**TITLE**: Assessment of Beech Bark Disease in Michigan: Rate of Spread and Impacts on Stand Composition and Down Woody Material – Progress Report, September 2009

**LOCATION**: Michigan
**DURATION:** 3 years; Current request is for Yr 2.

**PROJECT LEADER**: Deborah G. McCullough, Professor, Dept. of Entomology and Dept. of Forestry, 243 Natural Science, Michigan State University, 517-355-7445; mccullo6@msu.edu

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**FHP SPONSOR/CONTACT**: Manfred Mielke, USDA Forest Service, St. Paul, MN

**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.

Our work builds upon results from our previous BBD projects, addresses important information gaps regarding beech scale dynamics and supplements information collected in FIA and FHM monitoring plots. Between 2003 and 2008, we visited more than 750 sites in MI with beech, identified nine satellite populations of beech scale and delineated advancing fronts in Upper and Lower MI. Inverse, iterative modeling processes suggested that spread of the advancing front ranges from 2.5 miles per to 0.9 miles per year. 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). Sites were selected to represent three levels of beech basal area and three levels of beech scale infestation (absent, low, heavy) (Kearney 2006). There was little evidence of BBD impact in most of the stands at that time. These plots effectively serve as pre-BBD controls, enabling us to 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, regeneration and DWM, as well as the ability to accurately predict the spread of the advancing and killing fronts will provide forest managers with information related to the future composition, productivity and wildlife value of stands in the aftermath forest 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. 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 from our work are currently used by Michigan DNR foresters to identify stands for underplanting to increase species 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). Beech scale presence and density, and evidence of fungal infection will be recorded. 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 will be recorded in subplots. Frequency, size and decay class of DWM will be recorded along a minimum of two transects. Beech scale density will be monitored on marked areas of tagged trees in selected sites periodically to assess winter mortality and reproduction. , We will continue to monitor the advancing and killing fronts of BBD and evaluate spread rates of BBD.

**PROGRESS TO DATE:** Funds did not arrive until fall 2009, which was substantially later than anticipated. Nevertheless, in 2009, we were able to re-visit a subset of the permanent plots to assess beech condition and the progression of BBD in these stands. Regeneration was sampled in six plots in lower Michigan and six additional plots in Upper Michigan. We also evaluated three different methods for recording beech scale density with digital photographs and image analysis software. Data entry and analysis are in progress. We are currently establishing the network of sites that will be visited in 2010.

**Expected Products**: Advancing and killing fronts of BBD, estimates of BBD spread rates and related data will be mapped. Results provided to forest health specialists, managers and property owners at state, regional

and national meetings. Data will be used to revise BBD models used for the National Forest Risk Map project. Final results will be published in scientific journals.

**Schedule of Activities:** In 2010, we expect to hire a graduate student and conduct fieldwork (monitor advancing front, re-survey plots) during the field season. 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, followed by data analysis and preparation of final reports/manuscripts.

## REQUEST FOR YEAR 2 FUNDING

| **Year 2** | | | | |
|---|---|---|---|---|
| Administration | Salary | 39,500[1] | 8,264 | 5% PI effort; fringe at 29.04% |
| | Overhead | | | |
| | Travel | 5,000[2] | | |
| Procurements | Contracting | | | |
| | Equipment | | | |
| | Supplies | 3,000 | | |
| Indirect | | | 28,997 | Total Direct MSU & USDA FS x 52% |
| **Total Year 2** | | **47,500** | **37,261** | |
| **Year 3** | | | | |
| Administration | Salary | 40,700[1] | 8,540 | 5% PI effort; fringe at 29.47% |
| | Overhead | | | |
| | Travel | 4,000[2] | | |
| Procurements | Contracting | | | |
| | Equipment | | | |
| | Supplies | 2,500 | | |
| Indirect | | | 28,985 | Total Direct MSU & USDA FS x 52% |
| **Total Year 3** | | **47,200** | **37,525** | |
| | | | | |
| **Project Total Years 1 to 3** | | **141,400** | **111,219** | |

[1]Expected costs include stipend and health benefits for a graduate student (1/2-time, M.S. level). Undergraduate student assistants 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](PI assumes 5% annual time commitment; fringe benefit rates of 28.54-29.47%).

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