Patterns of Pine Mortality in the Southeastern United States: Project Update (RC-1693)

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Background

The southeastern Department of Defense landscape is dominated by pines managed with fire. Lands once occupied by longleaf pine are dominated by other species, especially loblolly pine. As part of longleaf ecosystem restoration efforts, many loblolly stands are being allowed to age beyond typically management ages and are being regularly burned. Previous studies have suggested that older loblolly pine forests are declining in Central Alabama and Georgia ; it is unknown if this decline is an indication of unusual conditions rather than natural senescence.

Further, it is not known if other southern pines species are showing reduced growth. If accelerated mortality is occurring, its spatial extent and rate must be determined to allow land managers to plan actions.

Research Questions

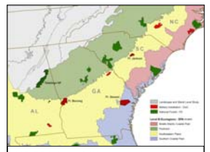
- **Is there a decline in pine forests (indicated by accelerated mortality or generalized loss of canopy health) that is measurably different from historical patterns of growth and mortality?**
- **If so, what are the patterns of decline over time and space?**

Approach and Methods

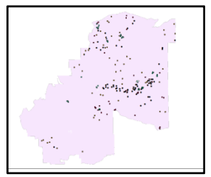
Temporal patterns of productivity will be quantified in loblolly, longleaf, and slash pine forests in AL, GA, SC, NC and northern FL. Data from field surveys, aerial photos, and satellite images will be used. Declining forest health will be indicated by (1) continuous decreases in canopy foliage area, (2) reductions in radial growth, and/or (3) abnormally high mortality rates.

Data Collection

- Intensive forest health and site conditions sampling at Fort Benning, Fort Jackson, Fort Stewart, and Talladega National Forest
- Expanded dataset available for Fort Benning analyses



US EPA Level III ecoregions map with study sites



Distribution of forest health plots at Fort Benning

Example of time series of aerial photos: 1999, 2004, 2009:

- Aerial photos (1 m resolution): 1970s – 2011
- Landsat images (30 m resolution): 2001 - 2011

The data will be used to develop and test remote sensing tools that can be used in other Southeastern landscapes to estimate pine forest health and leaf area index. Subsequently, the accuracy of these tools will be ground-truthed in 14 other locations using ground-based measurements and remote sensing data.

Canopy Health Assessments

Correlations between percent dieback (5% classes) and tree attributes

Fort Benning

For DBH, live crown ratio, and crown density, there were significant negative correlations for both canopy classes, although there was no relationship for the number of sides of light exposure. Dieback decreases as diameter and canopy vigor increases and that there is no evidence that larger diameter trees (assumed to be oldest) are declining.

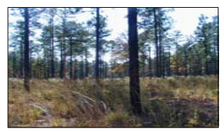
Fort Jackson

In contrast, there was no significant relationship between DBH for either canopy class, although there were significant negative correlations for live crown ratio and crown density for both canopy position and for sides of light exposure for overtopped trees. Thus, there does not appear to be any pine decline.

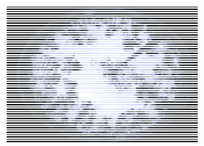
	Canopy position	Pearson's *r*	*n*
DBH	Dominant/codominant	-0.1803*	2283
	Overtopped	-0.1189*	434
Live crown ratio	Dominant/codominant	-0.1581*	2283
(1-100%)	Overtopped	-0.1531*	433
Crown density	Dominant/codominant	-0.1629*	2283
(5-100%)	Overtopped	-0.364*	434
Sides of light	Dominant/codominant	0.0118	2283
exposure (0-5)	Overtopped	-0.0239	434
DBH	Dominant/codominant	-0.0118	1826
	Overtopped	-0.0363	939
Live crown ratio	Dominant/codominant	-0.1254*	1824
(1-100%)	Overtopped	-0.1469*	937
Crown density	Dominant/codominant	-0.2364*	1826
(5-100%)	Overtopped	-0.2718*	939
Sides of light	Dominant/codominant	-0.0121	1826
exposure (0-5)	Overtopped	-0.0527*	939

Model Development

Linking forest health data with aerial photos and satellite imagery

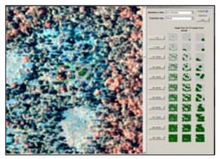


Basal area = 8 m^2/ha; 35 ft^2/acre
Tree specific data: Canopy condition, location



Dormant season - Canopy photo
Cover = 56.5%
Leaf Area Index (adjusted) = 0.638

Field data and canopy photos are related to aerial photos through canopy cover. Estimates of Leaf Area Index from canopy photos are used to calibrate Landsat based productivity indices using regression.



Aerial photos (1 m resolution)
Individual canopy cover delimited to develop custom image "chips".

Digital Mylar, software tool for cover estimates

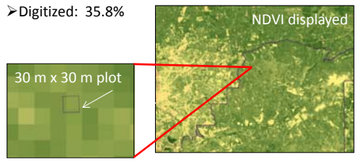
- **Cover Interpreter**, uses "image keys" with predetermined cover values ; User selects the key that matches the polygon of interest; Key cover value assigned directly into the polygon attribute table.
- **Image Sampler**, superimposes a dot grid for sampling within a selected polygon; then assigns a photo-interpreted cover types to each point in the grid.

Pine Canopy Cover Estimates from aerial photos

- DM estimate: 40-49%
- Digitized: 35.8%

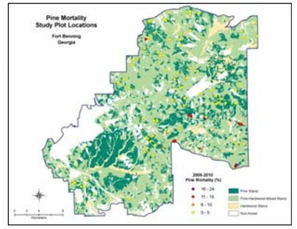
Landsat productivity indices

- NDVI –0.5452
- Band 4 v Band 3 ratio – 3.398

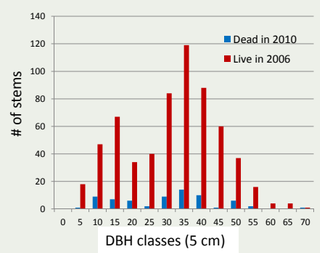


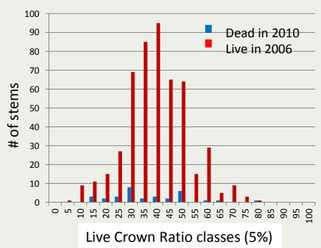
Fort Benning Pine Mortality Study

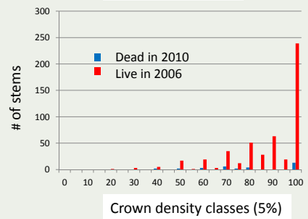
Sampling plots installed in 2006-2007 were re-measured at 1-4 year intervals. These measurements provide a measure of site-specific pine mortality rates and allow the investigation of localized site factors and tree health parameters as predictors of tree death on a landscape level.

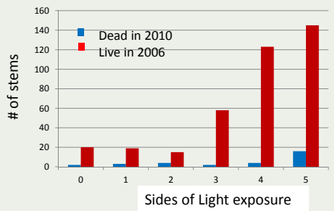


- Mortality was uneven across the landscape. Plots with mortality were clustered in the southeastern part of the base. Unusually high mortality rates in this area has been noted by other researchers and Fort Benning land managers, although the reasons for this are unclear.
- The average plot mortality rate was 12% (4-24%), although this was based on a relatively small number of trees (1-4) per 900 m^2 plot.
- Site factors such as texture, 2006 stand density, aspect, and slope were poor predictors of plot-level mortality rates.
- At least 10 of the 40 dead trees had snapped (25%), with 3 and 2 trees found in two plots respectively, indicating the importance of domino effects. Since the 2006 measurements did not indicate any structural defects , this type of mortality may represent a random loss independent of tree form.
- For dominant/codominant pines, 30 of 351 (9%) of trees died between 2006 and 2010, versus 10 of 67 (15%) of overtopped trees. However, mortality within a plot was uneven over time, with mortality rates in 2008 being a poor predictor of subsequent mortality in 2010.









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