**Title: Quantifying the impact of pine decline in the southeastern United States**

**Location:** TBD

**Duration:** 4 years

**Project leaders:**

Dr. Lori Eckhardt (Auburn University)

Dr. Ryan Nadel (Auburn University)

**Co-operators:**

Dr. George Matusick (TNC)

Dr. Emily Carter (US Forest Service, Soil Scientist)

**Project Background:**

Industrial wood plantations in the southeastern United States are crucial for the economic sustainability of the region (Wear and Greis 2002). The sustainability and profitability of these industrial wood plantations relies on optimal tree growth, however, the progressive arrival of new, and migration of endemic, insect pests and pathogens into these forest ecosystems results in significant economic impacts that require management response.

Both the understanding of the impact of pests and/or diseases on forest productivity, and the development of any control measures is not only critical, but also technically challenging. This may be in part attributed to the complexity of the pest/pathogen/host associations as a whole and the dynamic nature of current growing conditions. Although the majority of research focuses on unique aspects that can be quantified, the actual impacts caused by pests/diseases are difficult to quantify.

**Justification:**

Research into understanding pests, pathogens and hosts associated with pine decline in the southeastern United States has been the main research focus of the Forest Health Cooperative since its inception in 2008. A list of all scientifically peer reviewed manuscripts relating to understanding this disease triangle are presented in the **Table 1**. This research has stemmed from determining the strong association between poor crown health, root infection by pathogenic fungi, and activity of root-feeding insects found by Eckhardt *et al.* (2010). Subsequently there has been significant experimental research focused on the interactions between trees, pathogenic fungi, and bark beetles. Efforts to quantify the impact of pine decline on forest productivity have, however, been lacking. The significance of these pests and pathogens on actual stand productivity, and thus management, are still poorly understood. An understanding as to how pests/pathogens, involved in pine decline, impact plantation productivity, including tree mortality, growth reductions, and their interactions, needs to be determined in order to estimate economic losses. Quantifying the actual impact of pine decline on productivity will enable forest managers to make informed future management decisions.

**Project Objectives:**

The primary objectives of this project are to:

1. Quantify the impact of fungal root infection on tree and plantation productivity
2. Determine the threshold level of fungal root infection required to cause growth reductions and mortality of plantation trees.
3. Examine the role of fungal root infection on the water, nutrient, and carbon relations in plantation trees to determine why trees die (or suffer only growth losses) from the decline process (i.e. water/nutrient limitations, carbon allocations).
4. Determine the impact of fungal root infection on the population activity of bark beetles and other pests within affected stands (i.e. does the decline process represent a positive feedback cycle?).

**Predicted Project Outcomes:**

This work is not meant to replace any research that is currently underway focused on developing solutions, but rather aimed at determining the actual impacts on productivity, so that landowners and forest managers may more precisely predict future timber revenues from affected stands. Results from the project shall provide:

1. A correction factor, needed to account for losses from pine decline in growth/productivity models.
2. The impact from fungal infection on tree physiology and functioning required for developing potential growth curative solutions and models for trees and stands already affected.
3. The levels of infection that are acceptable (minimal growth loss and low probability of mortality) and those that fall above the damage thresholds.
4. An understanding of tree-level infection levels and their potential for attracting beetle vectors and additional infection at both a tree and site level (positive feedback: infection attracts beetles, which facilitate more infection).

The knowledge produced by this project will be used to develop best management practices for areas affected by decline. It shall also help direct future research actions, especially when little is known regarding the impact of the pests/pathogens associated with pine decline in the southeastern United States.

**Methodology:**

Approximately 20 acres of thinned forest plantation with good vehicle and equipment access (following 1st thin), is required to undertake this proposed trial in order to provide adequate replication. Multiple, large-scale, tree-level root inoculation experiments will be used to simulate the natural root infection process under semi-controlled conditions in the field. Precise tree physiological condition (water, nutrients, carbon) and growth measurements prior to and post inoculation treatments, is required to accomplish objectives 1 and 3.

Varying infection levels among treated trees shall assist in determining the threshold infection level necessary to cause significant losses in tree growth and thus productivity (objective 2). Beetle behaviour surrounding and within infected trees will be monitored both prior to- and post inoculation treatment in order to examine the reaction of disease vectors to infection (objective 4).

**Budget:**



**Budget justification:**

The total requested funds for the proposed project from the Forest Health Cooperative over a four year period is $182,858. A Ph.D. student stipend of $19,100 plus benefits of $478 per year is requested for four year period. Supply costs of $10,000 cover the purchase of 100 traps ($20 each for $2,000), baits (turpentine and ethanol, $2,000), other supplies (soil moisture probe, anti-freeze, insect collection supplies, field supplies, trap poles and wire, lab supplies at a cost of $6,000). Laboratory analyses for both soil and foliage will be undertaken annually at a cost of $3,350. Purchase of high-tech physiological and climate instrumentation for field measurements $29,080. Travel costs will cover an estimated 24 trips to field sites per year. Insect collections will occur during each of the field trips. Measurements of stem diameter, soil moisture, and leaf area index will be taken at monthly intervals (every other trip) throughout the study (possibly also stomatal conductance/photosynthesis, depending on availability of a cherry picker). Travel costs to present research findings at a meeting in years 2, 3 and 4 has also included for graduate student or Project Leaders ($4,000).

**References:**

Eckhardt, L.G., Sword-Sayer, M.A., and Imm, D.W. (**2010**). State of pine decline in the southern United States: A Technical Note. [*J. Appl. For*](http://www.auburn.edu/~eckhalg/PDF%20files/Eckhardt%2C%20Sword%2C%20Imm_SJAF%202010.pdf)*.* 34:138-141.

Wear, David N.; Greis, John G. (**2002**). Southern Forest Resource Assessment - Technical Report. Gen. Tech. Rep. SRS-53. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 635 p.

Table 1: Publications produced by members of the Forest Health Cooperative

