TITLE: A spatial cluster of poor crown conditions: Evaluating results from crown indicators and spatial scan statistics.

LOCATION: The location of the proposed project straddles the South Carolina - Georgia border. The areal extent is approximately 7 million acres roughly centered around Augusta, Georgia. There are several publicly owned lands and facilities located in the study area including the Sumter National Forest, Fort Gordon Military Reserve, and the Savannah River Plant.

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

PROJECT LEADER: Mike Schomaker, UNLV – Crown Indicator Advisor for the USDA FIA program, (970)420-8658, mschomak@lamar.colostate.edu

COOPERATORS: Bill Bechtold (USDA Forest Service) and John Coulston (NC State University)

PROJECT OBJECTIVES:
The objectives of the proposed work are: (1) to examine the influence of specific crown dimensions and tree species on the location and significance of a geographic cluster of plots containing trees with poor crown conditions, (2) identify and test the significance of explanatory variables, and (3) develop cause-effect hypotheses and test with statistical models.

JUSTIFICATION: Crown condition is an important indicator of health and productivity at the tree, stand, and forest level. The net primary production of a tree, stand, or forest largely depends on the ability of the tree crown to intercept light. Forests with sparse foliage capture less light; therefore, less energy is available for biomass production. The scope of the proposed research is to evaluate a potential forest health issue identified using crown measurements from detection monitoring plots.

DESCRIPTION:
a. Background:

As part of the South Carolina State report, a composite crown volume analysis was performed and the results were examined for spatial pattern. There was evidence of a spatial cluster of plots containing trees with poor crown conditions on the South Carolina - Georgia border. Upon further investigation, we found that the spatial cluster was statistically significant. Both hardwoods and softwoods were present in the cluster, however loblolly pine was the most observed species. The proposed research is based on these preliminary results from the South Carolina State report. More detail is provided below.

Techniques presented in Zarnoch and others (In Press) were used to estimate crown volume for each live tree 5.0-inches dbh and larger from field measurements associated with the Phase-3 Crown Indicator. Regression models were then used to adjust each crown volume for differences in stem size (dbh), by species. Regression model residuals were subsequently re-scaled to a mean of 0 and standard deviation of 1, thereby enabling direct comparisons of deviations from expected crown volumes across species and tree sizes. Trees below the 25th percentile on these adjusted statistical distributions were considered to have poor crown conditions.

The spatial pattern in the occurrence of plots containing trees with poor crown conditions was then examined using spatial scan statistics. Spatial scan statistics were used in epidemiological studies and have been applied to forest health assessments by Coulston and Riitters (2003). A statistically significant cluster of plots with trees that had poor crown conditions was identified on the South Carolina - Georgia border. Within this cluster, species with more than 10 individuals were eastern red cedar, shortleaf pine, loblolly pine, hackberry, sweetgum, blackgum, white oak, laural oak, water oak, and winged elm. There were 461 trees of these species. Loblolly pine accounted for roughly 60 percent of the trees and sweetgum account for an additional 14 percent.

Several variables may potentially explain the location of the spatial cluster. For example, Insects and pathogens often influence a tree's crown. Based on the current year's FHM national report, insect and pathogen activity has been relatively high in this area. Ozone can also influence the appearance of tree's crown (Miller and Millecan 1971) and several of the species in the spatial cluster are ozone sensitive. These species include loblolly pine, sweetgum, and white oak (Coulston and others 2003). Drought occurrence is another possible explanatory variable because it influences both transparency and dieback in trees (Ambrose 2003).

b. Methods:

There are several necessary steps to evaluate this potential forest health issue. First, we will examine the influence that specific crown dimensions (e.g. transparency, dieback, density) and tree species has on the preliminary results. To accomplish this we will use the regression and standardization procedures and spatial scan statistics described above on the individual crown components and species separately. This is an important step because if there is a specific crown dimension, say transparency, and/or a specific tree species, say loblolly pine, responsible for the geographic cluster then this information will guide explanatory variable selection.

The proposed research will also require additional fieldwork to evaluate assessment techniques and gain insight to cause-effect relationships. In the preliminary analysis, the composite crown volume indicator is based on an estimate of crown diameter using Bechtold's (In press) method. We will measure crown diameter on 10 plots in the cluster and 10 plots outside the cluster to examine any influence the crown diameter estimation procedure has on the results. While at these plots, we and a pest specialist will also examine other tree and crown characteristics (e.g. transparency, dieback, density, damage) to validate preliminary results and help develop cause-effect hypotheses.

Next, we will use multivariate statistical techniques to test for environmental differences between plots within the geographic cluster and plots outside the cluster. Differences in drought occurrence, ozone exposure, ozone injury, insect and pathogen activity, soil characteristics, and interactions will be analyzed and explanatory variables identified. Based on information collected in the field and the results from the multivariate analysis, we will then build regression models to evaluate and test cause-effect relationships.

c. Products:

1. Refereed journal article based on final results
2. Present final results at FIA Science Symposium
3. FHM Workshop poster presentation based on final results

d. Schedule of Activities:

- Winter 2004. Examine influence of specific crown dimensions and species on preliminary results.
- Summer 2004. Perform additional fieldwork
- Fall 2004. Identify and test potential explanatory variables

- Winter 2005. Develop and test cause-effect hypotheses
- Summer 2005. Draft peer reviewed journal article
- Fall 2005. Present findings and analysis techniques at FIA Science Symposium
- Winter 2006. Present finding and annual Forest Health Monitoring Workshop

e. Progress/Accomplishments:

f. References:

Ambrose, M. 2003. Crown Condition. In Stolte, K. and B. Conkling eds. Forest Health Monitoring National Technical Report 1991-1998. USDA Forest Service SRS-GTR. In Press.

Bechtold, W.A. In press. Largest-crown-width prediction models for 87 species in the eastern U.S. South. J. Appl. For.

Coulston, J.W. and K.H. Riitters. 2003. Geographic analysis of forest health indicators using spatial scan statistics. Environmental Management. 31: 764-773

Coulston, J.W, G.C. Smith and W.D. Smith. 2003. Regional assessment of ozone sensitive tree species using bioindicator plants. Environmental Monitoring and Assessment. 83: 113-127.

Miller, P.R. and A.A. Millecan. 1971. Extent of oxidant air pollution damage to some pines and other conifers in California. Plant Dis. Report. 55, 555–559.

Zarnoch, S.J., W.A. Bechtold, and K.W. Stolte. In Press. Crown condition as an indicator of forest health. Can. J For.

COSTS:

	Item	**Requested FHM EM Funding**	**Other-Source Funding**	**Source**
YEAR 2004 **Administration**	Salary	16,000		
	Overhead	4,000	Match*	
	Travel	10,000		
Procurements	Contracting			
	Equipment			
	Supplies			

	Item	Requested FHM EM Funding	Other-Source Funding	Source
YEAR 2005				
Administration	Salary	20,000		
	Overhead	4,000	Match*	
	Travel	6,000		
Procurements	Contracting			
	Equipment			
	Supplies			

* UNLV, Research Work Unit 4803, and NC State Univ. will provide matching funds.