Spruce Budworm

Choristoneura fumiferana (Clemens)
Lepidoptera: Tortricidae

Witter, J. A.; Lynch, A. M. 1985. Spruce budworms handbook: rating spruce-fir stands for spruce budworm damage in eastern North America. Agric. Handb. 636. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 22 p.

Objective: To describe several hazard-rating systems for *C. fumiferana* that provide information for short-term management decisions.

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, while epidemics can last 5–10 years.

The hazard-rating systems for *C. fumiferana* summarized in this handbook are a compilation resulting from a cooperative effort between the U.S. Department of Agriculture and the Canadian Department of the Environment (CANUSA). Ground-based and aerial sampling procedures allow forest managers to identify high-risk areas suitable for protective spraying or salvage operations using short-term (1–3 year) management decisions.

Sampling Procedure:

Ground-based sampling (based on Trial and Devine 1983): Conduct aerial surveys over spruce-fir stands in July and August and map the extent of defoliation over regional areas. Sample egg masses or overwintering second instars in August and September over widespread areas (1,000+ sampling sites used in Maine, 1982). Cut one branch from each of three dominant or codominant fir trees at each sampling site. Estimate the number of fresh egg masses or second instar *C. fumiferana* per 9.3 m^2 (100 sq. ft.) from the three branch samples. Estimate the level of defoliation of the current year and the previous year, as well as tree vigor, from these branch samples. In early fall, calculate a hazard-rating value for each stand or sample site using Table 1 and summing the values for each parameter included in the table. Develop a budworm population prediction map using the egg mass or second instar densities. Develop a composite hazard map using the individual stand hazard values generated from Table 1. Select spray or salvage areas for next year based on the composite hazard map while considering the availability of resources and weighing other inputs (i.e., social, political, and economic conditions).

Aerial sampling system (based on McCarthy et al. 1983): Take color photographs (35- or 70-mm) with stereo overlap from fixed-wing, light aircraft over spruce-fir stands. Interpret stand defoliation, mortality, density, and proportion of host species from the photos using Table 2. Rank crown defoliation as follows:

1 = 0–20%
2 = 21–50%
3 = 51% or more without topkill
4 = 51% or more with topkill

Compute the average tree defoliation rank for a stand and compare to the overall class label in Table 2. Calculate the percent mortality of host tree species in the stand and assign a class rank. Describe each stand as open, average, or dense. Calculate the proportion of stand comprised of host tree species and assign a class rank according to stand density. Finally, determine the overall stand hazard-rating value by summing the class ranks described above and comparing to Table 2. The hazard-rating value reflects the relative probability that a particular stand will be attacked and damaged by *C. fumiferana* during the next several years.

Notes: The ground-based sampling procedure is based on practices conducted in Maine in 1982. For more information, see Trial and Devine 1983. Olsen et al. (1982) produced an instruction manual for use with the aerial sampling system; see the original publication for more information.

References:

Trial, H., Jr.; Devine, M. E. Spruce budworm in Maine: results of the 1982 project, biological conditions in 1982 and expected infestation conditions for 1983. Tech. Rep. 19. Augusta, ME: Maine Department of Conservation, Maine Forest Service; 1983. 76 p.

McCarthy, J.; Olson, C. E., Jr.; Witter, J. A. 1983. Assessing spruce budworm damage with small-format aerial photographs. Canadian Journal of Forest Research 13: 395-399.

Olson, C. E., Jr.; Sacks, P. J.; Witter, J. A.; Bergelin, L. A. 1982. Spruce budworm damage assessment with 35 mm air photos: a training manual. Rep. 82-1A. Ann Arbor, MI: The University of Michigan, School of Natural Resources, Remote Sensing Laboratory. 41 p.

Tables

Table 1. Hazard-rating system used in Maine during 1982 (modified from Trial and Devine 1983).

Current defoliation (%)		**Value**	**Previous defoliation (%)**[1]		**Value**[2]
Trace	0–5	0	Trace	0–9	0
Light	6–20	1	Light	10–49	3
Moderate	21–50	2	Moderate	50–129	6
Heavy	51–80	4	Severe	130+	9
Severe	81+	6			

Egg-mass or overwintering larval deposit (number)			
Category	*Egg masses*[3]	*Second instar larvae*[4]	*Value*
Light	0–99	0–175	1
Moderate	100–239	176–500	2
High	240–399	501–1099	3
Very high	400–999	1100+	5
Extreme	1000+	1100+	5

		Total hazard rating	
Tree Vigor	**Value**	*Category*	*Hazard value*
Good (current foliage healthy)	0	Low	0–6
Fair (shoot production moderate)	1	Moderate	7–15
Poor (some growth capacity)	2	High	16–22
Very poor (nil)	3	Severe	23–26

[1]The 2 previous years' needles.
[2]Add three points if there are trees with dead tops in the area (10 to 20 percent of the trees).
[3]Number of budworm egg masses/100 ft^2 (9.3 m^2) of foliage.
[4]Number of second-instar budworm larvae/100 ft^2 of foliage.

Table 2. Stand hazard-rating values obtained from 35-mm photographs and used to predict amount potential damage (modified from Olson et al. 1982, McCarthy et al. 1983).

Average stand defoliation rank	**Class label**	**Class value**
0.0–1.2	Trace	0
1.3–1.9	Light	1
2.0–2.9	Moderate	2
3.0–4.0	Heavy	3

Stand mortality (%)		**Value**
Low	0–9	0
Medium	10–29	2
High	30–49	4
Severe	≥50	6

Proportion of stand in host species

Proportion of host species	*Stand density value*		
	Open	Average	Dense
< 30	1	1	2
30 to 60	2	2	4
> 60	3	4	6

Stand hazard-rating value

Category	*Hazard value*
Low	0–4
Moderate	5–8
High	9–10
Severe	11–15