TITLE: Impact of laurel wilt disease on redbay (*Persea borbonia*) ecosystems

LOCATION: Southeast United States (SC, GA and FL)

DATE: 2012 New Start

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

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PROJECT OBJECTIVES: The proposed research will assess redbay (*Persea borbonia*) ecosystem responses to laurel wilt (LW). Specifically, we will study (1) the range-wide changes in redbay population, (2) the patterns of redbay mortality and regeneration, (3) forest succession and possible expansion of invasive plants, and (4) changes in dead woody materials and its implication to fire behavior.

JUSTIFICATION:
a. Linkage: Extensive LW monitoring through the collaboration between FHM Program and State Forestry Agencies indicated that redbay trees suffered significant mortality. Based on FIA data obtained in 2004 and 2009, redbay population in GA declined 12% for trees > 1 in diameter at breast height (dbh) and 35% for trees > 7 in dbh, and no trees > 15 in dbh survived. Clearly, the impact of LW on redbay ecosystems is significant and needs to be assessed.
b. Significance: Although field sampling will only be conducted in SC and GA where LW was initially detected, our analysis based on FIA and LW monitoring plots will cover the entire native range of redbay along the Atlantic and Gulf Coastal Plains.
c. Biological impact and/or political importance: LW is a newly emerged disease with a rapid rate of spread (~55 km/year). Redbay mortality due to LW is likely change the composition, structure, and function of redbay ecosystems. Currently, no study has systematically evaluated the response of redbay ecosystems to LW.
d. Scientific Basis/Feasibility: The proposed study will conduct analyses based on both available data and newly collected data through field sampling. FIA data required for the study is available online, and our collaboration with SCFC will help us to acquire data from monitoring plots. We have worked extensively with FIA data (e.g., Hu and Wang 2008), and our research team has a wealth of experience in conducting field ecological research similar to the one proposed here.
e. Priority Issues: The study directly relates to "Tree mortality – deviations from expected levels"

DESCRIPTION:
a. Background: LW is a vascular disease that is currently causing the widespread mortality of redbay throughout forests in the southeastern US (Fraedrich et al. 2008, Mayfield et al. 2008). This disease is caused by a fungus (*Raffaelea lauricola*) that is transported by the nonnative ambrosia beetle (*Xyleborus glabratus*). Redbay mortality due to LW was first detected in 2003 in SC. Since then, LW has spread throughout most coastal plain counties in SC and GA, as well as peninsular FL (Mayfield et al. 2008). Given redbay has already been stressed by ongoing coastal development, the added impact from LW could potentially render redbay to become functionally extinct from coastal forest ecosystems. To our knowledge, it remains unknown whether healthy stands can persist in LW infested areas. In infested stands, it is not clear whether survived redbay trees of small diameters can develop into the canopy.

Previous studies suggest that redbay mortality due to LW is size dependent because smaller stems are attacked less frequently by the beetle (Fraedrich et al. 2008). However, there exist conflict evidences on the threshold size. For example, Sheilds et al. (2011) reported that stem < 4 in dbh appeared to be less susceptible while Fraedrich et al. (2008) found that mortality is much higher in stem > 1 in dbh. Although redbay seedlings and sprouts did not appear to be affected by LW in the field (e.g., Mayfield et al. 2008), it is not clear if the mortality

rate of smaller stems will increase once larger redbay trees are depleted as a host. In some LW affected stands, extensive redbay regeneration (including sprouts from dead stems) has been observed. With the beetle population declining dramatically after suitable host trees was depleted (Hanula et al. 2008), redbay regeneration may have an window of opportunity to grow into maturity, thus perpetuating the local population through sexual reproduction because stump sprouts may be infested by LW from the root system without attacked by the beetle.

Canopy loss from redbay mortality may result in significant ecosystem changes. Smaller canopy gaps may be quickly closed by the increased growth of adjacent dominant and co-dominant trees, and post-LW changes may occur only in the understory. Larger gaps will likely cause significant changes both in the canopy layer and in the understory (Goldberg and Heine 2009, Sheilds 2011). It is not clear which species would replace redbay trees lost from the canopy, and whether existing and/or new redbay regeneration can survive long enough to be recruited into the canopy again. It is possible that redbay mortality may promote the growth of exotic invasive species such as privet (*Ligustrum spp.*)*,* which will lead to the displacement of native species, or the growth of and wax myrtle (*Myrica cerifera*), which will increase the fire hazard.

Depending on initial size of redbay population in a stand, redbay mortality may accumulate a significant amount of fuel in the affected ecosystem, which may increase fire risk and alter fire behavior. Dead redbay trees retain leaves for more than a year on trees and thus provide gradual inputs of woody debris and litter. Therefore, quantifying dead woody materials in LW infested stands is necessary to understand both fire hazard and nutrient cycling.

b. Methods:
Our study area will be the Atlantic Coastal Plain in SC, GA and FL where LW has been detected at least five years ago. We will obtain FIA data online and LW monitoring data from State Forestry Agencies. All FIA plots for the counties within the distribution range of redbay, with one repeated measurements between 2004 and 2011, will be acquired and compiled. These data will be analyzed to show range-wide changes in redbay population by dbh classes.

A minimum of 50 stands infested between 2004 and 2011 will be selected and sampled. In all sampled stands, redbay should be a dominant or co-dominant canopy species. A minimum of 10 control stands will be selected to match the range of site and stand conditions of those infested stands sampled. In each selected stands, three to five 20 x 20 m plots will be set up to sample woody stems > 7.6 cm dbh. Plot location will be recorded by GPS, and soil and topographic condition of each plot will be described. Within each plot, two 5 x 5 m subplots will be set up to sample woody stems > 1.4 m tall but < 7.6 cm dbh. On each plot and subplot, the dbh of each stem and its status (live or dead) will be measured and recorded by species; number of live and dead stump sprouts and presence/absence of LW will be recorded for each redbay stem. Within each subplot, four 1 x 1 m sub-subplot will be set up to sample understory. The number of live and dead redbay seedlings will be counted by height classes (< 30, 30-60 and > 60 cm) and the % cover will be estimated for other species or species groups in each sub-subplot. For those dead redbay trees that were toped, dbh will be measured from fallen trees if identifiable or estimated from diameter measured from ground level. A subset of live redbay stems will be destructive sampled or cored to determine age and diameter growth using tree ring analysis. These data will be analyzed to show redbay mortality pattern and population dynamics as well changes in plant community.

Brown's (1974) planar intersect method will be used to quantify down woody materials. Starting from one randomly selected corner of each plot, three 50-ft sampling transects will be established. The inner transect will be established along the diagonal line, and other two transects will be placed at $+22^o$ and -23° from the inner transect. Down woody materials 0.00–0.25 in, 0.25 – 1.0 in, 1.1 – 3.0 in, and over 3 inches in diameter that intersected the sampling plane will be tallied, and materials over 3 inches will be recorded by species (redbay, pine or other hardwood), diameter and decaying class. Depths of fuel bed, litter and duff will be measured at three equally spaced points along each transect. Percent cover of herb (forb and grass) and woody species will be estimated in mil-acre plots centered at 0, 9, 18, 27, 36, and 45 ft along the inner transect. Counts of down woody fuel, depths of litter and duff, and covers of herb and woody species will be converted to dry weights using published equations. These data will be used (1) to compare fuel loading among different infestation years and between healthy and infested stands, and (2) to model fire behavior, using behavePlus, under various fire weather and fuel moisture conditions.

c. Products: A poster will be presented at FHM workshop, a Ph.D. dissertation and a final report will be produced, and two manuscripts will be submitted for publication in refereed journals.

d. Schedule of Activities: Year 1: Acquire FIA and LW monitoring plot data; identify sample stands; sample stands infested between 2004 and 2007. **Year 2:** analyze FIA and LW monitoring data; sample stands infested between 2008 and 20011 as well as control stands. **Year 3:** conduct data analysis; prepare poster, final report, Ph.D. dissertation and two manuscripts.

Costs: (*Please transfer the requested funds to SC Forestry Commission. **Matching fund will be coming from the entire consolidated grant, which will be used for the continuous monitoring of the research plots.)

	Item	*Requested FHM EM Funding	**Other-Source Funding	Source
Year 1				
Administration	Salary	$40,458		
	Overhead	$0		
	Travel	$5,500		
Procurements	Supplies	$500		
Total		**$46,458**	**$46,458**	
Year 2				
Administration	Salary	$40,746		
	Overhead	$0		
	Travel	$5,500		
Procurements	Supplies	$500		
Total		**$46,746**	**$46,746**	
Year 3				
Administration	Salary	$34,020		
	Overhead	$0		
	Travel	$2,500		
Procurements	Supplies	$1,000		
Total		**$37,260**	**$37,260**	

Budget Narrative: Salary: 3 years of research assistantship for a Ph.D. graduate student (stipend plus fringe) = $21,020/year. One month summer salary plus fringe is budgeted for the project leader in Year 1 = $12,334, Year 2 = $12,622, and Year 3 = $13,000. Field assistant salary plus fringe: Year 1 and 2 = $7,104/year. Travel = $5,500/year in Year 1 and 2 (field work) and $2,500 in Year 3. Supplies = $500/year in Year 1-2 and $1,000 (for publication cost). Summer salary for project leader factored in 3% cost of living increase/year.

f. Literature Cited:

Brown J.K., 1974. Handbook for inventorying downed woody material. USDA For. Serv. Gen. Tech. Rep. INT-16.

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