TITLE: Landscape patterns of white ash (*Fraxinus americana*) health in the Allegheny Plateau Region

LOCATION: Pennsylvania

DURATION: Year 1 of 2-year project **FUNDING SOURCE**: Base EM

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PROJECT OBJECTIVES:

To assess white ash (*Fraxinus americana*) health status in the Allegheny Plateau region via 1) examination and refinement of existing FHM/FIA plot data and 2) establishment and sampling of additional ash health plots to enhance existing FHM/FIA data. This enhanced sampling will allow us to explore, in detail, how topographic position and site characteristics (e.g., soil pH and nutrition) are related to ash decline and mortality patterns across the landscape. Additionally, we will create a formula to convert between FHM canopy health ratings (dieback, crown density, etc) and a user-friendly health rating system developed for use by managers and based on the typical decline progression of ash trees. Finally, this enhanced ash monitoring plot will serve as a basis to monitor future ash mortality with the anticipated arrival of emerald ash borer (EAB) within the next five to ten years.

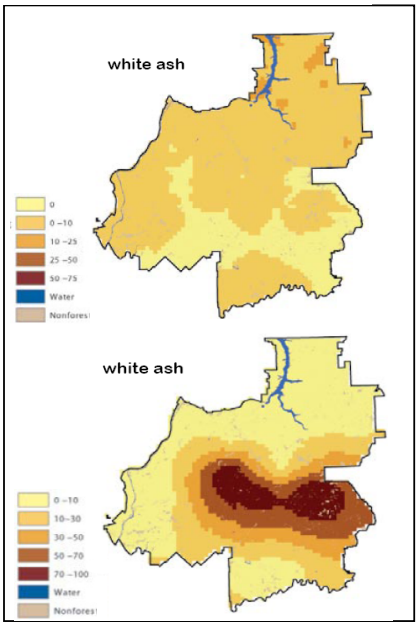
JUSTIFICATION: Our proposed project addresses the selection criteria as follows:

a. ***Linkage to FHM detection monitoring***: Forest health monitoring reports reveal that ash decline and dieback are a significant threat to forest health throughout Pennsylvania and beyond [1, 2]. In fact, Morin and colleagues [1] reported that FIA/FHM surveys in the Allegheny National Forest (ANF) conducted in 1989 and again in 1998-2001 document a 60% decrease in ash live basal area/acre; most likely due to ash decline. Furthermore, this data also indicates the prevalence of ash decline and suggests canopy dieback from decline tends to be concentrated on ridgetops and upper slope positions (Figures 1 & 2).

b. ***Geographic scale***: The distribution of white ash extends across much of eastern North America with nearly the entire area experiencing periodic decline. Thus, our results will be useful for interpreting decline patterns region-wide.

c. ***Biological impact***: Ash is an important tree component of eastern deciduous forests and a valued timber species with an estimated 322 million trees in Pennsylvania alone [3]. Emerald ash borer (EAB) is known to preferentially infest stressed ash trees [4] when it first enters an area, so knowing what landscape positions are likely to contain stressed ash trees may lead to better risk models and monitoring strategies.

Figure 1. Kriged surfaces of percent basal area (top) and percent canopy dieback (lower) within the ANF.[1]



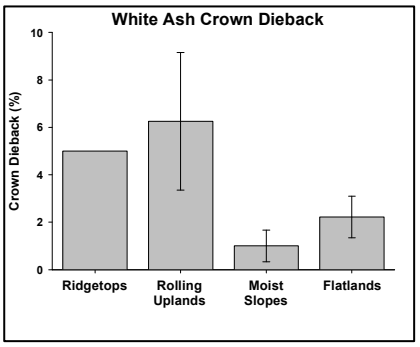
d. ***Scientific Basis/Feasibility***: Our collaborative team is uniquely poised to extend our knowledge of ash decline with combined experiences in ash health and decline syndromes in other species (e.g., *A. saccharum*). By linking information from the existing FHM monitoring network to the proposed ash health monitoring network, we will examine ash decline across a broad gradient of soil properties.

e. ***Priority issues***: This proposal explicitly addresses how soil properties affect both ash canopy health status and mortality across a wide range of stand conditions. In addition, this proposal establishes a base network of ash health monitoring plots to follow decline and mortality given the impending arrival of emerald ash borer.

DESCRIPTION

a. ***Background***: White ash decline has been a concern since at least the 1930's with more recent decline/dieback episodes heightening interest in this problem [1, 5]. Within the ANF, although white ash is an associated species found at moderate abundances (< 10% of live basal area), it experiences the 2nd highest levels of crown dieback (following sugar maple) of all the major tree species regionally (Figure 1).

Figure 2. Percent crown dieback by physiographic class.



While drought, fungal pathogens, and mycoplasma-like organisms (MLOs) are identified as factors contributing and inciting ash decline [5], several lines of evidence suggest nutrient deficiencies may play a role in predisposing ash trees to decline. First, several studies indicate white ash and sugar maple are base cation demanding species and are consistently associated with soils with higher pH and greater base cation availability [5 - 9]. Second, researchers have found strong relationships between soil nutrition and decline for sugar maple [10]. Within the unglaciated portion of the ANF, these nutrient deficiencies are closely related to topographic position (poor nutrition on the upper slope positions and good nutrition on lower slopes) [11]. Finally, mangers and scientists alike have observed that, in a manner similar to sugar maple, ash health is poor on upper slopes (Robert White & Robert Long, *personal observations*). This observed relationship is perceptible (although not statistically significant) in the ANF's FHM/FIA data which suggests greater dieback on physiographic classes that include ridgetops and rolling uplands (Figure 2).

Although this FHM data indicates ash canopy health may decline on upper slope positions, the existing data presents several challenges that preclude rigorous statistical examination. First, the physiographic classifications utilized integrate land form, topographic position, and soil moisture and are therefore too broad to isolate the effect of topography, much less, soil nutrition. Intriguingly, the existing data contain sporadic records (<28% of plots) with more precise terrain position descriptions. When this data is examined, canopy dieback is an order of magnitude higher on upper slope positions (caveat: N=1) than lower slope positions. Second, within the existing FHM plot network, ash is underrepresented with just 60 live individuals distributed across 27/177 (15%) of the plots. Finally, existing individuals are distributed unevenly across physiographic or topographic positions (e.g., 1 individual on dry, upper ridgetops vs. 40 in rolling uplands) making a well-replicated analysis impossible.

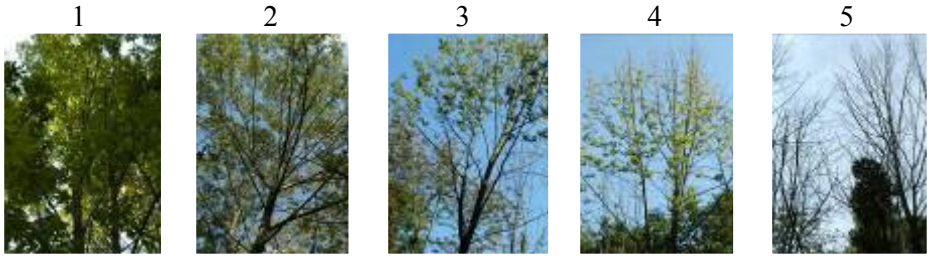
Given the low resolution in slope position data, the small sample sizes, and the highly unbalanced representation of ash, a definitive assessment of how white ash health conditions differ across topographic gradients (i.e., soil nutrition) will require enhancement of existing data and greater ash canopy sampling. Our proposed project will provide significant amounts of new information on the health status of this species and will greatly complement FHM detection and monitoring efforts.

Methods: We have consulted with our collaborators to identify the limited subset of plots within the network of FIA/FHM Phase II & III plots within the ANF containing white ash. We will expand this network by establishing new plots to increase our spatial coverage across the ANF and capture a wide gradient of soil fertility (e.g., topographic gradient & soil parent materials). We will consult with FIA statisticians as well as our ANF collaborators to identify potential areas to establish new FHM Phase 3 plots containing both an ash component and considerable topographic variation across the entire region.

On both existing and newly established plots we will precisely describe the physiography utilizing the terrain position variable previously used by FHM (categorical ranking of 1 – 7 where 1= top of slope, 7=flatland, and 2 – 6 are positions along the gradient). All inventoried trees will be numbered and mapped

using GPS to provide a database for long-term evaluation. The size and health of all ash individuals within the plots will be assessed using both the standard FHM Phase 3 crown measurement methodology (crown class, crown density, dieback, etc.) and a simple 1-5 rating system developed for easy use by managers and based on the typical decline progression of EAB-infested ash trees [12] (Figure 3). The 1-5 rating system has been used to study the decline of >3000 ash trees in EAB-infested areas in Ohio and Michigan. The 95% confidence intervals for FHM crown density and dieback ratings will be determined for each of the five rating classes for the easy rating system, and we will create a conversion table based on this information which will allow for conversion from the more detailed FHM ratings to the simpler 1-5 rating system. Ash tree trunks will be examined for D-shaped exit holes characteristic of EAB. Presence of woodpecker feeding holes and epicormic sprouts on ash trees, both symptoms of EAB which can also occur due to other causes, will also be recorded. Finally, foliage chemistry from monitored ash trees will be sampled and utilized as a bioassay of soil nutrition. This measure is commonly used to detect nutrient deficiencies in trees and is well correlated with soil nutrition [13].

Figure 3. Ash condition rating system. 1 is healthy, 5 is dead, and 2-4 are stages of decline



b. ***Products***: This project will provide: 1) baseline measures of ash health within the region; 2) maps of landscape patterns of ash decline and understanding of the site-level characteristics (i.e., soil fertility) that may cause those patterns; 3) the ability to compare and convert between FHM health canopy ratings and a user-friendly decline rating; 4) technical/non-technical presentations and peer-reviewed publications.

c. ***Schedule of Activities***:

Summer 2009: Assessing ash health on existing FHM/FIA plots with white ash; Locating, establishing, and inventorying new FHM P3 ash plots.

Summer – Fall 10: Complete inventory of new monitoring plots; data entry, analysis, and write-up.

COSTS:

	Item	Requested FHM EM Funding	Other Source Funding	Source
FY 2009				
Administration	Salary	$19,011	$25,324	NRS budget
	Overhead	$2,241		
	Travel	$6,500		
Procurements	Contracting	$6,000		
	Supplies	$1,000	$2,000	NRS budget
Total FY09		$34,752	$27,324	
FY 2010				
Administration	Salary	$19,581	$26,084	NRS budget
	Overhead	$2,167		
	Travel	$6,500		
Procurements	Contracting			
	Supplies	$1,000	$2,000	NRS budget
Total FY10		$29,248	$28,084	
Total Budget		**$64,000**	$55,408	

- Requested salaries represent 14 weeks salary for an FHM certified, GS-5 lead technician and a GS-4 assistant. The NRS contributions represent 0.15 scientist-year, each year for the PI's. Salary increases in FY10 assume a 3%/year inflation adjustment.
- Travel costs represent $2000 for a leased GSA vehicle during the summer, $1500 for gasoline and maintenance, and $3000 for travel between the Delaware and Warren labs for training and collaboration, travel to attend FHM training sessions, and travel to scientific meetings.
- Contracting costs correspond to the foliar analyses conducted by the University of Minnesota Research Analytical Laboratory. Cost represents ~ 500 samples @ 12.00/sample.
- Overhead costs are 8% for direct costs and 2% pass-thru for the contracting costs per NRS overhead policy for FY09

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