Quantifying the Impact of Pine Decline in the Southeastern United States

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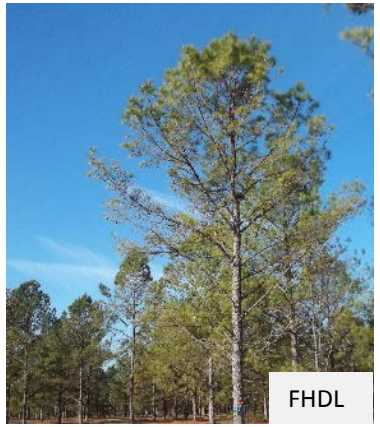
Forestry in the southeastern U.S.

- During the 1900's loblolly pine was extensively planted
- Recent years, decline in forested area
- Forestry remains a vital component of the southeastern U.S. economy
- Southeastern U.S. remains the foremost softwood producing area of the U.S.

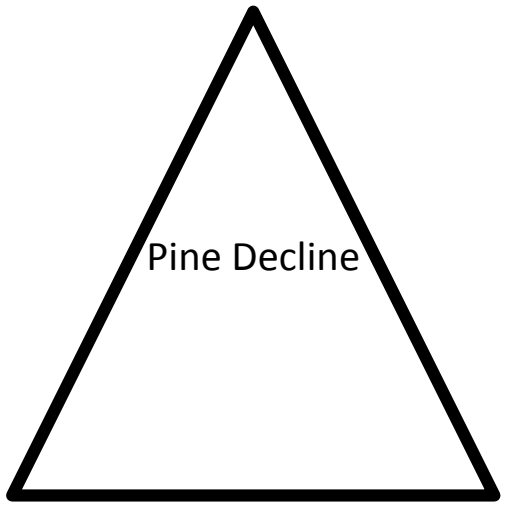
Southern Pine Decline

Pathogen: *Ophiostomatoid* fungi


FHDL


FHDL

Host:
Loblolly pine



Environment

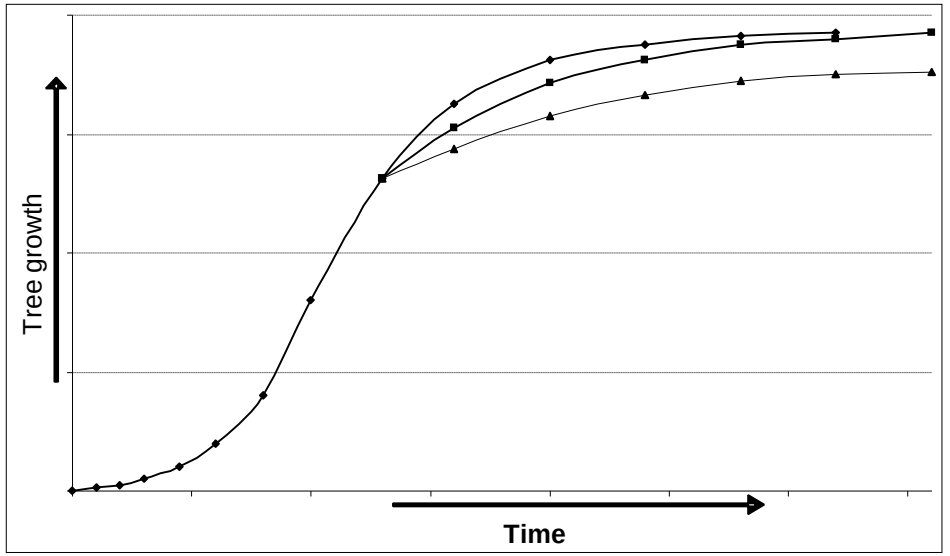

FHDL

Leptographium terebrantis

- Associated with dying or declining pine trees throughout the U.S. and Canada
- Occurs on numerous pine species
- Fungus is commonly associated with root feeding bark beetles and weevils

Forest productivity

- Driven by photosynthesis to produce woody biomass
- Rate of photosynthesis depends on leaf area
- Environmental and site constraints influence leaf area production and tree growth rate
- Fine root production and replacement require a large proportion of net primary productivity



Objectives

1. Quantify the impact of fungal root infection on tree and plantation productivity and investigate the early detection potential of a subset of variables.
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 and its interaction with the water, nutrient, and carbon relations of plantation trees to determine the cause(s) of tree mortality and growth losses by the pine decline process.
4. Determine the impact of fungal root infection on the behavior of bark beetles and other pests within affected stands.

Experimental plan

- Site characteristics
  - Physiographic information
  - Soil description data
- A weather station installed to measure microclimate
- Experimental treatments: namely fungal inoculum loads
  - Control (no inoculum and no wound)
  - Wound (no inoculum)
  - Low inoculum load
  - Medium Inoculum load
  - High inoculum load

Objective 1: Quantify the impact of fungal root infection

- We hypothesize that tree growth and physiological measurements will be significantly different between trees impacted by pests and pathogens compared to trees that are not

Objective 1: Quantify the impact of fungal root infection

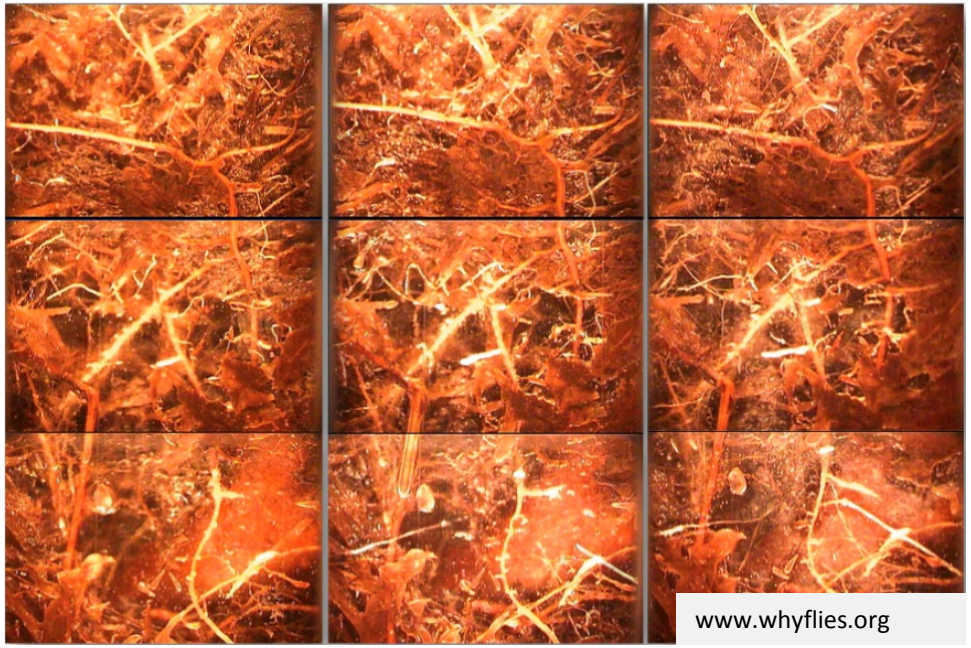
- Tree and plot growth measurements
  - Age
  - Basal area
  - Diameter at breast height (DBH)
  - Tree heights
- Physiological measurement
  - Leaf area index (LAI) taken seasonally

Objective 2: Determine the threshold level of fungal root infection required to cause growth reduction

- We hypothesize varying pathogen levels among treated trees will result in significantly different losses in growth and stand productivity
- Inoculation methods

Objective 3:Fungal root infection and its interaction with water, nutrient and carbon relations

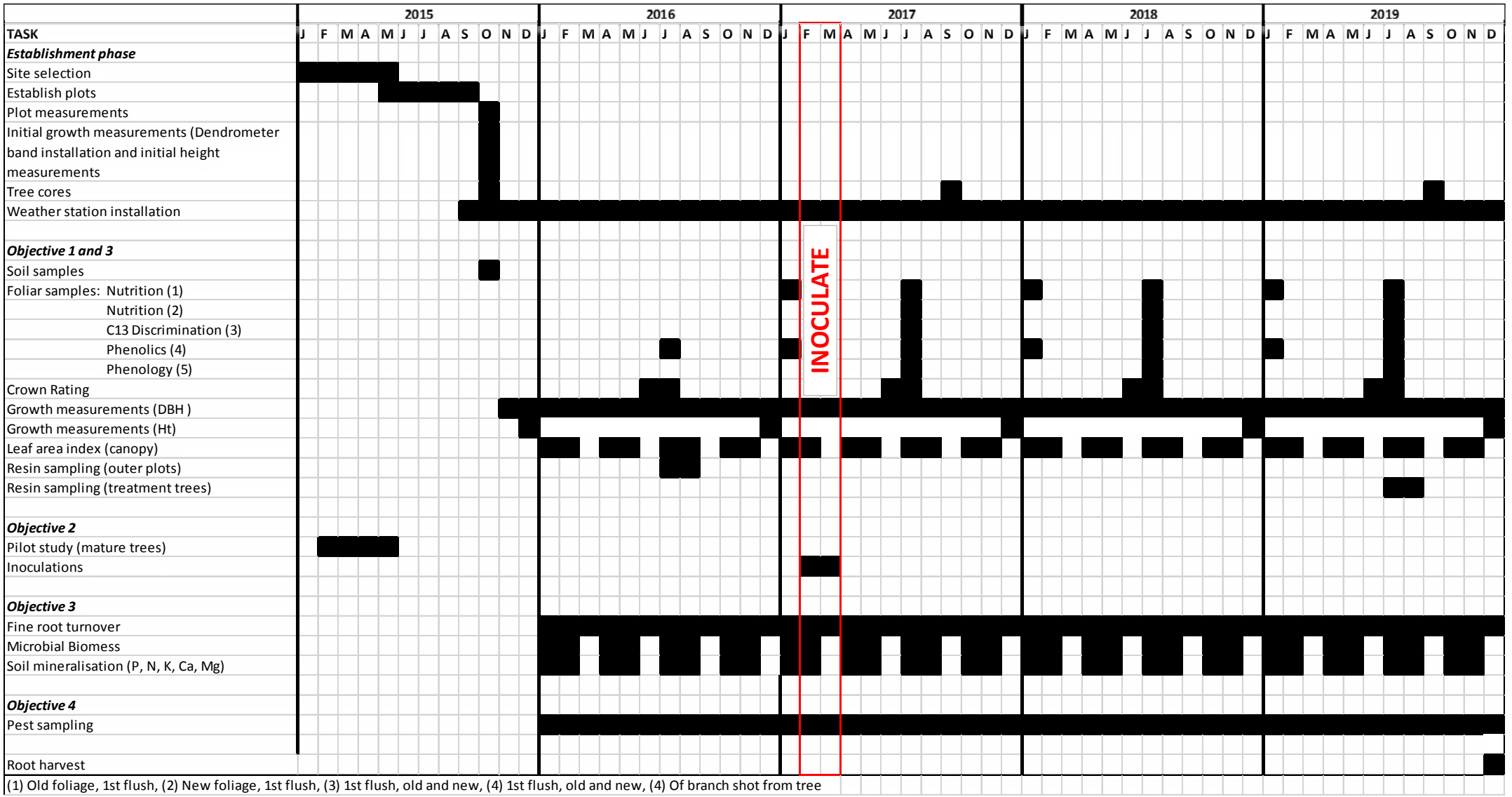
- We hypothesize that a loss in tree vigor and stand production by pine decline is triggered by a carbon deficit
- Measurement of new growth
  - Monitored by mini-rhizotron
- Measure defense
  - Resin analyses
- Branch phenology measurements
- Soil nutrition measurements
- C_{13} discrimination analysis



Objective 4: Impact of fungal root infection on behavior of bark beetles and other pests

- We hypothesize that beetle behavior surrounding and within infected trees will be significantly different between treatments

Timeline


2015
2016
2017
2018
2019
J F M A M J J A S O N D
TASK
Establishment phase
Site selection
Establish plots
Plot measurements
Initial growth measurements (Dendrometer band installation and initial height measurements
Tree cores
Weather station installation
Objective 1 and 3
Soil samples
Foliar samples: Nutrition (1)
Nutrition (2)
C13 Discrimination (3)
Phenolics (4)
Phenology (5)
Crown Rating
Growth measurements (DBH)
Growth measurements (Ht)
Leaf area index (canopy)
Resin sampling (outer plots)
Resin sampling (treatment trees)
Objective 2
Pilot study (mature trees)
Inoculations
Objective 3
Fine root turnover
Microbial Biomess
Soil mineralisation (P, N, K, Ca, Mg)
Objective 4
Pest sampling
Root harvest
INOCULATE
(1) Old foliage, 1st flush, (2) New foliage, 1st flush, (3) 1st flush, old and new, (4) 1st flush, old and new, (4) Of branch shot from tree

Work to date

- Establishment phase and inoculation pilot study
- Find most virulent isolates
- Sites located, plots installed
- Baseline data collected

Long-term goals

- Aimed at determining the actual impacts on productivity and biological cause(s) of Pine Decline so that landowners and forest managers may more precisely predict future timber revenues from affected stands and adjust management activities accordingly.

- The knowledge produced by this project will be used to develop best management practices for areas affected by decline. It will allow for the development of a correction factor, needed to account for losses (tree death as well as predicted growth losses) from pine decline in productivity models.

Deliverables

- A correction factor, needed to account for losses from pine decline in productivity models
- An improved understanding of the interactive effect among fungal infection, stand environment, and tree physiology on loblolly pine sustainability which is required for developing remedial actions and productivity models for trees and stands already affected
- The levels of infection that are acceptable and that fall above the damage thresholds
- An understanding of tree-level infection levels and their potential for attracting beetle vectors, as well as additional infection both at the tree and site level
- The knowledge produced by this project will be used to develop best management practices for areas affected by decline so as to reduce productivity losses.

Acknowledgements

- Forest Health Cooperative