Western Spruce Budworm Management Strategies

Introduction

The western spruce budworm (*Choristoneura occidentalis*) is a very destructive native defoliator of western coniferous forests, which periodically reaches outbreak levels in British Columbia. It was first recorded in 1909 on Vancouver Island and since that time, infestations have occurred throughout BC. It feeds primarily on Douglas-fir, but is also found on true firs, larch and on spruce.

Landscape of defoliation due to budworm

Trees of all ages are susceptible, although mature forests are preferentially attacked. Mortality is often associated with suppressed or younger trees, particularly in multi-layered stands. Mature trees may also die from the western spruce budworm, depending upon the length and intensity of the outbreak and general tree vigour. Outbreak cycles can last for up to 25 years.

In the Southern Interior Region there have been approximately eight outbreaks recorded since 1916 with over 1.6 million hectares defoliated. Some stands can sustain up to nine consecutive years of defoliation. It has been shown that outbreak frequency, severity and duration have increased over the last century as a result of fire exclusion, forestry practices and changing climate patterns. Climate, host and stand suitability play an important role in outbreak duration and intensity.

In 1987, and again in 2007-2008, over 800,000 hectares were affected by the western spruce budworm, mostly in the southern interior of the province. Effects of budworm defoliation include stem deformities, loss of incremental growth, top kill, and tree mortality. Defoliation can also pre-dispose trees to other forest health problems such as root diseases and the Douglas-fir bark beetle.

Insect description and life cycle

Western spruce budworm moth

Western spruce budworm moths mate and lay eggs in late July-August. The female deposits overlapping, shingle-like egg masses on the underside of foliage on large, overstory Douglas-fir trees. Up to 150 eggs may be laid by each female. The egg masses are bright green when laid, and translucent white when empty. Eggs hatch within 12 days.

Egg mass on a single Douglas-fir needle. Note dark head capsules inside individual eggs.

Newly hatched larvae do not feed. Instead, they seek shelter primarily under bark scales where they overwinter as second instars. In spring, they emerge from their hibernacula (silken webs) and

begin feeding by mining needles or newly swelling buds.

Small budworm larva inside hibernaculum.

Newly hatching western spruce budworm caterpillars

In total, there are six larval instars (stages). As larvae mature they change colour, going from a yellowish-green to an orangey-brown and they also feed more openly as they mature. Mature budworms are about 25 mm long, with a brown body and four distinct spots on each segment. The head is usually browny-black. Larvae feed primarily on new foliage, spinning loose webs, which are used as feeding shelters. If all the new foliage has been destroyed then the insect will feed on old foliage. Damage is most severe in years when this back-feeding occurs.

Severe budworm defoliation on understory trees.

Mature western spruce budworm larvae on Douglas-fir branch feeding gregariously

The budworm pupates in early to mid July, generally within the webbed foliage. Pupae are about 14 mm long, brown and tapered at the tail end. Adults emerge two weeks later and the cycle begins again.

Western spruce budworm pupa

The moths are about 13 mm long with mottled brown wings. Males and females are similar in appearance and the female emits a pheromone to attract the male. Both sexes fly, allowing for long-range dispersal and colonization of new sites.

Tree damage and detection

Tree damage caused by budworm larvae ranges from destruction of needles and developing buds and cones, to complete defoliation. Trees appear reddish in colour as a result of this feeding. The upper part of the crown and the branch tips are defoliated first. The remainder of the foliage can be destroyed as larvae migrate down the crown.

By July, defoliated trees appear scorched. Repeated budworm defoliation causes tree mortality over large areas, reduction of growth rates and reduced lumber quality.

The most noticeable life stages of this insect are the actively feeding caterpillars in spring, which feed within webbed foliage, and make quite a mess. They are very sensitive to disturbance and will fall from their feeding sites if touched. Later in the summer, the moths are quite noticeable as they flutter around the trees looking for egg laying sites. Eggs can be found on the underside of the needles, but these require a more careful examination of the tree.

Current feeding by western spruce budworm caterpillars

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Evidence of back feeding by budworm

Natural control

Western spruce budworms have many natural predators and parasites, as well as viral and fungal diseases, which help maintain populations below outbreak levels. Climate also plays a significant role in budworm success, especially spring weather where windy conditions may dislodge feeding larvae from branches; or late spring frosts, which can freeze them or their food supply. In outbreak conditions, natural factors are not able to hold populations in check.

Short- and long-term management

Short-term direct control measures are taken only when budworm populations reach proportions that threaten stewardship goals and significant tree mortality is imminent. Long-term management strategies can reduce the risk of defoliator damage as well as improve the health and productivity of forested ecosystems.

Short-term management reduces immediate losses through foliage protection and defoliator population reduction. Direct control should be considered when moderate to severe defoliation is predicted in a stand the following year, budworm populations are increasing and tree mortality will occur if spraying is not conducted.

Timing of insecticide treatment usually coincides with peak 4th instar (open feeding caterpillars), depending upon treatment objectives.

Open feeding caterpillar; correct stage for optimal spraying of *B.t.k.*

The Southern Interior Region has a fully integrated management plan for western spruce budworm, which includes the application of a naturally occurring biological insecticide, *Bacillus thuringiensis* var. *kurstaki* (*B.t.k.*) the preferred insecticide treatment for budworm in BC.

Environmental impact due to the application of biological insecticides is minimal, and efficacy is high provided the insecticide is applied in a correct and timely fashion.

Hiller 12-E spraying *B.t.k.* over budworm infested forest

Planning and implementing a spray program

There are a number of critical activities leading up to the successful implementation a spray program for the western spruce budworm. Use hazard rating maps to identify historic areas of budworm activity. Hazard maps are based on forest species and age composition overlayed with historic budworm defoliation. In August of each year aerial overview data is available showing the most recent areas of budworm defoliation, by severity. Within the hazard areas and currently defoliated sites identify priority management areas. Use all of this information as a starting point for identifying areas to conduct fall egg mass sampling (this will give the predicted defoliation for the coming year). Areas where moderate to severe defoliation is predicted for the coming year, and has already incurred

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one or more years of defoliation, should be considered for treatment. Delineate potential spray blocks.

Ensure that there is an updated "Pest Management Plan" in place for the areas of interest that will be sprayed (administered by Ministry of Environment). Consult and meet with First Nations and other interest groups. In February order sufficient *B.t.k.* to treat high priority sites (application rate of 2.4 litres per ha).

Determine the aircraft type that will be applying the *B.t.k.* Fixed-wing application will need an airstrip within a reasonable distance of spray blocks and all *B.t.k* must be delivered to these airstrips. Rotary-wing aircraft usually stage from within a spray block so large enough openings must be located for staging sites Helicopters load from these sites so fuel and *B.t.k.* must be delivered to staging sites.

Lama helicopter being loaded with *B.t.k.* on staging site.

In order for *B.t.k* to be effective, insects must be actively, open feeding on newly expanded shoots. Typically 4th instar larvae are targeted (mid- to late-June) to achieve optimal foliage protection. Larvae feed most actively in warm, dry weather. For aerial application, wind speeds should not exceed 8 kph (gust to 15 kph), the relative humidity should be > 50%, temperature up to 20°C and there should be no heavy precipitation immediately prior to, during, or after the spray.

Hiller 12-E helicopter spraying *B.t.k.* over an infested forest

Long-term management goals seek to reduce the impact of western spruce budworm on susceptible interior forests through silvicultural practices such as promoting species diversity and lowering stand density. Developing lower density stands having fewer canopy layers (i.e. removing the understory layers through controlled burns or spacing in suitable areas) will increase tree resilience and decrease susceptibility. Encouraging an age/species mosaic across the landscape will also decrease hazard to the western spruce budworm.

Underburning Interior Douglas-fir stands can create more resilient forests.

For more information on western spruce budworm and its control, please contact:

British Columbia Ministry of Forests and Range
Southern Interior Regional Office, Kamloops, BC
Website: http://www.for.gov.bc.ca/rsi/ForestHealth/Western_Spruce_Budworm.htm
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