



# Monitoring of Upland Pine Tree Vigor and Mortality on Fort Benning, GA/AL



Robert N. Addington<sup>1,6</sup>, Wade C. Harrison<sup>1</sup>, Lori G. Eckhardt<sup>2</sup>, Roger D. Menard<sup>3,4</sup>, John K. Doresky<sup>5</sup>

<sup>1</sup>The Nature Conservancy, Fort Benning Field Office, Fort Benning, GA <sup>2</sup>Forest Health Dynamics Laboratory, School of Forestry and Wildlife Sciences, Auburn University, Auburn, AL <sup>3</sup>Department of Plant Pathology and Crop Physiology, Louisiana Agricultural Experiment Station, Louisiana State University Agricultural Center, Baton Rouge, LA <sup>4</sup>U.S. Forest Service, Forest Health Protection, Pineville, LA <sup>5</sup>Fort Benning Army Installation Conservation Branch, Fort Benning, GA <sup>6</sup>Contact: Rob Addington (raddington@tnc.org)



## Introduction

Monitoring of upland pine tree vigor and mortality is important on Fort Benning because pine trees and upland pine-dominated habitat provide nesting and foraging opportunities for the federally endangered red cockaded woodpecker (RCW).

Restoration of longleaf pine is a prevailing management goal, but the majority of upland forested areas currently support mixed pine (loblolly, shortleaf and longleaf) and mixed pine-hardwood stands.

Loblolly is the most abundant pine species on Fort Benning; most of Fort Benning's RCW cavity trees are loblolly pine.

Pine decline, brought about by a complex of stress factors including disease, has been observed throughout Fort Benning's forested uplands, particularly in loblolly and shortleaf pines.

## Objectives

- To quantify tree vigor and mortality among Fort Benning's dominant pine species.
- To evaluate possible influences on tree vigor and mortality, including tree density, species composition, decline risk rating, soils, and soil disturbance.
- To initiate long-term monitoring of tree vigor and mortality on permanent plots.



## Methods

An initial inventory of dead and low-vigor pine trees was conducted in conjunction with a low-intensity, installation-wide, temporary plot forest inventory sample during summer 2004. The following measurements were conducted on 156 fifth-acre (0.2 acre) plots:

- tally of trees by species
- diameter at breast height (DBH) of all trees, including dead trees, greater than 4 inches DBH
- tally of dead trees
- tally of low-vigor trees (based on a qualitative assessment of bole and crown condition)
- presence of soil surface disturbance such as hog rooting

Using ArcGIS, plots were grouped into pine decline risk categories based on a loblolly decline risk map (Figure 2). Plots were also grouped into soil texture categories and stand age classes using available soil and stand inventory layers. The time period over which trees died or became low-vigor cannot be determined from this dataset. However, to provide some idea of expected mortality in a "healthy" forest, mortality predictions from a Piedmont loblolly pine growth and yield model (Martin and Brister 1999) were developed over the range of pine density present in our data. Both 1- and 5-year mortality projections were estimated. The influence of additional independent variables (e.g. risk category, soil texture, hog damage) on the number of dead + low-vigor trees per plot was analyzed using Analysis of Covariance (ANCOVA), with total number of pine trees per plot as the covariate. Longleaf dominated plots were removed from this analysis.

Table 1. Number of total trees, dead trees and low-vigor trees tallied by species across all 156 plots.

Species	Total # trees	Mean DBH (in)	#Dead	#Low-Vigor	#Dead + Low-Vigor	Mean DBH (in) Dead+Low-Vigor
Loblolly	1692	11.3 (±0.10)	104(6.1%)	173(10.9%)*	277(16.4%)	11.3 (±0.23)
Longleaf	706	13.3 (±0.14)	10(1.4%)	2(0.3%)	12(1.7%)	10.2 (±0.92)
Shortleaf	345	10.2 (±0.20)	25(7.2%)	10(3.1%)	35(10.1%)	9.7 (±0.58)
Slash	15	14.2 (±0.72)	0	1(6.7%)	1(6.7%)	19.1 (±0)
<b>Total</b>	<b>2758</b>	<b>N/A</b>	<b>139(5.0%)</b>	<b>186(7.1%)*</b>	<b>325(11.8%)</b>	<b>N/A</b>

\*Percentage of live trees

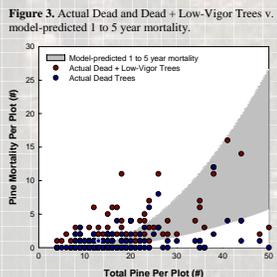


Figure 3. Actual Dead and Dead + Low-Vigor Trees v. model-predicted 1 to 5 year mortality.

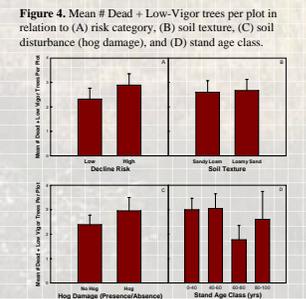


Figure 4. Mean # Dead + Low-Vigor trees per plot in relation to (A) risk category, (B) soil texture, (C) soil disturbance (hog damage), and (D) stand age class.

## Results

- The percentage of dead and low-vigor trees was highest for loblolly pine and lowest for longleaf pine (Table 1).
- Multiple regression analysis suggests that the most dead + low-vigor trees occur on plots with high numbers of trees and low mean diameters ( $R^2=0.41$ ), consistent with known relationships between tree density and mortality.
- According to the published model, density-related mortality starts at a pine density of ~85 trees per acre (17 trees per fifth-acre plot) and increases with higher densities. Much of the mortality evident in our data occurs at densities below this threshold, and in the stand structure-type most needed for sustainable RCW habitat. Mortality above this threshold may be difficult to distinguish from density-related "self-thinning" (Figure 3).
- Mean number of dead + low-vigor trees per plot was slightly higher on plots categorized as high risk by the risk map, and on plots with hog disturbance (total number of pine trees per plot) and risk category ( $P=0.0495$ ) and soil texture ( $P=0.0402$ ) (Figure 5).
- Two-way ANCOVA models (risk category × soil texture, risk category × hog disturbance, and soil texture × hog disturbance) suggest that the number of dead + low-vigor trees per total number of pine trees was highest on plots categorized as high risk and with hog disturbance. No consistent patterns emerged from this analysis, however, likely due to confounding among the independent variables.

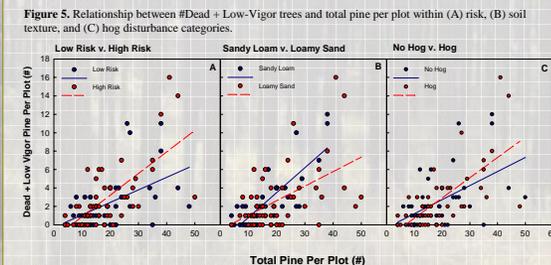


Figure 5. Relationship between #Dead + Low-Vigor trees and total pine per plot within (A) risk, (B) soil texture, and (C) hog disturbance categories.

## Future Work

- An association between *Leptographium*, a fungal pathogen vectored by root feeding insects, and pine decline has been documented on Fort Benning (Menard, Eckhardt and Jones 2005). *Leptographium* appears to accelerate mortality of southern pines, but more research is needed to better understand the mechanism. Symptoms of infected trees include sparse crowns, reduced radial growth and deterioration of fine roots.
- Long-term monitoring of permanent plots on Fort Benning will be initiated to track mortality, stand dynamics, and management impacts in upland pine stands. More detailed evaluations of tree vigor will be conducted using the Forest Health Monitoring (FHM) Crown Rating System.

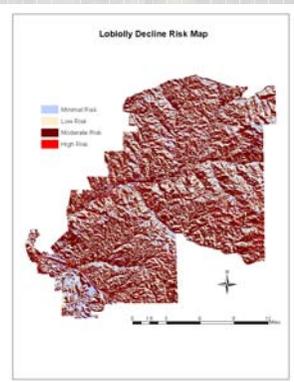
## Literature Cited

Eckhardt, L.G. 2003. Biology and ecology of *Leptographium* species and their vectors as components of loblolly pine decline. Ph.D. Dissertation, Louisiana State University, Baton Rouge, LA.  
Martin, S.W. and G.H. Brister. 1999. A growth and yield model incorporating hardwood competition for natural loblolly pine stands in the Georgia Piedmont. So. J. Appl. For. 16(3):179-185.  
Menard, R.D., Eckhardt, L.G., and J.P. Jones. 2005. Assessment of Loblolly pine decline risk mapping system on Fort Benning Military Installation, Fort Benning, Georgia. Southwide Forest Disease Workshop, Jan 10-13, Baton Rouge, LA, p. 25

Figure 1. Fort Benning location and location of sample plots.



Figure 2. Fort Benning's Loblolly Decline Risk Map (LDRM) was developed from correlations found between biological data (collected from root sampling and pitfall traps) and topographical features in the Talladega National Forest, Alabama (Eckhardt 2003). Plot topographical features were derived from Digital Elevation Models (DEMs) and percent slope and aspect provided the best fit for decline risk assessment. Applying the above information, location probabilities of decline over a definable geographic landscape were mapped at Fort Benning. For analysis purposes here, risk categories were collapsed into Low and High (i.e. Low = Minimum and Low; High = Moderate and High)



**Acknowledgments** We thank Randy Jarzyniecki, Matt Young, Craig Hrnecir and Forest Moore for help in the field, and James Parker and Rusty Bufford for logistical help. Funding for this project was provided by the Department of Defense. We appreciate the support of Fort Benning's Environmental Management Division, including John Brent, Bob Larimore and Pete Swiderek.

## Photo Credits

Decline photos, top panel: Lori Eckhardt  
Background photo: © Mark Godfrey/TNC