

Predicting Gypsy Moth Defoliation Patterns in Shenandoah National Park

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It's not often that major disruptions to Park ecosystems occur. Usually they are associated with volcanic eruptions, floods, hurricanes, or catastrophic wildfire. However, in the case of Shenandoah National Park (SNP) the currently expected change will be brought about not by a natural cataclysm but by a lowly caterpillar.

Gypsy moths have become the most serious and devastating forest pest in the Mid-Atlantic area of the Eastern Seaboard. Accidentally introduced into Massachusetts in 1860, the alien forest pest has been spreading south and west for the past 120 years. This defoliator prefers oaks, and the forests of Pennsylvania, Maryland, Virginia, and West Virginia have a much higher percentage of oaks than do northern forests. As the insect moves south, the increase in preferred habitat has caused the rate and intensity of defoliation to increase dramatically. Repeated defoliation not only leads to high rates of tree mortality but greatly reduces the production of hard mast such as acorns and hickory nuts, so important to the winter survival of many wildlife species.

The forests of SNP are dominated by oaks, many of the ridge-line to mid-slope areas being over 80 percent oak. Trees on the higher elevation ridges are damaged repeatedly by severe winter ice storms. Poor soils in other areas place additional natural stresses on the trees. Because of all this, the SNP staff has become increasingly concerned about the potential impact this alien invader could have on the park.

Methods

Gypsy moths were first discovered in the park in 1984. To guide future management actions, a Gypsy Moth Management Plan was devised, calling for development of a defoliation hazard rating system, or map, that would delineate high risk areas. This was considered essential in order to assess this insect's potential impact on park operations, visitor use areas, wildlife, forest ecosystems, and adjacent landowners.

The first phase was to determine the park's forest cover types. A forest cover-type map based on color infrared photography was completed in 1987 (article by Teetor, *Park Science*, Spring 1987). This map became one of the first major components of the park's new Geographic Information System (GIS). Since factors other than tree species affect the likelihood that a given area will be defoliated, a literature review was conducted under NPS contract by Shumway and Bowersox, 1987. The review indicated that very little definitive work had been accomplished on this topic. The most promising systems used in the past to determine stand susceptibility were those developed by Houston and Valentine, 1977 and Herrick and Gansner, 1986. Both systems used two major factors, the percent of oak in the stand and the ability of the stand to provide larva hiding and resting places, e.g. broken branches, knot holes, hollows, etc., caused by fire, ice damage, or other disturbances.

Although not yet documented, it is believed that the upper half of ridges provides climatic conditions more favorable to gypsy moth survival and spread. These areas have good air movement and lower humidity, which seems to reduce larval susceptibility to disease.

Strong spring winds aid the rapid spread of the young larva.

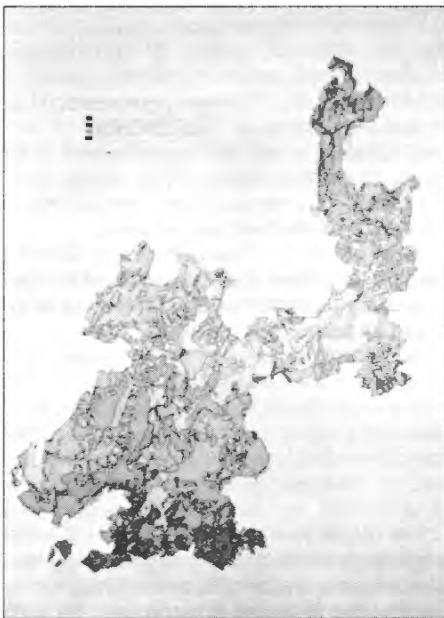
Based on this information, we chose to base our forest susceptibility map on two primary factors: (1) *the forest type classification*, i.e., percentage of preferred or non-preferred species, and (2) *the degree of known tree stress* due to ice damage, human development, severe fire and soil conditions. The relative values for the ice damage and soil conditions are expressed as elevation. High elevation ridges in the park receive severe ice damage and also quite often have poor, quickly draining soils subject to the effects of drought. The major developed areas, which contain a high percentage of preferred host tree species, were assigned a high risk rating because of tree stresses due to pavement, soil compaction, and damage caused by campers. These areas also are more susceptible because of the movement of RVs, which could transport gypsy moths into the developed area from other infested areas.

Susceptibility classes were divided into four groups; very high, high, moderate, and low. The parameters of each class are as follows:

Very high: chestnut oak stands > 2000 feet elevation and all developed areas with forest types of chestnut oak, red oak, or red oak/ash/basswood.

High: chestnut oak stands < 2000 feet elevation, red oak stands > 2800 feet elevation.

Moderate: red oak stands < 2800 feet elevation, red oak/ash/basswood stands > 2800 feet elevation.



This GIS plotter product represents the North District of Shenandoah NP in four colors – red, orange, yellow and green – denoting very high, high, moderate, and low susceptibility to Gypsy moth infestation. The GIS plotter also can show the same information in black and white by using a variety of shadings, hatchings, etc., and provides an at-a-glance picture of insect hazards to the park.

Low: red oak/ash/basswood stands < 2800 feet elevation, black locust stands any elevation, pine stands any elevation, poplar stands any elevation.

Mapping of these classes was started using the northern most district as a test area. The two factors for each susceptibility class were combined on the park GIS. Since the forest types were in polygon format and the elevation data in cellular format, we had to convert our forest stand GIS theme to cellular format in order to combine the two themes. This was accomplished with the assistance of the GIS Division in Denver. The final product was a scale map of the park in the four colors chosen to represent the susceptibility classes. Major roads and developed areas were added to provide reference points. North District acreage values generated by the computer were: very high = 10,305, high = 15,386, moderate = 10,804, and low = 17,543.

Conclusions

This method of predicting susceptibility of forests to gypsy moth defoliation is based on information currently available. The system's validity will be determined over the next several years as areas actually defoliated are entered in the GIS and overlays compared. By the time the infestation has moved through the North District, we should have determined the accuracy of the new susceptibility map. Since our data bases are on a GIS, corrections or modifications to the system can be easily made.

The next phase in determining the impact of gypsy moths on the park is to assess actual tree mortality levels as this relates to stand type. Not all trees defoliated by gypsy moth larva will die; however, there are some factors known to affect mortality and other factors suspected of playing a role. Since both defoliation and tree mortality affect ecosystem dynamics, the study of both factors will be necessary before we can obtain a clear picture as to the degree of gypsy moth impact on park resources and the visitors enjoyment of them.

Literature Cited

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