TITLE: Development of geospatial techniques for the prediction and assessment of red oak decline due to red oak borer.

LOCATION: Ozark-St. Francis National Forest, Ouachita National Forest, Mark Twain National Forest, Forest Health Protection - Region 8

DURATION: Year one of two year project **FUNDING SOURCE:** Base Plan

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PROJECT OBJECTIVES: Our goal is to improve management and prediction of the forest impacts of the red oak borer outbreak now occurring in Arkansas. Our specific objectives are to:

1) Take advantage of new scientific information provided by Stephen et al 2003 and their development of a management-oriented rapid sampling procedure that will permit stand-level assessment of ROB populations.

(2) Provide spatially based predictions of ROB impacts based on newly available datasets and extensive and intensive population sampling.

(3) Prepare spatial distribution maps of *Armillaria* in relation to existing ROB population levels

(4) Develop pre-visualization methods to assess stand impacts due to ROB utilizing high resolution multi-spectral data.

(5) Develop geo-spatially referenced hazard rating maps of ROB accessible to general public

JUSTIFICATION: Many of the serious forest insect problems that normally confront forest pest managers are either long-standing pests such as some *Dendroctonus* bark beetles and certain defoliators, or exotic species such as gypsy moth, balsam woolly adelgid, emerald ash borer and a frightening list of similar introduced problems. More unusual is the type of problem now being encountered in the Ozark Mountains where a previously innocuous native insect species has suddenly appeared as a serious tree killer. No adequate population sampling or monitoring techniques currently exist. The predictive capabilities, red oak borer population monitoring plans, and correlation of predictive variables with forest site and stand conditions should enable pest managers to more completely assess the risk from this pest and define management alternatives to alleviate its damage. The work we propose directly addresses all aspects of the 'talking points' on the FHM website that stress "*Survey and monitoring needs are urgent. Remote sensing and ground plot data are needed*".

Our project links well to FHM survey and plot data. Mapped areas or hazard-rated areas can be used in comparison with existing aerial detection surveys, and also to plan future detection surveys to monitor red oak borer and oak decline and/or detect new incidences. Data from field plots within mapped or hazard-rated areas can be used to corroborate our results,

quantify mortality levels in those areas, and identify these plots as decline and borer affected for explanations of future forest composition and structure changes. In terms of geographic scale, the oak-dominated forests in southern Missouri, eastern Oklahoma, and northern and west central Arkansas are all at risk from this unique insect outbreak/oak decline phenomenon. Surveys on the Ozark National Forests of Arkansas and Missouri show that red oaks make up approximately 46% of the hardwood component. Extensive oak mortality was first detected in 1999, and preliminary estimates of the extent of damage are indeed sobering. Roughly 33 percent of the area in the Interior Highlands, where oaks that are 70+ years old dominate stands, is potentially at risk. We conservatively estimate that 33 percent of these trees are severely affected. The dollar value at risk, in timber value alone, exceeds $1.1 billion and certainly the impact on wildlife, tourism and other values would dramatically inflate that figure. The direct impact on the local economies would include losses of jobs in logging, mills and companies making hardwood products. There would also be losses to companies that provide equipment and supplies to these industries. Arkansas Senator Blanche Lincoln's office estimates that loss of 2,200 jobs in the logging and milling industries is anticipated. The oak decline - red oak borer complex is the greatest threat to the oak component in the Interior Highlands in recent history.

DESCRIPTION:

a. Background: Stephen et al (2003) have recently selected, during two years work on a USFS funded red oak borer project, a series of plots across the Ozark-St. Francis National Forest that incorporate an appropriate representation of existing variation in site and stand conditions and red oak borer infestation density. All infestation plots are GPS referenced. Within these plots the team sampled trees infested with red oak borer and used the resulting data to create a management-oriented rapid estimation procedure that uses crown condition and red oak borer emergence holes in the basal 2 m of standing trees. We propose to take advantage of these data and a series of newly available spatial data sets and remote sensed instruments to improve the spatial prediction of red oak mortality and to develop methods to identify decline area pre-visually. The information Stephen et al are currently are gathering, combined with the results of this proposed work will also enable us to develop on-line, geo-spatially referenced, hazard rating maps of ROB for locations throughout the area.

b. Methods: We will expand earlier work on predicting the spatial distribution of ROB populations impacts utilizing rapid estimation procedure developed by Stephen et al (2003) to establish the relationship of a series of spatially referenced site properties in comparison to the oak decline/red oak borer epidemic. A generalized spatial model will be developed that predicts areas more susceptible to ROB based on these characteristics. High and low mortality areas will be compared as the basis for this model. This approach will take advantage of newly released spatial data, especially county level SSURGO soils data made available for the majority of the study area by NRCS in late 2003, and will utilize the tools provided in ArcGIS 8.3 Spatial Analyst. We anticipate the release of new "model builder" capabilities in the ArcGIS 9.x software during the project and (if released) will utilize this modeling environment to insure that the resulting models can be reused and expanded by others.

As the result of a NSF MRI (major research instrument) award in August 2003, the proposal principals now have available a suite of high resolution instruments that we believe can be effectively used for pre-visual detection of red oak borer caused tree mortality. A Duncan

MS4100 multi-spectral camera, ADSI field spectroradiometer and Palm IR 250 thermal camera and supporting data recording systems will be used in terrestrial mode to image individual tree canopies and compare the results of the instruments measurements to the results of the newly developed Stephen et al RAPID assessments protocol. An Optech ILRIS 3D terrestrial LIDAR system will also be used to prepare high resolution 3D characterizations of the tree. We anticipate that the outcomes of this close range analysis will provide significant insights into the potential for a regionally applicable remote sensing analysis using available space and aircraft based systems.

c. Products: Successful completion of this proposal will result in (1) effective spatial models and model protocols that can be used by scientists, forest pest managers and the general public to predict the location of future red oak decline and (2) accurate pre-visual detection of decline locations.

In addition to the scientific models for prediction, a publicly accessible web site will be created that will allow users to delineate locations on a map that will the be dynamically compared to the model results providing an assessment of the location's future susceptibility to ROB decline. Newly released SSURGO soils for much of the Ozark area, coupled with existing spatial data, will permit this system to be applied throughout much of the impacted area.

d. Schedule of Activities: All geospatial analyses will utilize ArcGIS 8.3 and extensions and map results will be fully documented with FGDC compliant metadata. All developed geospatial data will be provided in compatible map projection and geodatabase formats. Instrument results will be fully documented.

e. Progress/Accomplishments: We were funded two years ago with a FHM project that has enabled us to gather a large data base on red oak borer. We intensively monitored red oak borer populations over the past two years, and from 15 sites, representing a variety of site and stand conditions, we felled and returned to the lab for intensive study, more than 70 infested oaks. This is extremely labor-intensive work, but we anticipate that it will result in detailed life history data on ROB distribution, abundance and mortality. These data along with extensive site, stand and individual tree data have been used to develop the rapid estimation procedure that enables stand level assessment of ROB populations. Preliminary work has resulted in 3 publications and more than 10 scientific presentations. Currently we have four graduate students and a post-doc working on this project. We also have established good working relationships with National Forest Ranger Districts and Len Bollman, the Ozark NF Oak Sustainability Coordinator who is overseeing the red oak borer crisis. In June, 2003, F. M Stephen testified before the US Senate Committee on Agriculture, Nutrition and Forestry in relationship to the Healthy Forests Initiative during which he highlighted the red oak borer problem and its relationship to forest management and resources needed to minimize such losses as we now face. The data collected and relationships that we have developed put us in an excellent situation to extend our work and complete the series of objectives proposed above.

COSTS:

	Item	Requested FHP STDP Funding	Other-Source Funding	Source
FY 2004				
Administration	Salary	$23,000	$27,000	UA
	Overhead	$3,500	$8,000	UA
	Travel-UAR	$3,000		
	Travel-FHP	$1,000		
Procurements	Contracting			
	Equipment	$1,500		
	Supplies	$3,000		
YEAR TOTALS		$35,000	$35,000	