United States
Department of
Agriculture

Forest Service

**Northeastern Forest
Experiment Station**

NE-RN-337

Estimating the Benefits of Gypsy Moth Control on Timberland

David A. Gansner

Owen W. Herrick

Abstract

A recent study of forest stand losses to gypsy moth has provided basic information for evaluating the benefits of control on new frontiers of infestation. Protecting highly susceptible trees from impending attack can prevent a potential loss of 15 percent in their timber value and 2.8 percent in their compound rate of value growth.

Evaluations of the economic effectiveness of gypsy moth control programs on timberland require reliable estimates of program costs and benefits. The **costs** of aerial spraying, silvicultural cutting, or other actions designed to control gypsy moth are relatively easy to estimate. But accounting for the **benefits** of such actions is no simple task. A recent study of changes in forest stand condition attributable to gypsy moth in central Pennsylvania has provided basic information for evaluating the potential economic returns to control work on new frontiers of infestation.

Approach

Measurements have been taken each year since 1978 to monitor and evaluate impacts of the gypsy moth on forest trees in central Pennsylvania. The project, a cooperative venture of the Pennsylvania Bureau of Forestry and the USDA Forest Service, uses a network of some six hundred 1/10-acre plots located between Carlisle and State College, Pennsylvania. This was the leading edge of gypsy moth infestation in 1978 when the plots were established, before the stands were infested.

DAVID A. GANSNER and OWEN W. HERRICK are research foresters with the Northeastern Forest Experiment Station, Broomall, PA.

Of particular interest here are records of defoliation, mortality, and rates of change in value for **tree species that are highly susceptible to gypsy moth**. We can use these data to net out losses in timber value caused by a gypsy moth infestation and thus derive estimates of the potential benefits of control.

Defoliation

Visual estimates of defoliation for all trees 3.0 inches in d.b.h. and larger were recorded each year at peak periods of defoliation (June or July). The percentage of foliage stripped from each tree was estimated to the nearest 10 percent. Most of the defoliation in central Pennsylvania occurred from 1980 to 1982. To make allowance for the progressive but uneven nature of gypsy moth infestations, we averaged each tree's defoliation measurements for these 3 years. Clearly, more trees in a sample area are likely to be defoliated sometime during several years of gypsy moth buildup than in any single year. Thus, the 3-year average provides a more comprehensive measure of defoliation for any one tree during the outbreak.

Tree Values and Rates of Growth

Rates of change in tree value were based on measured changes in diameter, merchantable height, and quality attributes applied in the compound interest expression:

$$r = (V_n/V_o)^{1/n} - 1$$

where r is the compound interest rate of value change, n is the period of time between measurements, V_n is the value of the tree after n years and, V_o is its initial value.

Tree merchantable height and d.b.h. were converted to board-foot and cubic-foot volumes (Scott 1979, 1981). The volumes were then translated into dollar values to express the rate of value change for each tree between 1978 and 1985. The dollar values are based on tree-value conversion standards (Mendel et al. 1976; DeBald and Mendel 1976). These standards represent consistent regional measures of a standing tree's net value (marginal value product or shadow price) in the production of 4/4-inch lumber and/or pulpwood, allowing for the cost of conversion. They account for a tree's species, diameter, merchantable height, and tree grade (based on butt-log grade measures). For example, a 16-inch-diameter red oak with a grade 2 butt log and merchantable height of two logs, containing 180 board feet (International 1/4-inch rule), was valued at $7.08.

The same (current) dollar-value standards were applied to both 1978 and 1985 measurements to evaluate each tree's development, thereby eliminating valuation items that are irrelevant to biological change. This ignored unpredictable effects of inflation and changes in timber prices and markets, but did account for the value of biological change in tree diameter, merchantable height, and tree grade.

Results

Commercial tree species most susceptible to gypsy moth during the central Pennsylvania infestation were the oaks and aspen (Gansner and Herrick 1985). Chestnut oak ranked number one on the list of species preferred by the pest. Ranking next to chestnut oak was black oak. Following in relatively close order were the other oaks and aspen. Between 1978 and 1985, cumulative mortality for this group of species totaled 17 percent of their original value. Because of heavy defoliation and mortality, the compound rates of change in timber value for these trees averaged only 0.6 percent. Defoliation history had a noticeable effect on loss in value and rate of value change:

Item	All susceptible trees	Tree defoliation (%), 1980–82 average: <20	20–29	30–39	40–49	50–59	60–69	70–79	80+
Loss in timber value (%)	17.3	2.2	5.2	10.9	13.6	27.1	47.3	72.5	88.9
Compound rate of value change (%)	0.6	3.4	2.5	1.3	1.3	−0.5	−7.8	−11.6	−18.5

Loss in timber value and compound rate of value change for trees with less than 20 percent average defoliation were 2 and 3.4 percent, respectively. At the other extreme, for trees that average 80 percent or greater defoliation loss in timber value was 89 percent and rate of value change was minus 18.5 percent.

Obviously, increases in timber value for these highly susceptible tree species would have been greater without gypsy moth. But how much greater? The answer to this question would presumably give us estimates of the potential benefits of effective control.

To approximate what might have happened in the absence of gypsy moth, we looked at losses in timber value and rates of value change for oak and aspen trees that underwent relatively light (<20 percent) average defoliation from 1980 through 1982. Loss in timber value for these trees was only 2.2 percent and their compound rates of value change averaged 3.4 percent. So leaving the gypsy moth infestation unchecked presumably results in a net loss of 15.1 percent in timber value and a net reduction of 2.8 percent in rate of value change:

Item	Gypsy moth control: Without	With	Net loss attributed to gypsy moth
Loss in timber value (%)	17.3	2.2	15.1
Compound rate of value change (%)	0.6	3.4	2.8

These estimated benefits of control are by no means perfect. For example, they do not account for timber values gained from ingrowth or from the "thinning effect" of gypsy moth defoliation and resulting mortality on less susceptible tree species such as red maple, ash, and yellow-poplar. In this sense, the estimated benefits are too high. On the other hand, our assumption that trees with average defoliation of less than 20 percent represent a resource with gypsy moth under control is not totally realistic. Even small amounts of defoliation can cause some mortality and reduce timber growth. In this sense the estimated benefits are too low. There are a number of other limitations, but the bottom line is that actual benefits for any particular case will depend on stand and market conditions and perceptions about loss that vary from place to place. Such limitations are matters for future research. In the meantime we now have two empirical indices of net loss for approximating the potential benefits of gypsy moth control.

Picture, for example, a 10,000-acre forest containing preferred host-tree species valued at $100 per acre. This translates into a highly susceptible resource worth $1 million. Protecting this resource from an impending gypsy moth infestation presumably would prevent a loss of 15 percent or $150,000 in timber value that is at risk. Looking at it another way, an expected difference of 2.8 percent in rate of value growth over the next 7 years would net out to a savings of well over $200,000. Such benefits can be compared with costs of undertaking remedial action in evaluations of the economic effectiveness of control.

Literature Cited

DeBald, P. S.; Mendel, J. J. 1976. **Composite volume and value tables for hardwood pulpwood. SETs: Stand Evaluation Tools 3.** Res. Pap. NE-338. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 43 p.

Gansner, D. A.; Herrick, O. W. 1985. **Host preferences of gypsy moth on a new frontier of infestation.** Res. Note NE-330. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 3 p.

Mendel, J. J.; DeBald, P. S.; Dale, M. E. 1976. **Tree value conversion standards for hardwood sawtimber. SETs: Stand Evaluation Tools 2.** Res. Pap. NE-337. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 74 p.

Scott, C. T. 1979. **Northeastern forest survey board-foot volume equations.** Res. Note NE-271. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 3 p.

Scott, C. T. 1981. **Northeastern forest survey revised cubic-foot volume equations.** Res. Note NE-304. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 3 p.

Northeastern Forest Experiment Station
Broomall, PA 19008
July 1987

☆U.S. G.P.O. 1987- 748-076:40034