United States
Department of
Agriculture

Forest Service

**Northeastern Forest
Experiment Station**

Research Note NE-340

# Site Productivity and Tree Mortality on New Frontiers of Gypsy Moth Infestation

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## Abstract

Recent analysis of forest stand losses to gypsy moth has provided basic information for analyzing the relationship between forest site productivity and tree mortality on new frontiers of infestation. Poor timber-growing sites had the lowest rates of mortality. Oak mortality (number of trees) amounted to 18 percent on poor sites compared with 26 percent on medium and 28 percent on good sites.

A number of studies have explored the relationship between forest site productivity and tree mortality in forest stands infested with gypsy moth. Results have been mixed. For example, Kegg (1973) and Herrick (1982) found higher mortality rates associated with poorer timber-growing sites. But Hicks and Fosbroke (1987) and Statler and Serrao (1983) discovered greater mortality on better sites. To add to the body of research on this subject, we analyzed the relationship between mortality rates and forest site productivity on new frontiers of infestation in central Pennsylvania.

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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. Herrick and Gansner (in press) contains a complete description of the plot network.

Of particular interest in this paper are estimates of site productivity, tree mortality, and timber-value loss. Cumulative mortality rates were recorded on 574 central Pennsylvania plots from 1979 through 1985 for nearly 15,000 trees 3.0 inches d.b.h. and larger. Site indexes were estimated for each plot from age and height data for dominant northern red oaks *(Quercus rubra)* within or in the immediate vicinity of the plots. Trees that had been suppressed in the past were avoided. Site-index estimates were determined from Schnur's (1937) chart for upland oaks. Plots and their respective sample trees were sorted into three site index (SI) classes—poor (SI $<$ 55), medium (SI 55 to 74), and good (SI 75 +).

Tree-value conversion standards (Mendel et al. 1976; DeBald and Mendel 1976) were used to estimate timber-value losses. 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 on the stump.

## Results

Table 1 summarizes observed rates of tree mortality and losses in basal area and timber value for the central Pennsylvania plots by species group and site productivity class. As expected, the oaks bore the brunt of gypsy moth attacks and suffered much higher mortality rates than other less vulnerable species. By 1985, the cumulative mortality rate for oak trees was 23 percent. The rate of timber-value loss for oaks was 4 times that for all other species combined.

Generally, poor sites had the lowest rates of mortality. Oak mortality (number of trees) amounted to 18 percent on poor sites compared with 26 percent on medium and 28 percent on good sites. Rates of loss in oak basal area and timber value also were significantly lower on poor sites.

Why mortality rates for oak were lower on poorer timber-growing sites remains a mystery. One hypothesis is that trees on poor sites develop root systems and crown structures that make them more adaptable to stresses brought on by things like gypsy moth defoliation and short-term drought. Another related theory is that shoestring root rot and the two-lined chestnut borer (both major mortality agents) are less active on poorer sites. These are matters for future study.

**Table 1.—Mortality associated with gypsy moth in central Pennsylvania (1978-85), by site productivity class and species group**

| Site class | No. of plots | Species group | No. of sample trees | Mortality rate for: | | |
|---|---|---|---|---|---|---|
| | | | | Trees | Basal area | Timber value |
| | | | | *Percent* | | |
| Poor | 189 | Oaks | 2,985 | 18 | 13 | 12 |
| | | Other | 2,343 | 10 | 9 | 8 |
| | | All | 5,328 | 14 | 12 | 11 |
| Medium | 269 | Oaks | 3,320 | 26 | 23 | 23 |
| | | Other | 3,335 | 15 | 11 | 7 |
| | | All | 6,655 | 21 | 20 | 20 |
| Good | 116 | Oaks | 1,056 | 28 | 24 | 18 |
| | | Other | 1,649 | 17 | 12 | 4 |
| | | All | 2,705 | 21 | 19 | 13 |
| All | 574 | Oaks | 7,361 | 23 | 20 | 20 |
| | | Other | 7,327 | 14 | 11 | 5 |
| | | All | 14,688 | 19 | 17 | 16 |

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Northeastern Forest Experiment Station
Broomall, PA 19008
December 1987

☆U. S. GOVERNMENT PRINTING OFFICE: 1987/548-066-60010