Forest Health Processes on the Allegheny National Forest: Integrating Aerial Survey and Plot Data

Randall Morin, Andrew Liebhold, Kurt Gottschalk, Stephen Horsley, and Eugene Luzader - *Northeastern Research Station*

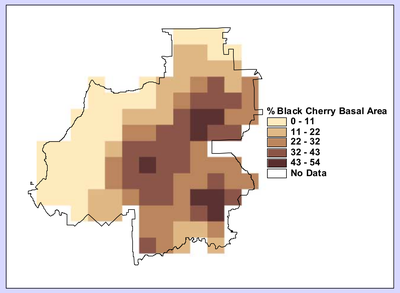
Daniel Twardus and Robert Acciavatti - *Northeastern Area State and Private Forestry*

Robert White - *Region 9, Allegheny National Forest*

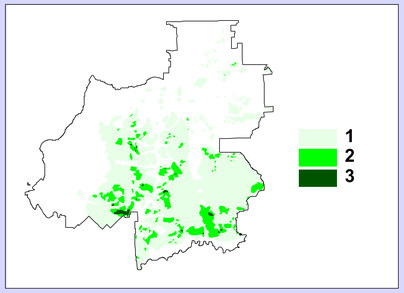
William Smith - *Southern Research Station*

CHERRY SCALLOPSHELL MOTH

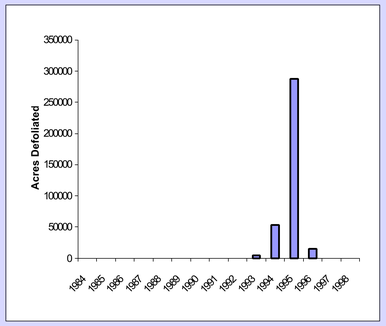
This species is native and is widely distributed in the eastern United States and Canada. It is not considered to be a serious pest in most areas. As larvae grow the shelters are enlarged or reformed on new, undefoliated branches (Craighead 1950). This progressive feeding often defoliates entire trees, reducing radial growth the following year and causing rapid decline in some stands.



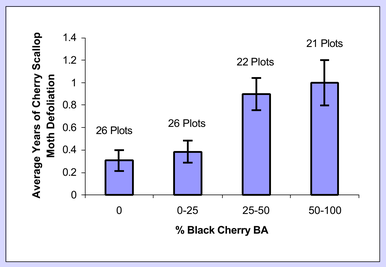
A kriged surface of percent black cherry basal area highlights the areas where cherry makes up the majority of stand stocking.



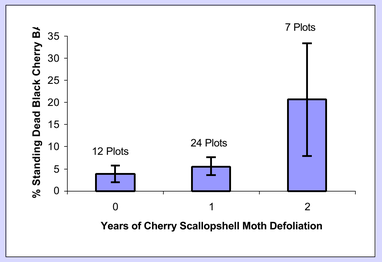
The most recent cherry scallop shell moth outbreak on the Allegheny was in 1993, 1994, 1995, and 1996. Outbreaks generally last two to three years.



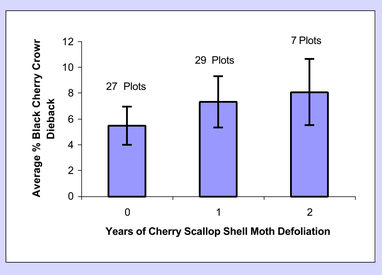
Historically outbreaks occur approximately every 10 years in the region. Previous outbreaks occurred in 1972-1974 and 1982-1984. The most severe defoliation occurred in 1995 when nearly 290,000 acres were affected.



The preferred host for this species on the ANF is black cherry. Therefore, black cherry dominated stands are normally the hardest hit by cherry scallopshell moth outbreaks There was significant evidence of a linear trend between percent black cherry basal area and years of cherry scallopshell moth defoliation (regression, F=14.96, p=0.0002).



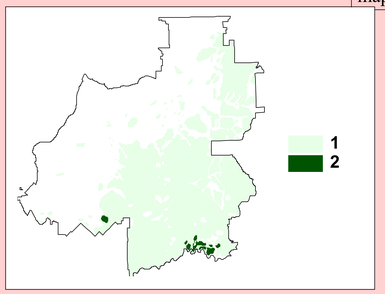
The amount of standing dead black cherry was significantly greater in areas that were defoliated for two years. There was significant evidence of a linear trend between years of cherry scallopshell moth defoliation and percent standing dead black cherry (one-way ANOVA, F=3.83, p=0.0302).



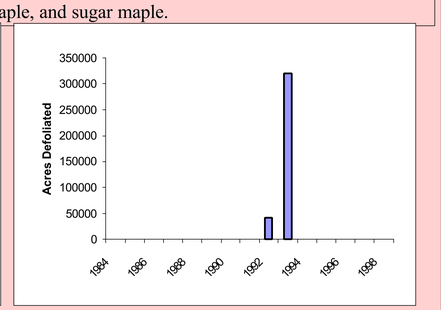
The average crown dieback value reported for black cherry trees that were defoliated increased as the number of years of defoliation increased but was not significantly different. There was significant evidence of a linear trend between years of defoliation and black cherry crown dieback (one-way ANOVA, F=0.38, p=0.6845).

ELM SPANWORM

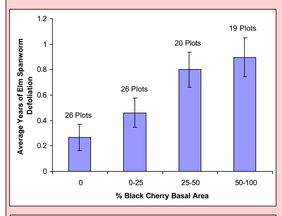
This is a native species that is found throughout the eastern United States and into Canada. Elm spanworm outbreaks are relatively uncommon. Though it periodically severely defoliates hardwoods such as ash, hickory, walnut, beech, black cherry, elm, basswood, red maple, and yellow birch. One year of defoliation often has little impact, but two consecutive summers of elm spanworm defoliation can cause dieback and even mortality when an invasion of secondary pests occurs. Elm spanworm is highly polyphagous and nearly all major tree species on the ANF except yellow-poplar are hosts. The preferred hosts for elm spanworm on the Allegheny during this outbreak were black cherry, red maple, and sugar maple.



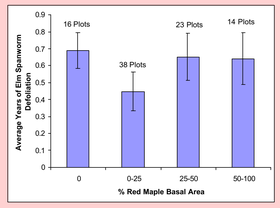
The most recent elm spanworm outbreak on the ANF was in 1992 and 1993.



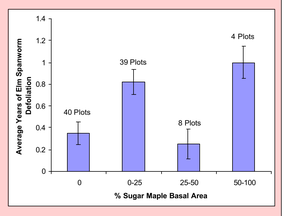
The area defoliated by the elm spanworm within the proclamation boundary of the ANF covered almost 320,000 acres in 1993.



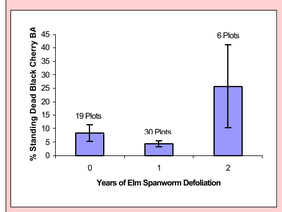
The average duration of defoliation was significantly greater on plots with greater than 25% black cherry basal area. There was significant evidence of a linear trend between percent black cherry basal area and years of elm spanworm defoliation (regression, F=14.57, p=.0002).



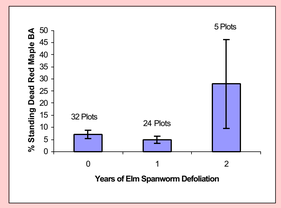
There was not evidence of a relationship between percent red maple basal area and years of elm spanworm defoliation.



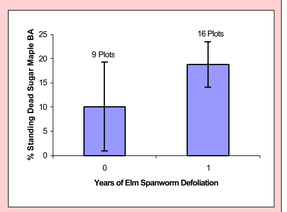
The average number of years of elm spanworm defoliation was greatest for plots with greater than 50% sugar maple basal area.



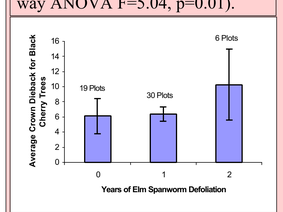
The percent standing dead black cherry basal area was significantly greater on plots that were defoliated by elm spanworm in two successive years than ones that were defoliated once. There was significant evidence of a linear relationship between years of elm spanworm defoliation and percent standing dead black cherry basal area (one-way ANOVA F=5.04, p=0.01).



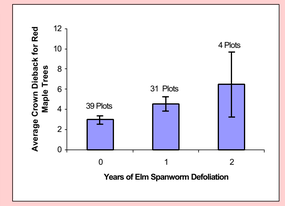
Plots that were defoliated twice had a significantly greater percent of standing dead red maple. There was significant evidence of a linear trend between years of elm spanworm defoliation and percent standing dead red maple basal area (one-way ANOVA F=5.96, p=0.0044).



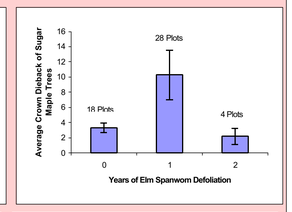
Plots that suffered defoliation had a greater percentage of standing dead sugar maple, but the difference was not significant. There was not significant evidence of a linear trend between years of elm spanworm defoliation and percent standing dead sugar maple basal area.



Crown dieback did increase with years of defoliation but the relationship was not significant.



The average crown dieback value for stands that were defoliated twice was higher but the difference was not significantly different. There was significant linear relationship (one-way ANOVA F=3.13, p=0.0496).

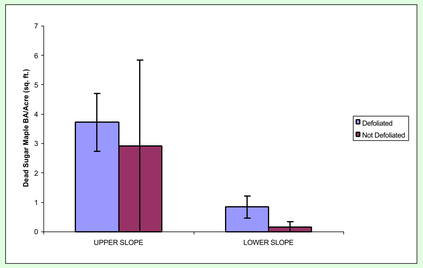


Sugar maple trees that were defoliated once by elm spanworm exhibited significantly more crown dieback than trees that were not defoliated or defoliated in two years.

SUGAR MALE DECLINE

Numerous reports of sugar maple decline or dieback have been recorded over the last 50 years. Crown dieback and death result when one or more predisposing stress events reduce resistance to invasion by opportunistic, secondary-action organisms that cause the death of tissues. Episodes of maple dieback/decline have been associated with insect defoliation, drought, logging, and root freezing. In study by Horsley et. al., sugar maple growing on the lower slopes of unglaciated sites and in any topographical position on glaciated sites seemed unaffected or only slightly affected. In contrast, trees located on the upper slopes of unglaciated sites were the most affected. Defoliated stands were more likely to be unhealthy. Conversely, all stands that were defoliated did not have unhealthy sugar maple. Therefore it was concluded that some factor or factors must by involved in making some stands more resistant to defoliation. This resistance was attributed to foliar chemistry. Unhealthy sugar maple was found on sites with lowest foliar Ca and Mg and the highest Al and Mn. (Horsley, S.B.; Long, R.P.; Bailey, S.W.; Hallett, R.A.; and Hall, T.J. 2000. **Factors associated with the decline disease of sugar maple on the Allegheny plateau.** Canadian Journal of Forest Research 30: 1-14)

The FHM data for the Allegheny National Forest was used to compare live and dead sugar maple basal area to the terrain position of the trees and whether they had been defoliated by elm spanworm. The most standing dead sugar maple was located on the upper slopes regardless of whether the areas were defoliated or not. This suggests that the less nutrient rich upper slopes are less suitable for sugar maple growth. Overall mortality was greater in defoliated stands.

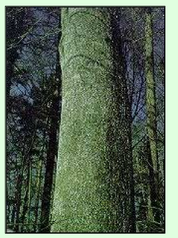


Upper slope sugar maple stand showing extensive mortality.

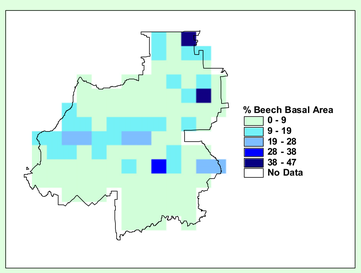
Lower slope sugar maple stand showing healthy trees.

BEECH BARK DISEASE

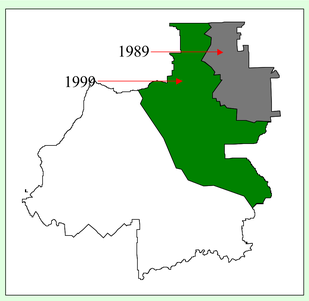
Also known as beech scale Nectria canker, beech bark disease is an insect-fungus “complex” that kills or injures American beech. The disease results when a Nectria fungus infects the bark through the feeding wounds caused by beech scale insects. Around the turn of the century the beech scale insect was introduced into Nova Scotia from Europe. It has since spread south westward into New England, New York, Pennsylvania, and West Virginia.



Wingless young scale insects are attracted to rough areas on the smooth bark of beech trees. They insert their stylets through the bark and into the phloem to feed. Once they begin feeding, they cease to move. Each insect then secretes a white, woolly, protective covering to overwinter. The insects may cover the entire trunk. Female insects reproduce parthenogenetically (in the absence of fertilization) causing the population to increase rapidly. One generation occurs annually.



A kriged surface of percent American beech basal area illustrates that the highest concentrations of beech are located in the northeastern part of the ANF.



Beech bark disease first moved into Pennsylvania in 1958. Currently the killing front is moving across the northeast corner of the ANF.

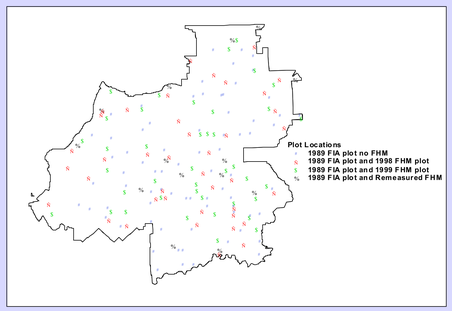
	1989 Killing Front		2000 Killing Front	
	IN	OUT	IN	OUT
1989 FIA	2.9%	1.4%	1.8%	1.6%
2000 FHM	2.6%	5.5%	9.7%	0.9%

The percent standing dead beech is almost twice as great inside the 1989 killing front according to the 1989 FIA data. The percent standing dead beech is over ten times greater inside the 2000 killing front as indicated by the 1998 and 1999 FHM data.

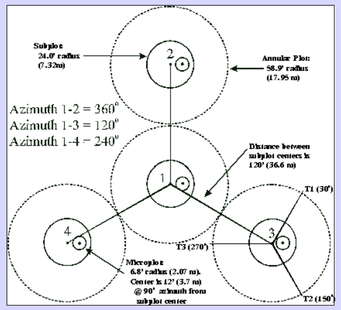
THE FOREST

The Allegheny National Forest (ANF) comprises 740,500 acres and is located in northwestern Pennsylvania on the unglaciated portion of the Allegheny Plateau. The ANF is characterized by an abundance of black cherry, maple, and other hardwoods. The ANF was established in 1923 and currently the Forest Service performs a range of management activities designed to provide multiple benefits. Recently, there has been increasing concern about forest health issues on the ANF due to actions by both endemic and exotic disturbance agents. This project focused on quantifying the effects of several forest disturbance agents including gypsy moth, cherry scallopshell moth, elm spanworm, and beech bark disease. These objectives were addressed via comparisons of historical aerial survey with forest conditions recorded in permanent plots that are maintained by the Forest Service Forest Inventory and Analysis (FIA) and Forest Health Monitoring (FHM) programs.

THE DATA



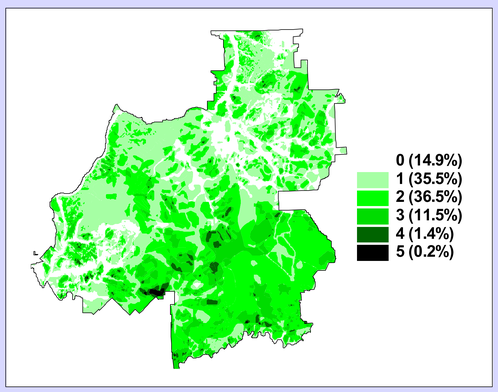
FIA and FHM plot locations on the ANF



FHM field plot design

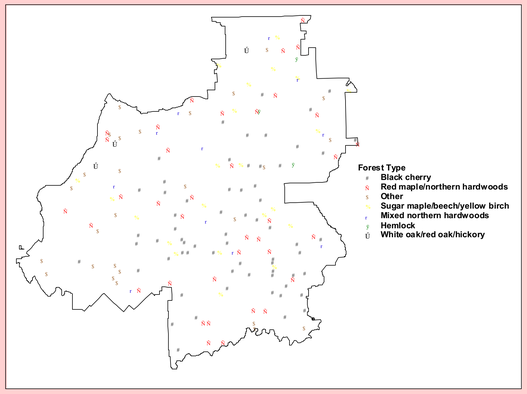
The analyses for this project were derived from three sources of data:

1. Forest Inventory and Analysis (FIA) plot data,
2. Forest Health Monitoring (FHM) plot data, and
3. aerial surveys of defoliation.

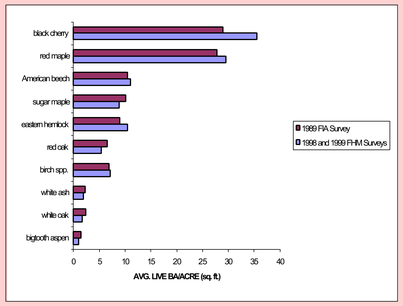


Years of defoliation and percent of land area defoliated by all damage causing agents (1984-1998)

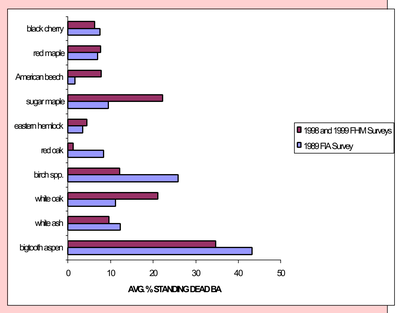
CURRENT FOREST CONDITIONS



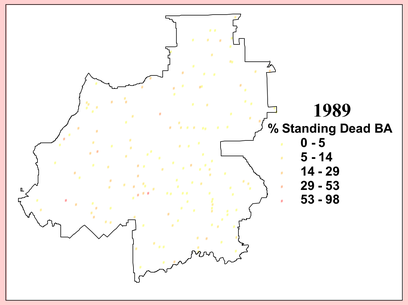
The two major forest types represented on the ANF are black cherry and red maple/northern hardwoods. The western and southern edges are the only areas that have a significant oak component. The rest of forest is predominantly northern and Allegheny hardwoods.



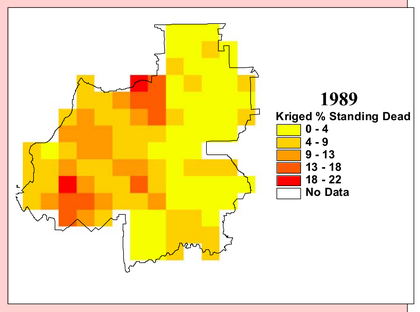
Black cherry and red maple are the two most abundant species on the ANF.



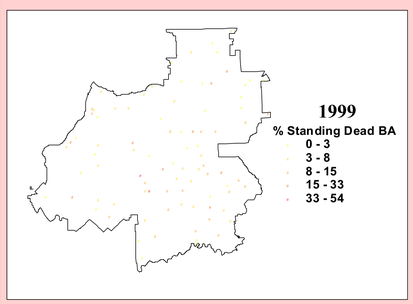
Among the five most abundant species, mortality was proportionally greatest in sugar maple. The increase in the percent of dead sugar maple may due to a general decline in sugar maple on the ANF. Beech bark disease is probably the cause of the increase in percent dead American beech basal area.



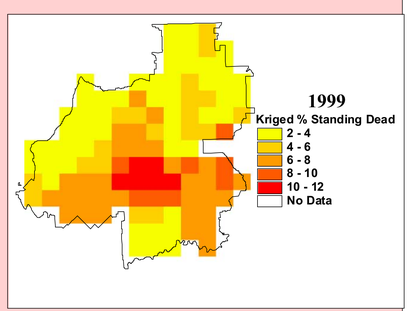
According to the 1989 FIA survey, the western part of the forest had a higher percentage of standing dead basal area.



A kriged surface of percent standing dead basal area from the 1989 FIA survey illustrates that the area defoliated by gypsy moth had a higher proportion of mortality.



A posting of percent standing dead basal area from the 1998 and 1999 FHM surveys shows that the south central portion of the forest appears to have more plots with greater than 8% mortality.



The kriged surface of percent standing dead basal area from the 1998 and 1999 FHM surveys highlights the areas with the highest mortality. The area is similar to the area defoliated by cherry scallopshell moth.

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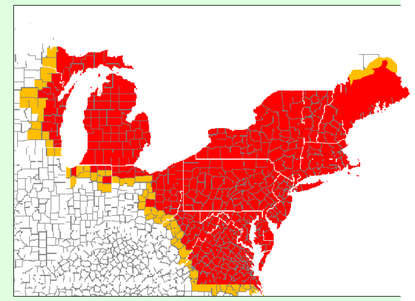
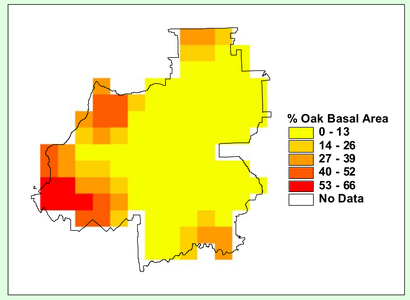
GYPSY MOTH

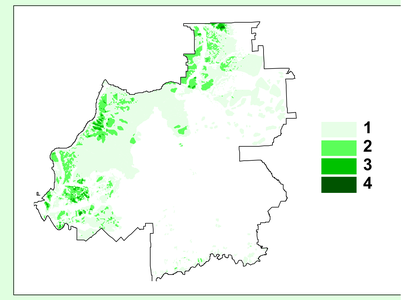
Gypsy moths spend the winter in the egg stage as embryonated eggs. In April or early May the eggs hatch, and larvae feed until June. After feeding is complete the larvae pupate and emerge as adult moths after about two weeks. The adults then mate and the female lays eggs, usually on tree trunks. The gypsy moth has one generation per year.



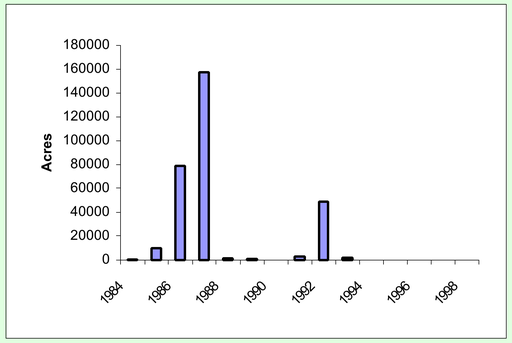
RANGE OF THE GYPSY MOTH AS OF 1999
The gypsy moth was introduced in 1868 or 1869 near Boston, Massachusetts. Outbreaks began to occur in the area about 10 years later. Since then the range of the gypsy moth has been slowly spreading. The gypsy moth invaded the ANF in the early 1980s.



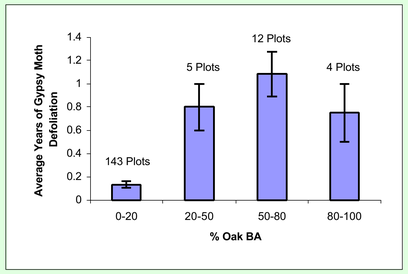
A kriged surface of percent oak basal area from the 1989 FIA data shows that most of the oak on the ANF is on the western edge.



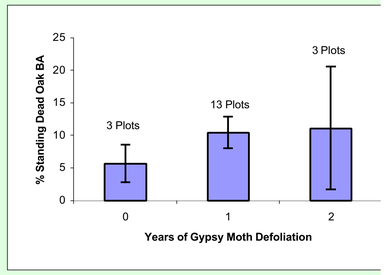
The most recent major outbreak of gypsy moth occurred in 1984-1989 on the Allegheny National Forest. A second, less intense, outbreak took place in 1992. Most of the defoliation occurred ir areas with a major oak component.



A major outbreak occurred from 1984 to 1989. The worst year during that episode was 1987 when nearly 160,000 acres were defoliated. Another less extensive outbreak occurred from 1991 to 1993. Almost 50,000 acres were defoliated in 1992.



On the ANF, stands with a higher percentage of oak were defoliated more often by gypsy moth. There was significant evidence of a linear trend between percent oak basal area and years of gypsy moth defoliation (regression, $F=92.51$, $p<0.0001$).



The average amount of standing dead oak basal area increased with frequency of defoliation although the relationship was not significant.