TITLE: Assessment of Beech Bark Disease in Michigan: Rate of Spread and Impacts on Stand Composition and Down Woody Material

LOCATION: Michigan

DURATION: Year 1 of 3

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PROJECT OBJECTIVES:
1. Monitor and delineate advancing and killing fronts of beech bark disease (BBD) in MI;
2. Validate and refine the risk model we developed in 2007 to predict rate of spread of the advancing fronts in upper and lower MI;
3. Assess changes in within-stand beech scale density and distribution over time;
4. Re-visit BBD plots established in 2002-2003; record changes in beech scale density, tree mortality and crown condition, species composition (overstory and regeneration) and down woody material;
5. Quantify overstory conditions (species composition, DBH, crown condition, canopy transparency) in additional sites established in 2007 at, near or beyond the advancing fronts.

JUSTIFICATION AND BACKGROUND: Beech bark disease (BBD), an etiological complex consisting of the nonindigenous, sap-feeding beech scale insect (*Cryptococcus fagisuga* Lind.) and cambium-killing *Neonectria* and *Nectria* spp. fungi, has caused widespread mortality of American beech (*Fagus grandifolia*) across much of its range in North America. The disease complex was introduced to Nova Scotia in the 1890s (Ehrlich 1934) and has slowly progressed to the south and west. Discovery of BBD in 2002 in areas of Oceana and Luce counties in MI was disheartening. Michigan forests, which have been severely impacted by numerous invasive pests, encompass the western range limit of beech in North America. However, there is little reason to believe that they will fare better than their eastern counterparts as the killing front of BBD advances. The maple-beech-birch cover type comprises roughly 33% of the timberland in MI and includes more than 1.4 million board feet of beech (Hanson and Brand 2006). Beech is a particularly important species for wildlife (Tubbs and Houston 1990, McCullough et al. 2002), especially in late successional northern hardwood stands, where it is often the only hard mast producer. Mature beech trees provide cavities and perching branches used by a wide array of birds and mammals. Numerous Michigan state forest campgrounds, state parks and other recreational areas have a substantial amount of mature beech; windthrow (Papaik et al. 2005) and hazard trees have become important issues. The loss of overstory beech may dramatically affect aesthetics, productivity (Gavin and Peart 1993), regeneration (Hane 2003), biodiversity and overall forest health. The lack of information about the distribution and spread rate of beech scale in Michigan seriously limits the ability of resource managers to assess stand susceptibility and vulnerability, and to prioritize risk management operations including pre-salvage, salvage and stand regeneration activities.

The work we propose here will build upon results from our previous BBD projects, address important information gaps regarding beech scale dynamics and supplement information collected in FIA and FHM monitoring plots. To date, we have visited more than 750 sites in MI where beech occurs. We identified nine apparent satellite populations of beech scale and accurately delineated advancing fronts in the eastern Upper Peninsula and northwestern lower MI. Using inverse, iterative modeling processes, we estimated that the advancing front has spread an average of roughly 2.5 miles per year in the Upper Peninsula and 0.9 miles per year in the Lower Peninsula. Estimated spread rates, however, varied considerably between the two years encompassed by our survey. Additional monitoring of sites at and beyond the advancing fronts will enable us to validate and refine our model, ensuring a high level of confidence in predictions of spread rates.

We also have a relatively unique opportunity to document changes in forest composition and structure as the killing front of BBD advances. In 2002-2003, we established 62 permanent plots, with individually tagged trees, and intensively surveyed vegetation and down woody material (DWM). These sites were selected to represent three levels of beech basal area (low, moderate, high) and three levels of beech scale infestation (absent, low, heavy) (Kearney 2006). At that time, there was little evidence of BBD impact in most of the stands. These plots, however, effectively serve as pre-BBD controls, enabling us to accurately quantify the extent, progression and rate of change in composition and structure, including DWM, as BBD advances. The absence of such pre-BBD data has largely precluded any detailed assessment of the impact of the BBD complex in beech forests of the Northeast.

Another question, which became apparent during our previous work, involves the spatial and temporal dynamics of beech scale. We do not yet know (1) how rapidly beech scale density builds on individual trees; (2) how within-stand distribution of beech scale progresses and (3) whether substantial beech scale mortality frequently occurs in stands ahead of the killing front. Intensive monitoring of beech scale density and distribution in selected stands will enable us to address these questions, which have major implications for spread rates and ultimately the health of these forests.

Long-term monitoring of beech scale establishment and BBD impacts as well as the ability to accurately predict the spread of the advancing and killing fronts will provide forest managers with critically important information. Forest health specialists have estimated that 7.5 million large beech trees (DBH ≥ 10 inches) representing 800 million board feet of sawtimber will likely die as the killing front moves through MI (McCullough et al. 2001). This mortality represents an enormous, regionally synchronous pulse of DWM (McGee 2000) that merits documentation and study. The ability to predict the rate of spread of BBD will allow silviculturists to incorporate BBD into 5-10 year planning horizons. We also expect our activities will support ongoing efforts to identify and monitor potentially resistant beech trees.

In addition, our results will provide managers with information related to the future composition, productivity and wildlife value of stands in the aftermath forest. For example, while dense thickets of beech sprouts typify the aftermath forest in PA and other northeastern stands, they so far appear to be uncommon in MI. Information we acquire will enable managers to appropriately adjust harvests, regeneration, and planning to ensure objectives related to forest health, sustainability, diversity and habitat quality are met. Data acquired from our previous and ongoing work are currently used by Michigan DNR forest managers to identify stands for underplanting with non-target hardwood species to increase diversity and reduce stand susceptibility to BBD.

Methods: We will re-visit the original 62 stands to re-survey overstory and understory species composition, density of beech scale, diameter and condition of beech trees, and down woody material abundance and composition following methods described by Kearney (2006). A center subplot (24 ft radius) and four subplots of equal size, located 60 ft away from the center plot in each cardinal direction, were established in each stand. Each subplot was marked with a stake and GPS coordinates were recorded at the center subplot. Trees (> 6 inches DBH) in the five subplots will be re-examined to assess species composition, DBH and canopy condition, including P3 crown indicators for dieback and transparency. Beech scale presence and density, and evidence of fungal infection (e.g. fruiting bodies) will be recorded for beech trees in the subplots. Four regeneration plots will be established equidistantly between the center subplot and the four subplots in the cardinal directions to minimize effects of trampling. From the center of each regeneration plot, we will determine number and species of seedlings (< 12 inches tall) within an 8 ft radius, saplings (> 12 inches tall; <1 inch diam) within a 12 ft radius and recruits (1 to 6 inches DBH) within a 24 ft radius. Frequency, size and decay class of DWM will be recorded along a minimum of two transects, each 329 ft x 3.3 ft (1 x 100 m), running diagonally between subplots.

Beech scale density will be recorded on marked areas of tagged trees in selected sites. Trees will be re-visited at least monthly during late summer and fall to monitor scale reproduction and dispersal, in spring to assess winter mortality, and at least twice in early or mid summer. Using additional plots established as part of a previous PTIPS project, we will continue to monitor the advancing fronts and killing fronts of BBD in lower and upper MI each summer. GPS coordinates and overstory variables (number, species and size of trees; canopy condition) will be recorded in 0.1 acre fixed radius plots. Predictions from our existing model of the rate of spread of the advancing front and the actual distribution of beech scale will be compared using data collected annually. Parameters will be refined as necessary, using an iterative approach. Rate of spread of the advancing front in MI will be compared with published spread rates from other regions.

Products: Results from the projects outlined above will be summarized and reported in various forms. We will map the advancing and killing fronts of BBD and refine our estimates of the rate of spread of the advancing front. Our results will be used to revise the BBD models used for the National Forest Risk Map project. We expect to present results to forest health and silvilculture specialists, forest managers, property owners and others involved with management of beech at state, regional and national meetings. The MI Dept. of Natural Resources will continue to use our maps and related data for silvicultural decisions, including harvest scheduling. Information generated by our survey and modeling will also be used to assess hazard tree risk in private, state and federal recreation areas. Final results will be published in scientific journals.

Schedule of Activities: In Year 1, we plan to hire a graduate student, identify sampling locations and conduct fieldwork (monitor advancing front, re-survey plots) during the summer. Scale dynamics will be monitored through the summer, fall and spring to track reproduction, dispersal and mortality. Data analysis, modeling and mapping will occur over the winter. A similar schedule will be followed in Year 2. We expect sampling in permanent plots will be completed in Year 2. Data analyses, modeling and mapping will again occur over the winter. Fieldwork in Year 3 will focus on documenting the advancing and killing fronts, scale dynamics and final model revisions. Analysis of data and preparation of final reports/manuscripts will be completed by the end of Year 3.

COSTS

	Item	Requested FHM EM funding	Other source funding[3]	Source
Year 1				
Administration	Salary	38,200[1]	20,900	MSU, related projects
	Overhead			
	Travel	5,000[2]		
Procurements	Contracting			
	Equipment			

	Supplies	3,500		
Indirect			16,511	MSU
Total Year 1		**46,700**	**37,411**	
Year 2				
Administration	Salary	39,500[1]	21,600	MSU, related projects
	Overhead			
	Travel	5,000[2]		
Procurements	Contracting			
	Equipment			
	Supplies	3,000		
Indirect			17,007	MSU
Total Year 2		**47,500**	**38,607**	
Year 3				
Administration	Salary	40,700[1]	22,250	MSU
	Overhead			
	Travel	4,000[2]		
Procurements	Contracting			
	Equipment			
	Supplies	2,500		
Indirect			17,576	MSU
Total Year 3		**47,200**	**39,826**	
Project Total Years 1 to 3		**141,400**	**115,844**	

[1]Expected costs include stipend and fringe benefits for a graduate student (1/2-time, M.S. level). An undergraduate student assistant will be needed to assist with fieldwork ($10/hr). [2]A long-term lease of an MSU Motor Pool vehicle (3-4 months) will be needed for summer fieldwork.

[3]Additional support from other sources, including partial salary support for the PI, laboratory facilities, office space and analytical supplies will supplement funds from the FHM EM program. (PI assumes 3-7% annual time commitment; fringe benefit rates of 29.51-31.55%). In-kind support, including access to forest inventory data, maps and permits, will be provided by the MI Dept. of Natural Resources.

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