Modeling Pine Litter Dispersal and Assessing Impacts of Needle Loading on Longleaf Pine Seedlings After Prescribed Burn

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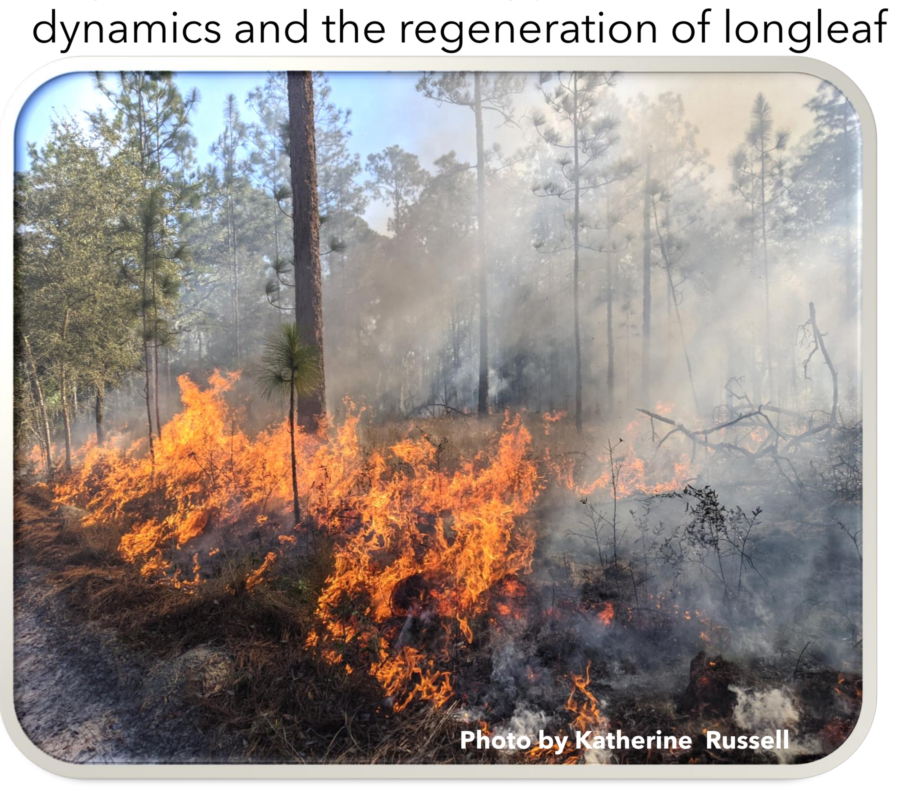
Background

- Longleaf pine (*Pinus palustris*) ecosystems rely on frequent, low intensity fires to suppress woody encroachment; however, longleaf seedlings can also be vulnerable to fire.
- Longleaf needle litter is a highly flammable fuel that can increase fire intensity and residence time.
- It is important to understand how fuel dispersal from the canopy influences fire dynamics and the regeneration of longleaf



Objectives

1. Develop, compare, and validate multiple models that predict spatial distribution and accumulation of needle litter under different silvicultural treatments

2. Test the effect of a gradient of needle litter loading on the damage response and survival of longleaf pine seedlings after prescribed burn.

Site Description

This study will be conducted at the Jones Center at Ichauway. The study site was burned at a one-year burn interval prior to this study. The Jones Center spans 30,000 acres of managed woodlands and wetlands. Longleaf pine is the most common overstory species and wiregrass (*Aristida stricta*) and broomsedge (*Andropogon virginicus*) dominate the understory.

Methods

Objective 1

Develop an individual-based spatially explicit **model** for longleaf pine litter dispersal from stem maps using maximum likelihood analysis to estimate parameters to predict the influence of trees >10cm dbh.

Example Litter Model Equation (Ferrari & Sugita 1996)

$$\underset{(g/cm^2)}{\text{Total litter fall}} = \Sigma_j \frac{\alpha\gamma^2}{2\pi} \times (\mathrm{DBH}_{ij})^\beta \exp[-\gamma z_{ij} - \delta(\mathrm{DBH}_{ij})]$$

DBH_{ij}= diameter at breast height of tree *j*

z_{ij}= distance (m) between litter trap *i* and tree *j*

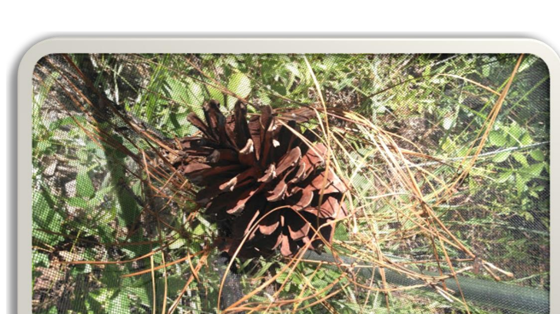
The equation above is derived from:

$\alpha(DBH)^\beta \exp[-\delta(DBH)]$ = allometric foliar biomass equation

$\frac{\gamma}{2\pi}\exp(-\gamma z)$ = negative exponential function of litter dispersal

Validate model using another independent long-term litterfall dataset completed across plots varying along a productivity gradient.

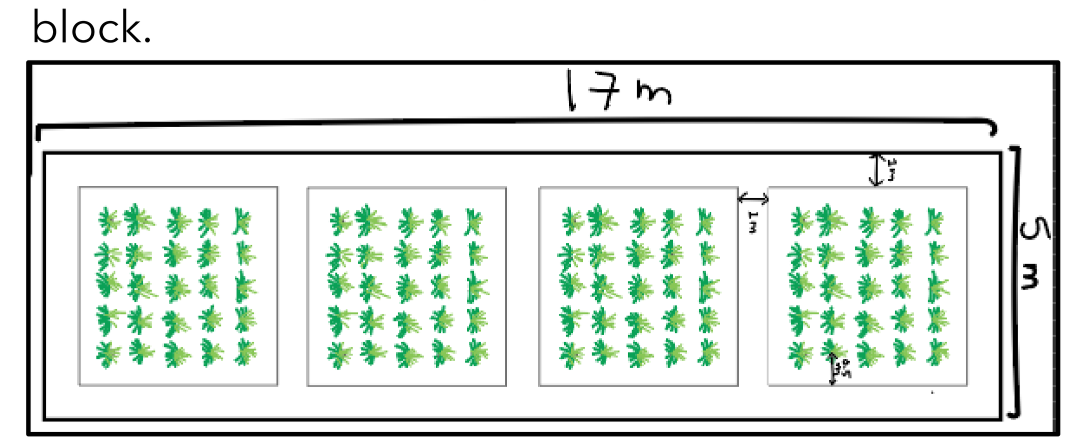
Litterfall data from a long-term Ecological Forestry study at the Jones Center will be used to develop models. Needle litter from conical mesh traps ($0.25m^2$) has been collected, dried, and weighed quarterly since 2010.



Pine needles are separated from other canopy-derived fuels such as cones, bark, and hardwood litter.

Objective 2

Plant containerized seedlings at 0.5m spacing within 4 treatment subplots in each 17x5m block.



Determine litter treatments (g/cm^2) based on Ecological Forestry data and other previous studies

Litter treatments:

Burn seedlings in Feb 2022 and measure post-fire response until the beginning of the 2022 growing season.

Measure seedlings

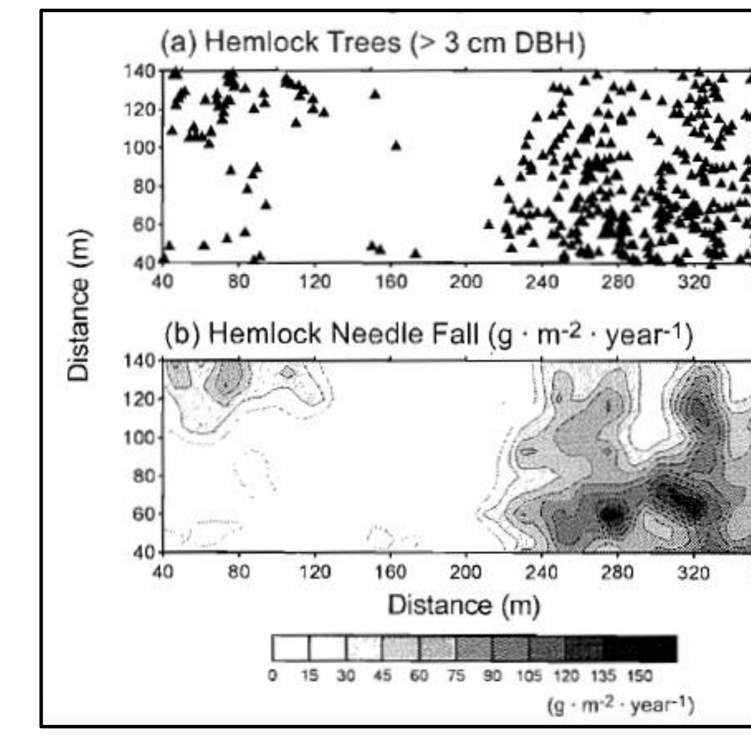
Pre-Fire
- Root collar diameter (mm)
- Leaf area (cm^2)
- Height (cm)

Post-fire
- % scorch
- % consumption
- Resprouting and mortality

Use **Image J** to conduct leaf area scorch, and consumption analyses

Anticipated Results

Objective 1: Our study will develop a similar model to predict needle dispersal in longleaf pine-dominated forests, that varies based on overstory density and size structure



Hemlock (trees >3cm DBH) locations are plotted in (a) and (b) shows the model prediction of hemlock leaf litter fall.

Source: Ferrari & Sugita (1996)

Objective 2: We expect a lower post-fire survival rate, greater crown consumption, and higher scorch percentage in longleaf pine seedings with higher needle loading.

Impacts

- Inform how a range of forest management scenarios and forest development will affect litter dispersal, fire continuity, and seedling survival.
- Maintain a source of canopy-derived fuels when converting commercial pine species such as slash and loblolly pine to longleaf pine.
- Contribute to better fire behavior models and our understanding of how pine needles contribute to prescribed fire outcomes.

Acknowledgements

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