## Spruce Budworm

*Choristoneura fumiferana* (Clemens)
Lepidoptera: Tortricidae

Montgomery, B. A.; Simmons, G. A.; Witter, J. A.; Flexner, J. L. 1982. The spruce budworm handbook: a management guide for spruce-fir stands in the Lake States. Handb. 82-7. Ann Arbor, MI: Michigan Cooperative Forest Pest Management Program; 35 p.

**Objectives:** To provide a summary of sampling plans for adults, larvae, pupae, and egg masses of *C. fumiferana* for stands of white spruce and balsam fir in the Great Lakes region; to describe methods of estimating defoliation in this region.

**Abstract:** Spruce budworm, *Choristoneura fumiferana* (Clemens), is the most destructive defoliator of balsam fir, *Abies balsamea* (L.) Mill., and white spruce, *Picea glauca* (Moench) Voss, in eastern North America. The last three larval instars cause most of the defoliation. Periodic outbreaks occur every 30 years and epidemics can last 5–10 years.

Methods used to sample *C. fumiferana* in the Great Lakes region of the US are summarized as a cooperative effort between the U.S. Department of Agriculture and the Canadian Department of the Environment. Detailed information on sampling all life stages of *C. fumiferana*, as well as aerial surveys of feeding damage, are presented in the handbook. Such methods allow forest managers to monitor endemic populations of *C. fumiferana* and detect increasing densities before defoliation and tree mortality occurs.

**Sampling Procedure:**

**Aerial survey of defoliation:** Conduct surveys in late July when infested foliage appears reddish-brown. At a height of 305 m, fly east and west lines 4.8 km apart. Use 1:50,000 scale maps to delineate areas of infestation and measure the acreage with a dot grid. Determine the level of defoliation and stand condition using the following codes established by the USDA Forest Service, State and Private Forestry:

| | Defoliation | | Stand Condition |
|---|---|---|---|
| L. | Light to Moderate, 0 to 50% of crown showing red-brown discoloration. | | No tree mortality or top kill. |
| H. | Heavy, 51 to 100% of crown showing red-brown discoloration. | | No tree mortality or top kill. |
| S. | Severe, 51 to 100% of crown showing red-brown and gray discoloration. | | Tree mortality and top kill. |

Follow the aerial survey with a ground check of 10% of the heavily or severely defoliated areas to verify that *C. fumiferana* produced the observed damage and that the aerial mapping was accurate.

**Ground assessment of defoliation using the Fettes Method:** This technique is generally used with a sampling method for insects. In July and August, cut branches from the mid-crown of white spruce or balsam fir trees. Visually estimate the percentage of defoliation (needles removed) from each current-year shoot on each branch (Fig. 6). Average the percentage of defoliation of the current-year shoots to obtain an overall percentage of defoliation for the branch. Determine the level of defoliation using the following categories:

| Defoliation level | Percent defoliation |
|---|---|
| Trace | 0 to 5 |
| Low | 6 to 20 |
| Moderate | 21 to 50 |
| High | 51 to 80 |
| Severe | 81 to 100+ |

**Binocular assessment of defoliation:** This technique is used independently of insect populations. Evaluate stand defoliation of spruce and fir trees using binoculars. Rank the green (live foliage) portion of the crown using the following categories:

| | |
|---|---|
| 1 | No defoliation: no observable feeding damage, 0 to 20% of total foliage missing. |
| 2 | Light to moderate defoliation: 21 to 50% defoliation of total foliage. |
| 3 | Heavy defoliation: 51% or greater defoliation with no observable top-kill. |
| 4 | Severe defoliation: 51% or greater defoliation with obvious top-kill. |

**Sampling pupae:** Sampling should not be conducted until all larvae have pupated (late June or early July) but can continue through moth emergence (August) by counting pupal cases. However, empty pupal cases can be dislodged from branches so sampling earlier will provide a more accurate estimate of population density. Pupal sampling requires less time and is less expensive than sampling egg masses.

Randomly select two dominant or co-dominant balsam fir or white spruce trees at each of five collection sites in a stand. Clip one branch at least 45-cm long from the upper mid-crown of both trees. Use pole pruners with a collection basket below the cutting head to catch the branches. Examine each branch and tally the number of pupae and empty pupal cases on the apical 45-cm length. Compare the cumulative pupal density to Table 3 to classify the population of *C. fumiferana* in the stand as high or low densities.

**Sampling adults:** As of 1982, pheromone traps had been tested but not used operationally in the Great Lakes region. Test trials showed that traps baited with *C. fumiferana* sex pheromone effectively attracted males even when larval densities were below 1 larva per branch.

Prioritize stands for sampling, taking into consideration stand accessibility, value, and risk rating. Establish 1 to 5 permanent sampling sites in 25 to 50% of the stands identified as having the highest risk. Deploy traps baited with synthetic spruce budworm pheromone at the permanent sampling sites in early summer, before larvae pupate. Hang traps on branches 2 m above ground with no branches or foliage within 30 cm of each trap to open the air space (trim foliage if needed). Leave traps undisturbed from late June through July until the flight period is completed and then tally the number of captured moths in each trap. Plot the total trap catch over years to detect increasing densities. Large increases in the number of trapped moths over several consecutive years may signal an incipient outbreak of *C. fumiferana* within 3–5 years and precautions should be considered to limit tree damage and mortality.

**Sampling egg masses:** Egg mass surveys are more time-consuming and expensive than sampling pupae. Sampling should begin after adult moths are no longer present (usually August) and can continue through September. Randomly select 1 to 3 collection sites for each 16-ha stand. At each collection site, use pole pruners to cut three 38-cm mid-crown branches from each of 3 balsam firs or 5 white spruces. Trees should be dominant or co-dominant. Count the number of current-year egg masses (i.e., round, green/white egg masses) on each branch. Do not include old egg masses that appear flat and gray or parasitized egg masses, which appear black. Calculate the mean number of current-year egg masses per branch and use Table 4 to predict the defoliation level expected for that stand the following summer.

**Sampling small larvae (second instars):** This procedure is a useful alternative if egg mass surveys are limited by available resources. Sample second instars between September and April in most areas. Using pole pruners, cut several 45-cm branch tips randomly through the upper mid-crown of several dominant balsam firs or white spruces. Trees should be widely distributed. Allow branch samples to thaw overnight in the laboratory before cutting them into 5–10 cm pieces. Place pieces in a wire basket and submerge into a bucket containing 9 liters of 2% aqueous solution of sodium hydroxide between 49-60°C (120-140°F) overnight. Agitate the soaked branch pieces and collect all needles and bark scales into labeled collection jars. Filter the contents of each jar through sieves and a separation funnel. Add hexane to the oil/water interface where most of the larvae collect and vacuum filter the larvae onto gridded filter paper. Using a stereomicroscope, count the number of larvae on the filter paper to determine the number of larvae per branch. Refer to Sanders (1980) for more detailed information regarding this procedure.

**Notes:** These procedures are established for balsam fir and white spruce in upper Minnesota and Wisconsin as well as Michigan's Upper Peninsula. As such, these procedures may not be effective for other host trees or in other geographical regions.

The authors did not specify the number of branch samples per tree or the number of trees to be sampled when sampling second instars. Do not expose hexane to flame or another heat source as it is an explosive, volatile chemical.

**References**

* Sanders, C. J. 1980. A summary of current techniques used for sampling spruce budworm populations and estimating defoliation in eastern Canada. Rep. 0-X-306. Canadian Forest Service, Great Lakes Forestry Centre; 33 p.

**Figure and Tables**

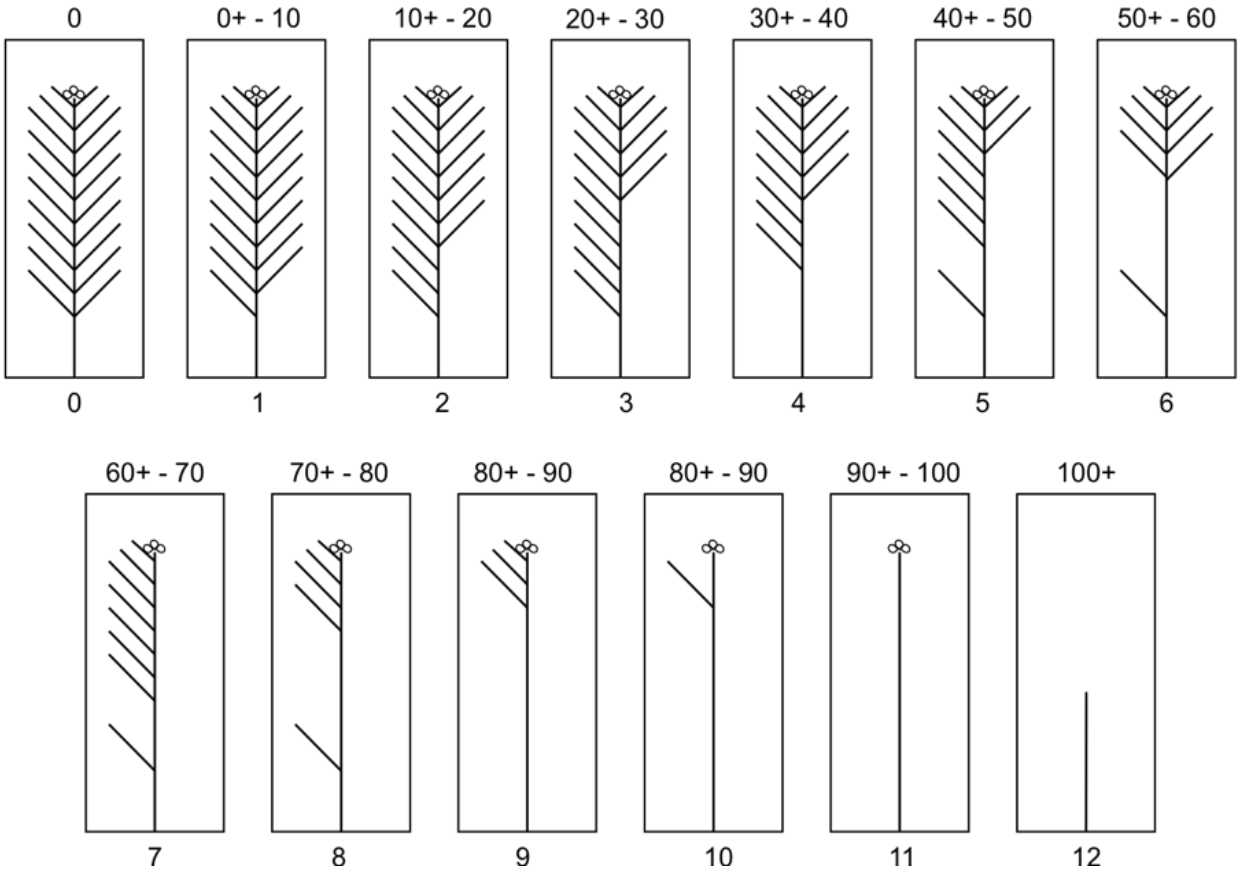


Fig. 6. Fettes method of estimating defoliation.

Table 3. Classification of the number of budworm pupae per 18-in. (45-cm) branch tip on balsam fir into low or high population densities.

| Number of sampled branches per stand | Population category | |
|---|---|---|
| | Low | High |
| | (Cumulative pupae) | |
| 2 | — | 33 or more |
| 4 | 1 or less | 50 |
| 6 | 5 | 66 |
| 8 | 10 | 83 |
| 10 | 14 | 100 |

The same classification is also currently being used for white spruce.

Table 4. Defoliation predictions based on the average number of egg masses per 15-in. (38-cm) balsam fir branch.

| Average number of egg masses/branch/stand | Expected defoliation | |
|---|---|---|
| | % | intensity |
| Less than 0.2 | less than 26 | Light |
| 0.2 –0.5 | 26–50 | Moderate |
| 0.6 –0.9 | 51–75 | Heavy |
| more than 1.0 | more than 75 | Severe |

Less defoliation would be expected for similar egg mass density levels on white spruce.