TITLE: Survey for Beech Bark Disease Resistant American Beech Trees (on the Hiawatha and Monangahela National Forests)

LOCATION: Michigan, Pennsylvania and West Virginia

DATE: Sept. 30, 2010

DURATION: Year 1 of 3-year project **FUNDING SOURCE:** Base

PROJECT LEADER: Jennifer Koch, US Forest Service, NRS, (740)368-0188, jkoch@fs.fed.us

COOPERATORS: Jean Perkins, Hiawatha National Forest jeperkins@fs.fed.us (304-257-4488; Jeff Kochendorfer jdkochenderfer@fs.fed.us (304-257-4488) & Glenn Juergens gpjuergens@frontiernet.net (304-338-2145) Monangahela National Forest; Tom Hall thall@state.pa.us (717-948-3941), Pennsylvania Dept. of Conservation and Natural Resources; Jill Rose jrose@ag.state.wv.us (304-558-2212), West Virginia Dept. of Agriculture, Bill MacDonald University of West Virginia

FHP SPONSOR/CONTACT: Alan Iskra, Morgantown, WV; (304) 285-1553, aiskra@fs.fed.us

PROJECT OBJECTIVES: 1) Survey for potential beech bark disease (BBD)-resistant American beech 2) Confirm resistance using artificial infestation with scale eggs 3) Collect scion for grafting and inclusion of these resistant trees in ongoing efforts to develop seed orchards.

JUSTIFICATION: < How does the project address each of the following Evaluation Monitoring selection criteria?>

a. Linkage to FHM Detection Monitoring- the need for the project should arise from an analysis of FHM survey data: Based on FIA data and FHP county level survey records it has been shown that BBD has invaded 30 % of the region of the United States where beech is present and is expected to continue to expand (Morin et al., 2007). FIA data also showed there was a regional increase in beech mortality following BBD invasion, but considerable amounts of live beech remain. Fortunately, a small portion (estimated at 1-5 %) of surviving beech appear to be resistant to the beech scale component of beech bark disease.

b. Significance in terms of the geographic scale: This project will support the survey and identification of BBD resistant beech trees on the Hiawatha National Forest (HNF), the Monangahela National Forest (MNF) and on state forest land in heavily BBD impacted regions of PA and WV. These resistant trees will be incorporated into seed orchards to be established at the Oconto River Seed Orchard (ORSO) in Wisconsin, the Monangahela National Forest in West Virginia and the Pennsylvania State Nursery. These seed orchards will supply both state and federal forest managers with genetically diverse, regionally-adapted, BBD resistant planting stock to carry out management plans for dealing with BBD. Both state and national forest managers have been including beech bark disease related silvicultural treatments as well as general plans for restoration/regeneration as part of their resource management plans. Specifically, the Allegheny National Forest (ANF) Land and Resource Management Plan (LRMP, September 2006) includes the goal to “maintain, restore, or enhance mast-producing trees and habitat diversity.” This plan also states that, “reforestation prescriptions should include the consideration of genetically improved planting stock.” In some cases, full planting may be necessary where natural regeneration methods have failed, or where extensive overstory tree mortality has occurred due to factors such as windthrow or insect and disease activity.

Biological impact and/or political importance of the issue: American beech (*Fagus grandifolia*) is an important component of hardwood and mixed-hardwood forests throughout eastern North America. The mast and buds of beech trees provide an important food source for many species of birds and mammals. In some Northern hardwood forests, beech is the only mast-producing species and has been linked with the success of black bear reproduction (Jakubus et al. 2005). On the Hiawatha National Forest, beech is by far the major producer of mast. The Hiawatha has only one commercial species of oak and one non-commerical species, but both are minor components compared to beech. The decline of such a predominant mast-producing species will undoubtedly have a major impact on many different wildlife species.

Mortality levels in the first wave of the disease can be as high as 50 % (Miller-Weeks 1983). Often cankers form, resulting in stem defects and a reduction in wood product value. Many severely deformed American beech trees persist in long-affected stands and their propensity for root-sprouting results in the formation of “thickets” that take up space and prevent other species from establishing, offering little economic or ecological value. **Studies indicate that genetic improvement of stands can be realized either through traditional tree improvement (seedling development and planting) or through silvicultural methods designed to manipulate stand genetics by favoring resistant trees, or a combination of both (Koch et al., 2010).** However, as the age of the remaining resistant trees increases, so does the risk of mortality and loss of valuable genotypes. There is a need to preserve valuable genotypes and a need to expedite the process of enhancing stands with resistant trees. Funding of this project will allow the identification of BBD-resistant trees, information that can be used by managers to develop disease-management plans. In addition, the selected resistant trees will be incorporated into seed orchards, providing a source of resistant seed for carrying out restorative plantings where needed.

Scientific Basis/Feasibility - likelihood that the project will be successfully completed: It has been documented that there are American beech trees that remain disease free in forests long-affected by beech bark disease. Testing has shown that resistance is to the insect portion of the disease complex (Houston, 1983), which we have confirmed in recent genetic experiments (Koch et al., 2010; Koch 2010). In our study, trees were chosen based on a field assessment using criteria such as absence of scale and cankers, proximity to infested trees, and a DBH > 9”. The trees were challenged by placing foam pads containing insect eggs face down against the bark and looking for scale colonization one year later. All of the trees chosen tested as resistant in the artificial challenges. In addition, we have worked with partners on the Allegheny National Forest and with the Michigan Department of Natural Resources who have field-selected putative resistant trees and sent us scion for grafting. The grafted material was then artificially challenged with insect eggs to confirm this resistance. To date, of 30 different individual genotypes selected as resistant in the field all but 2 tested as resistant when grafted ramets were challenged in this manner. Combining field assessment with field insect challenges and post-graft testing allows us to be certain that genotypes selected as BBD resistant are truly resistant prior to installation in a seed orchard.

Priority Issues (addressed from Request for Proposals): This proposal addresses tree mortality deviating from expected levels due to BBD. The proposed survey work will give estimates of the density of live, resistant trees in the stands which will be useful information for managers in decision-making. Maintenance of a healthy beech component in a stand with a higher density of resistant trees can be accomplished through silvicultural approaches alone, while low occurrences of resistance may require supplemental plantings. The data from these surveys can be incorporated into FHM Detection Monitoring databases as it will also give indications of the extent and severity of BBD in the targeted areas.

DESCRIPTION:

a. Background: <Brief description of the project including scientific basis.> Beech bark disease (BBD) has long been negatively impacting the aesthetic, ecologic and economic qualities of hardwood and mixed hardwood forests throughout eastern North America. Fortunately, there are American beech trees that remain disease-free in forests long-affected by beech bark disease. Recent studies have confirmed that this resistance has a genetic basis (Koch et al., 2010). Recommended silvicultural treatments for BBD include removal of poor quality, susceptible beech with the overall goal of increasing the number of healthy, resistant beech. Both state and national forest managers have been including beech bark disease related silvicultural treatments as well as plans for restoration/regeneration of beech as part of their resource management plans. However, there is a lack of genetically diverse, regionally adapted, disease-resistant planting stock for forest managers to carry out such plans. The goal of this proposal is to identify potentially BBD-resistant trees, test them with scale eggs to confirm their resistance, and collect scion for their inclusion in ongoing efforts to establish seed orchards using grafted BBD-resistant American beech trees.

b. Methods: <Brief description of methods including data availability.>
To select stands for surveys, the FSVeg or FIA database will be queried to identify stands with a high basal area of beech, in areas where beech bark disease has been known to be present for many years. The stand examiner will follow random but predetermined transect routes similar to methods used for conducting conventional

stand examinations. However, instead of collecting data only at predetermined plot locations as is done in conventional stand examinations, the examiner will collect GPS data whenever an apparently-resistant beech tree is encountered. The examiner will also hang bright-colored flagging on or beside these apparently BBD-resistant beech trees. Data collected during survey portion will include the number of beech trees greater than DBH 9" and the level of scale infestation, absent, low or high. Trees that are absent of scale infestation and meet additional criteria (free of cankers, within 25-50 feet of infested tree, healthy canopy) will be field tested using the beech scale artificial infestation technique adapted from Houston (1982). To insure that clusters of resistant beech, should they be found, are not just root sprouts of a single genotype, resistant trees should not be counted as two separate individuals unless they are at least 30 ft. apart.

Scale challenges/artificial infestations: Viable scale eggs will be collected between mid-July and early August in areas with high densities of scale infestation. A paintbrush is used to dislodge the eggs from the bark of infested trees, and brushed directly into collection bags. The white wax-like waste that is secreted by the adult scale insect will be dislodged along with the eggs as will the adult insects, juvenile stage insects, various non-scale insects, and general debris. To isolate the eggs from the adults and other contaminants, the material will be passed through a 200 micron nylon mesh. Using a portable field dissecting microscope, 200 eggs are counted out and place on a 6" x 6" piece of ½ inch think polyurethane foam padding that has been pre-moistened. The pad is then placed onto the test tree, with the eggs facing the bark. Plastic-coated wire is wrapped around the pad and tree to hold the pad in place. To prevent excessive moisture from being trapped in the pad and the eggs from being washed out by rainfall, a piece of Tyvek house wrap cut roughy an inch larger than the foam pad, is affixed directly to the bark overtop of the foam using silicone. Each test tree will have three separate pads placed on it, each at a different aspect around the bole of the tree at about breast height. A fourth pad will be placed on each tree without scale eggs on it, as a negative control. The pads and Tyvek are left in place for 48-52 weeks at which point they are removed and scale development and infestation is counted. Hand lenses are used to count the number of adult scale that have colonized the tree as well as if there is any evidence of viable eggs or juvenile stages of the insect. The foam pad is surveyed underneath a dissecting scope to count the number of adults and egg clusters. As a positive control, a tree nearby the test tree that has visible scale infestation will also have test pads with eggs put onto it. Prior to placement of these pads, a scrub brush will be used to remove pre-existing scale insects. A t-test will be performed to determine if the mean number of adult insects and egg clusters on the test tree is lower than the mean on the positive control tree. In cases where there is a significant difference, the final selection of the tree as resistant will also be based on the actual scale counts observed.

Dormant scion from trees that are selected after testing as being scale-resistant, will be shipped to the NRS lab in Delaware, OH for inclusion in their hot-callus grafting program where multiple ramets of each genotype will be propagated for inclusion in seed orchards.

c. Products: <Brief description of anticipated products.> By the end of this project 20 resistant genotypes should be identified for each site. A database will be established that will include county, township, GPS coordinates of the trees, DBH, distance from the nearest infested tree, presence of cankers, overall canopy health rating, and condition of other beech at site. Each of the resistant trees identified will have undergone a field test for resistance, by placement of scale eggs directly onto the tree and assessing scale infestation levels a year later. Trees that are confirmed to be resistant by this technique, or by testing grafted ramets in a similar fashion, will be propagated through grafting for inclusion in a beech seed orchard.

d. Schedule of Activities: Year 1: Survey all sites to identify putative BBD resistant trees (goal 5 genotypes per site per year). Set up field scale artificial infestation. Collect scion for grafting. Year 2. Continue survey and setting up field scale artificial infestation. Collect data from year 1 scale infestations. Collect scion for grafting. Year 3. Continue survey and setting up field scale infestation tests. Collect data from year 2 scale infestations, collect scion for grafting. Year 4: Collect data from year 3 scale infestation, collect scion for grafting.

e. Progress/Accomplishments: <Brief description of progress/accomplishments for multi-year projects.> By the end of this project 20 resistant genotypes will have been identified for each site. A database will be established that will include county, township, GPS coordinates of the trees, DBH, distance from the nearest infested tree, presence of cankers, overall canopy health rating, and condition of other beech at site. Each of the resistant trees identified will have undergone a field test for resistance, by placement of scale eggs directly onto the tree and assessing scale infestation levels a year later. Trees that are confirmed to be resistant by this technique, or by testing grafted ramets in a similar fashion, will be propagated through grafting for inclusion in a beech seed orchard.

COSTS: < Budget estimates for each year of project.>

	Item	Requested FHM EM Funding	Other-Source Funding	Source
YEAR FY2011				
Administration	Salary	38,850	50,750	NRS-4, HNF
	Overhead			
	Travel	8,200		PA-DCNR
Procurements	Contracting			
	Equipment			
	Supplies		4,000	
Total		47,050	54,750	

	Item	Requested FHM EM Funding	Other-Source Funding	Source
YEAR FY2012				
Administration	Salary	36,330	52,680	NRS-4, HNF
	Overhead			
	Travel	8,200		
Procurements	Contracting			
	Equipment			
	Supplies		4,000	NRS-4
Total		44,530	56,680	

	Item	Requested FHM EM Funding	Other-Source Funding	Source
YEAR FY2013				
Administration	Salary	40,850	54,690	NRS-4,HNF
	Overhead			
	Travel	8,200		
Procurements	Contracting			
	Equipment			
	Supplies		4,000	NRS-4
Total		49,050	58,690	

Literature

Houston, D.R. 1982a. A technique to artificially infest beech bark with the scale, *Cryptococcus fagisuga* (Lindinger). Research Paper NE-507. USDA Forest Service, Northeastern Forest Experiment Station, Broomhall, PA, 8p.

Jakubus, W.J., C.R. McLauglin, P.G. Jensen and S.A. McNulty. 2005. Alternate year beechnut production and its influence on bear and marten populations. *In*: Evans, C.A., J.A. Lucas, and M.J. Twery. 2005. Beech Bark Disease: Proceedings of the Beech Bark Disease Symposium. Gen. Tech. Rep. NE-331. USDA Forest Service, Northeastern Research Station, Newtown Square, PA, pp. 79-87.

Koch, J.L., Carey, D.W., Mason, M.E., and Nelson, C.D. 2010. Assessment of beech scale resistance in full- and half-sib families. The Canadian Journal of Forest Research 40:265-272.

Koch, J.L. 2010. Beech bark disease: The oldest “new” threat to American beech in the United States. Outlooks on Pest Management 21(2):64-68.

Miller-Weeks, M. 1983. Current status of beech bark disease in New England and New York. *In*: Proceedings, IUFRO Beech Bark Disease Working Party Conference. Gen. Tech. Rep. WO-37. USDA Forest Service, Northeastern Forest Experiment Station, Washington, DC, pp. 21-23.