

## Western Spruce Budworm Biology & History

The western spruce budworm is an important native defoliator of Interior Douglas-fir. Other tree species such as the true firs, larch and, to a lesser degree, spruce can also be affected.

Periodically, population levels reach outbreak proportions in B.C., the most current of which covered 800,000 ha at its peak in 1987, mostly in B.C.'s southern Interior. Outbreaks in susceptible interior forests are thought to be influenced primarily by weather, and therefore fluctuate in an irregular and unpredictable fashion. Budworm outbreaks may be sustained for up to 25 years.

### Stand Susceptibility

The greatest impact and highest mortality due to budworm is among suppressed and intermediate trees. Factors contributing to stand susceptibility include:

- high stand density
- species composition (high Douglas-fir component)
- stand structure (single versus multi-layered)
- elevation
- aspect
- tree vigor



**Pupa:** The larva pupates from late June to mid-July. The reddish brown pupa is 12-16 mm long, being broad at the head end, tapering to a point at the rear. The pupal stage lasts on average two weeks.

Table 14, below, presents expected volume losses in stands in B.C.'s southern Interior given three different levels of defoliation. Reduction in the 20-year periodic annual increment of the total volume averaged 54.1, 75.0 and 82.3%, for light, moderate, and severe infestations.

Loss		Average per cent losses in three levels of defoliation ( $\pm$ S.D.)		
Type	Period	Light	Moderate	Severe
Total volume	10 years	5.9 (1.8)	19.5 (6.1)	28.2 (9.4)
Total volume	20 years	6.2 (2.1)	23.3 (17.1)	32.8 (10.2)
Harvest volume	10 years	8.3 (5.6)	18.9 (11.0)	25.4 (13.8)
Harvest volume	20 years	6.1 (3.5)	24.0 (12.4)	31.8 (14.9)

**Table 14.** Average per cent loss in the first decade of a 20-year projection in total volume (volume of all trees, between stump and 10 cm top diameter) and harvest volume (volume of logs from trees with a dbh of 30 cm or greater) in interior B.C. after a simulated 7-year western spruce budworm infestation.

Repeated budworm defoliation causes scattered tree mortality over large areas, reduction of growth rates, volume loss and reduced lumber quality. Sustained attack results in complete defoliation in four to five years. Once an infestation has subsided, defoliated trees take several years to regain a full foliage complement and, therefore, radial growth rates require several years to attain normal growth. Successive years of defoliation in stands may predispose trees to other insects and pathogens. Tree mortality may continue due to root disease, bark beetles, loss of vigor, and other causes even though the infestation has subsided.

Past forestry practices in the interior Douglas-fir types have exacerbated the impact of budworm. Selective harvesting has removed much of the ponderosa pine component, leaving a predominantly Douglas-fir forest. Pine regeneration has been excluded on many sites due to the regenerative features of Douglas-fir. In a more natural scenario, frequent ground fires would kill much of this regeneration, promoting a higher proportion of ponderosa pine.

However, improved fire suppression has resulted in dense regeneration of Douglas-fir in some stands, particularly in the suppressed and intermediate layers. This combination of reduced species mix, fire exclusion, multi-layered canopies and dense understorey and intermediate canopies, has created a high hazard environment in terms of the budworm.

## Population dynamics

Outbreaks of western spruce budworm are influenced primarily by climate and weather and, therefore, fluctuate in an irregular and unpredictable manner. In stands which are chronically affected by budworm, outbreaks may be sustained for 25 years or longer. Feeding by larvae causes damage to buds, cones, and new



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Budworm moths mate and lay eggs in late July through August. The eggs are laid in masses (up to 150) on the underside of needles, overlapping like fish scales. They are bright green when laid, measuring slightly less than 1 cm in total length, and become translucent when empty. They hatch within 12 days

foliage. When populations reach very high densities, larvae will also back-feed on the older foliage causing significant damage in one growing season. Understorey trees in multi-layered stands may sustain intense damage due to larval migration from overstorey trees.

By combining the historical occurrence of outbreaks, both in terms of area affected and periodicity of outbreaks, with stand parameters influencing hazard (Table 13), the relative risk in a particular area can be estimated.

Outbreaks may decline through any combination of processes that operate against any one of the life stages. Exceptionally low survival of 2nd instar larvae could be caused by differences in timing between larval emergence from hibernation and budburst, late frosts that destroy both the new foliage and the budworm, foliage depletion through previous feeding, and prolonged rainfall during moth dispersal. Natural mortality factors include parasites, predators (mainly ants and birds), pathogens, and starvation.