Extension Note

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British Columbia's Coastal Forests

Spruce Weevil and Western Spruce Budworm Forest Health Stand Establishment Decision Aids

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Introduction

Western spruce budworm (*Choristoneura occidentalis*) is a defoliator of Douglas-fir throughout the tree's range in British Columbia. Although recent defoliation levels within the Coast Forest Region (CFR) have been primarily light, this insect has caused significant damage within the region in previous years. In the past, western spruce budworm has had its largest impacts in the Squamish and Chilliwack forest districts, particularly in the Pemberton/Birkenhead area and the Fraser Canyon area near Boston Bar.

The spruce weevil (*Pissodes strobi*) is a major pest in the CFR where it seriously limits the use of Sitka spruce for reforestation. Repeated weevil attacks to the leading shoots of young Sitka spruce trees result in suppressed height growth and stem deformities; however, improving supplies of weevil-resistant planting stock may lead to new reforestation strategies for Sitka spruce.

The Stand Establishment Decision Aid (SEDA) format has been used to extend information on a variety of vegetation and forest health concerns in British Columbia. The two-page SEDAs presented in this extension note were developed to summarize information about spruce weevil and western spruce budworm occurrence and management in the CFR. The first page of each SEDA provides general information, hazard ratings for the CFR's biogeoclimatic zones and subzones, and silvicultural considerations. The second page outlines the growth and yield implications and other effects and associations of these insects. A valuable resource and reference list that readers can use to find more detailed information is also included. Most reference material that is not available on-line can be ordered through libraries or the Queen's Printer at: *http://www.qp.gov.bc.ca*

Acknowledgements

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KEYWORDS: Choristoneura occidentalis, *forest health, harvesting,* Pissodes strobi, *productivity, silviculture.*

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URL: *http://www.forrex.org/publications/jem/ISS38/vol7_no3_art6.pdf*

Spruce Weevil–British Columbia's Coastal Forests

Ladd Livingston, Idaho Department of Lands, http://www.forestryimages.org

Spruce weevil damage

Characteristics of Susceptible Stands

- Open, fast-growing stands of Sitka spruce, 5–30 years old and 1.5–20 m tall are most susceptible. Dense stands have slightly lower attack rates and less deformity.
- Warmer sites are more susceptible (sites where heat accumulation exceeds 888 degree-days per year above a 7.2°C threshold [see McMullen 1976]).
- Spruce plantations where adjacent stands have been heavily attacked are at risk.
- Engelmann spruce is also susceptible, but because of the higher elevation and cooler climate associated with this species, weevil attack is usually less intense (this decision aid focusses on Sitka spruce).

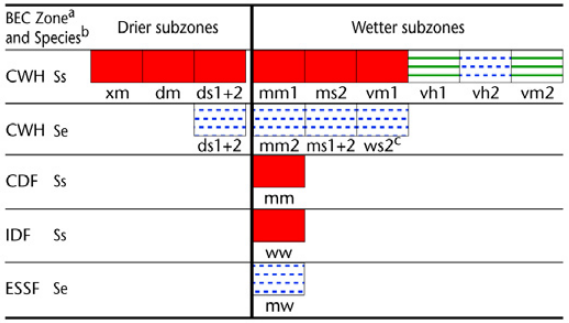
General Information

- Oviposition in the bark of the previous year's leading shoot occurs from late April to late June. Larvae hatch from the eggs in about 10 days and feed downwards, girdling and killing the leader. Pupation occurs from late July to September. Adults emerge from the leader in August and September and overwinter in the duff.
- Spruce weevil attacks are most common on vigorous trees that are 1.5–10 m in height and have long, healthy leaders.
- Outbreaks of the spruce weevil in Sitka spruce plantations can begin in stands as young as 5 years old, when leaders first reach a size attractive to the weevils.
- Once an outbreak stabilizes (i.e., has invaded and established itself well within the plantation), the rate of attack will vary from year to year due to the effects of weather, natural enemies, larval crowding, and other factors.
- An Integrated Pest Management system for spruce weevil should include hazard rating, silvicultural control, use of genetic resistance, and possibly direct control.

Symptoms of weevil attack include:

- Spring: Resin oozing from feeding punctures on the leader.
- Late April–late June: Small oviposition holes plugged with black fecal caps found in the bark at the top of the leading shoot.
- July–August: Wilting tops and the eventual formation of dead "shepherd's crooks" with needle discoloration as they dry out.
- August–September: 2–3 mm diameter adult emergence holes in what was the previous year's leader.
- A cool, wet summer will delay needle discoloration and adult weevil emergence. A hot dry summer will speed insect development and needle colour change.

Hazard Rating[1]



[a] See Meidinger and Pojar (1991) for an explanation of Biogeoclimatic Ecosystem Classification (bec) zone, subzone, and variant abbreviations.

[b] Ss = Sitka spruce, Se = Engelmann spruce.

[c] Hazard is for hybrid Engelmann–white spruce only.

Hazard Rating Key

[1] Hazard ratings are estimates based on limited data. For accurate hazard ratings, degree days of heat accumulation are calculated from temperature data for each subzone (McMullen 1976).

Host: Spruce species

Harvesting Considerations

- Consider leaving naturally regenerated deciduous trees during harvesting or implementing alternative silvicultural systems (e.g., group selection) whenever feasible. Open clearcuts are warmer and favour weevil development. However, more evidence is needed to determine the effect of these management strategies on weevil populations and attack rates.

Silvicultural Considerations

- Feeding and larval mining by this weevil kills terminal growth and, therefore, can cause unacceptable growth loss and stem deformation as lateral branches turn upward and compete for dominance. Forks, crooks, and heavy branching can result.
- This pest can cause extreme depletion of stand productivity. However, as spruce weevil is native to the province, management should aim to minimize damage rather than eradicate the pest.

Establishment

- In low-hazard areas, plant Sitka spruce in accordance with normal species-selection guidelines. Low levels of weevil attack are tolerable at the stand level (e.g., ≤ 10% stems attacked per year).
- In moderate-hazard areas, limit planted Sitka spruce to 20% of the stand composition.
- In high-hazard areas, plant alternative non-host tree species, and limit spruce to 10% of the total stocking.
- Plant spruce with other tree species at higher densities (greater than 1600 stems per hectare) and delay thinning (or don't thin). Weevil attack rates decline when the stand height reaches approximately 12 m.
- When weevil-resistant planting stock is used, a substantially higher percentage of spruce is possible. If improved "A" seed is used (from selected orchard-grown, weevil-resistant trees [R+87]), up to half of the stand could be planted with Sitka spruce in moderate- or high-hazard areas. If "B+" seed is used (from naturally resistant stands [R+64]), exercise caution; only about a third of the stand should be planted with Sitka spruce. Further research is required to refine these recommendations.

Plantation Maintenance

- Maintain high densities; lower densities can promote greater brood survival and allow weevils to more easily locate terminal leaders. Remove seriously damaged trees when thinning.

Silvicultural Considerations (continued)

Plantation Maintenance

- Brushing can increase weevil incidence; however, weigh the benefits of brushing to reduce competition against the impact of the weevil.
- Results from interior studies and preliminary results from coastal studies suggest that an overstorey of non-susceptible tree species (e.g., deciduous trees) reduces weevil incidence on regenerating spruce until they grow beyond a susceptible height. Shading can reduce leader thickness; thinner leaders are less suitable to the weevil. However, this may only be practical on specific sites (e.g., high productivity sites suitable for growing alder) within the high-hazard zone, where the benefit of reduced weevil incidence through overstorey retention is greater than the negative effects to spruce growth as a result of competition. Overstorey densities may require management. The effectiveness of this option requires confirmation from coastal studies.
- When economically viable, prune multiple leaders.
- Although stand fertilization may increase the incidence of weevil attack, the gains in height growth of interior spruce can be larger than growth losses due to weevil attack; however, losses due to deformity have not been assessed.
- Direct control methods for spruce weevil are not recommended (other than for small isolated patches of Sitka spruce). Leader clipping, although potentially successful, is very labour-intensive and must continue for many years.

Forest Productivity Implications

- Volume losses will depend on the outbreak's severity and duration. A severe infestation that persists for 30–40 years may decrease stand volume by as much as 30–40%.
- Although volume may not be substantially affected in some weevil-attacked stands, lumber recovery from chronically attacked trees is a concern due to stem deformities and heavy branching.
- The SWAT (Spruce Weevil ATtack) Decision Support System (Canadian Forest Service, Pacific Forestry Centre 2006) can be used to evaluate weevil incidence and management effects on growth and yield in British Columbia.
- High-severity weevil attacks may shift species composition from Sitka-spruce-dominated stands to western hemlock-, amabilis fir-, and (or) red-alder-dominated stands.

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Western Spruce Budworm – British Columbia's Coastal Forests

David McComb, USDA Forest Service, http://www.forestryimages.org

Western spruce budworm larva and pupa

Characteristics of Susceptible Stands

- Defoliation often occurs in elevational bands across mountain sides, particularly on south- and west-facing slopes.
- Warm, dry sites with greater then 80% Douglas-fir; Douglas-fir is the principal host; amabilis and grand fir are secondary hosts, and spruce is sometimes fed upon.
- Budworm defoliation typically reoccurs in the same general sites during each outbreak episode.

General Information

- Defoliation is most common in the Boston Bar area, the D'arcy/Birkenhead area northeast of Pemberton, and the mountain slopes on the north side of the Lillooet River, northwest of Pemberton. Defoliation occasionally expands beyond these areas, but seldom causes significant damage.
- The budworm is a native component of Douglas-fir forest ecosystems. Populations periodically increase over several years to levels that cause noticeable defoliation (approx. every decade in the CFR). Outbreaks usually last 3–5 years.
- Budworm eggs are laid in summer; without feeding they overwinter as second instar larvae. Larvae emerge in the spring and mine into swelling buds or year-old needles. In early May, the larvae begin feeding on new foliage as the buds expand and grow. Adults begin to emerge by the end of June.

Hazard Rating

BEC Zone[a]	Drier subzones	Wetter subzones
CWH	ds1	ms1
IDF		ww

[a] See Meidinger and Pojar (1991) for an explanation of Biogeoclimatic Ecosystem Classification (BEC) zone, subzone, and variant abbreviations.

Hazard Rating Key

Signs and symptoms of western spruce budworm attack include:

- Reddish brown foliage at the tips of branches; affected trees and stands will appear red; the intensity of colour increases with the severity of defoliation.
- In May and June, larvae occur amongst chewed needles accumulated in webbing at the branch tips.
- Mature larvae have brown heads, olive brown or reddish brown bodies, and two paired white spots on each body segment.
- Defoliation, top-kill, or mortality of host trees; mortality is rare, but may occur after several years of severe defoliation.

Harvesting Considerations

- Even-aged stand management (i.e., clearcut, seedtree, and shelterwood) offers the greatest chance of reducing budworm impacts. Remove seedtree and shelterwood overstorey when regeneration objectives have been met. If partial cutting is employed, choose group selection over single-tree selection; single-tree selection will produce non-recommended uneven-aged stands.
- In high-hazard areas, target uneven-aged mature stands for harvest and conversion to even-aged stands.
- In high-hazard areas, develop age class and species mosaics to reduce budworm impacts over the long term.
- Fire suppression and selection harvesting, especially of non-host species, modify forest conditions that can lead to higher-intensity outbreaks.

Silvicultural Considerations

Establishment

- Re-establishing Douglas-fir in high-hazard areas creates a risk of future defoliation damage; spray treatments may be required to meet regeneration and stand objectives.
- In high-hazard areas, suitable species for reforestation are limited; however, combining non-host species (e.g., ponderosa pine, lodgepole pine) with Douglas-fir in a mixed planting may help to reduce impacts, especially along edges of mature timber; at higher elevations, use hybrid spruce as an alternative to Douglas-fir.
- In high-hazard areas, exercise caution when planting Douglas-fir during an outbreak, or when an outbreak is forecast; seedling mortality is a risk, especially adjacent to affected mature stands.

Plantation Maintenance

- Young stands are the most vulnerable to damage; dead tops can result in stem deformities in a tree's most important log at harvest.
- Dense stands are more susceptible; manage density to target stocking standard and thin from below to maintain even-aged structure.
- Ecosystem restoration treatments that thin and underburn dense uneven-aged stands should reduce budworm populations and damage.
- Commercial thinning should also reduce budworm feeding damage.
- Thinning and fertilizing improve tree vigour and may help trees withstand repeated attacks; however, these treatments may not reduce susceptibility to defoliators.
- Consider the use of spray treatments for young Douglas-fir stands when severe defoliation is predicted for the following year (as determined by predictive egg sampling surveys; refer to the Defoliator Management Guidebook).
- Although several insecticides are currently registered for budworm control, *Bacillus thuringiensis* var. *kurstaki* is the product of choice (refer to the Defoliator Management Guidebook).

Forest Productivity Implications

- A severe attack can cause loss in height and radial increment, dieback, deformities, and, less frequently, mortality.
- If the outbreak lasts 3–5 years or more, as many as one in four trees may die in severely defoliated stands.
- Stands weakened by 3 or more years of defoliation may become susceptible to attack by the Douglas-fir beetle.

Other Associations

- Along with adverse weather conditions (e.g., late frosts, prolonged rainfall during moth dispersal), parasitic insects and predators, such as spiders, insects, and various birds, will reduce abundance of the western spruce budworm.

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Test Your Knowledge . . .

British Columbia's coastal forests: Spruce weevil and western spruce budworm forest health Stand Establishment Decision Aids

How well can you recall some of the main messages in the preceding Extension Note? Test your knowledge by answering the following questions. Answers are at the bottom of the page.

1. What is the most effective method to prevent or limit spruce weevil infestation?
   A) Plant non-host tree species
   B) Plant weevil-resistant spruce seedlings
   C) Plant stands densely
   D) Clip infested leaders

2. What is the resulting damage caused by spruce weevil attack?
   A) Reduced stand productivity
   B) Stunted height growth
   C) Stem deformities
   D) Conversion to other tree species
   E) All of the above

3. Which biogeoclimatic variant is most susceptible to budworm defoliation?
   A) IDFww
   B) CDFmm
   C) CWHds1
   D) CWHms1

4. What is the best preventative treatment for western spruce budworm?
   A) Aerial spray treatments with *Bacillus thuringiensis* var. *kurstaki*
   B) Harvest susceptible stands
   C) Establish and (or) convert stands to an even-aged management regime
   D) Convert to alternative tree species

ANSWERS

1. B 2. E
3. A, although sometimes if weather conditions are favourable in the spring, CWHds1 can receive defoliation while the IDFww does not.
4. C