Assessment of Loblolly Pine Decline in Central Alabama

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ABSTRACT

Loblolly pine (*Pinus taeda* L.) decline has been prevalent on upland sites of central Alabama since the 1960's. The purpose of this study is to use Forest Health Monitoring (FHM) standards and protocols to evaluate root health of declining trees relative to crown, stem, and site measurements. Thirty-nine 1/6 acre plots were established on loblolly decline sites in nine central Alabama counties. Sites were selected on federal, state, and private industrial lands to measure variables of decline symptoms, age classes and management procedures. Two-root sampling procedures, selective media and soil baiting assay methods were used to isolate pathogenic root fungi. Pitfall traps collected root-feeding insects from which *Leptographium* species have been recovered. Edaphic measurements are ongoing, including soil porosity, bulk density, soil description and nutrient analysis. FHM indicators of tree crown conditions and damages were recorded on all pines in the plots. Preliminary results show a significant correlation with live crown ratio and incidence of *Leptographium* spp. Eighty-four percent of plots recovered *Leptographium* from damaged roots. The pine basal area (ft²/acre) is significantly reduced with increased incidence of *Phytophthora cinnamomi* Rands. *P. cinnamomi* was recovered from 50 percent of the plot sites. Histology examination of root damage indicates a significant correlation with reduced growth and root wounding

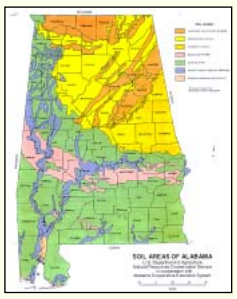
INTRODUCTION

Loblolly pine (*Pinus taeda* L.) decline has been prevalent on upland sites of central Alabama since the 1960's. The purpose of this study is to use Forest Health Monitoring (FHM) standards and protocols to evaluate root health of declining trees relative to crown, stem, and site measurements. Thirty-nine 1/6 acre plots including sub-plots were established within loblolly decline areas of nine central Alabama counties. Decline symptoms include short chlorotic needles, sparse crowns, and reduced radial growth by stand age class 40-50, with mortality occurring two to three years after symptoms appear .

METHODS

Plot Description

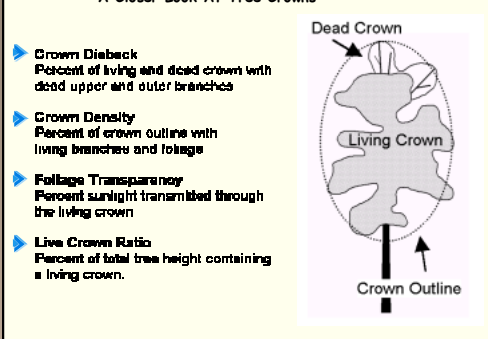
Sites for plot establishment were selected on federal, state, and private industrial lands. Plot establishment followed the FHM guidelines (Dunn 1999), using a cluster of four 1/24-acre subplots. The plot locations fell within four Physiographic Regions of Alabama: the Piedmont, Ridge and Valley, Upper Coastal Plain, and Cumberland Plateau (Figure 2). At each location, root health assessment was accomplished by selecting three dominant, or co-dominant, symptomatic pines nearest the plot center of the center subplot.



Plot Locations and Physiographic Setting	
Physiographic Region	County
Piedmont	Clay, Cleburne, Talladega
Alabama Ridge & Valley	Calhoun
Cumberland Plateau	Tuscaloosa
Upper Coastal Plain	Bibb, Chilton, Hale, Perry,

FHM Indicators of Tree Crown Conditions

Tree crown conditions were measured on all pine trees (DBH ≥ 5.0) within all 39 plots. The crown measurements included live crown ratio, crown light exposure, crown density, crown dieback, and foliage transparency.



Insect Interactions

Pitfall traps were installed on 15 of the 39 plots, and insects collected weekly from April 17th to June 5th, 2000. Each trap was baited with two 8 ml glass vials, one containing 95 percent alcohol and one containing turpentine. Two freshly cut pine stems were also placed inside the traps (Klepzig and others 1991). Insects were inventoried and rolled across cycloheximide-streptomycin amended malt extract agar (CSMA--2 percent MEA containing 800 ug/ml of cycloheximide and 200 ug/ml of streptomycin sulfate) and unamended malt extract agar (MEA) (Hicks and others 1980). Agar plates were incubated at 25°C and colonies resembling *Leptographium* were transferred to sterile plates or slants of MEA.

Pitfall Trap

Hylastes spp.

Processing Roots

Root sampling was done with the modified two root exacavation method (Otrosino and others 1997).

Two primary roots from each sample tree were excavated using hand tools, beginning at the root collar and extending out to the tree drip line. The primary roots were then cut from the tree and removed. Soil samples were collected adjacent to the roots.

Root samples were collected during April, May, and June of 2000. The fine roots from each primary root were excised, bagged, labeled and maintained in the field on ice. The primary roots were also randomly chipped or cut into pieces, bagged, labeled, and iced for transportation to the laboratory. Roots were excavated from 117 trees, with 234 primary roots sampled, along with collections of fine roots and soil samples from the root zones.

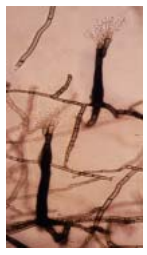
Isolation of Microorganisms, Louisiana State University, Plant Pathology Laboratory, Baton Rouge, LA.

Phytophthora spp. and *Pythium* spp. were isolated from fine roots and soils using three methods; (1.) selective medium PARP(H) (Ferguson and Jeffers 1999), (2.) soil assay from a soil suspension on PARP(H) (Jeffers 2000), (3.) with fresh camellia, juniper, or pine stems (Jeffers 2000). Incubated plates were checked after 24 and 72 hours for characteristic *Pythium* or *Phytophthora* sporangia.

Isolation of Ophiostomatoid fungi from primary roots also utilized selective media. Roots were cut, decontaminated and placed in Petri dishes containing selective medium (CSMA) to isolate *Leptographium* species. Plates were incubated at 25°C and *Leptographium* isolates were subcultured from hyphal tips and conidial heads onto MEA.

Soil samples were analyzed for *Leptographium* sp. by removing a 10 g aliquot from thoroughly mixed soil previously collected near lateral roots. Root fragments were removed from the aliquot by sieving and suspending them in 40 mls of sterile, 0.5 percent water agar. One milliliter of this suspension was pipetted into 10 petri dishes containing 10 mls of CSMA. Dishes were incubated at 25°C and examined daily for the presence of fungus.

Phytophthora spp.



Leptographium spp.

Root Damage Assessment

During the root excavation and sampling procedures, a sub-sample of 17 plots was chosen to evaluate fine root damage through histological examination. Random samples of unwashed fine roots were taken from the primary roots and placed in formalin/acetic acid/alcohol fixative (FAA) for 14 days (Sass 1951). Slides were stained with a variety of schedules, including Papanicolaou's hemotoxylin-eosin or an acid-Schiff procedure (Hass 1980, Horobin and Bancroft 1998). Stained sections where observed under a light microscope and then catalogued into damage categories (Walkinshaw and Tiarks 1997, Walkinshaw and others, 2001).

Data Analysis

Measures of stand structure, tree growth, and tree crown and damage conditions were used to summarize decline symptoms of loblolly pine for each plot. Values were compared between the 30 plots located on public land and the 9 plots on industrial ownership to determine if the presence of decline symptoms was related to different types of forest management these ownerships represent. Data were analyzed using T-tests.

Correlations of stand structure, crown conditions, radial growth, and root conditions were also calculated. These summaries were used to interpret physiological and pathological relationships among different indicators that express decline symptoms. Plot values for stand structure, tree growth, and tree crown conditions were compared to the categories of pathogen incidence by analyses of variance.

Proportions of damaged roots, root mortality, and number of starch grains in cortical cells were recorded from histological examinations and paired with tree growth and crown variables. (Walkinshaw and Otrosina 2001).

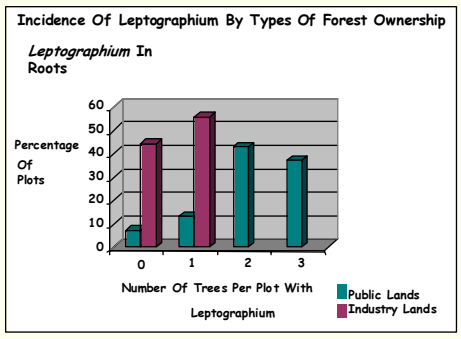
RESULTS

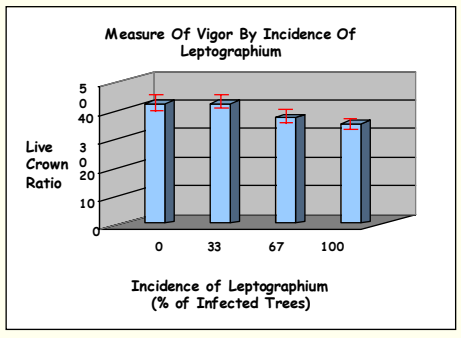
Tree crown condition indicators showed a significant correlation between DBH growth, crown density, and live crown ratio. Live crown ratio was less on plots having a greater incidence of *Leptographium* spp. On a plot basis, the incidence of *Leptographium* spp. from roots of the 39 sample plots was 84 percent from roots, and 33 percent from soils. Overall *Leptographium* isolation percentage was greater on public lands (93 percent) when compared to industrial lands (55 percent).

Table 1—Correlations between crown vigor associated with plot sample trees

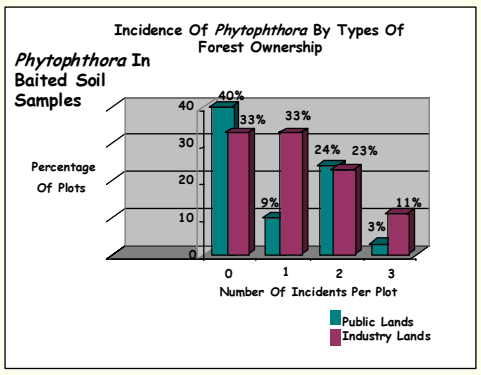
	Crown dieback (pct)	Crown density (pct)	Foliage transparency (pct)	Live crown ratio (pct)	BAI* Last 5 years (ft²/trees)	BAI Last 10 years (ft²/tree)
	Pearson correlation coefficient					
	Probability of significance					
BAI last 5 years (ft²/tree)	-0.15 0.36	0.38 0.02	-0.2 0.21	0.54 0		
BAI last 10 years (ft²/tree)	-0.23 0.15	0.43 0.01	-0.1 0.52	0.49 0		
Pine basal area (ft²/acre)	-0.1 0.55	-0.15 0.35	-0.19 0.25	-0.04 0.79	-0.27 0.09	-0.24 0.13
Stand basal area (ft²/acre)	-0.06 0.71	-0.14 0.4	-0.02 0.88	-0.11 0.5	-0.25 0.13	-0.19 0.26

* BAI = basal area increment



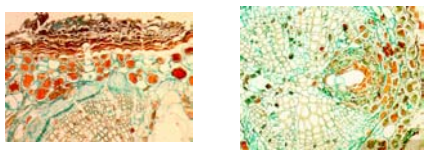


Using baiting procedures, *Phytophthora cinnamomi* was isolated from soils in 50 percent of the plots on public land and slightly higher on industrial land (55 percent). *P. cinnamomi* was not recovered from root isolations. Plots with *P. cinnamomi* had less pine basal area than those plots where *P. cinnamomi* was not found.



Microscopic examination of 700 fine root pieces from the 17 selected plots showed high incidence of root injury and mortality. The number of starch grains in the cortical cells was reduced and the disposition of tannin was excessive (Walkinshaw and others 2001).

Injured Root



DISCUSSION AND CONCLUSIONS

This assessment of loblolly decline included plots in four Physiographic Regions, encompassing a zone in central Alabama from the east (Cleburne and Clay counties) to the west (Tuscaloosa and Hale counties). The evaluation of site variables, including soil classification, bulk density, soil porosity and moisture capacity, and soil nutrient analysis will be a key to assessing the influence of soil and root pathogens recovered from these sites and their relationship to crown characteristics of symptomatic loblolly pines. The soil and site measurements will not be completed until 2002, at which time a complete evaluation and analysis of all data, including site, root, soil, tree growth, crown indicators, and crown damage will be accomplished. The results of this preliminary study indicate: (1) On public lands, damage and mortality increases with age of the stands, especially after age 40. (2) Loblolly pine decline symptoms are the same as littleleaf disease of shortleaf pine, and preliminary results of our evaluation show a correlation between reduced radial growth, reduced BA, declining crowns, root damage, and recovery of *P. cinnamomi* and *Leptographium* spp. (3) Loblolly pine decline is prevalent on sites within the historic range of littleleaf disease and is associated with sites and soils other than the heavy clay soils of the Piedmont Province.

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