

# Forest Health Monitoring on the Allegheny National Forest

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## Abstract

During the past 15-20 years, the Allegheny National Forest (ANF) has experienced four severe droughts, several outbreaks of exotic and native insect defoliators, and the effects of other disturbance agents. An increase in tree mortality has raised concerns about forest health. Historical aerial surveys (1984-98) and the 1998-2001 Forest Health Monitoring (FHM) plot data were analyzed to compare disturbed and undisturbed areas. Tree mortality and crown dieback levels were compared between undefoliated areas and areas defoliated by cherry scalloped moth and elm spanworm. American beech mortality was compared inside and outside the beech bark disease killing front. This study illustrates the value of an intensified grid of FHM plots and demonstrates the integration of aerial survey and plot data.

Although not presented here, forest managers were also interested in describing forest-wide conditions to support current ANF issues. This consisted of mapping tree species distributions, estimating seedling and sapling stocking, summarizing FHM indicators (e.g. lichen, ozone, soils, etc.), and estimating threatened and endangered species habitat. A technical report completing the four-year analysis will be published by mid-2003.

## Introduction

The Allegheny National Forest (ANF) (Figure 1) is situated in the Allegheny Plateau in northwestern Pennsylvania. The forest is dominated by mixed northern hardwoods including black cherry, red maple, sugar maple, beech, and oak species; it represents an important source of high quality veneer-grade logs but it is also heavily used for recreation given its proximity to the densely populated mid-Atlantic region. In recent years, there have been recurrent instances in the ANF where considerable tree dieback and mortality has occurred (McWilliams et al. 1999). These incidents have been a matter of considerable public concern and this has led to increased scrutiny of forest practices on the ANF, including legal actions. Many of the public concerns about the ANF focus on tree dieback and mortality, forest management practices and air pollution (e.g. Hopye 2001).

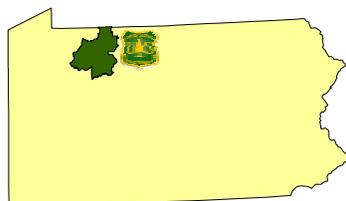


Figure 1. The Allegheny National Forest is located in northeastern Pennsylvania.

Forest managers on the ANF, recognized the need for a comprehensive survey of forest health conditions and in collaboration with USDA Forest Service Forest Health Protection (FHP) and research staff, an intensified grid of 168 Forest Health Monitoring (FHM) plots was established in 1998. One reason for this intensified grid was the desire to base forest management practices on scientifically based data that would stand up to increased public scrutiny. It was also recognized that the intensified grid would serve as a model system to illustrate the value of FHM to forest management activities such as forest plan implementation monitoring and forest plan revision that other national forests could use to implement similar systems.

In 2000 we began an analysis of forest health conditions on the ANF using the first two years of FHM data. That analysis was completed and published as a NA Technical Paper (Morin et al. 2001). A new report completing the four year effort will be published by mid-2003. Tree mortality and crown dieback levels were compared between undefoliated areas and areas defoliated by cherry scalloped moth and elm spanworm. American beech mortality was compared inside and outside the beech bark disease killing front. Although not presented here, forest managers were also interested in describing forest-wide conditions to support current ANF issues. This consisted of mapping tree species distributions, estimating seedling and sapling stocking, summarizing FHM indicators (e.g. lichen, ozone, soils, etc.), and estimating threatened and endangered species habitat.

## Results

### CHERRY SCALLOPSHELL MOTH (*Hydria prunivora*)

This native species, distributed widely in the Eastern United States and Canada, is not considered to be a serious pest in most areas. The most recent cherry scalloped moth outbreak on the ANF was from 1993 through 1996 (Figure 2). Historically, outbreaks occur approximately every 10 years on the northern Allegheny Plateau. Previous outbreaks occurred from 1972 to 1974 and 1982 to 1984 (Bonstedt 1985). Outbreaks usually last 2 to 3 years and sometimes tree decline/mortality follows after an outbreak. On the ANF, decline seems to occur when repeated defoliation (including defoliation by other insects, e.g. elm spanworm) or other stresses (e.g. severe drought) occur concurrently or in successive years. Figure 3 shows the area defoliated by the cherry scalloped moth on the ANF during the last outbreak. The most severe defoliation occurred in 1995 when nearly 290,000 acres were affected (205,000 on federal land).

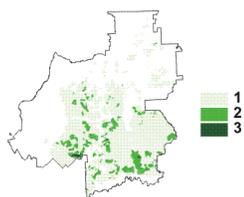


Figure 1. Map of years of cherry scalloped moth defoliation (1993-1996).

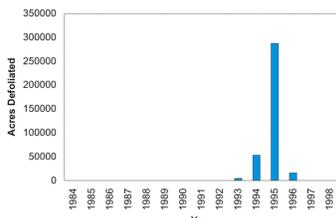


Figure 2. Acres defoliated by cherry scalloped moth (1993-1996).

The preferred host for cherry scalloped moth on the ANF is black cherry. Therefore, black cherry dominated stands are normally the most heavily defoliated during cherry scalloped moth outbreaks (Figure 3). There was evidence of a statistically significant increase in years of cherry scalloped moth defoliation with percent black cherry basal area ( $P=0.00101$ ). Areas with at least 25 percent black cherry basal area are more likely to suffer defoliation in an outbreak.

Cherry scalloped moth defoliation had an effect on black cherry mortality and crown condition. The average percent standing dead black cherry was significantly larger in areas that were defoliated in 2 years ( $P=0.0509$ ) (Figure 4). Plots defoliated twice had an average percent dead black cherry more than 3 times that of plots that were not defoliated or defoliated once. Plots with less than 10 percent black cherry basal area were not included because sampling error in estimates of mortality would be disproportionately high. In addition, there was a significant positive relationship between years of cherry scalloped moth defoliation and crown dieback on black cherry trees ( $P=0.0103$ ) (Figure 5).

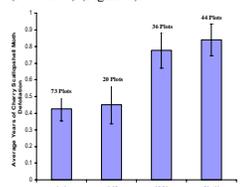


Figure 3. Average years of defoliation versus percent black cherry.

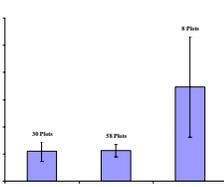


Figure 4. Percent dead black cherry versus years of defoliation.

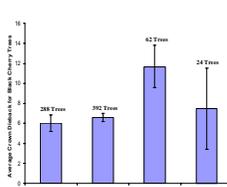


Figure 5. Percent black cherry crown dieback versus years of defoliation.

### ELM SPANWORM (*Ennomos subsignarius*)

The elm spanworm, a native species, is found throughout the Eastern United States and into Canada. Outbreaks are relatively uncommon though major multiyear elm spanworm outbreaks have occurred in Connecticut and North Carolina. The pest is responsible for periodical severe defoliation of hardwoods such as ash, hickory, walnut, beech, black cherry, elm, basswood, red maple, sugar maple, and yellow birch. One year of defoliation usually has little impact, but two consecutive summers of defoliation can cause dieback and even mortality when an invasion of secondary pests occurs (USDA For. Serv. 1979). The most recent elm spanworm outbreak on the ANF occurred from 1991 through 1993 (Figure 6). The area defoliated by the elm spanworm within the proclamation boundary of the ANF covered nearly 340,000 acres in 1993 (Figure 7).

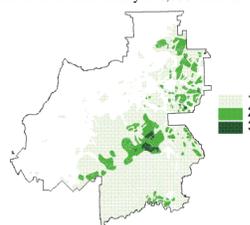


Figure 6. Map of years of elm spanworm defoliation (1991-1993).

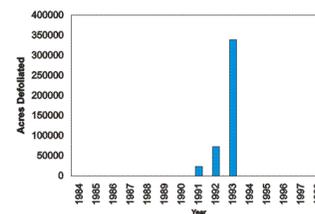


Figure 7. Acres defoliated by elm spanworm (1991-1993).

The preferred hosts for elm spanworm on the ANF during this outbreak were American beech, red maple, sugar maple, and black cherry. Percent basal area for each of these species plotted against the average number of years of elm spanworm defoliation is shown in Figure 8. There was a significant linear trend between percent black cherry basal area and years of elm spanworm defoliation ( $P=0.0002$ ) and between percent red maple basal area and years of elm spanworm defoliation ( $P=0.0476$ ).

Elm spanworm defoliation also had an effect on mortality and crown condition of some host species. Only significant relationships are presented here. There was a significant increase in black cherry mortality as years of elm spanworm defoliation increased ( $P=0.0213$ ) (Figure 9). There was a significant trend between percent standing dead sugar maple basal area and years of elm spanworm defoliation ( $P=0.0072$ ) (Figure 10). There was a significant increase in crown dieback for black cherry trees as years of elm spanworm defoliation increased ( $P=0.0118$ ) (Figure 11). There was evidence of a significant positive relationship between years of elm spanworm defoliation and sugar maple crown dieback ( $P=0.0031$ ) (Figure 12).

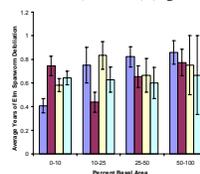


Figure 8. Average years of defoliation versus percent black species.

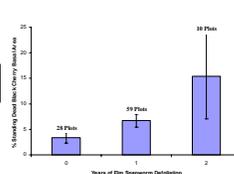


Figure 9. Percent dead black cherry versus years of defoliation.

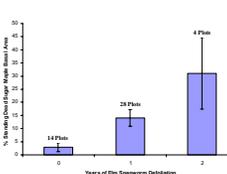


Figure 10. Percent dead sugar maple versus years of defoliation.

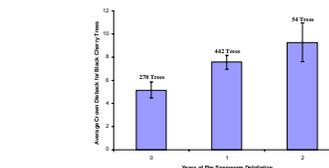


Figure 10. Percent black cherry crown dieback versus years of defoliation.

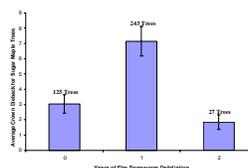


Figure 11. Percent sugar maple crown dieback versus years of defoliation.

### BEECH BARK DISEASE

Also known as beech scale *Nectria* canker, beech bark disease is an insect-fungus complex composed of the European scale insect (*Cryptococcus fagisuga*) and the exotic canker fungus *Nectria coccinea* var. *faginata* or the native *Nectria galligena* that kills or injures American beech (Houston 1994). The disease results when a *Nectria* fungus infects the bark through the feeding wounds caused by beech scale insects. Around the turn of the century, the beech scale insect was introduced into Nova Scotia from Europe. It has since spread southwestward into New England, New York, Pennsylvania, and West Virginia (Manion 1991). Beech bark disease was discovered in Pennsylvania in 1958. Currently, the killing front is moving across the northeast corner of the ANF (Fig. 12). Table 1 shows the percentage of dead American beech basal area inside and outside the killing front. Percent standing dead beech was more than twice as great inside the killing front compared to outside the front.

Table 1. Percent dead American beech basal area inside versus outside of the killing front.

2000 Killing Front	
In	Out
9.9% (58 Plots)	4.0% (63 Plots)



Figure 6. Map of the beech bark disease killing front on the ANF as of 2000.

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