incidence of Attack by Sitka Spruce Weevil in Sitka Spruce Natural Stands and Plantations, Vancouver Island, 1967

| Climatic Zone | No. of Sample Points | Total Trees Exam. | % Trees Attack. | Trees Examined and Attacked by Height Class (ft.) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1-10 | | 11-20 | | 21-30 | | 31-40 | | 41-50 | | 50+ | |
| | | | | No. Ex. | % Att. | No. Ex. | % Att. | No. Ex. | % Att. | No. Ex. | % Att. | No. Ex. | % Att. | No. Ex. | % Att. |
| Natural Stands | | | | | | | | | | | | | | | |
| West Coast | 24 | 1,657 | 5 | 698 | 6 | 640 | 14 | 212 | 13 | 71 | 4 | 18 | 0 | 10 | 22 |
| East Coast | 23 | 1,744 | 25 | 692 | 16 | 667 | 26 | 244 | 43 | 89 | 42 | 36 | 28 | 15 | 20 |
| Southeast Coast | 3 | 68 | 26 | 9 | 0 | 24 | 42 | 21 | 90 | 10 | 30 | 4 | 25 | 0 | 0 |
| All | 50 | 3,469 | 16 | 1,399 | 11 | 1,331 | 21 | 477 | 33 | 170 | 25 | 58 | 19 | 25 | 21 |
| Plantations | | | | | | | | | | | | | | | |
| West Coast | 21 | 1,890 | 3 | 1,813 | 2 | 77 | 25 | - | - | - | - | - | - | - | - |
| East Coast | 2 | 200 | 15 | 136 | 2 | 28 | 44 | - | - | - | - | - | - | - | - |
| Southeast Coast | 3 | 70 | 0 | 70 | 0 | 0 | 0 | - | - | - | - | - | - | - | - |
| All | 26 | 2,160 | 4 | 2,019 | 2 | 141 | 33 | - | - | - | - | - | - | - | - |

Table 6. Spruce Plantations Recorded During Surveys on Vancouver Island, 1967

| Climatic Zone | No. Plantations Reported | No. Acres | No. Trees | Av. No. Trees/acre | Av. Ht. (ft.) |
|---|---|---|---|---|---|
| Sitka spruce plantations of weevil-susceptible height. | | | | | |
| West Coast | 61 | 2,500 | 330,300 | 132 | 6 |
| East Coast | 25 | 857 | 193,000 | 225 | 7 |
| Southeast Coast | 3 | 5 | 83 | 17 | 4.5 |
| All | 87 | 3,362 | 523,383 | 156 | |
| Sitka spruce plantations below weevil-susceptible height[1] | | | | | |
| West Coast | 77 | 2,951 | 777,500 | 264 | 1.5 |
| East Coast | 17 | 615 | 223,750 | 364 | 2 |
| All | 94 | 3,566 | 1,001,250 | 281 | |
| Norway spruce plantations below weevil-susceptible height[1] | | | | | |
| West Coast | 1 | 20 | 1,650 | 83 | 1 |
| East Coast | 4 | 29 | 8,600 | 297 | 1 |
| Southeast Coast | 1 | 2 | 500 | 250 | 1 |
| All | 6 | 51 | 10,750 | 211 | |

[1] Less than 3 feet.




MAP 2

SPRUCE PLANTATIONS

VANCOUVER ISLAND

1967

| | | |
|---|---|---|
| Sitka Spruce | Susceptible height | ● |
| | Non-susceptible height | ○ |
| Norway Spruce | Non-susceptible height | △ |

# DISCUSSION

## Susceptibility to and Intensity of Weevil Attack

While a few stands were free of weevil attack (10 of the 40 sample points in highly susceptible, over 10 foot-high stands), we must conclude that the weevil is more-or-less generally distributed over the spruce types of Vancouver Island. There are no significant climatic or physiographic barriers which restrict the spread of the insect in this region.

Trees below 3 ft. generally are immune and those up to 5 ft. are attacked infrequently. However, above this height, trees rapidly become highly susceptible. The reason for the escape of these smaller trees was not possible to define but studies by Silver (1963) and others suggested that the relatively small leader growth of young trees may be one factor.

The relatively high susceptibility and wide distribution of the 11-20 ft. height class provided a good index for comparing intensity of weevil attack between stands, regions and climatic zones.

The intensity of weevil attack was quite variable between stands (using the 11-20 ft. index class, from 0 to 85% of the trees were attacked over 2 years), but no clear-cut basis for indexing hazard was apparent. A number of trends worthy of more critical evaluation did appear, however. Comparisons were made on the basis of climatic zone, topographic position and broad site class with the following indications in the 11-20 foot index class:

1. Climatic zones

The average intensity of attack (based on recent leader damage) was lower in the West Coast Zone (15%; range at sample points was 0 to 67)

than the East Coast Zone, (27%; range 0 to 85). The Southeast Coast Zone, based on a rather small sample, averaged 42% infested.

It should be remembered that these divisions are very broad and aside from using the height-susceptibility index it was not possible to sort out other possible influencing factors. Thus some stands classed as "west coast" might in fact have been growing under "east coast" conditions and be more suitably classed following more critical ecological evaluation in the field as being in the latter zone.

2. Topographic position

A similar trend appeared in both West Coast and East Coast zones when sample points were segregated by topographic position, the highest attack incidence occurring in "valley bottom", followed by "flat" and "tidal" areas. Again, more critical ecological evaluations in the field may clarify this picture further.

3. Site

Segregating by broad site class showed reversed trends between the West Coast and East Coast zones. It would be premature to throw out this basis of comparison, however, because the classes were inadequately defined and were based on the judgement of a great variety of people.

## Impact of Sitka Spruce Weevil

The factors on which we must judge the importance of Sitka spruce weevil include:

1. The distribution of the pest in relation to the distribution of the host; on Vancouver Island the two coincide.

2. The magnitude and importance of the resource involved and that proportion of it which is susceptible to damage by the pest.

At present our information on immature natural stands is inadequate. Planted stock recorded by this survey shows 87 plantations comprising 3,362 acres of weevil-susceptible height and 94 plantations comprising 3,566 acres soon to attain susceptible height. A small acreage of exotic spruce below susceptible height was recorded. These are conservative estimates because not all agencies responded to our survey. Perhaps of greater significance is the fact that many companies have sizable areas most suitable to re-stocking by spruce.

3. The frequency of high-intensity (epidemic) attack by the pest and what this means in terms of loss in yield, sawlog or fiber.

We can, as yet, answer only the first part of this problem, and that only in terms of recent attack intensity because the frequency of attack prior to the survey was not measured, nor was future attack estimated; the effect of this would be difficult to determine.

a. Thirty-three of the 76 sample points were free from attack, but the results of the survey show that the odds against trees below 5 feet sustaining attack are extremely high. Of the 60 stands averaging above this height, 30% were free from infestation.

b. Considering the 40 sample points in the highly susceptible classes over 10 ft. high, 19 or 47% sustained an attack incidence over 50%.

The limitations imposed by the scope of this survey still leave some important questions concerning the impact of this pest unanswered:

1. What volume losses may be expected, sawlog or pulp, under various intensities of attack? The present survey could take only recent (2 years approx.) attack into account.

2. What is the maximum intensity of attack that we can accept and how frequently is this limit exceeded? Critical analysis, taking into account the accumulated impact of weevil attack in a number of stands, will be necessary. This should produce a "damage index" by which stands may be classified.

3. Once attaining epidemic levels in a stand, does the weevil maintain a high level of attack during the susceptible age of the stand consistently, frequently, or occasionally?

4. Is there a fairly well defined limit of susceptibility governed by height or age, and if so, what is this limit? For example, how long do we have to be concerned with control?

A comparison was made between natural and planted stands with regard to weevil attack intensity. A few points of qualification are pertinent. Our results show that in the 1-10 ft. height class incidence of attack is significantly higher in natural stands. Two influences, not apparent from the data, are at work here. First, in setting up the survey, it was assumed that trees 3 ft. and above were susceptible, but our results indicated that trees below 5 ft. are unlikely to be attacked; a much higher proportion of plantations in the 1-10 ft. class were below 5 ft. Second, following planting stock, leader growth on planted stock will tend to be shorter for a few years; we used height not age in classing trees as susceptible.

Looking at the 11-20 ft. class, however, the incidence of attack appears significantly higher in planted stock. It is recognized that our data was relatively small for plantations in this class, but it would be unwise to discount it.

## Recommendations

In making recommendations we are assuming that our results to date indicate that further studies are warranted. On that basis we recommend further studies along the following lines:

1. Critical ecological studies should be carried out in a range of known weevilled and non-weevilled stands with the aim of producing a practical weevil-hazard index for lands intended for spruce plantations. An examination of the influence of stand density on weevil incidence should be included.

2. Based on the progress made in "1", an attempt should be made to relate (or isolate) the factor(s) which govern the success of the various life stages of the weevil. For example does the nature of the duff layer or perhaps periodic flooding inhibit overwintering stages? Does stocking or shading of the terminals affect susceptibility to attack?

3. Impact studies in stands of a range of weevil intensity should be carried out to clarify and provide:

    a. Damage (loss in sawlog volume and fiber) at various weevil intensity levels.

    b. Acceptable levels of infestation.

    c. A practical damage index for rating stands for inventory or possible control considerations.

4. Current studies should be continued to define weevil susceptibility of Sitka spruce with the view to selecting resistant stock.

5. While it is recognized that the range of Sitka spruce includes the mainland coast region, surveys should not be extended to that area until the suggested studies provide a more sound basis for assessing those areas. At that time, however, interior spruce species and the closely related Engelmann spruce weevil should be included.

## ACKNOWLEDGEMENTS

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