TITLE: Relating Black Ash (*Fraxinus nigra*) Decline and Regeneration to Tree Age and Site Hydrology
LOCATION: Minnesota
DURATION: Year 1 of 2-year project FUNDING SOURCE: Base
PROJECT LEADER: Brian Palik, USDA Forest Service, Northern Research Station, 218-326-7116, bpalik@fs.fed.us COOPERATORS: M. Ostry, R. Venette, K. Ward, USDA Forest Service, Northern Research Station, and Forestry Dept. Lake Co., MN, M. Dockry, College of Menominee Nation

PROJECT OBJECTIVES: 1. Conduct field evaluations of black ash decline, mortality and regeneration within selected sites varying in hydrology and decline incidence and severity. 2. Relate regeneration occurrence to mapped landscape-scale climatic, physiographic, and edaphic data.

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

a. The project is directly linked to FHM detection monitoring, which is indicating widespread black ash decline in parts of the region.
b. Geographic scale: black ash is wide-spread in the mid-west and northeastern region. Our results will be useful for interpreting decline patterns over much of this region.
c. Biological impact and/or political importance. Black ash is a significant tree component of riverine and palustrine wetlands throughout the region. Its decline and widespread mortality will fundamentally alter the function of these ecosystems and result in a reduction in availability of a unique timber resource, as well as a valued source of wood for Native American basketry.
d. Results we have obtained in a previously funded study of this problem have revealed that site factors and the age of affected trees may be critical variables determining the incidence of decline and level of black ash regeneration. The field sampling protocols we have developed, when applied to the project outlined in this proposal, will result in a high probability of successfully testing our new hypotheses on the underlying causes of black ash decline.

DESCRIPTION:
a. Background:

Black ash decline has been noted in the upper mid-west and the northeast (Livingston and White 1997; USDA Forest Service 2004). May drought has been implicated (Livingston, et al. 1995; Livingston and White 1997). It is at this time that ring-porous species, including black ash, fill new vessels prior to leaf expansion. Drought stress during this critical period may weaken trees, leading to decline and mortality. However, our preliminary observations suggest that black ash growing on better-drained soils in Minnesota are not experiencing decline to as great a degree as trees growing in wetter soil conditions. Understanding how site level factors, particularly hydrology and soil moisture, contribute to black ash decline is important for predicting the potential severity of a regional decline phenomenon. Additional factors that may contribute to the incidence of decline are the age of trees and the size of the wetland where black ash are growing. Our preliminary data suggest that older trees have a higher incidence of decline, pointing to a cohort senescence phenomenon as a potential causal mechanism. Mechanistically, cumulative stress events over time, such as droughts or flooding, may affect older trees disproportionately compared to younger trees. Finally, large wetlands may buffer the effects of occurrences of drought more effectively than smaller areas, resulting in less severe stress and damage to trees in the former.

There are several regional factors that make understanding black ash decline more complex, but also a priority. First, black ash most often occurs in wetlands that once supported American elm. Loss of a second dominant tree species from these ecosystems would likely have consequences on ecosystem function. Being able to predict when and where loss may occur will be important ecologically. Second, the emerald ash borer (EAB) is now causing significant ash mortality in parts of the region. Despite best efforts to halt its spread, the possibility exists that this exotic pest will impact ash over a wider geographic area in the Lake States and Northeast. Understanding black ash decline prior to potential impact from EAB will be important for understanding the true ecological impact of this pest. In addition, several non-native invasive plant species such as *Fallopia japonica* (Japanese knotweed), *Iris pseudacorus* and *Phalaris arundinacea* (Reed canary grass) may invade black ash sites if the loss of black ash results in conditions suitable for their establishment and spread. Finally, mortality of black ash in wetlands often is

associated with cultural features that disrupt site hydrology, e.g., roads that block flow across a wetland, causing one side of the road to be too wet.

b. Methods: We will locate and sample black ash populations in northern Minnesota and Wisconsin that are stratified within i) more and less hydric soil conditions, (upland and wetland black ash) to assess site hydrology as a factor in decline; and ii) large and small wetlands, to assess the wetland size buffering effect on decline. Moreover, we will age black ash trees from these sampling locations to further assess the cohort senescence hypothesis as a causal mechanism of decline. For this work, we will develop indices of site hydrology and soil moisture availability based on soil texture and geomorphology.

c. Products: 1) on-the-ground assessments of actual decline and mortality severity within regional ecosystems that appear to be heavily impacted based on FIA data; 2) quantitative assessment of the relationships between site hydrology and soil moisture, tree age, and decline; and 3) one or more peer-reviewed manuscripts

d. Schedule of Activities: Year 1-Field sampling of black ash decline and mortality and regeneration in selected rich mesic and wetland ecosystems (of varying size) in MN; measurement and identification of soil and geomorphic features potentially influencing hydrology and soil moisture status at selected field sites; analyze and summarize field data. Year 2- Use dendrochronology to examine age and growth of trees across the field sites and to relate weather and hydrological events. Analyze data and prepare comprehensive paper of results for publication.

E. Progress/Accomplishments:

In our previously funded FHM project, we have focused on 1) regional scale analysis using FIA data of trends in decline as related to large scale spatial features and 2) stand scales descriptions of decline severity to two landscapes in northern MN. Trends in the data we have collected thus far are the basis of the new research outlined in this proposal.

For the regional analysis, several variables, such as growth (DBH), mortality, and damage were derived from black ash tree data collected in Minnesota on the same FIA plots in 1990 and 2003 (792 plots), and in 1999 and 2004 (170 plots). The FIA black ash variables were found to differ among counties, ecological subsections, and climatic regions. Change in tree DBH between 1990 and 2003 was calculated and found to be associated with distance from water features. In addition, FIA plot locations were intersected with STATSGO soils mapping units for Minnesota forested plots that contain black ash to determine associations among the FIA variables and site characteristics, such as soil texture and available water carrying capacity. We determined that there was not a good association between the FIA variables and the STATSGO components. This indicates that the edaphic site factors may be acting at different spatial scales than those represented by STATSGO.

We also selected and mapped the 2004 FHM Minnesota black ash dieback/decline sketch map areas on a Gap Analysis Program (GAP) black ash land cover shapefile. A number of random points were generated within the GAP layer in the same quantity as the number of dieback/decline areas. A MN highways shapefile was overlayed, and numbers of dieback/decline areas within 10 distance categories at one-mile increments to highways was determined. This was repeated using the random point layer. The dieback/decline areas and the random points differed significantly in distance to highways ($P<0.001$), specifically, decline incidence decreased as distance from roads increased. For example, 40 percent of the dieback/decline areas were located within the first distance increment (1 mile), as opposed to 15 percent of the random points.

For the stand scale work, a total of 21 black ash stands in three Minnesota counties were sampled for the incidence and severity of decline. Within these stands over 2,100 black ash trees were sampled on 88- 1/20ac plots. Baseline tree data included: species present, tree diameter and height, crown height and width, tree health, extent of epicormic branching and selected tree increment cores. Additional plot data included hydrological condition, shrub

component, and presence of black ash regeneration. Trees growing on wetter plots (sites with standing water or saturated soils) had greater decline symptoms than trees growing on drier plots (Figure 1). Severity of decline was less in younger (<100 yrs) trees (based on tree size and core analysis) than in older trees. Black ash regeneration (seedling and sapling size classes) varied widely across sites but was generally greater on better drained sites.

COSTS:

	Item	Requested FHM EM Funding	Other-Source Funding	Source
YEAR 1				
Administration	Salary	$5500	0.3 FTE	NRS
	Overhead	$2729		
	Travel		$1500	NRS
Procurements	Contracting	$35000		
	Equipment			
	Supplies			
Total		$43,229		

Literature Cited

Livingston, W., H. A. Hager, A. S. White, and D. Hobbins. 1995. Drought associated with brown ash dieback in Maine. Phytopathology 85: 1558.

Livingston, W. H., and A. S. White. 1997. May drought confirmed as likely cause of brown ash dieback in Maine. Phytopathology 87: S59.

U.S.D.A. Forest Service. 2004. Lake States forest health watch. USDA Forest Service, Northeastern Area State and Private Forestry. August 1, 2004.

Figure 1. Relationship between tree health and site wetness.