Managing Longleaf Pine Ecosystems in a Changing Climate: An Ecological Silviculture Approach

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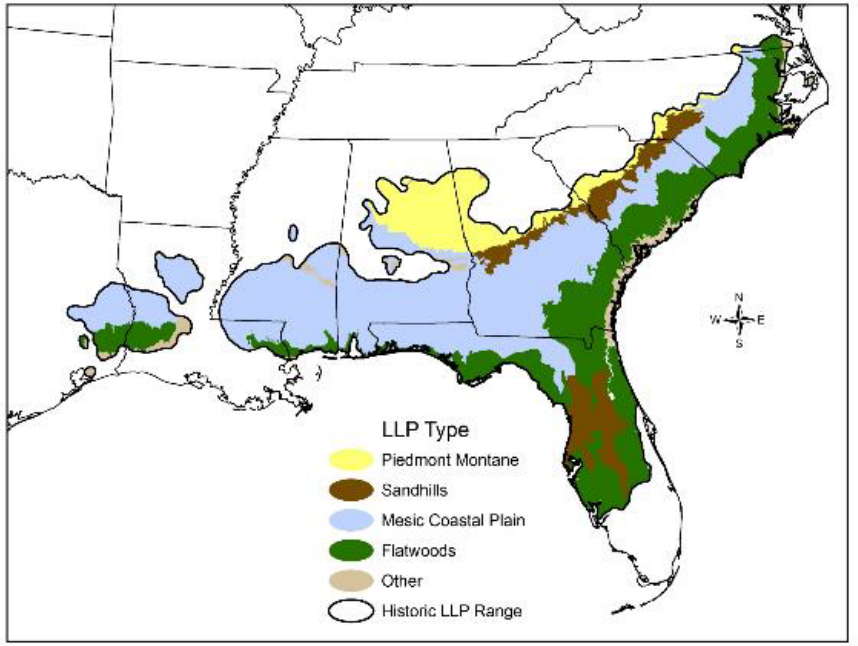
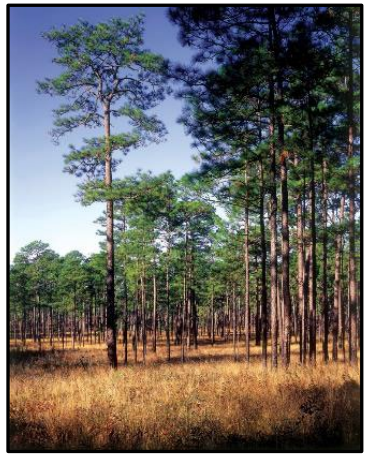
Longleaf Pine Distribution and Community Types

- ~92 million acres presettlement
- < 5% remains, highly fragmented
- Most diverse NA temperate ecosystem
- 900 endemic plants rangewide
- 31 Federally-listed T/E spp.
- Fire dependent ecosystem
- Wide range of site types
- Longest-lived southern pine (400+ yrs.)



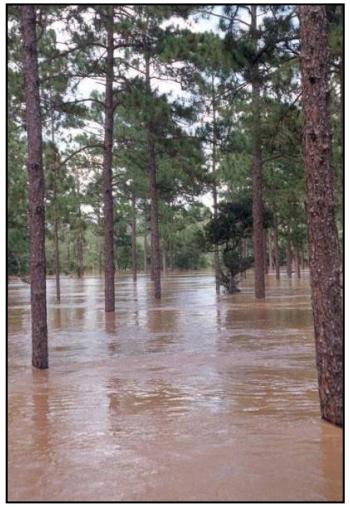


Longleaf Pine: Structure & Dynamics

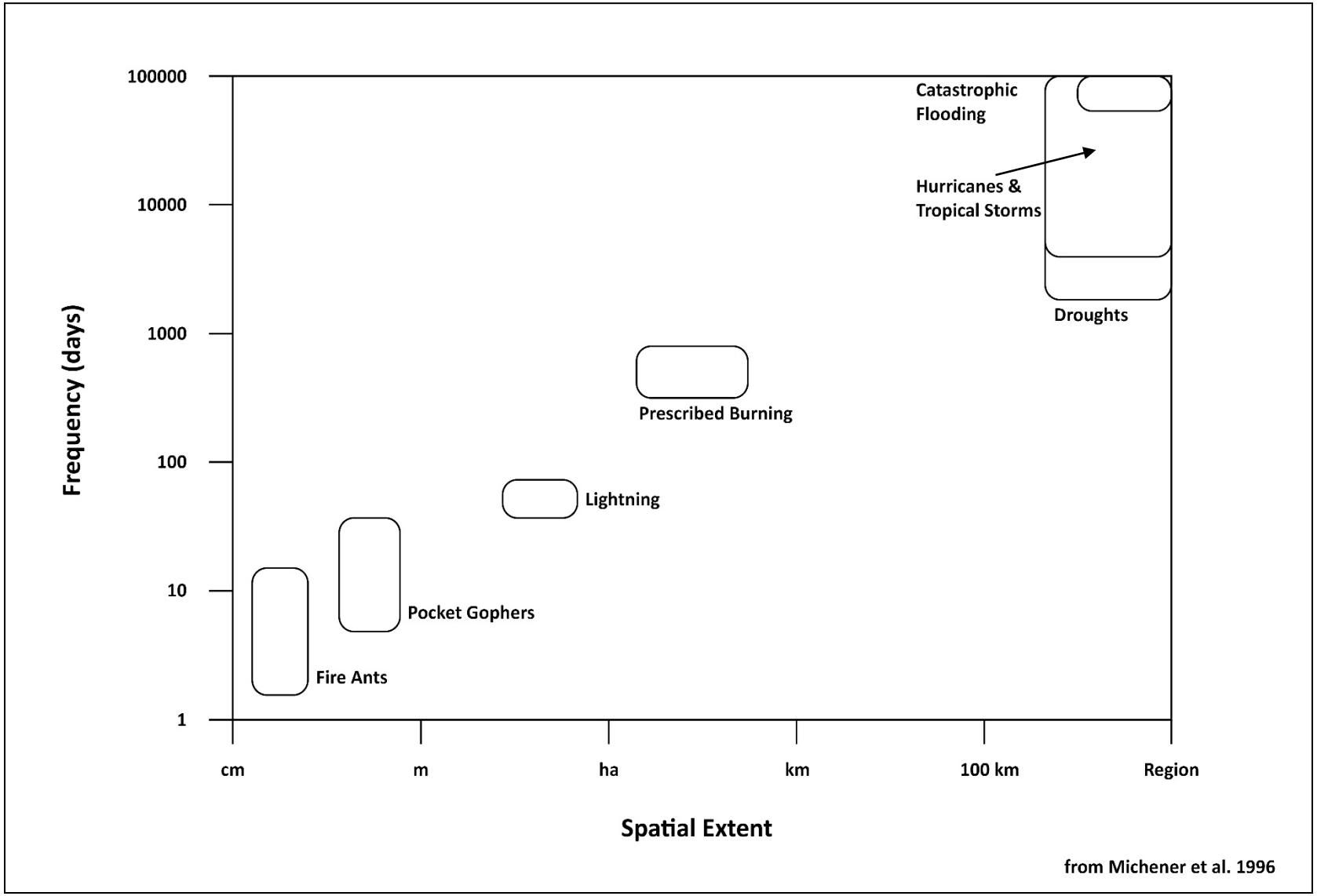
- **Disturbance** and **Competition** processes drive dynamics and create structure
- Both influence demography of longleaf pine and associated plant species
- Lead to multi-aged structure
- Wildlife respond to structure

- **Water**, **Wind** & **Fire**: disturbance agents and alter competitive interactions

Natural Overstory Disturbance

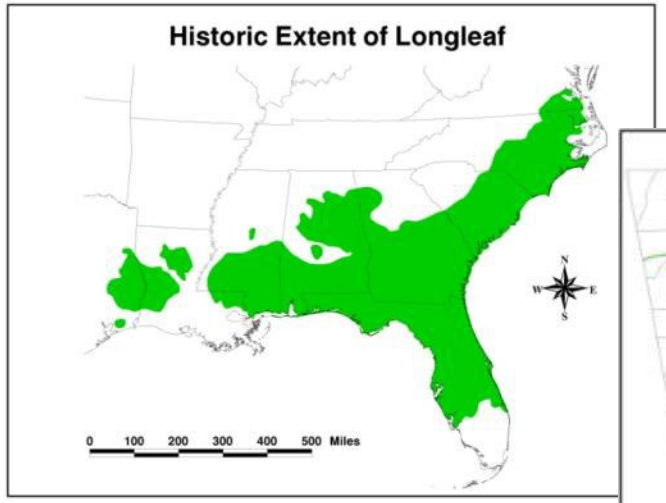


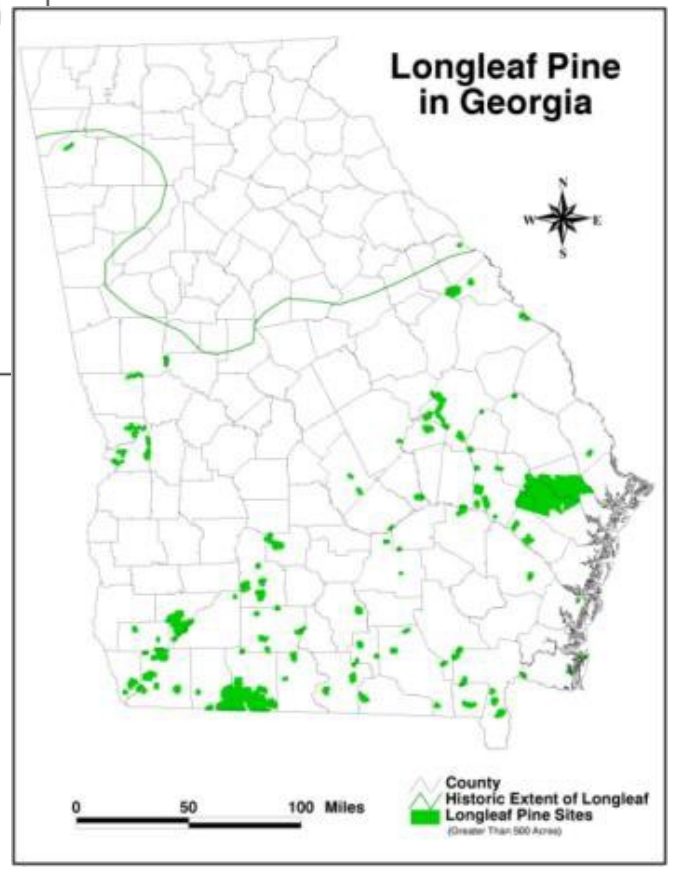
Conceptual Longleaf Pine Disturbance Model



Longleaf Pine Ecosystems – Why Restore?

- High biological diversity
- 31 Federally-listed T/E spp., numerous At-Risk spp.
- 900 endemic plants rangewide
- Critical habitat for 60% of all SE US herpetofauna
- < 5% historical extent remains, highly fragmented
- Only ~ 35% of remaining LLP within structural HRV





High Diversity and Conservation Value

Ecosystem Services – water and carbon?

Ground Cover Community

Many ETS & At-Risk Species

Desired Condition for Diversity & Conservation Objectives

- Open canopy
- Multi-aged
- Heterogeneous
- Diversity
- Old trees
- Dead wood component

How do we get to those conditions?

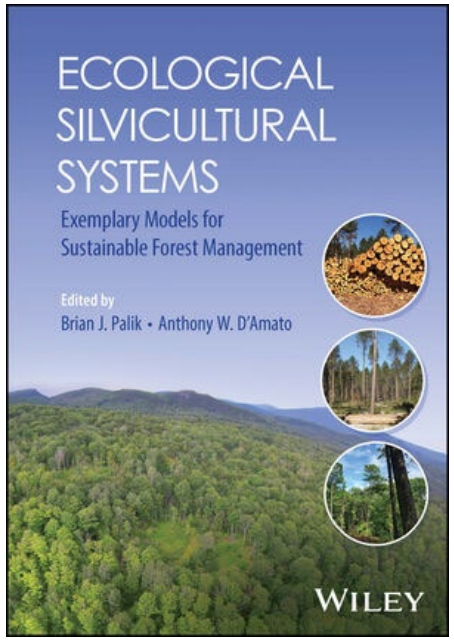
- Utilize an **Ecological Silviculture** approach

  From Tony D'Amato's earlier presentation, ecological silviculture is:

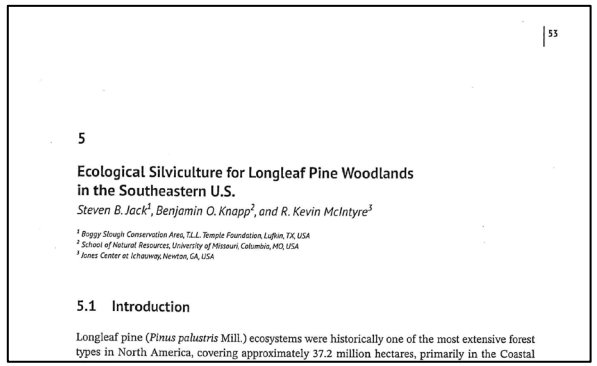
  "Management approach that applies an understanding of the structure, function, and dynamics of natural forest ecosystems to achieve integrated environmental, economic, and social outcomes (Palik et al. 2020)."

- Main elements of this approach
  - Continuity
  - Complexity/Diversity
  - Timing of disturbances or treatments
  - Landscape Context

For Longleaf Pine



It depends on the starting point!



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Ecological Silviculture for Longleaf Pine Woodlands in the Southeastern U.S.

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5.1 Introduction

Longleaf pine (*Pinus palustris* Mill.) ecosystems were historically one of the most extensive forest types in North America, covering approximately 37.2 million hectares, primarily in the Coastal

Suggested Sequence of Practices, Different Starting Conditions

STARTING CONDITION / DEVELOPMENT STAGE	DISTURBANCE	FOREST ESTABLISHMENT	YOUNG FOREST	MATURE FOREST	OLD FOREST
MAINTENANCE **Existing LLP-dominant canopy**	Frequent Rx fire			• Frequent Rx fire • Utilize selection harvests • Release LLP regeneration & overtopped LLP midstory	• Maintain frequent Rx fire • Selection harvests • Remove undesirable tree species • Release LLP regeneration & overtopped LLP midstory
RESTORATION **LLP plantation establishment**	Complete canopy removal – by harvest or major natural disturbance	• Rx fire • Site prep • Plant LLP	• Maintain Rx fire • Intermediate thinning (row thin or variable density) for ground cover and heterogeneous structure	• Maintain frequent Rx fire • Selection harvest to reduce canopy densities and release LLP advance reproduction	• Maintain frequent Rx fire • Selection harvests • Remove undesirable tree species • Release LLP regeneration & overtopped LLP midstory
RESTORATION **Conversion of mature stands of other pine species to LLP**	• Reduce canopy density • Create/expand canopy gaps • Reduce/control midstory • Start frequent Rx fire	• Frequent Rx fire • Plant LLP seedlings in gaps or throughout the stand if no LLP canopy trees present	• Frequent Rx fire • Intermediate thinning to remove competition • Maintain open-canopy conditions in mature cohorts	• Frequent Rx fire • Selection harvests to lower canopy densities • Preferentially retain LLP in the canopy • Release LLP regeneration	• Maintain frequent Rx fire • Selection harvests • Remove undesirable tree species • Release LLP regeneration & overtopped LLP midstory

Modified from Jack, Knapp & McIntyre 2024 in Ecological Silvicultural Systems (Palik and D'Amato, eds.)

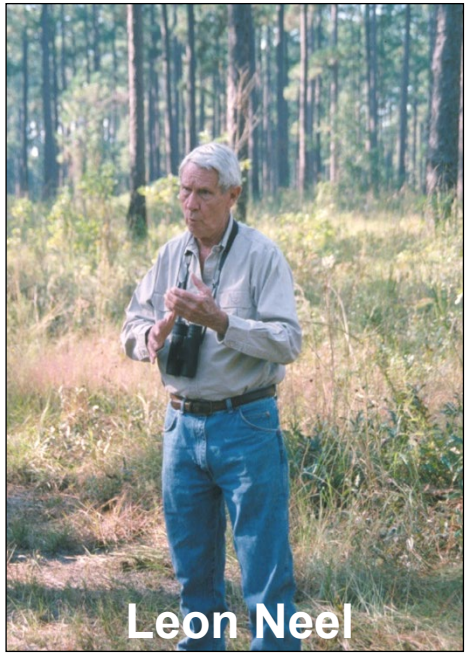
Fire is key in all trajectories

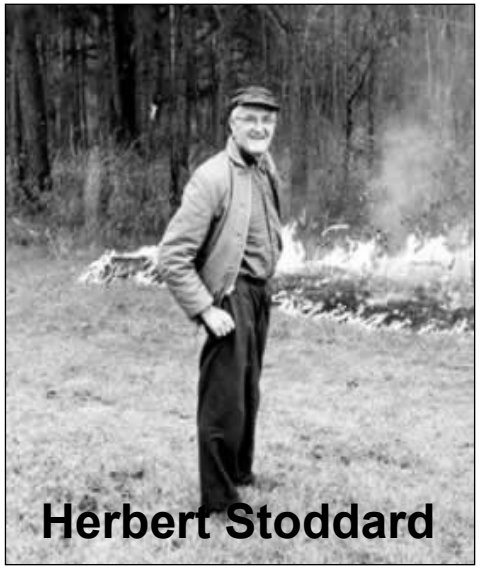
- Fire is **required** to obtain and maintain the desired structure and composition

- What if fire has not been present for significant time?
  - Slow process to reintroduce fire, multiple low intensity burn treatments
  - Restricted burn conditions to remove accumulated fuels
  - Can have significant mortality if reintroduce fire too quickly
  - More information in Varner et al., 2005 (Restoration Ecology 13(3):536-544) and https://talltimbers.org/articles/how-to-reintroduction-of-flames-in-a-fire-excluded-landscape/

The Stoddard-Neel Approach – A Model for ES in Longleaf Pine

- Developed by Herbert Stoddard in 1930-40's
- Refined and adapted by Leon Neel from 1950's until early 2000's
- Developed through their work on shooting plantations with objectives of aesthetics, wildlife management & hunting, and timber production



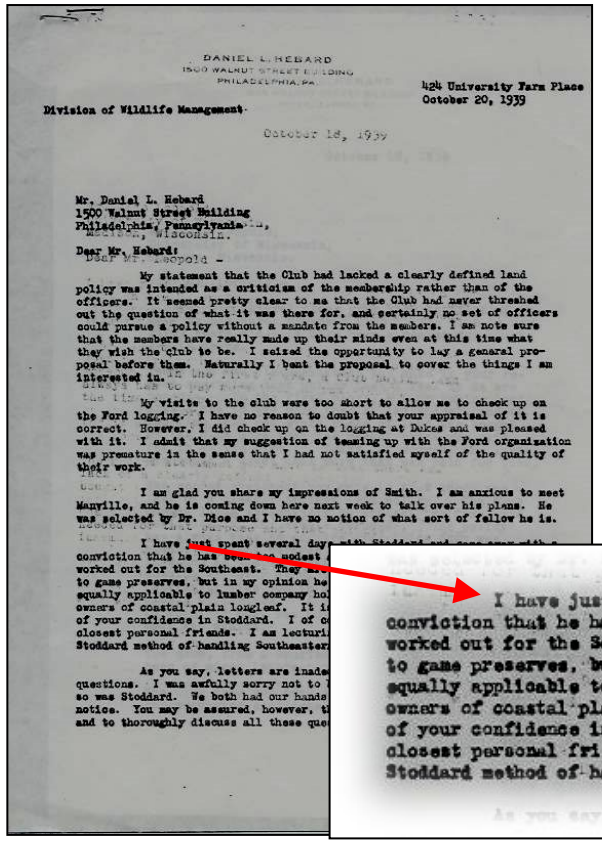


The Stoddard-Neel Approach

Central Tenets of the S-N Approach

- Leans toward “art” side of silviculture
- Holistic, not timber focused
- Maintain perpetual multi-aged canopy
- Patience, think long-term
- Conservative but utilize resources
- Consider how removals affect other resources
- “Cut the worst” …. But not all of them

Leopold’s Opinion of the S-N Approach



DANIEL L. HEBARD
1500 WALNUT STREET BUILDING
PHILADELPHIA, PA.

424 University Farm Place
October 20, 1939

Division of Wildlife Management

October 18, 1939

Mr. Daniel L. Hebard
1500 Walnut Street Building
Philadelphia, Pennsylvania

Dear Mr. Hebard:

Dear Mr. Leopold -

My statement that the Club had lacked a clearly defined land policy was intended as a criticism of the membership rather than of the officers. It seemed pretty clear to me that the Club had never threshed out the question of what it was there for, and certainly no set of officers could pursue a policy without a mandate from the members. I am note sure that the members have really made up their minds even at this time what they wish the Club to be. I seized the opportunity to lay a general proposal before them. Naturally I bent the proposal to cover the things I am interested in.

My visits to the club were too short to allow me to check up on the Ford logging. I have no reason to doubt that your appraisal of it is correct. However, I did check up on the logging at Dukes and was pleased with it. I admit that my suggestion of teaming up with the Ford organization was premature in the sense that I had not satisfied myself of the quality of their work.

I am glad you share my impressions of Smith. I am anxious to meet Manville, and he is coming down here next week to talk over his plans. He was selected by Dr. Dice and I have no notion of what sort of fellow he is.

I have just spent several days with Stoddard and came away with a conviction that he has been too modest about the conservation methods he has worked out for the Southeast. They are commonly regarded as applicable only to game preserves, but in my opinion he has developed principles which are equally applicable to lumber company holdings, national forests, and all other owners of coastal plain longleaf. It is a great satisfaction to me to know of your confidence in Stoddard. I of course am biased, for he is one of my closest personal friends. I am lecturing to my students Monday on the Stoddard method of handling Southeastern pine lands.

As you say, letters are inade
questions. I was awfully sorry not to
so was Stoddard. We both had our hands
notice. You may be assured, however,
and to thoroughly discuss all these que

Aldo Leopold

Herbert Stoddard

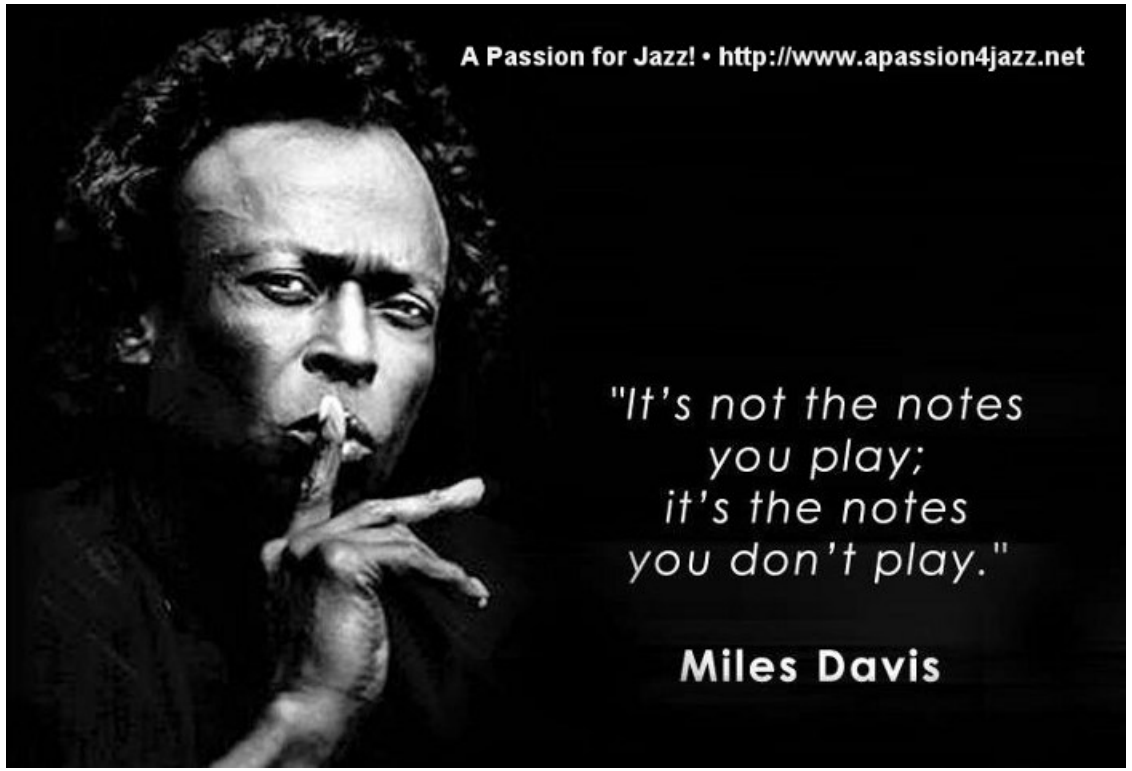
I have just spent several days with Stoddard and came away with a conviction that he has been too modest about the conservation methods he has worked out for the Southeast. They are commonly regarded as applicable only to game preserves, but in my opinion he has developed principles which are equally applicable to lumber company holdings, national forests, and all other owners of coastal plain longleaf. It is a great satisfaction to me to know of your confidence in Stoddard. I of course am biased, for he is one of my closest personal friends. I am lecturing to my students Monday on the Stoddard method of handling Southeastern pine lands.


Break for Questions

Maintenance - Multi-Aged Stands

- Selections allow for fuel continuity and release regeneration
- Economics compare favorably to even-aged systems (though not as robust)
- Maintain Fire Regime!

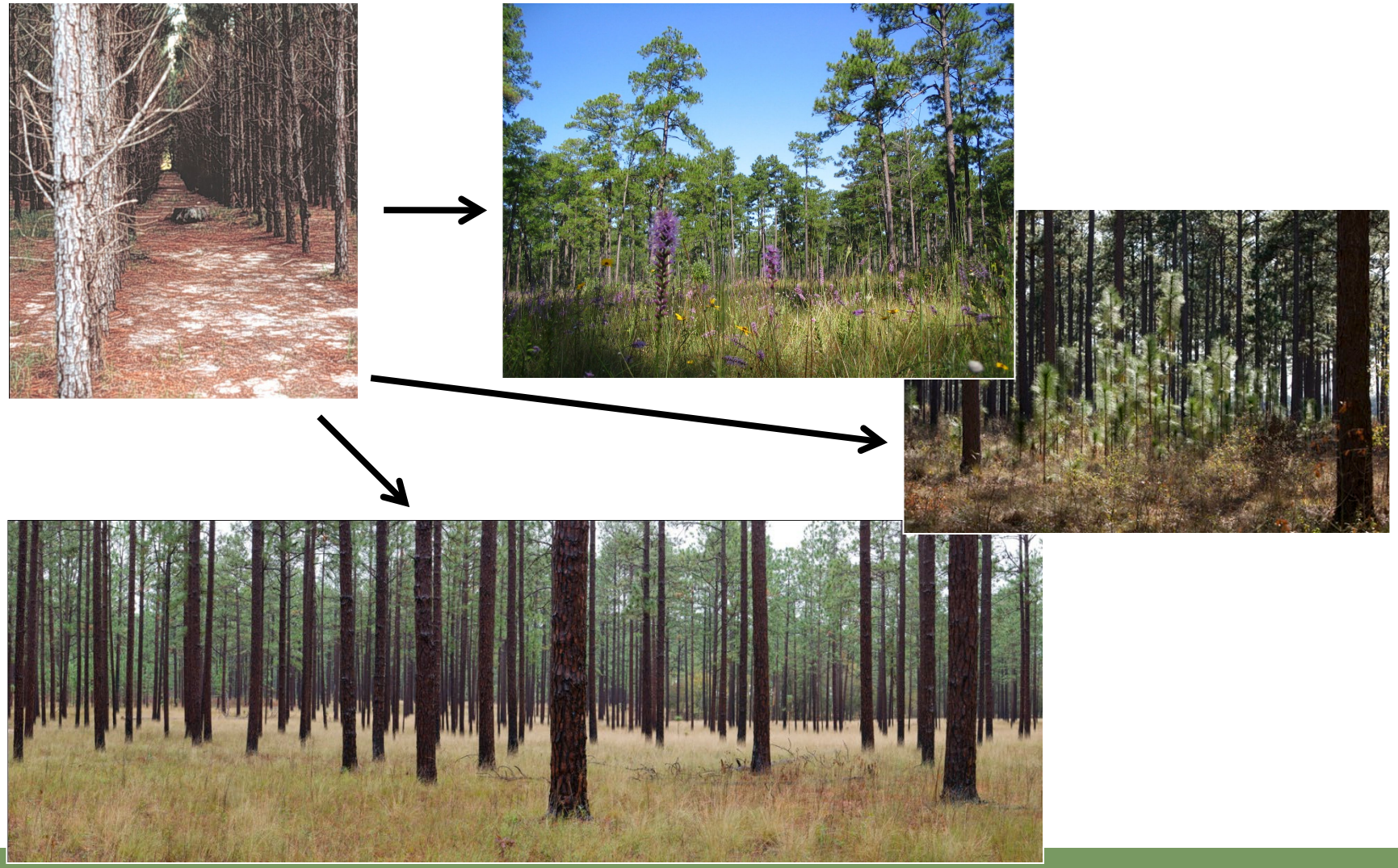
Individual Tree Selection for ES – A Jazz Analogy



It's not the trees you mark to be removed;
it's the trees you choose to leave behind.

Restoration – Plantation Establishment

Long-term: Convert Plantations to “Natural” Stands



Restoration Case Study #1

- Planted longleaf pine stand - established 1987 in abandoned agricultural field
- Restoration process
  - Plant bareroot LLP seedlings @ 700-900 TPA
  - Age 17: 3rd row thin, leave row selections and direct seed native grasses in takeout rows
  - Age 27 second thin
  - Age 30 tornado treatment ☺
  - Age 31 hurricane treatment ☺

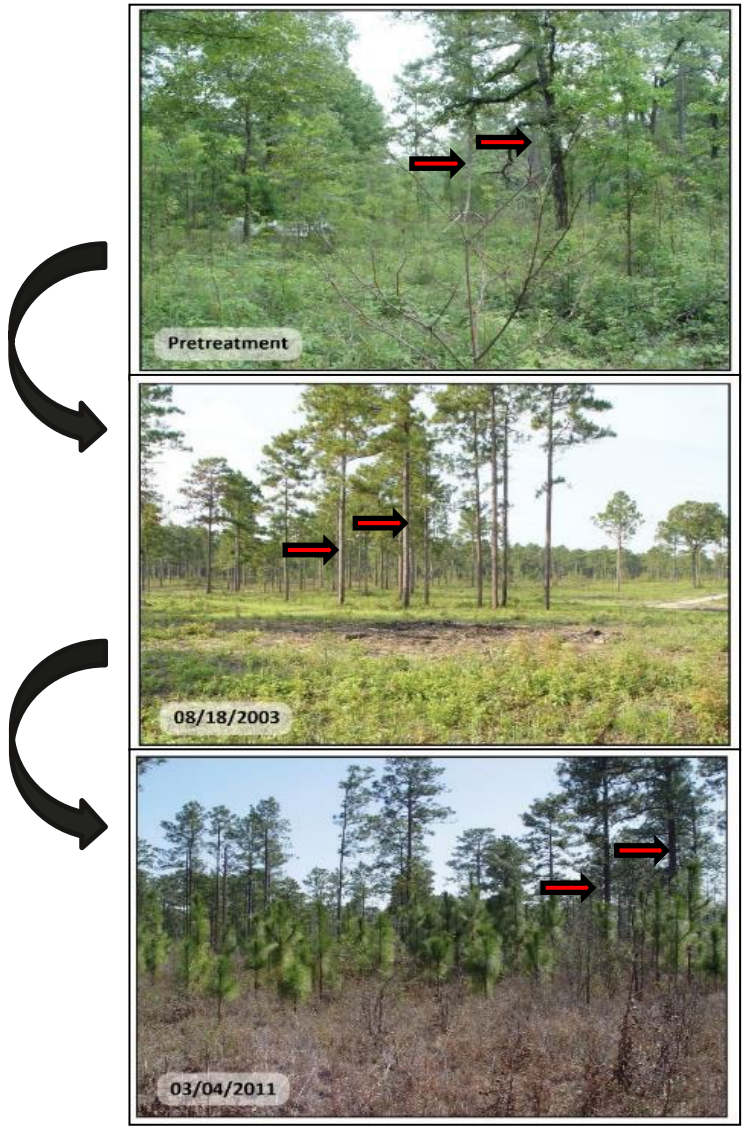
Restoration – Mature Stand Conversion

Thinning planted slash pine with gap creation

Underplanting longleaf seedlings in gaps

Restoration Case Study #2

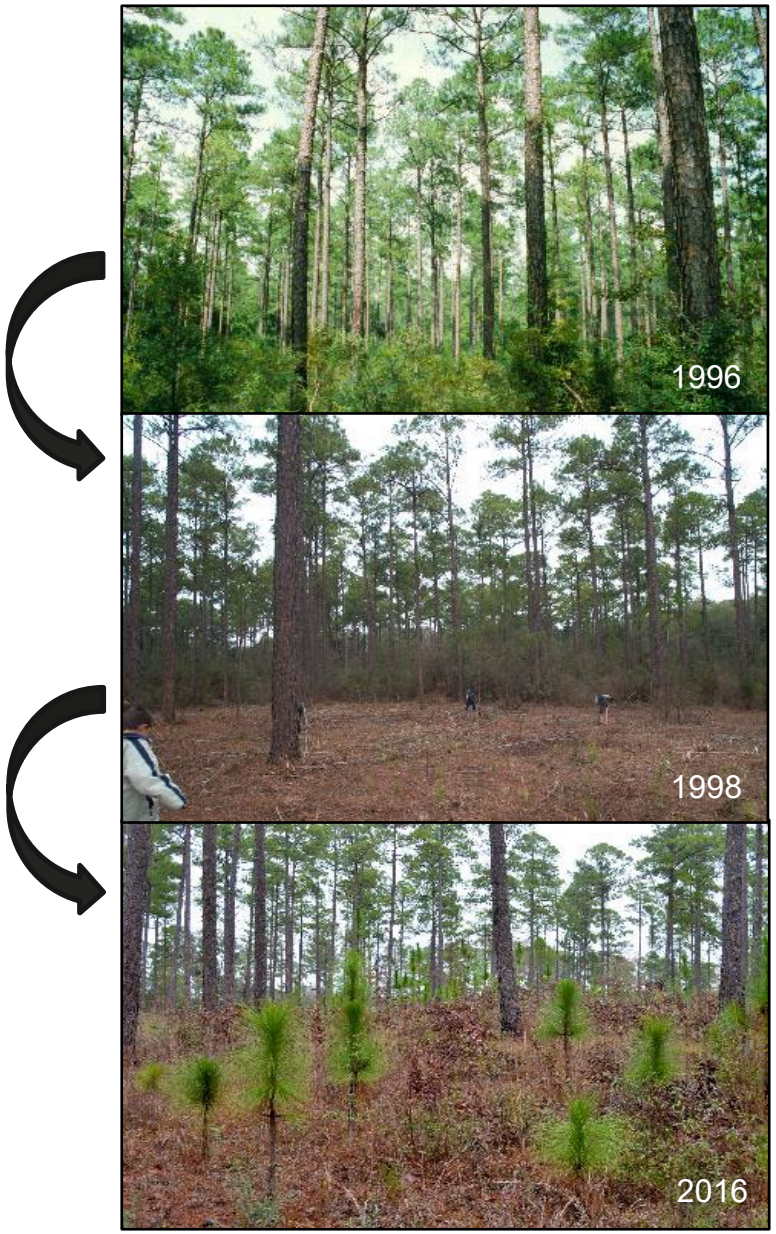
- Degraded LLP stand
  - Fire suppression
  - ~ 50% hardwood stocking
  - Poor wildlife habitat
- Restoration process
  - Remove most semi-evergreen hardwoods
  - Herbicide HW resprouts
  - Reintroduce normal Rx fire regime
  - Plant LLP where no canopy
  - Reduced HW and more active fire regime enhances groundcover



Restoration Case Study #3

- Planted slash pine stand
  - Established 1938
  - Infrequent fire
  - Concerns about long-term canopy persistence

- Restoration process
  - Reestablish more intense fire regime
    - Reduce hardwoods
    - Stimulates herbaceous groundcover
  - Thin stand, establish/enlarge gaps
  - Gap treatments (herbicide, mowing)
  - Plant longleaf pine in gaps

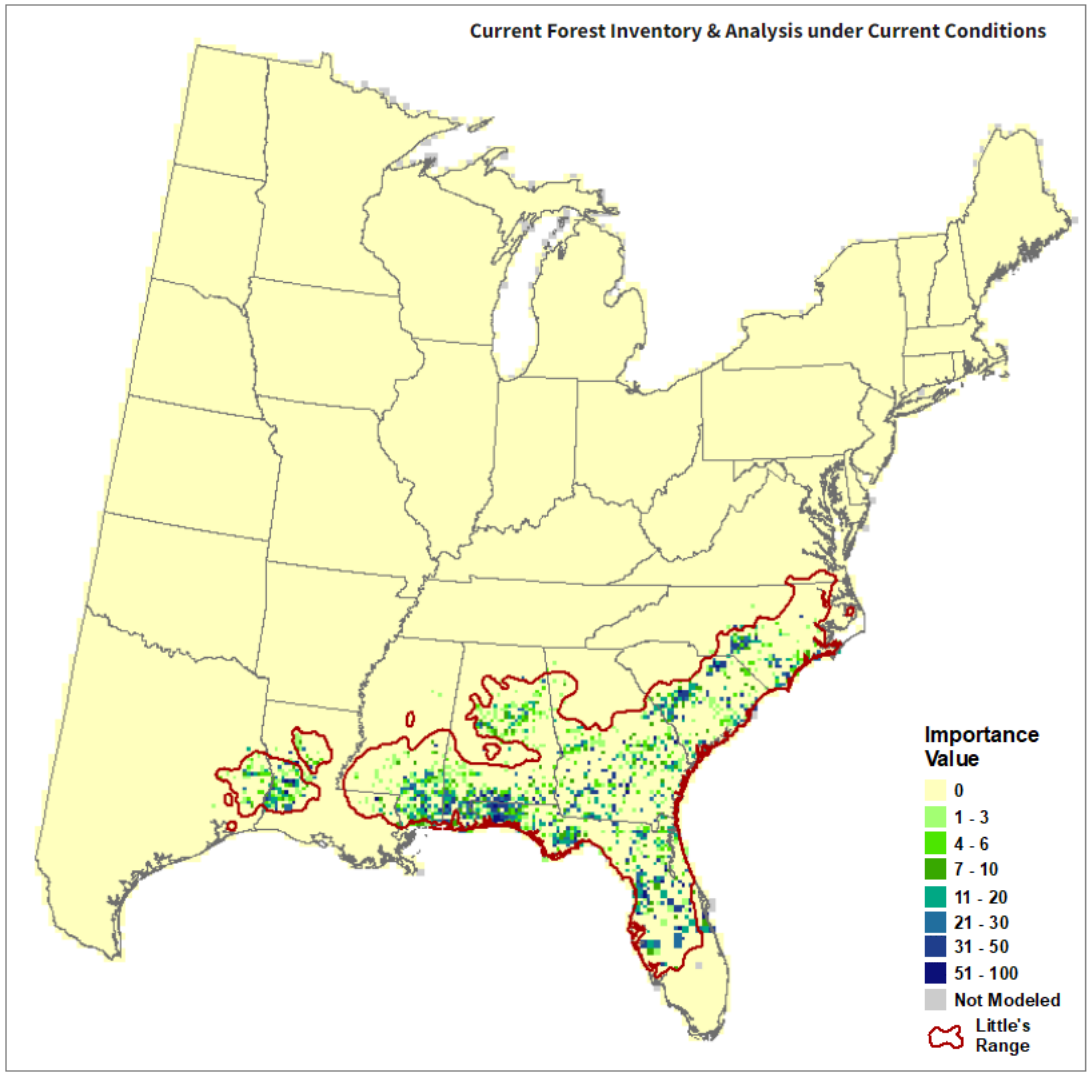


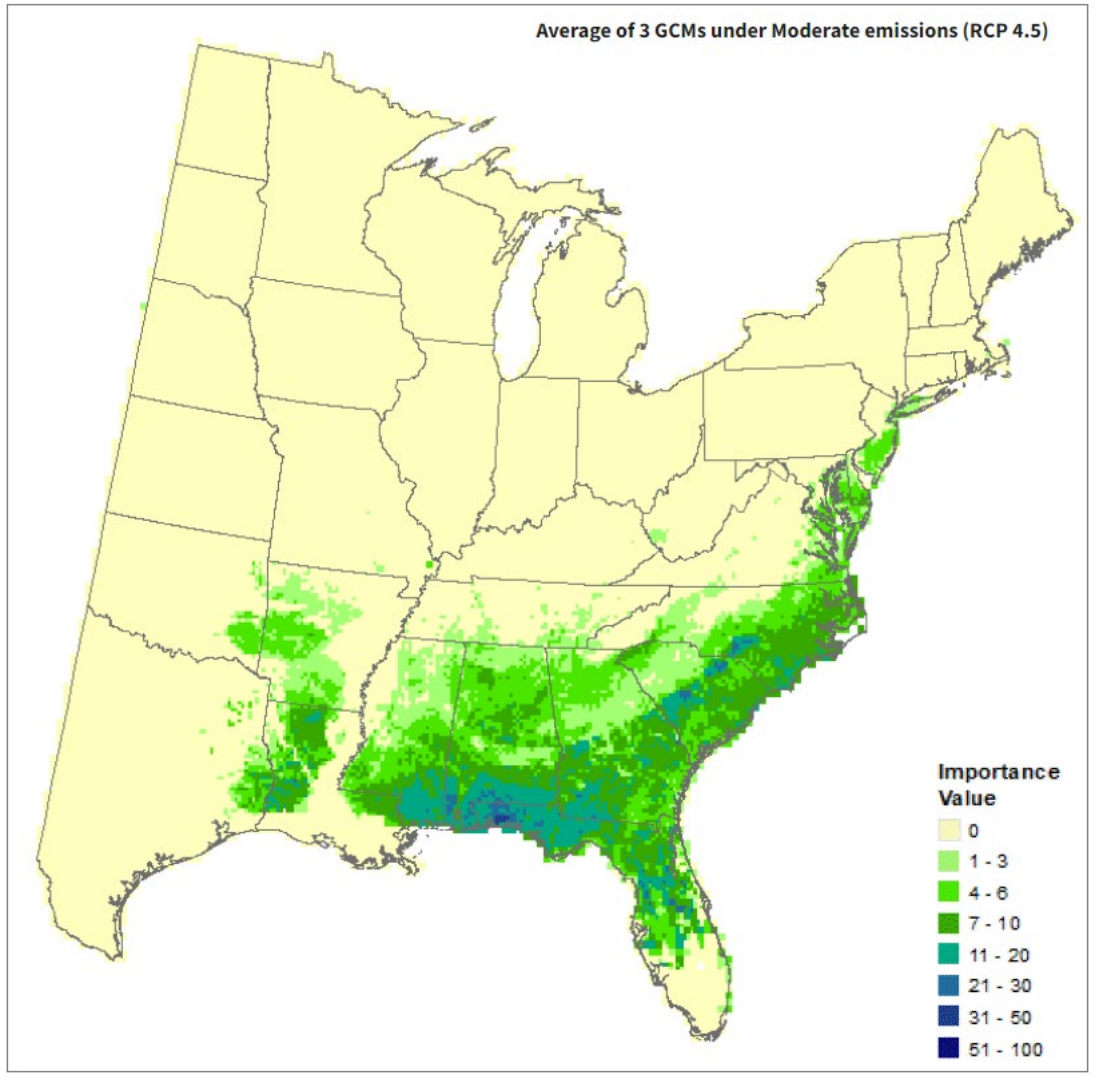
What Happens in a Changing Climate?

- Predictions are not disastrous for longleaf pine
  - Drought tolerant
  - Resistant to wind
  - Tolerates fire
  - Range expansion??
- Issues affected by changes in the climate:
  - Available days to burn
  - Response to severe disturbances
  - Wildlife responses (see https://talltimbers.org/articles/are-hurricanes-a-growing-threat-to-longleaf-and-other-rare-species/)

Predicted Response for Longleaf Pine

From Climate change atlas: https://www.fs.usda.gov/nrs/atlas/tree/121





Available Burn Days

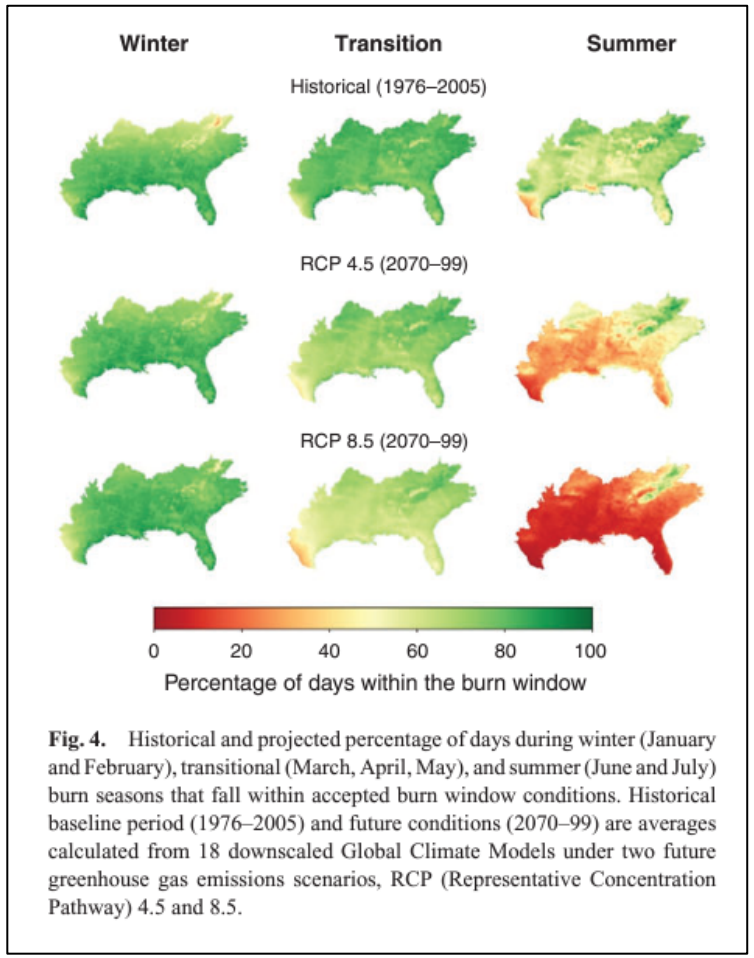


Fig. 4. Historical and projected percentage of days during winter (January and February), transitional (March, April, May), and summer (June and July) burn seasons that fall within accepted burn window conditions. Historical baseline period (1976–2005) and future conditions (2070–99) are averages calculated from 18 downscaled Global Climate Models under two future greenhouse gas emissions scenarios, RCP (Representative Concentration Pathway) 4.5 and 8.5.

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International Journal of Wildland Fire **2020**, *29*, 764–778
https://doi.org/10.1071/WF19198

Climate change projected to reduce prescribed burning opportunities in the south-eastern United States

John A. Kupfer [A,E], *Adam J. Terando* [B,C], *Peng Gao* [A], *Casey Teske* [D] and *J. Kevin Hiers* [D]

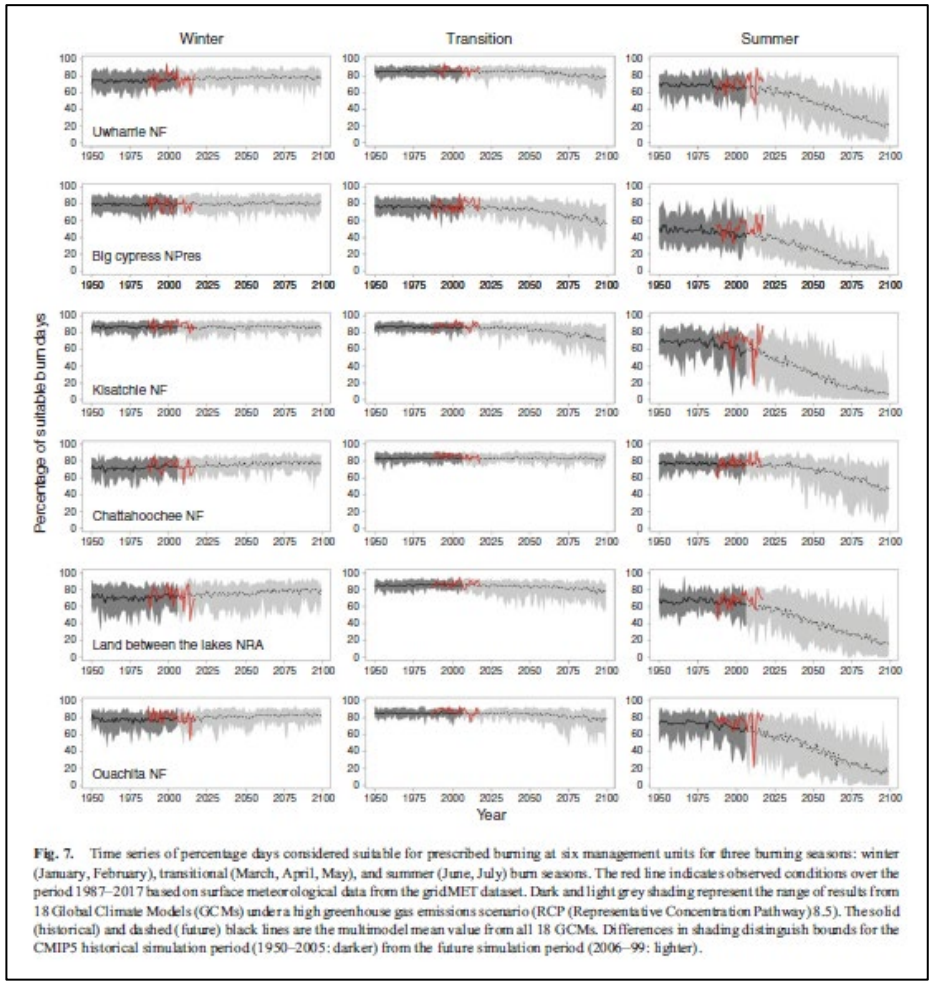

Fig. 7. Time series of percentage days considered suitable for prescribed burning at six management units for three burning seasons: winter (January, February), transitional (March, April, May), and summer (June, July) burn seasons. The red line indicates observed conditions over the period 1987–2017 based on surface meteorological data from the gridMET dataset. Dark and light grey shading represent the range of results from 18 Global Climate Models (GCMs) under a high greenhouse gas emissions scenario (RCP (Representative Concentration Pathway) 8.5). The solid (historical) and dashed (future) black lines are the multimodel mean value from all 18 GCMs. Differences in shading distinguish bounds for the CMIP5 historical simulation period (1950–2005: darker) from the future simulation period (2006–99: lighter).

Hurricane Impacts

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Tree, stand, and landscape factors contributing to hurricane damage in a coastal plain forest: Post-hurricane assessment in a longleaf pine landscape

Brandon T. Rutledge [a,*], Jeffery B. Cannon [a], R. Kevin McIntyre [a], Angela M. Holland [b], Steven B. Jack [c]

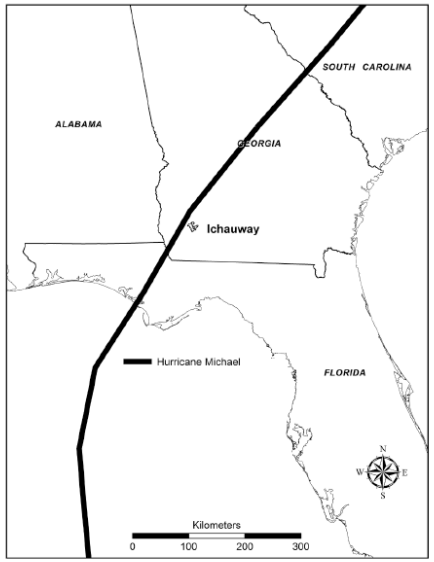


Fig. 1. Storm path of Hurricane Michael that made landfall on October 10, 2018 and the location of Ichauway, Baker County, Georgia USA.

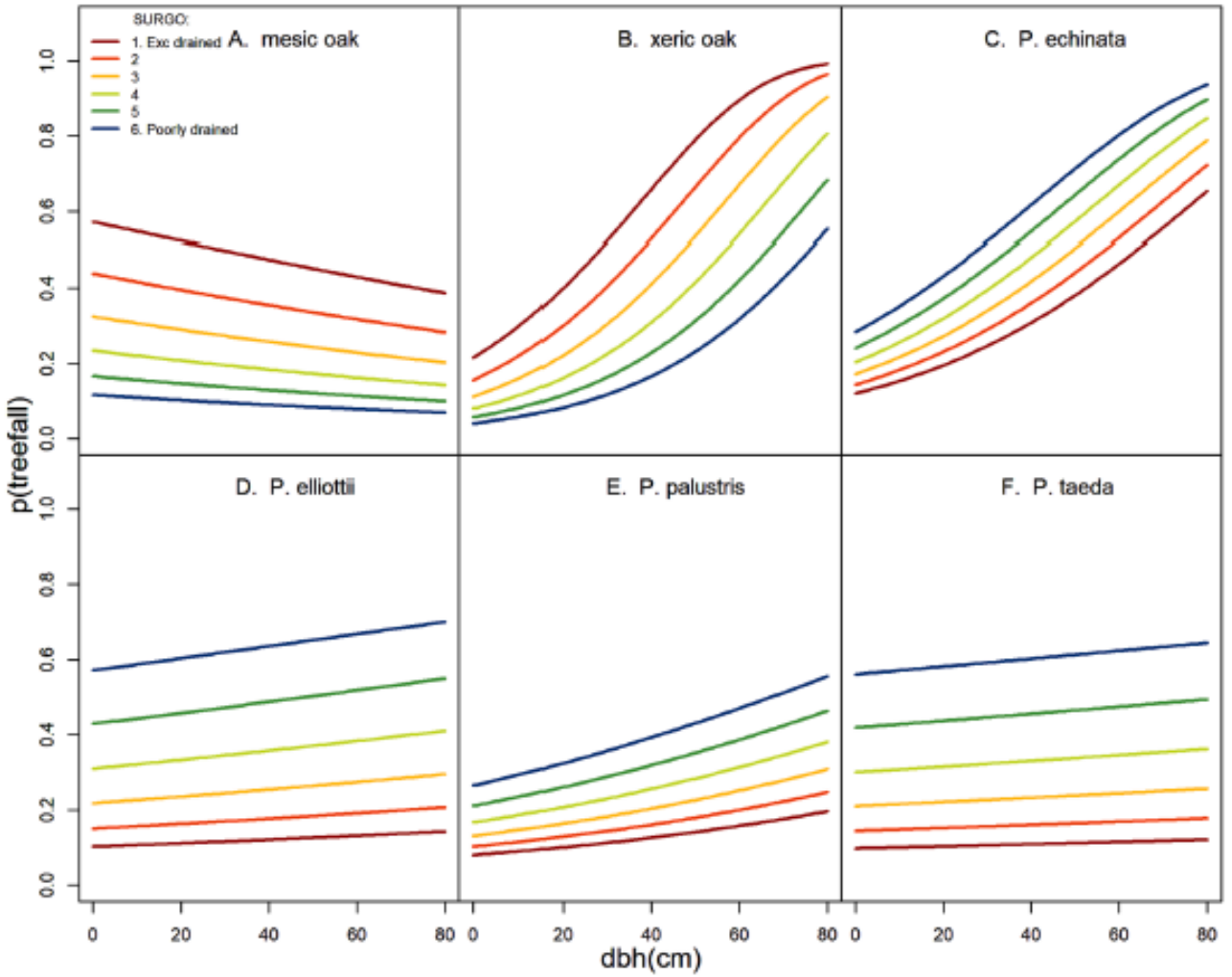
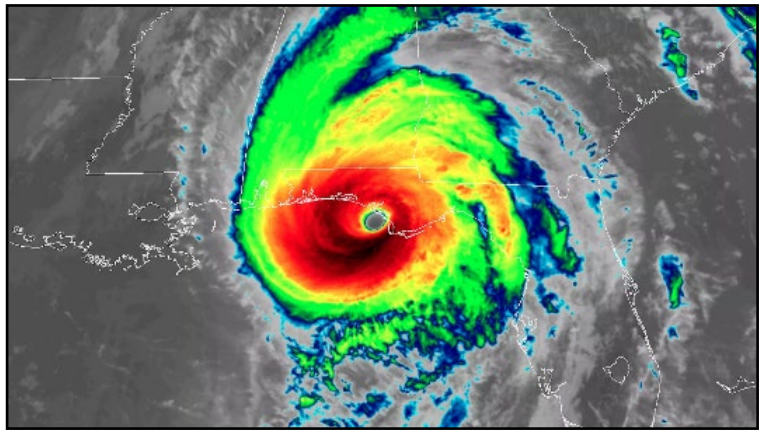


Fig. 4. Model prediction indicating the relationship between tree size (DBH) and estimated probability of treefall across six soil types for four pine species and two *Quercus* species groups. Soil types include excessively drained (drainage class 1) to very poorly-drained (drainage class 6). To simplify interpretation, model predictions were run using site-level averages for non-significant parameters (Table 3) and a random plot intercept of 0.

Adversity – A Test of How Well ES is “Working”



October 2018 – Hurricane Michael comes to call

Damaged, Not Destroyed

Partially Restored Area

SUMMARY

- Good examples for ecological silviculture exist for longleaf pine
- Longleaf pine appears to be well-adapted for predicted changes in climate
- Ecological silviculture approaches for longleaf pine provide resilience for severe disturbance events that are likely to become more common

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