PREDICTING TREE MORTALITY FOLLOWING GYPSY MOTH DEFOLIATION[1]

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Abstract: Appropriate application of gypsy moth control strategies requires an accurate prediction of the distribution and intensity of tree mortality prior to defoliation. This prior information is necessary to better target investments in control activities where they are needed. This poster lays the groundwork for developing hazard-rating systems for forests of the Appalachian Plateau (AP) and the Ridge and Valley (R&V) by comparing the impact of gypsy moth defoliation in these two provinces.

METHODS

Field plots were established in defoliated and undefoliated stands of both provinces from 1984-1986. Two hundred and twenty-seven 1/10-acre circular plots were located primarily on State Game Lands in Somerset County, Pennsylvania, and 158 plots were located at Green Ridge State Forest in Allegany County, Maryland. All plots were located along the leading edge of gypsy moth infestation and represented a range of site and stand conditions. On each plot, tree variables (e.g. species, height and d.b.h.) and site characteristics (e.g. site index, slope inclination and aspect) were measured. From 1984-1989, each tree was evaluated for defoliation and vigor annually. In 1989, all variables measured during plot establishment were remeasured. Z-tests were used to test for differences in initial stand conditions and in tree mortality between the two provinces.

RESULTS

Initial Stand Conditions

Pre-defoliation stand conditions were similar for the two provinces. On average, plots were located in fully stocked mixed-oak stands that had an average diameter of 8 inches. Initial stocking ranged from 72% to 91% and average basal area ranged from 101 to 109 square feet per acre. Stands in the R&V province contained a higher proportion of oak. Oaks in undefoliated stands of the R&V were evenly divided between northern red oak, black/scarlet oak, white oak and chestnut oak. In defoliated R&V stands, white oak and the black/scarlet oak group accounted for 81% of the total stand basal area. No non-host species accounted for a significant proportion of the R&V stands. In the AP, chestnut oak and northern red oak

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dominated the oak composition. Red maple was the most abundant of the non-host species present in the AP.

Defoliation History

Defoliation histories differed between the two provinces due to differences in land management philosophies. In the AP, lands managed by the Pennsylvania Game Commission were not treated following defoliation. Plot defoliation in the AP (weighted by d.b.h.) averaged nearly 60% in 1985 and 1986, 23% in 1987 and less than 10% in 1988 and 1989. The gypsy moth management strategy at Green Ridge State Forest was to limit defoliation by aerial application of Dimilin. The data suggest that our research areas were sprayed following a single year of heavy defoliation in 1985 (ave. defoliation = 55%). The following year, average defoliation had dropped to < 2%.

Tree Mortality

As expected from the differences in defoliation history, tree mortality was greater in the AP (34%) than in the R&V (16%) even though R&V stands contained more oak. In both provinces, as the amount of oak in stands increased, so did the amount of mortality. This increase was more noticeable in the AP than in the R&V due to the larger variability in species composition of AP stands.

Mortality also increased with the number and intensity of defoliations. Undefoliated stands had less than 10% basal area loss. A single defoliation increased mortality to between 16% (R&V) and 24% (AP); two, three and four defoliations resulted in 34, 45, and 77% mortality in the Appalachian Plateau. When the average annual defoliation over the five-year period was less than 20%, basal area loss was less than 20% in both provinces. In the R&V, which suffered one severe defoliation in five years (i.e. ave. annual defol. always < 20%), only one plot exceeded 25% mortality. In the AP, when average annual defoliation over the five-year period was greater than 25%, basal area loss exceeded 29%. When the average defoliation was greater than 40%, at least 56% of the stand basal area died.

Slope inclination, aspect, and site quality also appear to influence tree mortality following gypsy moth defoliation. In the R&V, mortality was greatest (30%) on fair sites (NROSI=60-70) and lowest (11%) on the poorest sites (NROSI < 60). In the AP, mortality was greatest on the poor and fair sites (32 and 35% respectively) and lowest (9%) on the good sites (NROSI>70). In the AP, slopes greater than 20% had the greatest mortality (31-46%) while there was no relationship between slope inclination and tree mortality in the R&V. In the AP, mortality was greatest on southern and southeastern aspects (41 & 55%) and lowest on southwestern and eastern aspects (< 10%). In the R&V, mortality was greatest on northeastern through southeastern aspects (26, 20, 29%) and lowest on northern through western aspects (8, 13, 10%).

It is difficult to accurately predict tree mortality following defoliation because of the complex interaction of host vigor, insect populations, weather, secondary organism populations and site conditions. However, the results indicate that the proportion of oak and the level of

defoliation in a stand are the strongest foretellers of tree mortality. Several site conditions also appear to be related to mortality; however, these relationships may be driven by species composition. The testing of these interactions will need to be completed as part of the process of developing a gypsy moth hazard-rating system for Appalachian hardwood stands.

INVASION OF A PARTIALLY CUT OAK STAND BY HAYSCENTED FERN

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Abstract: Hardwood forests in Pennsylvania frequently develop a dense understory of hayscented fern (*Dennstaedtia punctilobula* (Michx.) Moore)) following partial overstory removal. Seedlings of desirable hardwood species are unable to develop in these understories. A study was conducted in a central Pennsylvania mixed oak stand to determine how hayscented fern becomes established following partial cutting.

Hayscented fern is capable of reproducing both sexually through the production of spores and asexually through the extension of a perennial rhizome. While rhizome extension and transportation by logging equipment have traditionally been considered the primary mechanisms of fern reproduction and invasion, these processes can also be the result of development from spores. Spores are disseminated throughout late summer and early fall and can emerge within days after release or during the following spring when soil conditions are favorable. Rhizomes grow and fronds are produced throughout the growing season. Individuals are capable of reproducing sexually three years after development from spores.

The study area is a 100-year-old stand dominated by northern red oak (*Quercus rubra* L.), black oak (*Quercus velutina* Lam.), yellow-poplar (*Liriodendron tulipifera* L.), and red maple (*Acer rubrum* L.) located on state forest lands 7 miles south of State College, PA. The site occupies a lower slope position and has a southeasterly aspect. Soils range from poorly to well drained. The stand received an improvement shelterwood cut during the spring of 1989 in which the basal area was reduced to 80 sq. ft. per acre. The stand contained a few isolated clumps of hayscented fern before logging. A previously partially cut stand adjacent to the study area contained dense fern understories.

Hayscented ferns arising from spores were observed in the study area during the spring one year after cutting. Both gametophytes and sporophytes were noted. These individuals are characterized by a dense clumping of small fronds generally less than 4 inches tall. A small rhizome (< 0.5 inches long) was usually present. These newly developing ferns appeared to be restricted to areas with high soil moisture usually growing from moss patches. Sexually

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