Mapping the Defoliation Potential of Gypsy Moth

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Abstract: A model that uses forest stand characteristics to estimate the likelihood of gypsy moth (Lymantria dispar) defoliation has been developed. It was applied to recent forest inventory plot data to produce susceptibility ratings and a map showing defoliation potential for counties in Pennsylvania and six adjacent states on new frontiers of infestation.

Levels of defoliation vary greatly within areas infested by the gypsy moth. So, practical methods for identifying highly susceptible locations (that is, those most likely to suffer heavy defoliation during an infestation) would greatly aid forest resource and pest managers. A model that uses forest stand characteristics to estimate the likelihood of gypsy moth defoliation has been developed. Its application to recent forest inventory plot data has resulted in susceptibility ratings and a map showing defoliation potential for counties in Pennsylvania and six surrounding states on new frontiers of infestation.

DEFOLIATION MODEL

The combined relationship that 38 stand condition variables had with average defoliation during a gypsy moth outbreak was analyzed for 575 forest plots in central Pennsylvania. A technique called Automatic Interaction Detection was used to search characteristics of trees and plots for the best predictors of susceptibility (Sonquist et al. 1973). This analysis made it possible to assign potential rates of defoliation to forest stands (Herrick and Gansner 1986). Other methods for estimating susceptibility have been developed (for example, Valentine and Houston 1979). But to our knowledge, the Herrick/Gansner model is the only one available that links defoliation severity to key forest stand characteristics as predictor variables on new frontiers of infestation (Figure 1).

Only four of the many stand characteristics analyzed as predictors of defoliation were retained in the model: percentage of basal area in oaks, percentage of basal area in chestnut and black oaks, percentage of basal area in trees with good crowns, and average diameter of the stand. From 1980-82, defoliation for all sample plots in the central Pennsylvania study averaged 26 percent and ranged from <1 to 70 percent. The model identified the highest average defoliation in plots that had at least 80 percent basal area in oakspecies, at least 70 percent basal area in chestnut and black oaks, and at least 60 percent basal area in trees with good crowns. Plots with the lowest average defoliation had less than 20 percent basal area in oaks.

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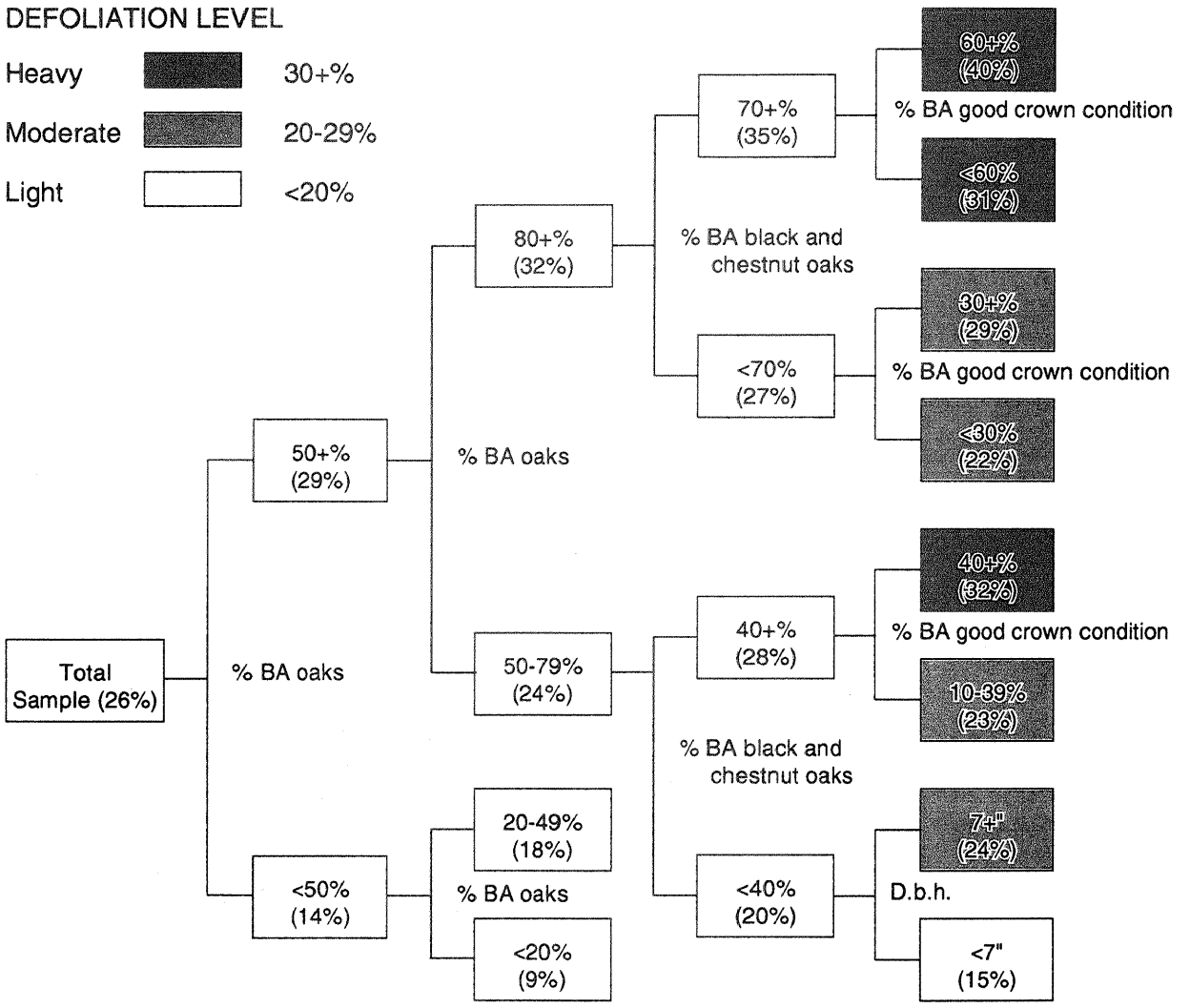

Figure 1.—Guide for estimating gypsy moth defoliation potential. Any hardwood stand can be assigned to defoliation group on the basis of characteristics of the stand. The 3-year average defoliation percentage is shown in parentheses for each group.

FOREST INVENTORY DATA BASE

The USDA Forest Service updates statewide timber resource information approximately every 10 years. The last inventory of Pennsylvania was completed for 1989. Latest reinventories for the six other states included in this analysis were: Delaware-1986, Kentucky-1988, Maryland-1986, Ohio-1990, Virginia-1986, and West Virginia-1989. Thousands of ground plots were measured in these seven states. Measurements from those plots provided the data base for mapping defoliation potential.

PROCEDURE

The defoliation potential model was used to calculate susceptibility ratings for all of the forest inventory ground plots in Pennsylvania and the six surrounding states. By design, each inventory plot represents a given proportional share of the forest area in a county. So, appropriate weights could be applied to plot data to derive average susceptibility ratings for each county. Exceptions are counties designated nonforest (such as Philadelphia county in Pennsylvania) where no ground plots have been sampled.

Only three of the four variables included in the defoliation potential model could be used in the analysis. Crown condition was not measured by forest inventory crews and no appropriate surrogates for the crown condition variable are available. This is not a serious problem because crown condition does not account for a large amount of the variation in defoliation.

The process of assigning susceptibility ratings to counties began with Pennsylvania. Values were calculated for each of Pennsylvania's forested counties using data from the 1978 inventory. Ratings ranged from a high of 26.8 for York to a low of 9 for Erie (Figure 2). Rating class boundaries of <12, to 17.9, and 18+ were used tosort Pennsylvania's counties into three groups representing low, medium, and high levels of defoliation potential (Figure 3). This grouping correlates well with the history of annual gypsy moth defoliation recorded on rough sketch maps since 1978. Satisfied with these results for Pennsylvania, we applied the methodology to the most recent forest inventory plot data available to compute susceptibility ratings for counties in all seven states (Figures 4-9).

RESULTS AND IMPLICATIONS

The final products of this effort are susceptibility ratings and maps showing current defoliation potential, by county, in a 7-state area where gypsy moth is an immediate concern (Figure 10). There are no major surprises here. Counties with the highest susceptibility ratings are those where oaks, especially chestnut and black, are major components of the forest. Low ratings reflect the prevalence of species such as yellow-poplar, ash, red maple, and black cherry that rank lower on the list of preferred hosts (Gansner and Herrick 1985).

Of course, counties with low susceptibility ratings can contain areas with high defoliation potential and vice versa. Also, average ratings tell us nothing about the amount or location of susceptible forest within a county. For example, Pike and Lebanon counties in Pennsylvania both have high ratings but Pike has five times more forest land. Ratings for counties with very little forest are based on data from very few ground plots and may be subject to high sampling errors. Individual plot locations are now being digitized to gain a better breakdown for critical spots.

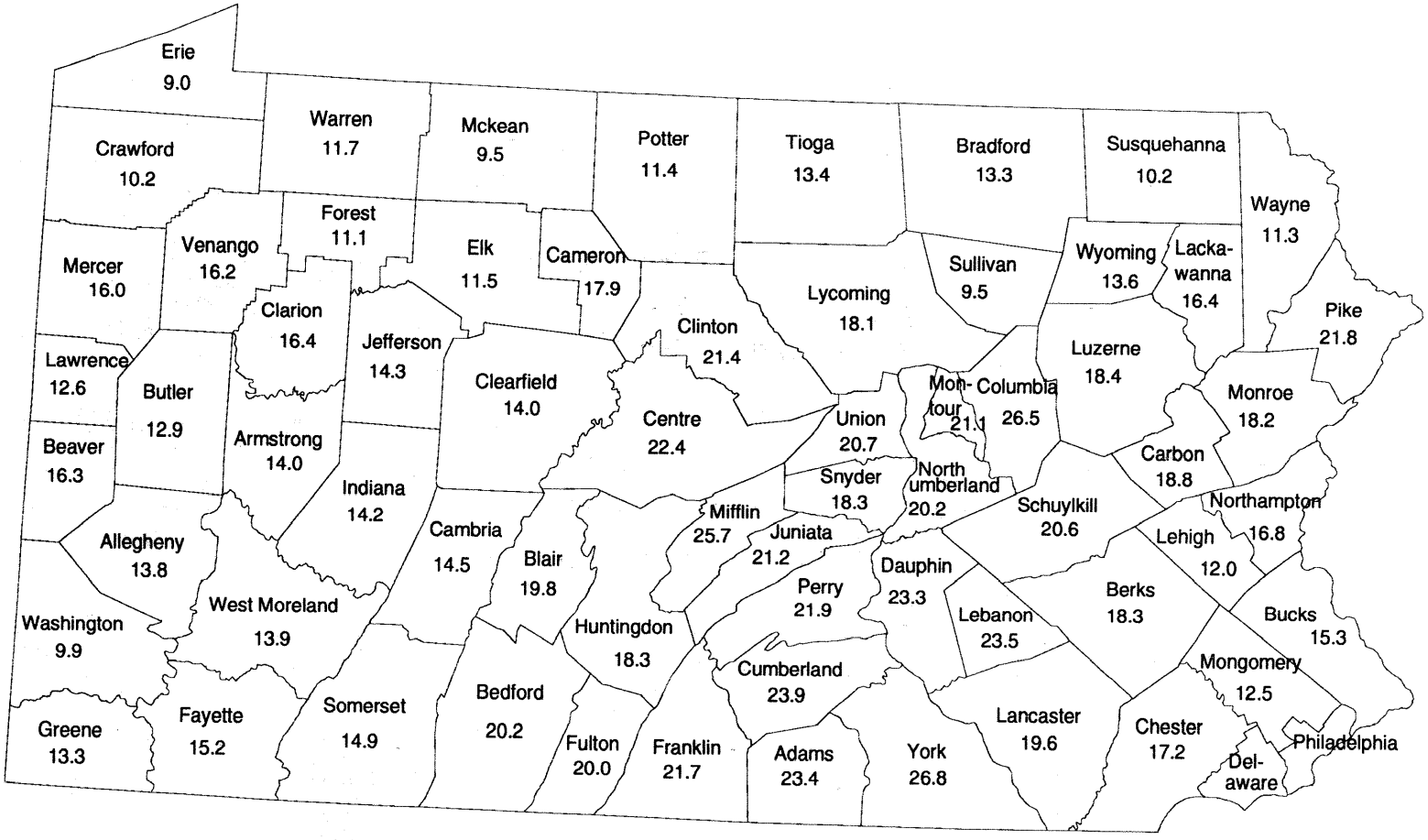

Figure 2.—Gypsy moth susceptibility ratings for Pennsylvania, by county, 1978.

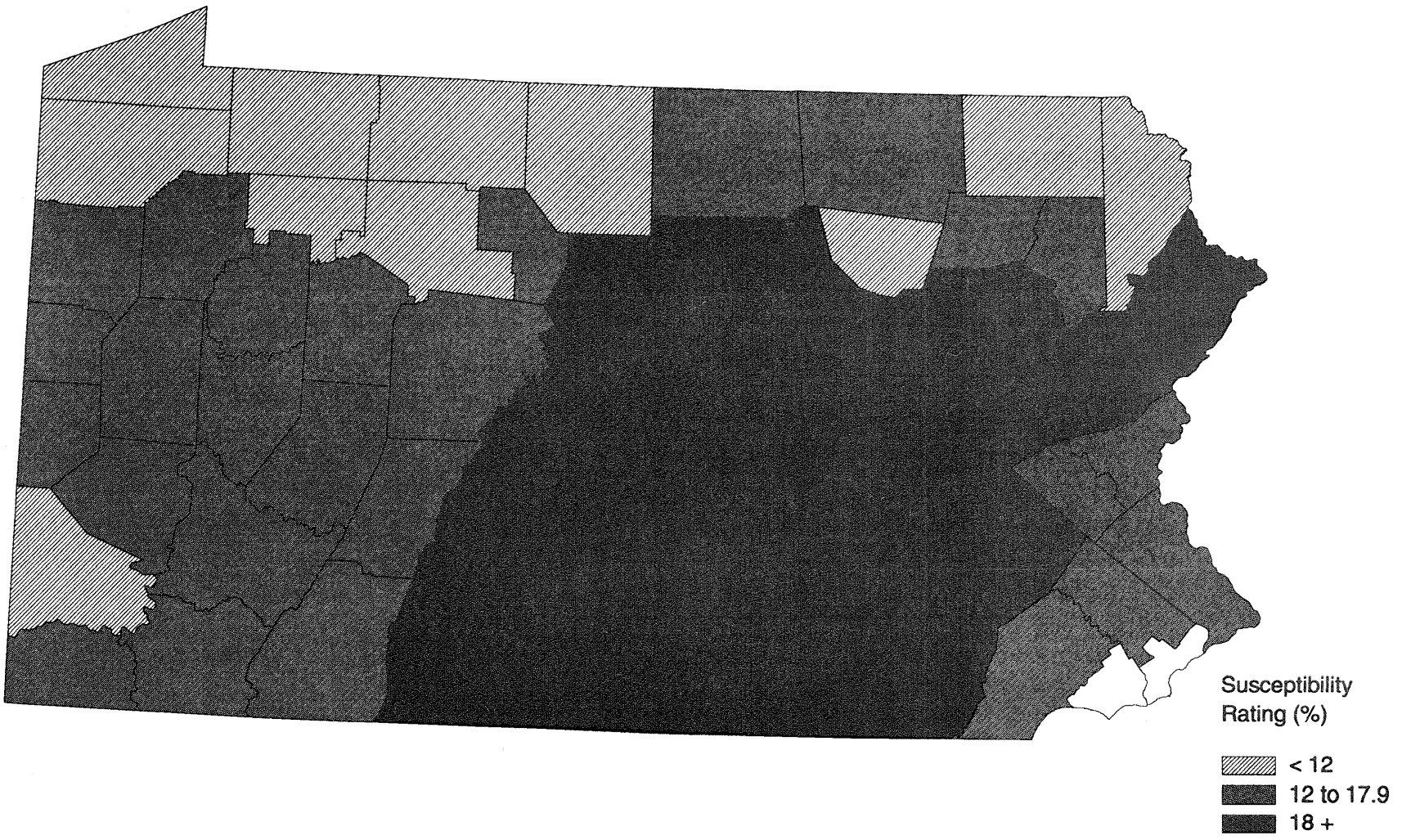

Figure 3.—Gypsy moth defoliation for Pennsylvania, by county, 1978.

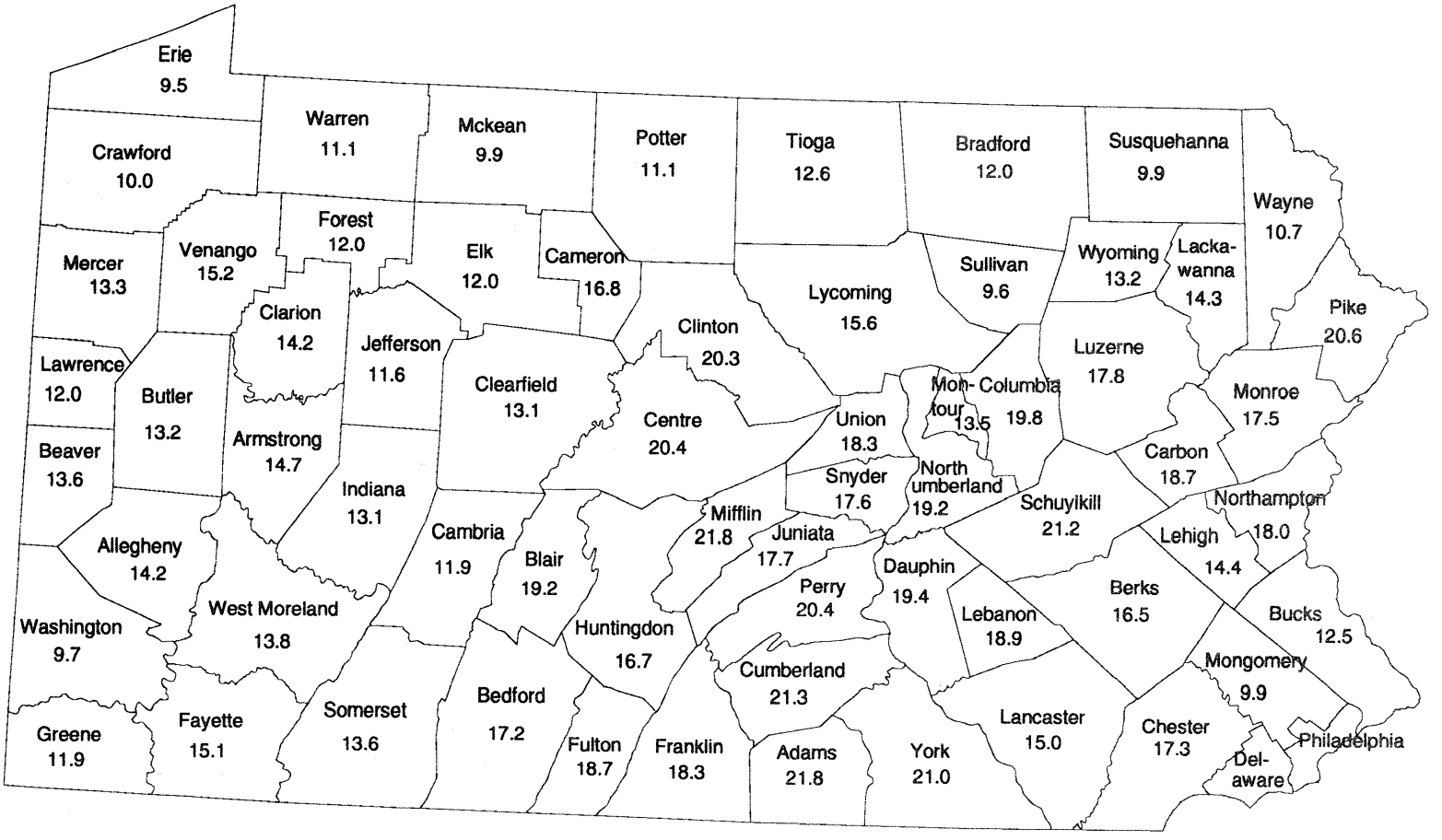

Figure 4.—Susceptibility ratings for Pennsylvania, by county, 1989.

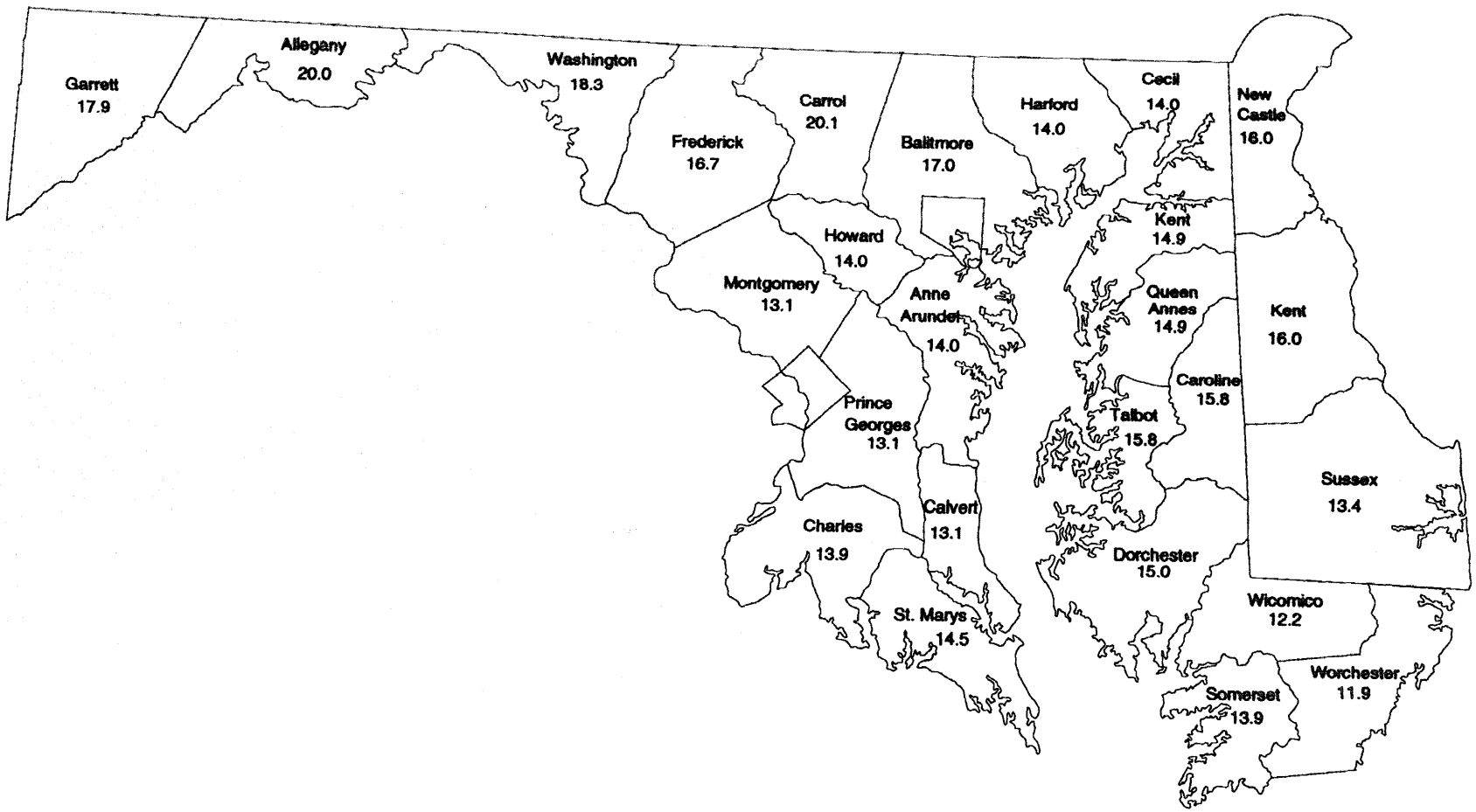

Figure 5.—Susceptibility ratings for Maryland and Delaware, by county, 1986.

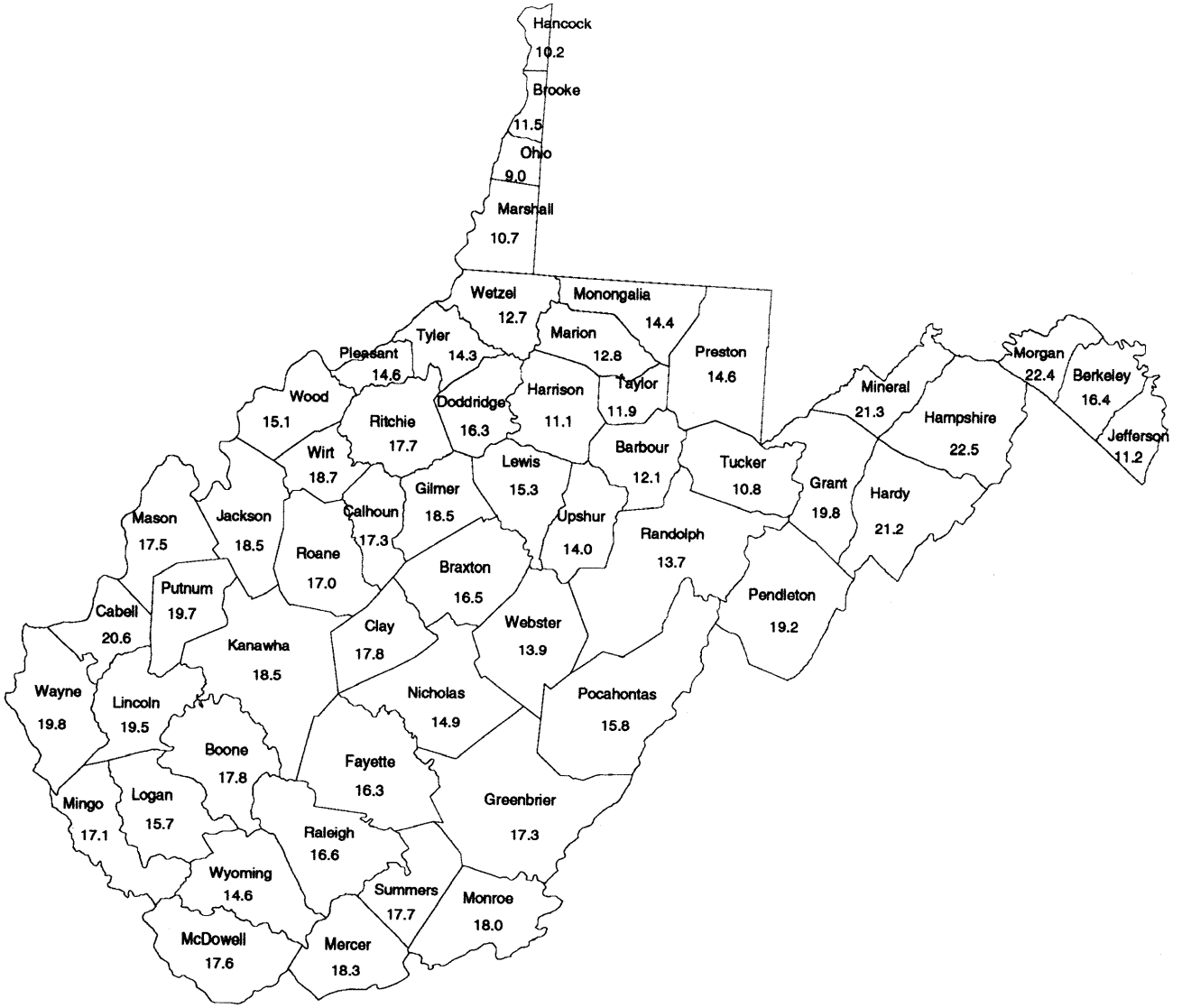

Figure 6.—Susceptibility ratings for West Virginia, by county, 1989.

Figure 7.—Susceptibility ratings for Virginia, by county, 1986.

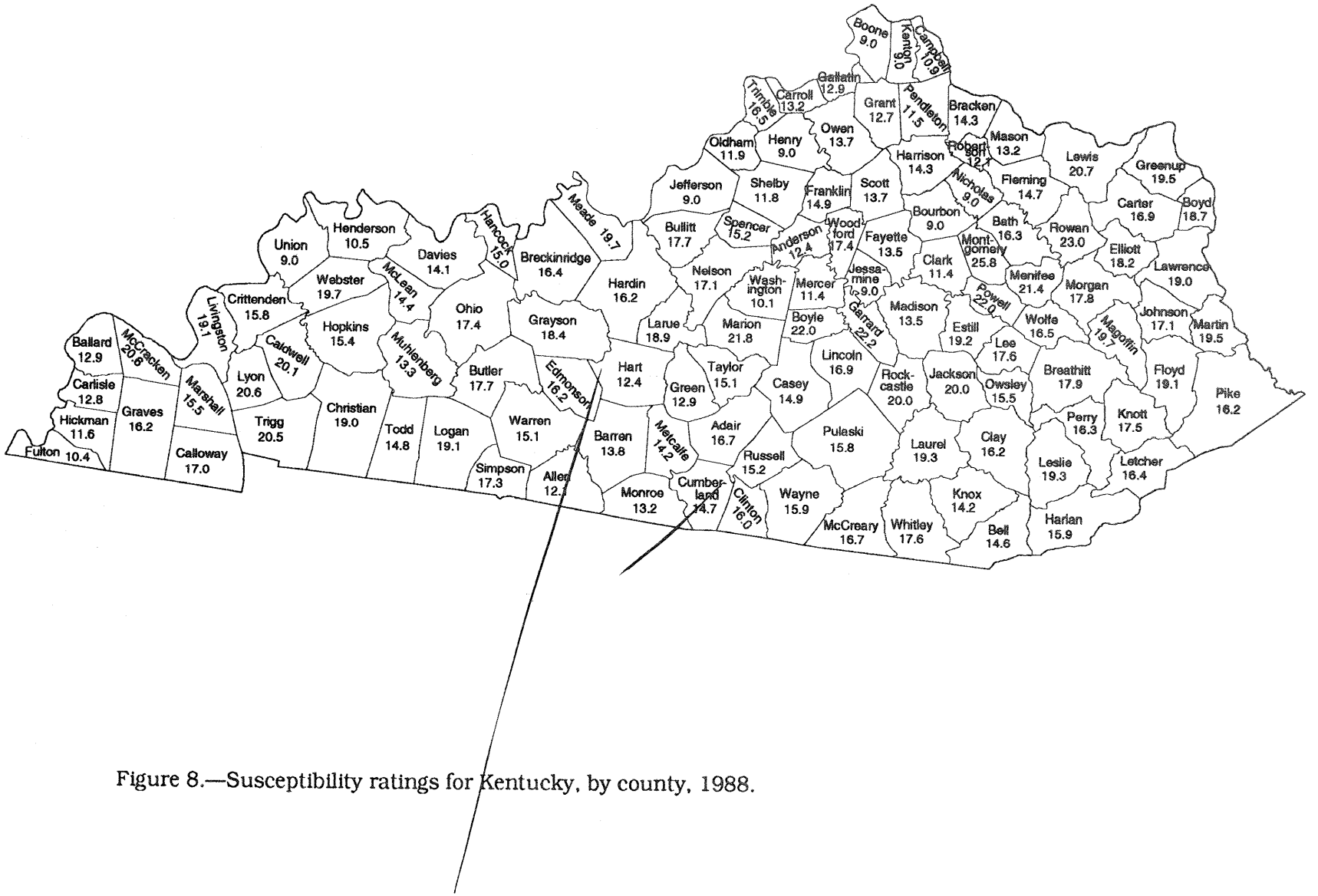

Figure 8.—Susceptibility ratings for Kentucky, by county, 1988.

Figure 9.—Susceptibility ratings for Ohio, by county, 1990.

Figure 10.—Gypsy moth defoliation potential in seven threatened states, by county.

A comparison of the Pennsylvania ratings for 1978 (Figure 2) with those for 1989 (Figure 4) indicates a shift in susceptibility for some Pennsylvania counties. For example, Bedford county had a susceptibility rating of 20.2 in 1978. But heavy defoliation and drought during the 1980's led to high mortality, salvage cutting, and growth loss in the oaks. At the same time, less preferred species such as hemlock, yellow-poplar, white ash, black gum, birch, cherry, and red maple flourished. By 1989, Bedford county's susceptibility rating dropped to 17.2. Future research will take a closer look at changes in susceptibility for counties and individual plots.

Opportunities for extending the analysis to other states such as North Carolina, Tennessee, and Indiana also will be explored. The defoliation potential model should yield accurate results for areas with stand characteristics similar to those of the study area where it was developed. But, who can say whether a post oak in the Ozarks of Missouri or sweetgum on the Coastal Plain of South Carolina will hold the same attraction for gypsy moth as a chestnut oak on a ridge in central Pennsylvania. For now, we hope the susceptibility ratings and map of defoliation potential will give resource and pest managers in at least seven threatened states a better understanding of what to expect from the gypsy moth and thus a basis for improved decisions for coping with the pest.

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