ODC 453--145.7 x 18.77 *Lymantria dispar* (L.):652.54

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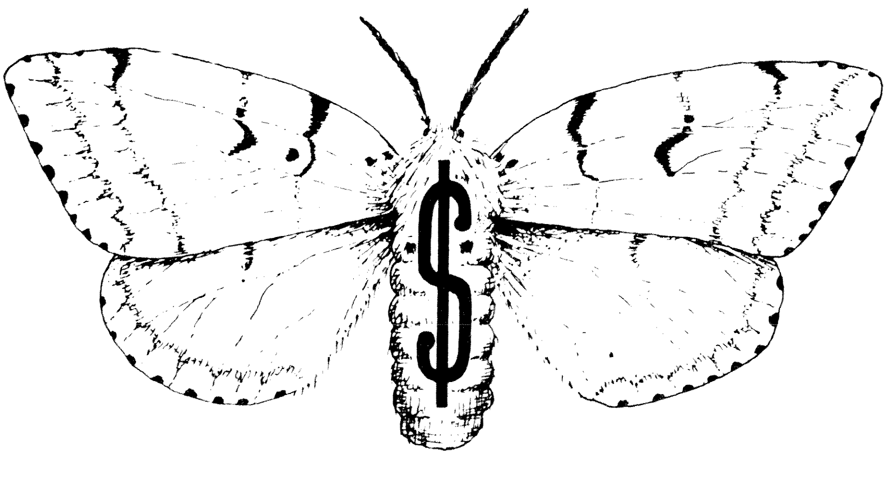
Economic Analysis of the Gypsy Moth Problem in the Northeast

IV. Forest Stand Hazard Ratings For Gypsy Moth



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Abstract

Provides a practical method for rating the potential hazard of impending gypsy moth attacks to forest stands. Stepwise multiple regression analysis is used to develop equations for estimating tree mortality from easy-to-measure key characteristics of stand condition.

This is part of the series of publications on the economic impact of the gypsy moth.

THE GYPSY MOTH, *Lymantria dispar* (L.) [1] is still going strong. During 1977 it defoliated 1.6 million acres of forest land. Half of the defoliation was severe and most of it occurred in Pennsylvania.

Decisions about controlling the gypsy moth are being made every year. They are often based on intuition alone because there are no reliable and practical means for predicting and evaluating impacts of the insect. In working toward a solution to this problem, we have developed models for rating the potential hazard of impending gypsy moth attacks to forest stands—simple equations that predict tree mortality in terms of easy-to-measure key characteristics of stand condition.

APPROACH

Underlying the development of the hazard rating equations is the premise that tree mortality caused by the gypsy moth in any particular forest stand is related to and can therefore be expressed as a function of selected characteristics of that stand's condition. Stepwise multiple regression analysis was used to develop equations for estimating tree mortality as a function of stand characteristics.

Data used for the analysis were collected from 1/10-acre sample field plots in Pike and Monroe Counties, Pennsylvania. This area was the frontier of gypsy moth infestation in 1970. The information came from 143 plots that remained untreated throughout the 1970-76 study period. Only trees 3 inches dbh and larger were considered. Cumulative tree mortality on the sample plots ranged from 0 to 67 percent and averaged 13 percent. Volume loss ranged from 0 to 26.6 cords per acre and averaged 2.5 cords. Value loss ranged from $0 to $468 per acre and averaged $14.

[1] Lepidoptera: Lymantriidae

Dependent variables

Two dependent variables were analyzed to rate forest stands for tree mortality caused by gypsy moth:

- Number of trees per acre that died during the study period
- Percentage of trees that died during the study period

Independent variables

A variety of forest stand characteristics assumed to be good predictors of tree loss were selected for analysis. They are measures of:

Stand-size composition
Species composition
Average tree diameter
Timber stocking
Stand age
Crown position
Crown condition
Site index
Land capability
Elevation

Aspect
Slope
Positon on slope

The choice of these variables was based primarily on findings of Kegg (1971), Campbell and Sloan (1977) Houston and Valentine (1977) and our own work (Herrick et al. 1978).

Data for these variables provided input for development of the hazard rating equations.

RESULTS

Stepwise multiple regression analyses gave us two simple equations for rating the hazard (HR) of impending gypsy moth attacks to forest stands:

$$HRN = 11.85 + 0.82\ (NPC) + 0.0005\ (NWO)^2$$
$$R^2 = 0.73$$

$$HRP = 4.16 + 0.83\ (PPC) + 0.001\ (PWO)^2$$
$$R^2 = 0.57$$

where HRN = Number of trees per acre that will die

HRP = Percentage of trees that will die
NPC = Number of live trees per acre with poor crowns[2]
NWO = Number of live trees per acre in the white oak species group
PPC = Percentage of live trees with poor crowns
PWO = Percentage of live trees in the white oak species group

Only two of the many elements of stand condition analyzed as independent variables are included in these equations and their inclusion makes good sense. *White oaks* are a preferred food of the gypsy moth and are usually attacked more severely than other tree species. Trees with *poor crowns* have low vigor and are more likely to die after defoliation.

The coefficient of multiple determination (R^2) for each equation is greater than 0.57. Thus the relatively small number of independent variables included in these equations explain a rather large share of the variation in tree mortality for the sample plots; the models fit the sample data rather well.

A CHECK ON PERFORMANCE

Does it work? This is the real measure of any predictive model's worth. Plans have been made by Northeastern Area State and Private Forestry's Forest Insect and Disease Management staff of the U.S. Forest Service to test and improve this and other systems for predicting and evaluating impacts of the gypsy moth. The tests are planned for forest stands in Pennsylvania, West Virginia and Maryland in advance of gypsy moth outbreaks.

We checked the performance of the hazard rating equations by applying them to the 143 sample plots used in this study. Tree loss estimated by the equations was compared with actual loss recorded on the plots. Each plot was assigned hazard ratings based on predicted estimates of tree loss as follows:

Tree mortality measure	Hazard rating class		
	Low	Moderate	High
Number per acre	<30	30–74.99	75+
Percent	<10	10–24.99	25+

Then, hazard ratings predicted by the equations were compared with actual ratings recorded for the plots. The percentage of plots in each rating category was:

Hazard rating predicted by equations	Actual hazard rating of plots					
	Trees per acre			Percent of trees		
	Low	Moderate	High	Low	Moderate	High
Low	72	24	4	76	21	3
Moderate	10	77	13	24	63	13
High	5	17	78	0	23	77

[2] The "poor" crown condition class was assigned to trees with: crowns consisting of 50 percent or more dead branches (allowances permitted for non self-pruning species); foliage density, size, and coloration of definite subnormal quality; or heavy epicormic sprouting.

Three-fourths of the ratings predicted for the plots agreed with actual outcomes. Very few of the predictions missed by more than one rating class. For example, less than 4 percent of the plots classified as low hazard actually turned out to be in high hazard situations.

This exercise by no means represents an exhaustive test of model performance, but it does indicate the kind of results that users of the hazard rating equations might expect.

SUMMARY

People who have to make decisions about controlling the gypsy moth need help with predicting and evaluating impacts of the insect. In response to this need, we have developed simple equations for rating the potential hazard of impending gypsy moth attacks to forest stands. The equations estimate expected tree mortality in terms of two easy-to-measure key elements of forest stand condition.

The models have some deficiencies. To begin with, they haven't been tested in the field, so we don't really know how well they work on new frontiers of infestation. Plans have been made to test them. Also, they take no account of important nontimber impacts such as the nuisance of caterpillars in recreation areas and back yards or the degrading effects of defoliation on environmental quality. And, while the analysis uses data that spans 6 years since outbreak, we can't be sure that all tree losses associated with the insect have yet accumulated.

But with all their faults, the models can provide useful tools for more effective gypsy moth control, particularly in situations where tree losses are considered important. We feel they can add a bit more objectivity to the process of making control decisions.

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