Douglas-Fir Tussock Moth

Orgyia pseudotsugata (McDonnough)
Lepidoptera: Lymantriidae

Mason, R. R.; Scott, D. W.; Paul, H. G. 1993. Forecasting outbreaks of the Douglas-fir tussock moth from lower crown cocoon samples. Research Pap. PNW-RP-460. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station; 12 p.

Objective: To determine whether suboutbreak populations of *O. pseudotsugata* will develop into a damaging outbreak the following season, based on the cocoon density present in the lower crown.

Abstract: Douglas-fir tussock moth, *Orgyia pseudotsugata* (McDonnough), is a periodic defoliator of Douglas-fir, *Pseudotsuga menziesii* (Mirb.), and true firs, *Abies* spp., in western North America. Outbreaks occur quite unexpectedly every 7–10 years and usually persist for 3–4 years. Defoliation by *O. pseudotsugata* can be severe and cause widespread tree mortality during the first year of an outbreak. Surviving trees may exhibit growth loss, top-kill, and tree deformity.

Research conducted throughout the Pacific Northwest indicates that, when *O. pseudotsugata* populations are in a suboutbreak phase, the density of cocoons in the lower crown is a good estimator of midcrown larval density the following year. This relationship between the number of cocoons per 0.65 m^2 of branch area in the lower crown (X) and the number of small larvae per 0.65 m^2 of branch area in the midcrown (Y) is expressed by the equation $Y = 1.70 + 55.14X$ ($R^2 = 0.66$). In general, each cocoon sampled from the lower crown in the fall represents 55–65 larvae in the midcrown the following spring. Furthermore, the density of sampled cocoons is related to the level of expected defoliation the following spring. Land managers using this technique to forecast larval densities can decide whether the application of suppression tactics is necessary the following spring with sufficient time to plan operations over the winter months.

Sampling Procedure: Determine the number of plots necessary to estimate cocoon densities at the desired level of precision, assuming 50 host trees are sampled in each plot (Table 3). Several plots of 50 trees each should be sampled to forecast larval densities the following year. Selected stands should have had increasing populations of *O. pseudotsugata* over the past several years but no defoliation should be apparent.

Sample cocoons in the fall, after moths have emerged and laid eggs. Randomly select 50 trees in each plot and cut three 45 cm terminal branches from the lower crown of each tree. Examine the underside of each branch sample for the presence or absence of *O. pseudotsugata* cocoons. Tally the number of 3-branch sample units with at least one cocoon present on a branch. Calculate the proportion of infested trees (*p*) using

the equation p = r/n, where r = the total number of sampled trees with at least one cocoon present and n = the total number of trees sampled.

Convert the proportion of infested trees (p) into the number of cocoons per 0.65 m^2 (1000 $inch^2$) of branch area (X) using the equation X = -2 ln(1-p) (Mason 1977). Alternatively, determine the total number of cocoons per 0.65 m^2 of branch area (X) using the following equation:

$$X = \frac{2\sum_{i=1}^{n} y_i}{n}$$

where y_i = the number of cocoons on the ith sample unit and n = the number of sample trees.

Calculate the number of small larvae per 0.65 m^2 of branch area in the midcrown (Y) expected next year from the number of cocoons per 0.65 m^2 of branch area in the lower crown (X) using the equation Y = 1.70 + 55.14X. Consult Table 4 to review the level of expected defoliation associated with the predicted density of young larvae the next year. The regression equation Y = 1.70 + 55.14X was developed from a dataset containing some very high densities of larvae from several geographic locations, so the model may overestimate subsequent larval densities more frequently than it underestimates populations.

Notes: This sampling method was developed using data from *O. pseudotsugata* populations that have been increasing in recent years but have not yet produced visible defoliation. The relationship between densities of cocoons and small larvae is less definable in outbreak conditions, when defoliation is visible on most trees, due to increasing variability produced by density-dependent mortality factors.

Reference:

* Mason, R. R. 1977. Sampling low density populations of the Douglas-fir tussock moth by frequency of occurrence in the lower crown. Res. Pap. PNW-216. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 8 p.

Tables

Table 3. Number of plots required to estimate cocoon densities at different levels of precision when sampling 50 trees per plot[a]

Mean cocoon density	Standard error as percent of the mean					
	10	20	30	40	50	60
No./1000 in²						
0.20	81	20	9	5	3	2
0.40	64	16	7	4	3	2
0.60	55	14	6	3	2	2
0.80	50	12	6	3	2	1
1.00	46	11	5	3	2	1
1.20	43	11	5	3	2	1
1.40	41	10	5	3	2	1

[a]Sample size, n, was calculated by solving the equation $n = s_2/s^2x$ where s^2 is between-plot variance and sx the desired standard error

Table 4. Relation of estimated cocoon densities in preoutbreak populations of the Douglas-fir tussock moth to predicted larval densities and status in the next generation

Range of cocoon densities in the lower crown	Predicted larval densities in the midcrown	Predicted population status
————No./1000 square inches————		
<0.01	<2.0	Low density; no defoliation
0.01–0.30	2.0–20.0	Suboutbreak; little or no visible defoliation
0.31–0.70	21.0–40.0	Moderate outbreak; defoliation visible on most host trees
>0.70	>40.0	Severe outbreak; defoliation intense in upper crowns of many host trees with some trees completely defoliated