MICHIGAN BEECH BARK DISEASE MONITORING AND IMPACT ANALYSIS SYSTEM

Holly A. Petrillo, John A. Witter, and Erin M. Thompson

School of Natural Resources and Environment, University of Michigan

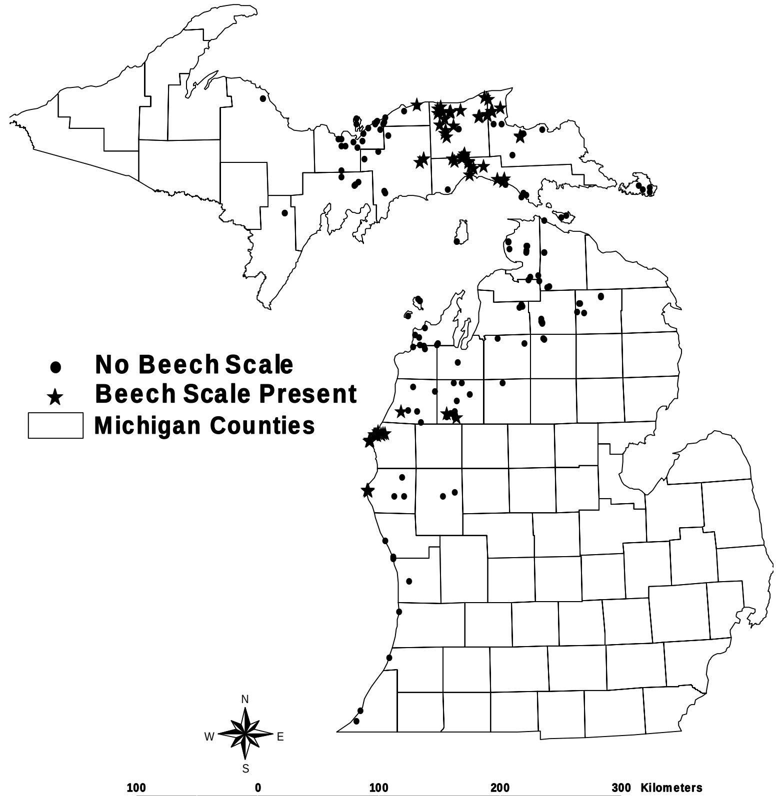

Figure 1.–Location of plots in the Michigan Beech Bark Disease Monitoring and Impact Analysis System.

Abstract

A beech bark disease monitoring and impact analysis system was established in Michigan in 2001 to measure the condition and change of overstory vegetation due to beech bark disease and other disturbances. Beech bark disease (BBD) is a disease complex involving the exotic beech scale (*Cryptococcus fagisuga* Lind.) and at least 3 species of *Nectria* fungi affecting the American beech tree (*Fagus grandifolia* Ehrh.). BBD was first discovered in Michigan in 2000, although experts now believe it has been present in the state for about 20 years. The plot system was established during the summers of 2001-2003. It currently consists of 202 extensive plots (less detailed) and 62 intensive plots (more detailed subset of extensive plots) distributed through the eastern Upper Peninsula and western and northern Lower Peninsula of Michigan. Beech scale is now present in 36% of the plots. Significantly higher transparency and dieback ratings and reduced vigor ratings occur in plots with beech scale as compared to plots without scale in both peninsulas. Dead beech basal area is also significantly greater in plots with beech scale present. In 2004, extensive plots established in 2001 were remeasured and data is being compared from 2001 and 2004 to determine the impact BBD is having in these areas.

Introduction

The University of Michigan and the Michigan Department of Natural Resources established the Michigan Beech Bark Disease Monitoring and Impact Analysis System (BBDMIAS) in 2001 in response to the presence of beech bark disease (BBD) in Michigan's northern hardwood forests. The objectives of BBDMIAS are to: 1) identify the extent of Michigan's beech resource that is affected by BBD, 2) collect baseline data on current conditions of the beech resource and northern hardwood stands containing beech before this resource is affected by BBD and 3) monitor changes in the condition of beech resource and northern hardwood forests due to BBD and other disturbances.

This monitoring system consists of two plot types: extensive and intensive (Thompson and Witter 2002). The extensive plot is composed of a matrix of 30 sampling points where basal area is determined. Tree crown and damage data, along with presence and abundance of BBD indicators, are also collected on the American beech (Fagus grandifolia Ehrh.) tree nearest each sampling point. Currently, 202 extensive plots are established throughout the northern and western Lower Peninsula (LP) and eastern Upper Peninsula (UP) (Figure 1).

The intensive plot consists of five circular subplots established within the sampling point matrix of the extensive plot. Intensive plots are established within a subset of the 202 extensive plots. Currently 62 intensive plots are established with 30 in the Lower Peninsula and 32 in the Upper Peninsula. In this plot type, data are collected on all tree species and on both live and dead trees.

Methods

The Michigan Beech Bark Disease Monitoring and Impact Analysis System is comprised of two types of plots: Type 1 (extensive) and Type 2 (intensive). The Type 1 plot system provides baseline data on northern hardwood forests and American beech trees before major disturbances due to beech bark disease occur. Type 1 plots primarily consist of one of sampling grids: 5 X 6 or 3 X 10. The particular sampling grid depends on the stand dimensions. If possible, the grid should be positioned so that one edge is parallel to the nearest road. Observations within the plot are made at 30 prism points that are spaced 40 m apart, with the first sample point being at least 40 m into the plot.

The azimuth and distance from the first sampling point to the reference point on the road is recorded. The location of the first sampling point in the plot is determined using a Trimble Geoexplorer® GPS unit. If the location of the first prism point cannot be determined due to GPS interference, a GPS location for the witness tree is taken. The azimuth and distance from each prism point to the beech tree sampled at that point is recorded. In most cases, the beech trees sampled are tagged with a numbered metal tag placed on the buttress root. For each beech tree sampled, the following variables are measured: tree status, DBH, tree number, live crown ratio, crown density, crown dieback, foliage transparency, crown light exposure, tree vigor/condition, crown class/position, tree damage, and % beech scale coverage.

After examination of the 202 stands, 30% of the stands are studied using a Type 2 plot system. Each subplot center is marked with a metal stake and a ribbon wrapped around the stake. A GPS location of each subplot center is recorded so that the stands can be relocated for additional sampling. The Type 2 plot design consists of a series of fixed-area, circular subplots tied to a cluster of five points with a subplot at the center and four others 36.6 m (120 ft) apart radiating in the four cardinal directions. The individual circular subplots are 1/59th ha (1/24th ac) in size with a 7.32 m radius (24 ft). In each plot, every living and dead tree 12.5 cm (5 in) or greater in diameter at DBH is marked with a numbered metal tag attached to the base of the tree (buttress root). The azimuth and distance from subplot center to the midpoint of these trees is recorded. For each tree within the subplots the following variables are measured: tree status, DBH, tree number, live crown ratio, crown density, crown dieback, foliage transparency, crown light exposure, tree vigor/condition, crown class/position, tree damage, and % beech scale coverage.

Results and Discussion

Beech scale infestation is currently present in 6 counties in the Lower Peninsula (Emmet, Grand Traverse, Manistee, Mason, Oceana, and Wexford) and 5 counties in the eastern Upper Peninsula (Alger, Chippewa, Luce, Mackinac, and Schoolcraft). Overall, both beech scale and BBD affect the vigor and condition of beech trees and northern hardwood stands in Michigan. Trees with scale have less photosynthetic material available based on average foliage and crown dieback levels. Slightly more trees with damage also are associated with trees with scale. Average mortality for beech is higher in infested stands. These findings agree with previous studies in the eastern U.S., which showed that levels of dieback, defects, and mortality increased, and radial growth decreased as BBD progressed through a stand (Yocum, 2002; Gavin and Peart, 1993; Burns and Houston, 1987; Houston and O'Brien, 1983; Mize and Lea, 1979; Shigo, 1972; Ehrlich, 1934).

Along with site conditions that intensify the effects of BBD, higher populations of scale and fungi that are present as the disease progresses place increasing demands on the physiological functioning of the tree (Shigo, 1964; Ehrlich, 1934). Although the etiology of BBD and the specific effects of the scale and disease on the tree's transport system are not completely understood, there is evidence in BBDMIAS plots that higher levels of scale and the presence of BBD do affect the transport system. Significantly greater amounts of dieback are found in high scale plots in the Lower Peninsula compared to no and low scale plots (Figure 2). In the Upper Peninsula, dieback increases significantly as scale intensity increases (Figure 2). In the Lower Peninsula, significantly greater crown transparency ratings are found in the high scale plots compared to no and low scale plots (Figure 3). In the Upper Peninsula, crown transparency ratings increase significantly as scale intensity increases (Figure 3).

High scale plots also show significantly reduced tree vigor compared to the no and low scale plots in both the Lower and Upper Peninsulas (Figure 4). Levels of mortality for beech also are greatest in stands in the highest scale infestation category; in both peninsulas, significantly greater amounts of dead beech BA are found in high scale plots compared to plots with no or low scale (Figure 5). The cumulative effects of beech scale and BBD infestation along with more frequent moisture stress may lead to poorer tree crown condition and higher tree mortality. Other studies have found similar increased crown dieback and tree mortality in northern hardwood stands experiencing drought-defoliation interactions (MacDonald et al., 1998; Brooks, 1994; Bauce and Allen, 1991).

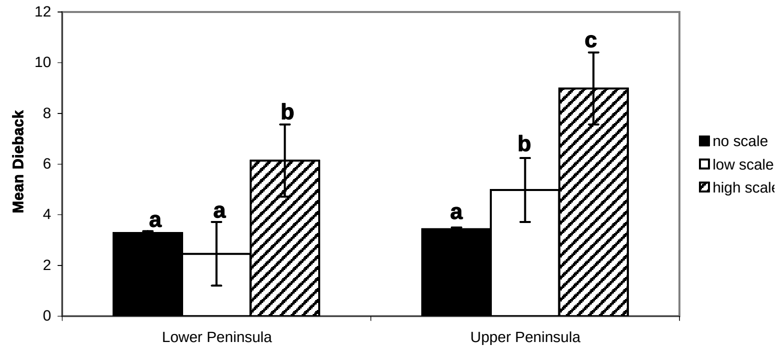

Figure 2.–Mean dieback ratings for plots with no, low and high beech scale in the Lower and Upper Peninsulas of Michigan. Bars indicate standard errors. Different letters indicate mean values that are significantly different within each scale rating.

BBD appears to be more advanced and/or having greater effects in the Lower Peninsula compared to the Upper Peninsula. Both the average level of scale infestation and mean amount of dead beech basal area were significantly higher for stands with BBD in Lower Peninsula. Another sign that BBD may be more advanced in the Lower Peninsula is the higher number of tarry spots recorded here compared to the Upper Peninsula. Tarry spots are commonly associated with *Nectria* infection, which is more abundant in the later stages of BBD (Shigo, 1972).

During the 2004 field season, we remeasured the intensive plots that were established during 2001, 2002, and 2003 and resampled the extensive plots established in 2001.

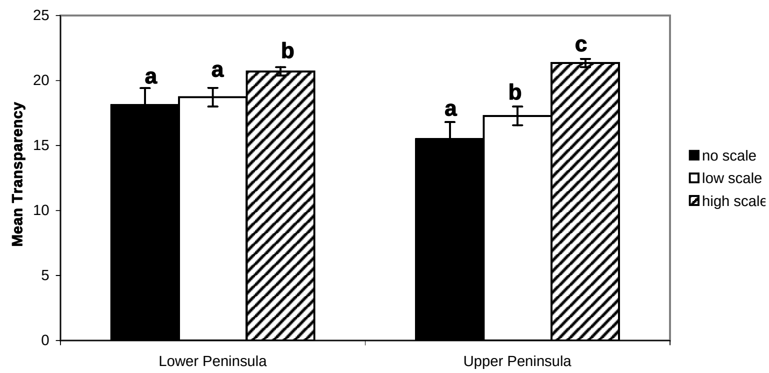

Figure 3.–Mean transparency ratings for plots with no, low and high beech scale in the Lower and Upper Peninsulas of Michigan. Bars indicate standard errors. Different letters indicate mean values that are significantly different within each scale rating.

Acknowledgments

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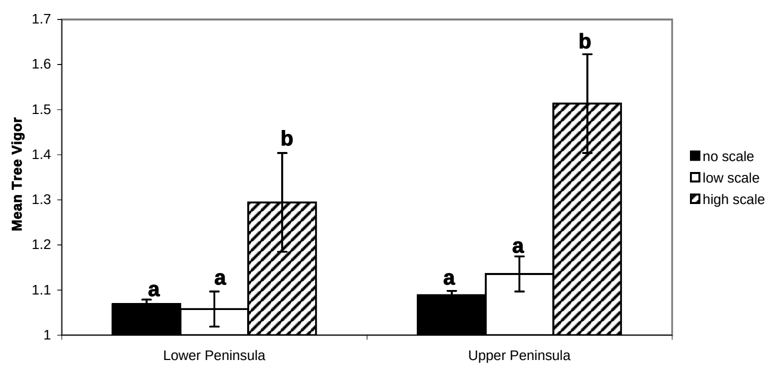

Figure 4.–Mean vigor ratings for plots with no, low and high beech scale in the Lower and Upper Peninsulas of Michigan. Bars indicate standard errors. Different letters indicate mean values that are significantly different within each scale rating.

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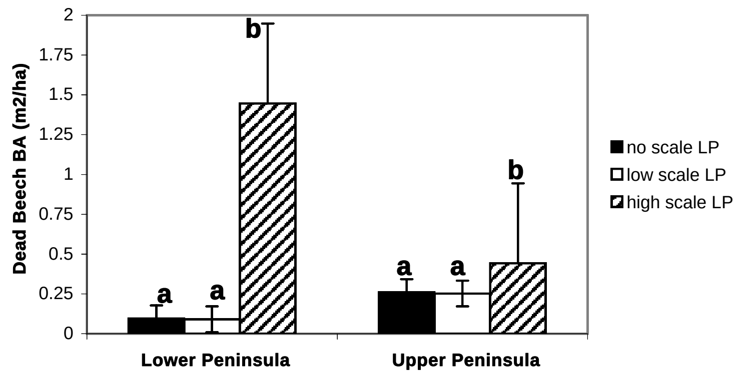

Figure 5.–Mean amounts of dead beech basal area (BA) (m^2/ha) for plots with no, low and high beech scale in the Lower and Upper Peninsulas of Michigan. Bars indicate standard errors. Different letters indicate mean values that are significantly different within each scale rating.

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Contains invited papers, short contributions, abstracts, and working group summaries from the Beech Bark Disease Symposium in Saranac Lake, NY, June 16-18, 2004.

Key Words: Beech Bark Disease, forest structure, wildlife, silviculture and management, genetics, Northeastern forests, research agenda, *Cryptococcus fagisuga*, *Nectria coccinea* var. faginata, *Fagus grandifolia*