## Western Spruce Budworm

*Choristoneura occidentalis* Freeman
Lepidoptera: Tortricidae

Schmid, J. M. 1984. Larval densities, mortality, and sampling at different canopy levels during a western spruce budworm (Lepidoptera: Tortricidae) suppression project. Environmental Entomology 13: 781-786.

**Objective:** To evaluate four sampling designs for *C. occidentalis* larvae on Douglas-fir and white fir before and after chemical application for suppression.

**Abstract:** Western spruce budworm, *Choristoneura occidentalis* Freeman, is an important pest of Douglas-fir [*Psuedotsugae menziesii* (Mirb.) Franco], true firs (*Abies* spp.), Englemann spruce (*Picea englemannii* Parry ex. Englem.), and larch (*Larix occidentalis* Nutt.) in the western US and Canada. Infestations in mature stands result in growth loss, top kill, and occasional tree mortality. Post-spray sampling of *C. occidentalis* larvae has followed a plan adapted from *C. occidentalis* egg mass surveys, where two mid-crown branches are taken from opposite sides from each of three Douglas-firs in a cluster, with 25 clusters of trees sampled throughout the spray unit. It was unknown if this plan accurately estimated larval mortality in lower crowns. Four new sampling designs were evaluated on Douglas-fir and white fir [*Abies concolor* (Gord. & Glend.] in northern New Mexico, USA. The sampling plans consisted of taking from each plot: 1) one branch from a single tree, 2) one branch from each tree in a cluster of three trees, 3) two branches from each tree in a cluster of three trees, or 4) a single branch from each tree in a cluster of six trees.

Variation in larval densities among crown levels was rarely significant in Douglas-fir, suggesting that samples could be collected from the lower crown if the lowest branches were avoided, thereby decreasing sampling effort and costs. In contrast, sampling should be restricted to the mid-crown of white fir due to inter-crown variation when sampling from clusters of trees. Sampling additional branches from a crown level, or taking one branch from both the mid- and lower crown increased sampling effort and cost with no improvement in sampling precision.

Mid-crown larval densities were similar for all four plans, indicating that each design was similar in accuracy. While the single branch per tree plan was the most economical in terms of sampling costs, it was not as precise as the other plans using clusters of trees at a higher associated cost of sampling. Significant variation among plots was observed, but significant variation among trees within plots was minimal. These results suggest that sampling a larger number of plots would improve the precision of all designs, but sampling a cluster of three or more trees does not necessarily improve the precision while increasing the cost of sampling. The authors recommended sampling a single branch from one tree in each plot if reduced sampling cost was desirable, or sampling a single branch from each tree in a cluster of three trees within a plot if increased precision was more desirable. Either design was

considered advantageous over the current sampling plan of two mid-crown branches from each of three Douglas-firs in a cluster.

**Sampling Procedure:** Refer to Table 4 for the appropriate number of plots and trees needed to obtain the desired coefficient of variance of 0.1 or 0.2. Establish the appropriate number of plots 100–200 m apart in areas to be sampled. Plots must be evenly distributed throughout the sampling area to fully measure the variation in *C. occidentalis* larval populations.

Each plot should contain seven Douglas-fir or white fir trees 8–15 m tall, even though not all seven trees will be sampled. Randomly select trees for sampling within each plot. Sample either Douglas-fir or white fir; do not combine data from both tree species. If minimizing sampling costs is an objective, sample one branch from a single tree within each plot. If increased precision is an objective, sample one branch from each tree in a cluster of 3 trees within each plot. Sample trees when third and fourth *C. occidentalis* instars are present. Collect pre- and post-spray samples if studying the efficacy of chemical suppression.

Using pole pruners, sample 35–50 cm branch tips from either the middle crown of white fir or from the lower crown of Douglas-fir. Avoid sampling the lowest branches on Douglas-fir. Record the number of *C. occidentalis* larvae, the number of new shoots or buds present, and the overall area of the branch ($cm^2$) for each sample. Express the data as the number of larvae per 100 buds and/or $m^2$ of foliage.

**Table**

Table 4. Number of plots and trees needed to obtain coefficients of variation (CV) of 0.1 and 0.2 of the mean number of larvae per $m^2$ of foliage on middle crown branches of Douglas-fir and white fir.

| Host / Sampling period / CV | Sampling Design: 1 branch from 1 tree | 1 branch from each of 3 trees | 2 branches from each of 3 trees | 1 branch from each of 6 trees |
|---|---|---|---|---|
| Douglas-fir | | | | |
| Before spraying | | | | |
| 0.1 | 76 (76)[a] | 40 (120) | 35 (105) | 30 (180) |
| 0.2 | 19 (19) | 10 (30) | 9 (27) | 8 (48) |
| After spraying | | | | |
| 0.1 | 272 (272) | 175 (525) | 113 (339) | 154 (924) |
| 0.2 | 68 (68) | 44 (132) | 28 (84) | 39 (234) |
| White fir | | | | |
| Before spraying | | | | |
| 0.1 | 48 (48) | 20 (60) | 20 (60) | 14 (84) |
| 0.2 | 12 (12) | 5 (15) | 5 (15) | 3 (18) |
| After spraying | | | | |
| 0.1 | 320 (320) | 174 (522) | 107 (321) | 133 (798) |
| 0.2 | 80 (80) | 43 (129) | 27 (81) | 33 (198) |

[a]Number of trees in parenthesis.