Thank you for signing in early

The webinar will begin promptly at
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SERDP and ESTCP Webinar Series

The webinar will begin promptly at 12:00 pm ET, 9:00 am PT

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Plant Diversity and Biological Nitrogen Fixation in Longleaf Pine Ecosystems at Military Installations

September 20, 2018

Welcome and Introductions

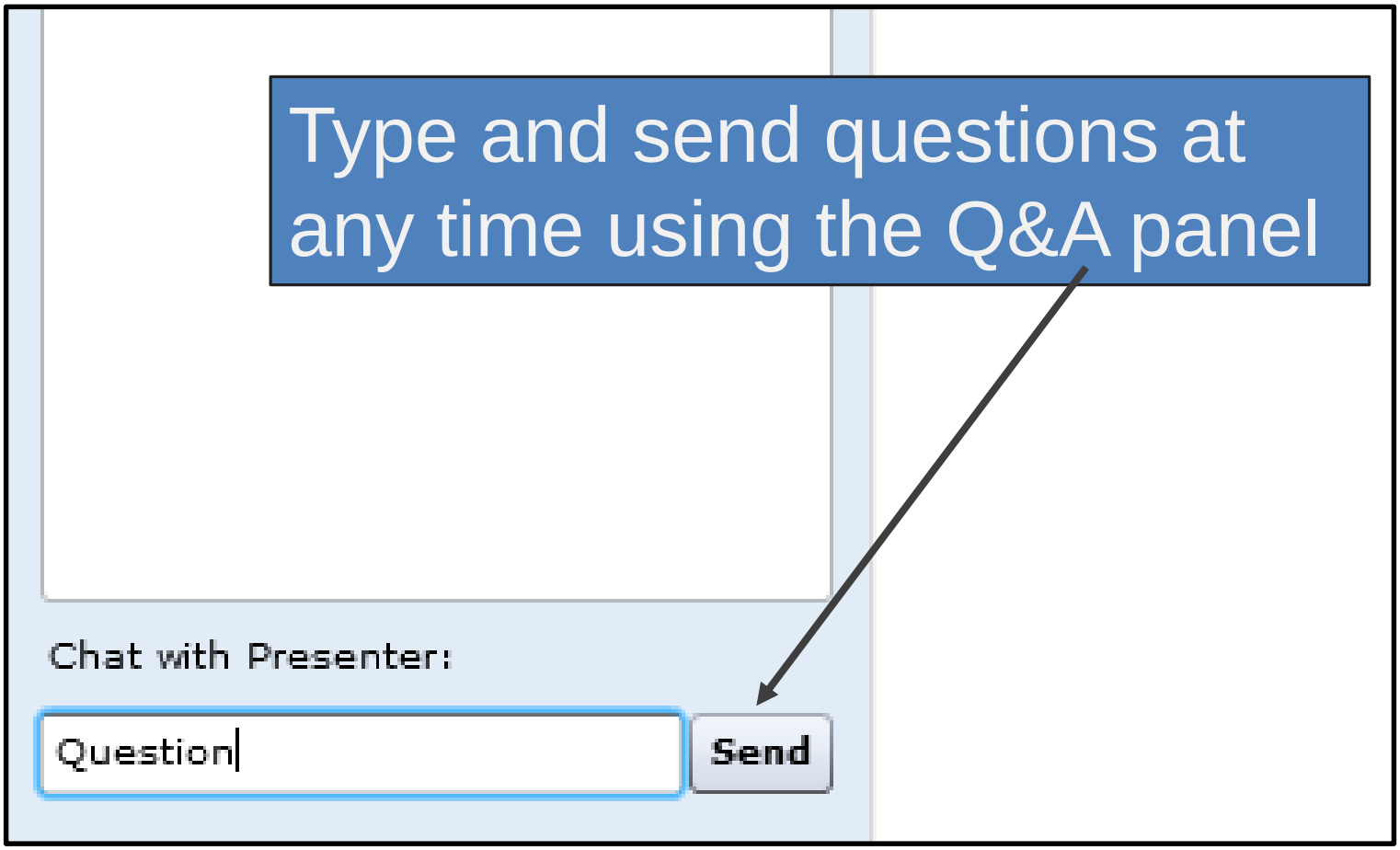
Jennifer Nyman, Ph.D., P.E.
Webinar Facilitator

SERDP DOD ▪ EPA ▪ DOE | ESTCP

Webinar Agenda

- **Webinar Logistics** (5 minutes)
  Dr. Jennifer Nyman, Geosyntec Consultants
- **Overview of SERDP and ESTCP** (5 minutes)
  Dr. Kurt Preston, SERDP and ESTCP
- **A Balancing Act: Fire and Biological Nitrogen Fixation in the Longleaf Pine Ecosystem** (25 minutes + Q&A)
  Dr. Nina Wurzburger, University of Georgia
- **Exploiting Theory To Guide Practice: Using Mechanistic Models to Streamline Monitoring and Inform Longleaf Pine Management** (25 minutes + Q&A)
  Dr. Joseph O'Brien, USDA Forest Service, Southern Research Station
- **Final Q&A session**

How to Ask Questions



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    - Required conference ID: 6102000
- Submit a question using the chat box

SERDP and ESTCP Overview

Kurt Preston, Ph.D.
Resource Conservation and Resiliency Program Manager

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SERDP

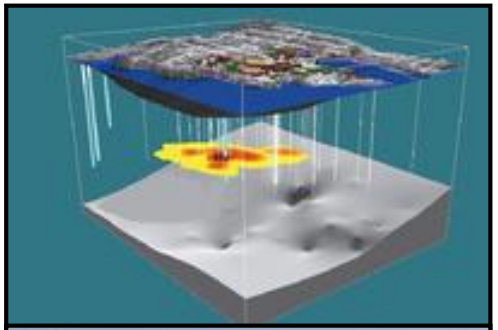
- Strategic Environmental Research and Development Program
- Established by Congress in FY 1991
  - DoD, DOE and EPA partnership
- SERDP is a requirements driven program which identifies high-priority environmental science and technology investment opportunities that address DoD requirements
  - Advanced technology development to address near term needs
  - Fundamental research to impact real world environmental management

ESTCP

- Environmental Security Technology Certification Program
- Demonstrate innovative cost-effective environmental and energy technologies
  - Capitalize on past investments
  - Transition technology out of the lab
- Promote implementation
  - Facilitate regulatory acceptance

Program Areas

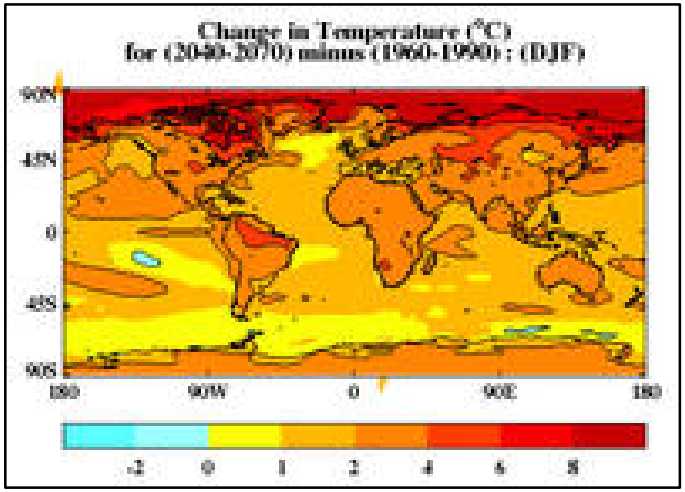
1. Environmental Restoration
2. Installation Energy and Water
3. Munitions Response
4. Resource Conservation and Resiliency
5. Weapons Systems and Platforms





Resource Conservation and Resiliency

- Natural resources
  - Ecological forestry
  - Arid lands ecology and management
  - Cold regions ecology and management
  - Pacific island ecology and management
  - Coastal and estuarine ecology and management
  - Living marine resources ecology and management
  - Species ecology and management
  - Watershed processes and management
- Resilience
  - Vulnerability and impact assessment
  - Adaptation science
  - Land use and carbon management
- Air quality
  - Wildland fire dynamics
  - Fugitive dust



SERDP and ESTCP Webinar Series

Date	Topic
October 4, 2018	Chlorinated Solvents Workshop Overview and Feature Projects
October 18, 2018	Restoration of Chlorinated Solvent Contaminated Groundwater Sites: The Value of Information Challenge
November 1, 2018	Supporting DoD Installation Sustainability Through Informed Stormwater Management
November 15, 2018	Stormwater Impacts on Sediment Recontamination
December 13, 2018	Installation Energy and Water Program Area Webinar

For upcoming webinars, please visit

http://serdp-estcp.org/Tools-and-Training/Webinar-Series

Save the Date!

A three-day symposium showcasing the latest technologies that enhance DoD's mission through improved environmental and energy performance

November 27-29, 2018

Washington Hilton Hotel

Registration is open

A Balancing Act: Fire and Biological Nitrogen Fixation in the Longleaf Pine Ecosystem

Nina Wurzburger, Ph.D.
University of Georgia

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Agenda

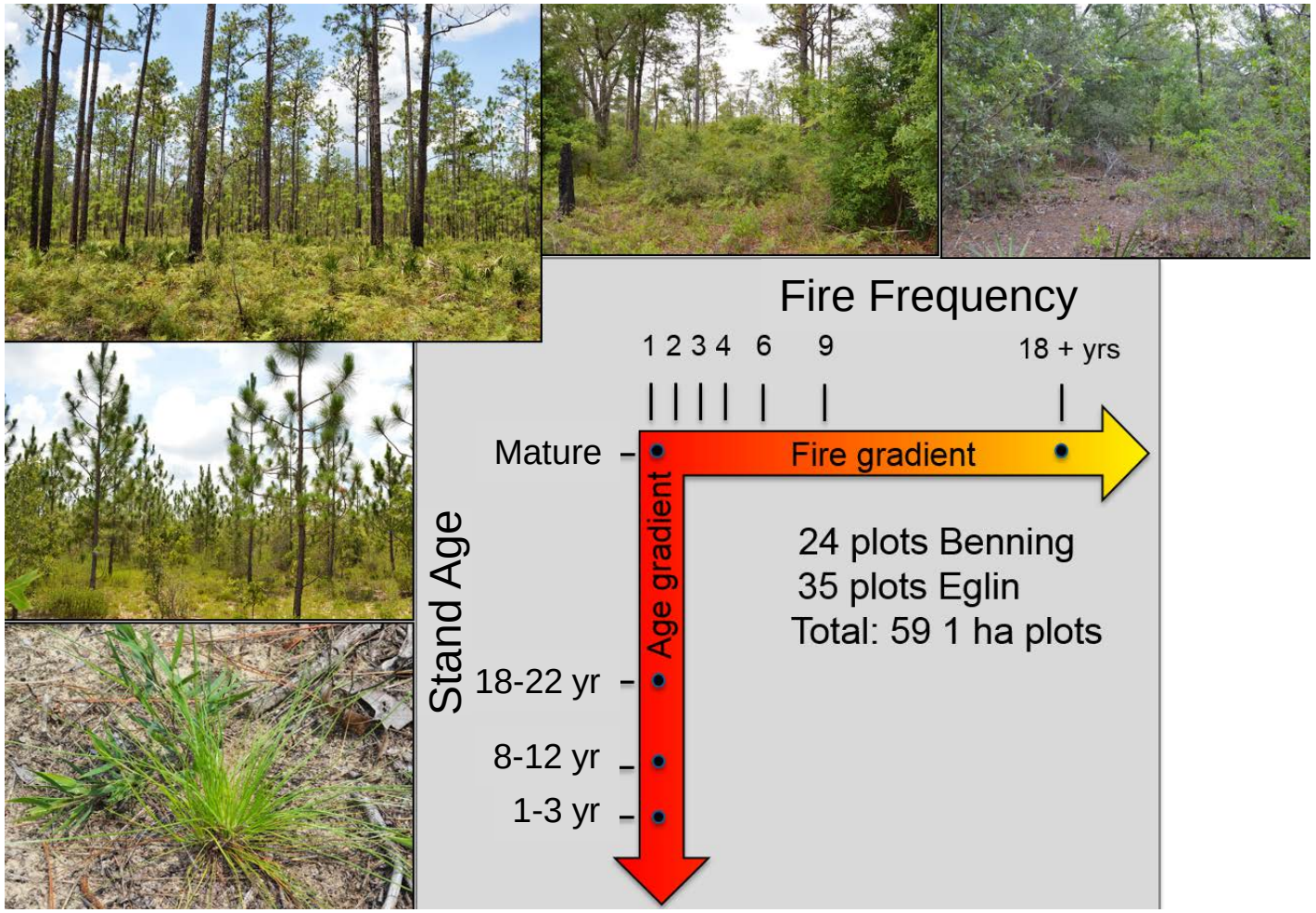
- Research objectives
- Approach
- Results
- Synthesis and implications
- Benefits to DoD
- Questions and answers

Research Objectives

- Quantify contribution of nitrogen (N)-fixing organisms to N fixation
- Determine:
  - How N fixation is affected by fire and soil nutrients
  - If N fixation balances N losses from fire

Approach

59 Plots in Sandhill Longleaf Pine



Note: Ha = hectare

Approach

Quantifying N_2 Fixation

- Legumes, soil crusts, asymbiotic fixers
- Abundance and activity
  - Acetylene reduction assays and $^{15}N_2$ calibration

Approach

Nutrient Controls on Fixation

- Greenhouse study
  - N, P, Mo and P+Mo addition
  - 7 legume spp
- Field study
  - N and P addition (50, 25 kg/ha yr)
  - Legume and tree response
- Ambient soil P and N availability
  - Relationship with N fixation

Notes: P = phosphorus, Mo = molybdenum, spp = several species, kg/ha yr = kilograms per hectare per year

Approach

Quantifying the N Cycle

- Tree growth and N demand
  - 1,200 trees measured annually
- Understory vegetation (biomass and N)
- Leaf and root production (biomass and N)

Approach

Quantifying the N Cycle

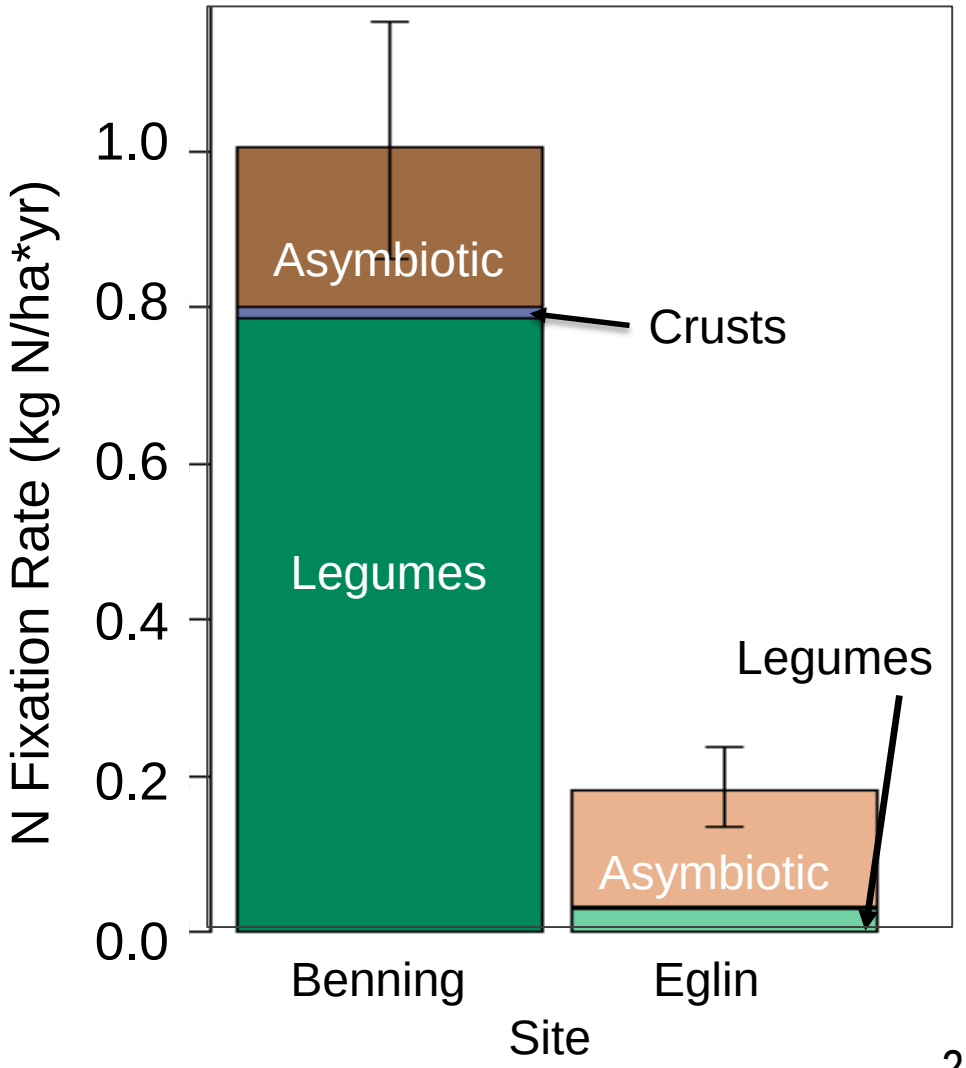
- N loss from fire
  - Organic (O) horizon and understory plant N
  - 73 fire events

Notes: Organic horizon = litter and duff layer

Results

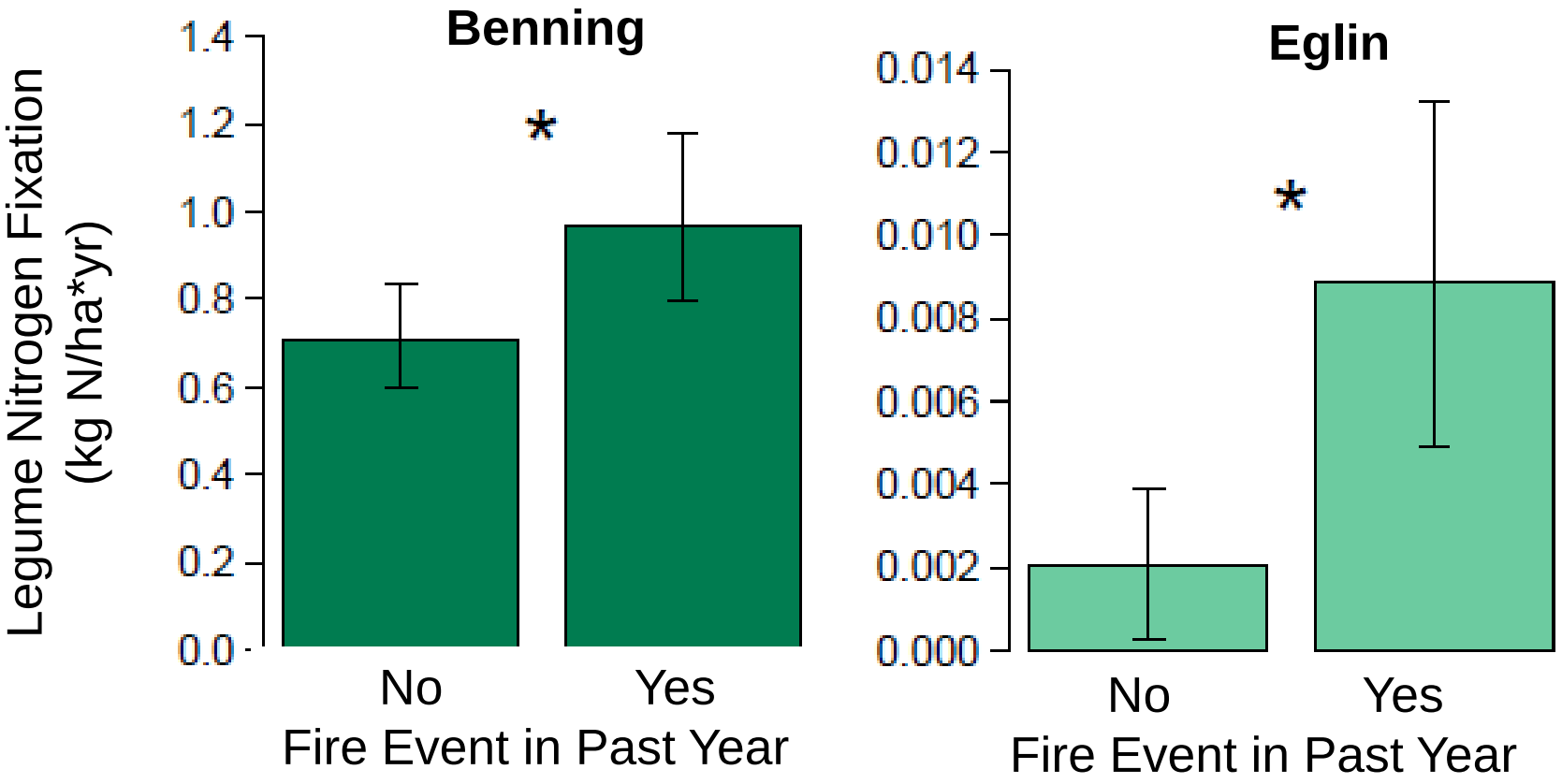
Low Rates of N Fixation

- Benning > Eglin
- Legumes abundant and diverse
  - Few fix N
- Crusts, minor contribution



Results

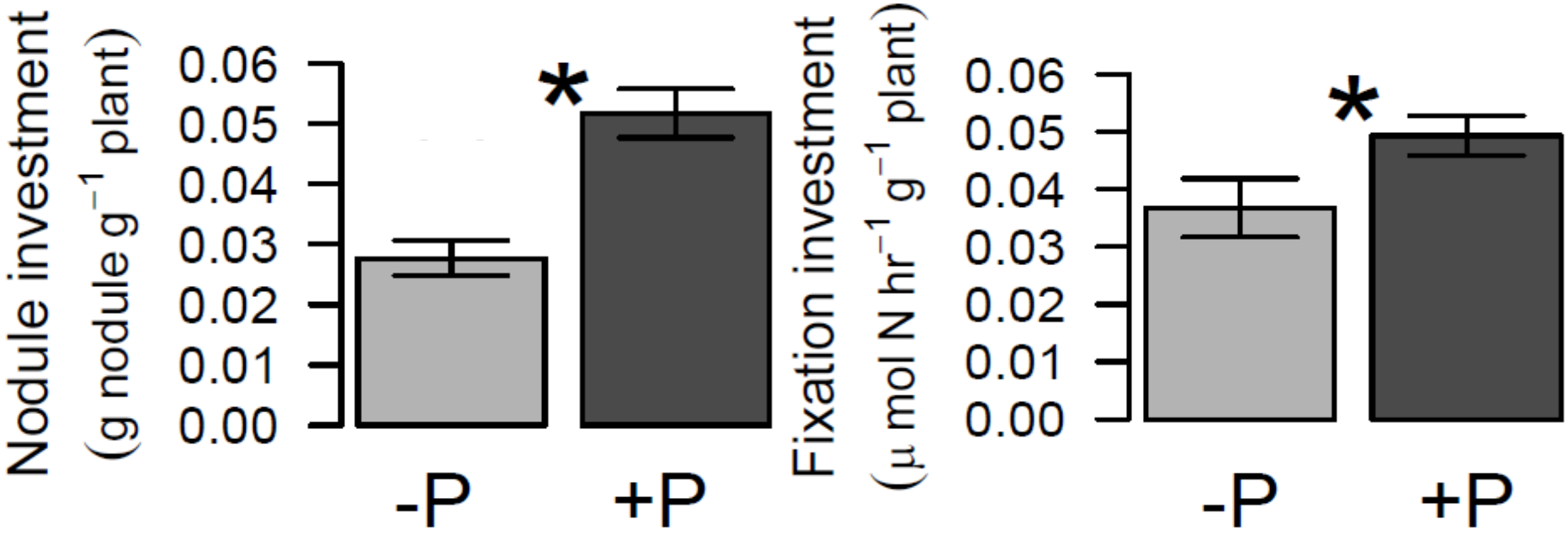
Fire Stimulates Legume N Fixation



Notes: * indicates statistically significant difference ($p < 0.05$)

Results – Greenhouse Study

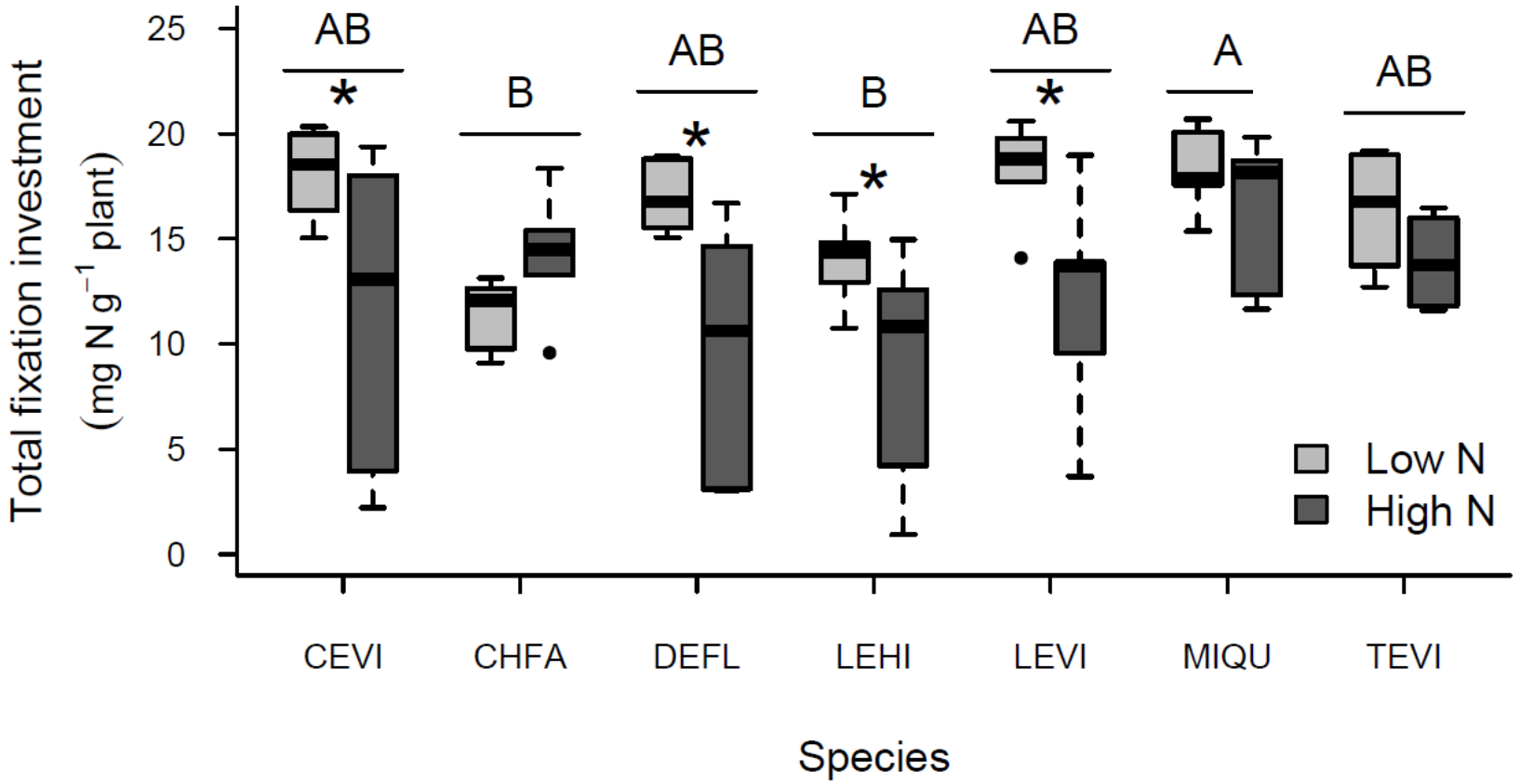
Phosphorus Stimulates Legume N Fixation



Notes: g = grams; µmol = micromoles; hr = hour

Results – Greenhouse Study

Nitrogen Suppresses N Fixation for Some Species



Notes: mg = milligrams, Significant differences ($p < 0.05$) among species denoted by different letters, and within species in response to N treatment denoted by *.

Results – Greenhouse Study

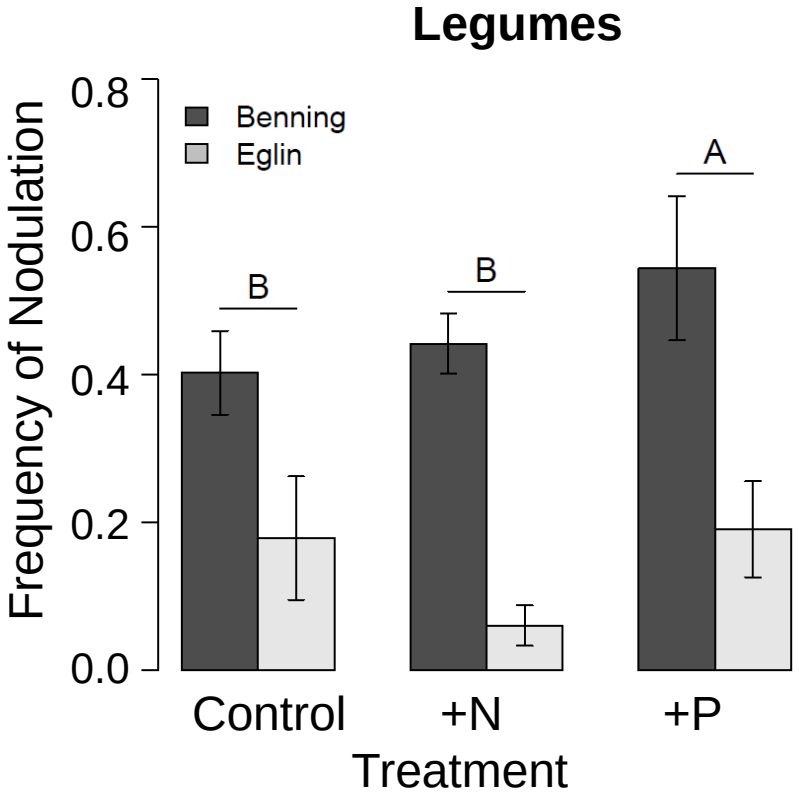
Summary

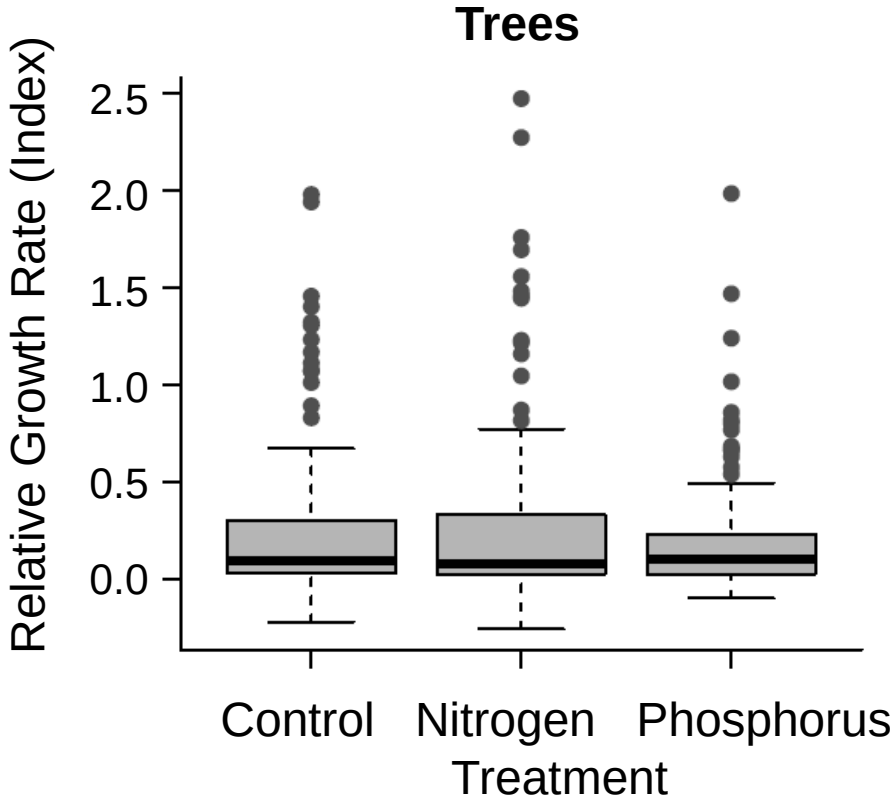
- P addition stimulates:
  - Growth
  - Nodulation
  - N fixation
- N addition suppresses N fixation
  - Depends on species

Results – Field Study

Contrasting Response of Legumes and Trees

- P addition stimulates legume nodulation
- No nutrient effect on tree growth

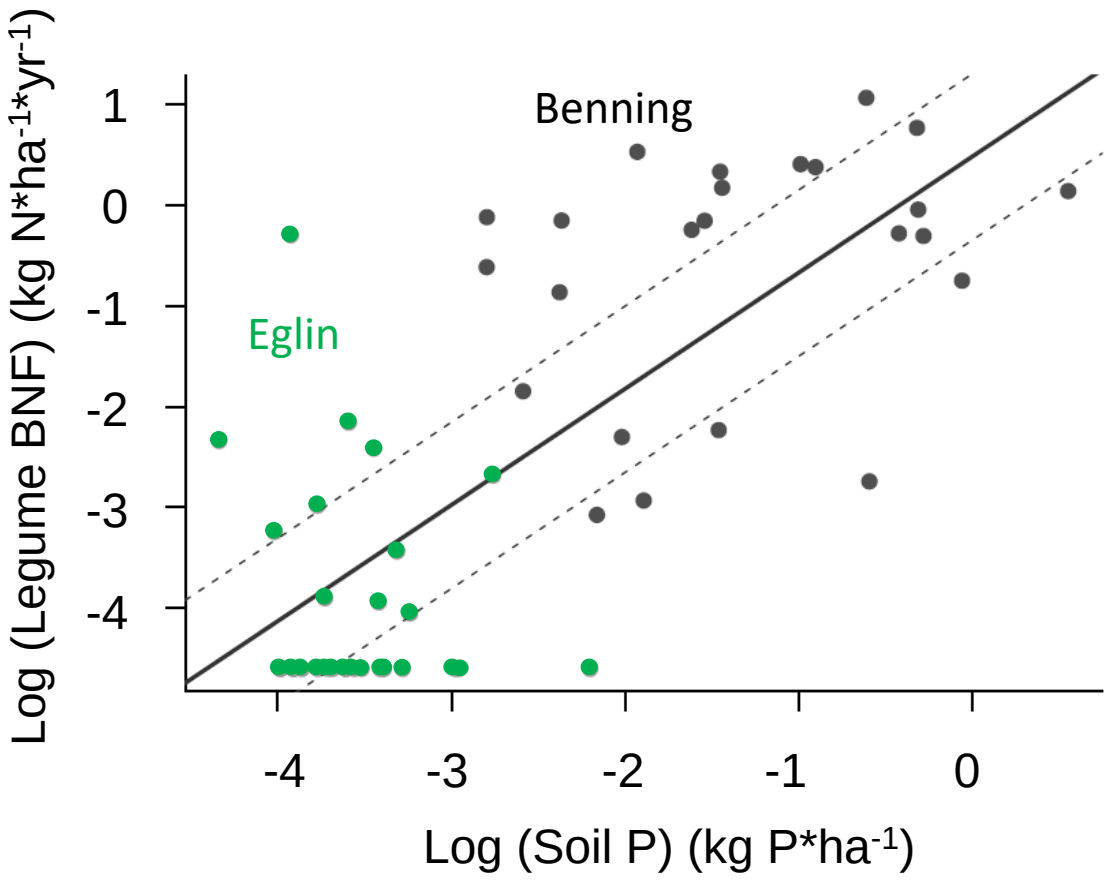




Results

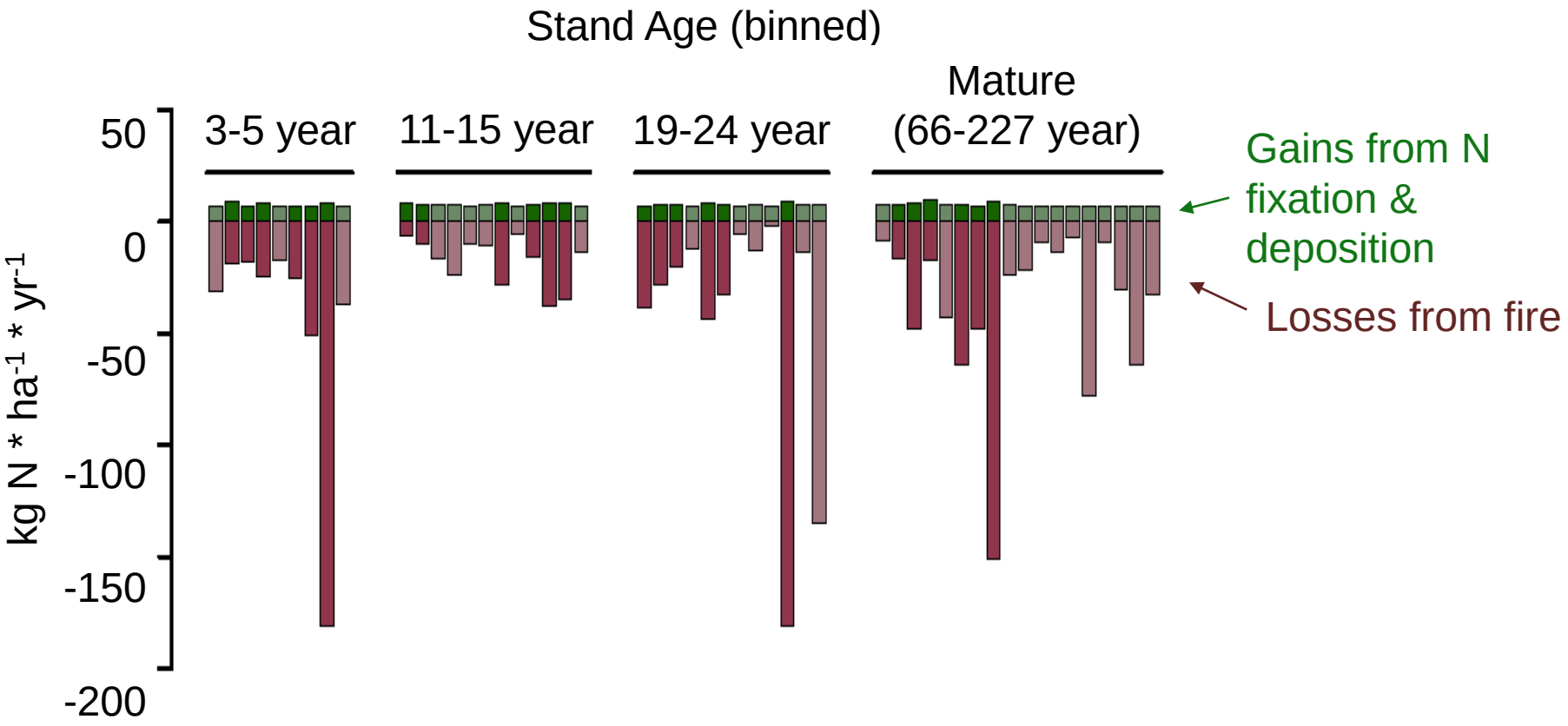
Correlation of N Fixation with Soil P

- Legume N fixation correlated with soil P
  - Across sites, not within



Results

Ecosystem N Imbalance: N Fixation and Deposition do not Balance N Losses from Fire



Synthesis

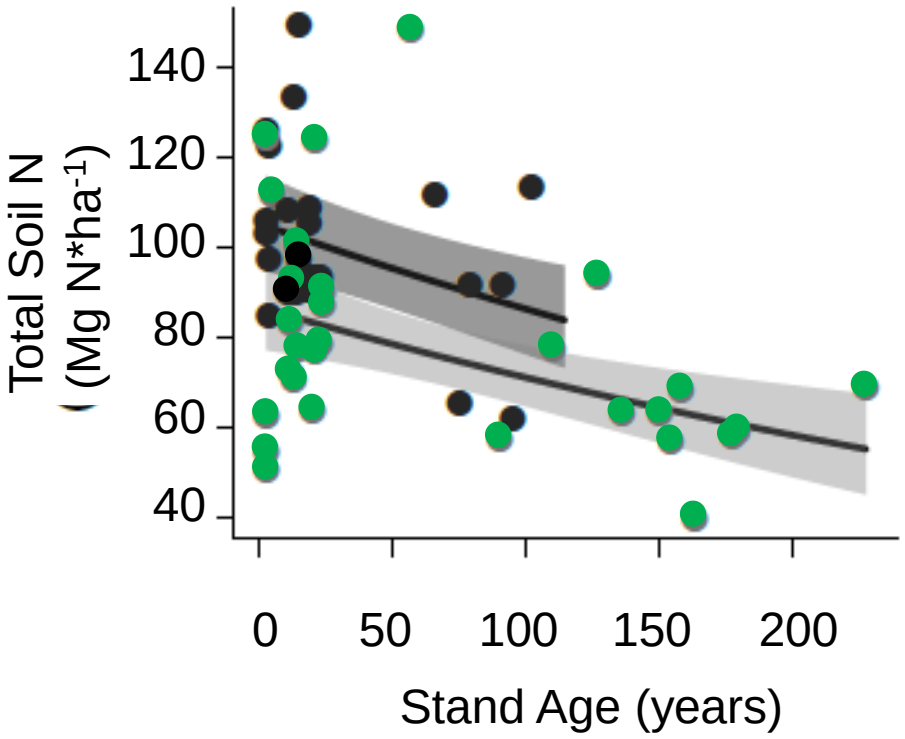
Why Ecosystem N Imbalance?

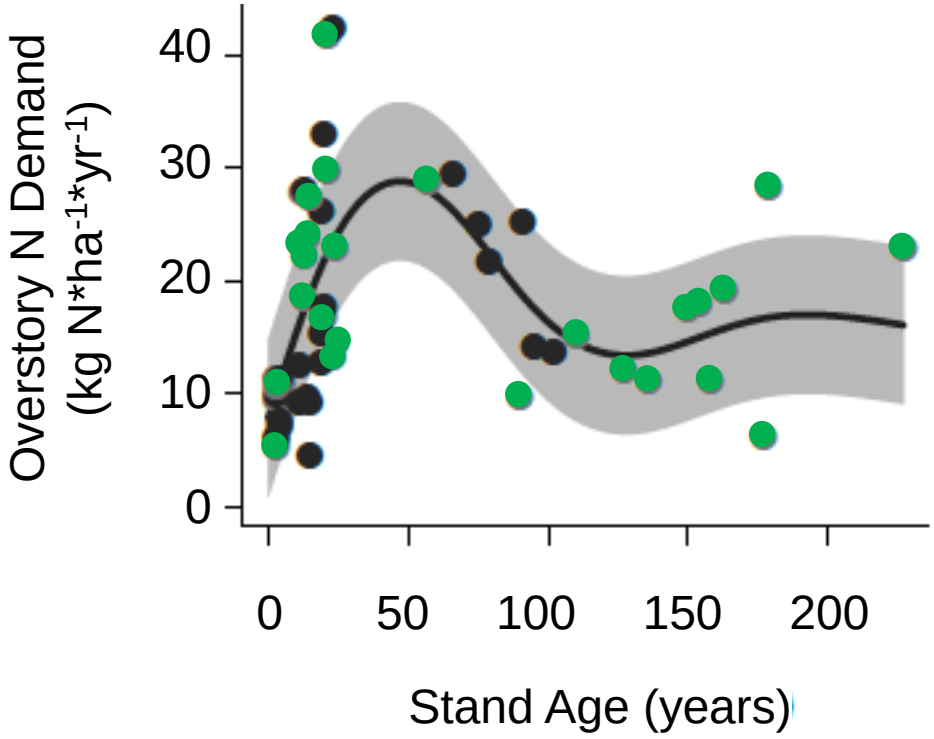
- Does fire reduce ecosystem resiliency?
- Excess N in ecosystem?

Synthesis

Support for "Excess Nitrogen" Hypothesis

Benning = black
Eglin = green





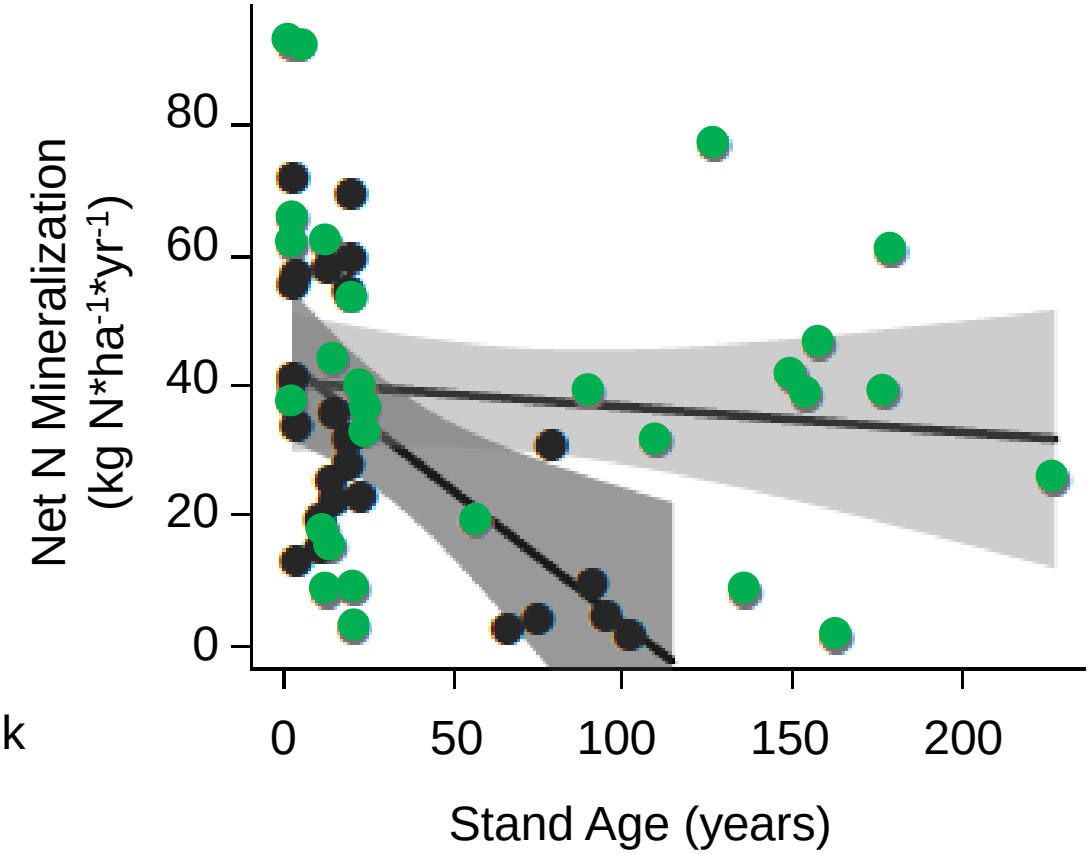
Synthesis

Support for "Excess Nitrogen" Hypothesis

- Soil N stocks decline over time
- Tree N demand does not
  - 0.1% of total N lost per year
  - Legacy of prior land use?

Synthesis

Support for "Excess Nitrogen" Hypothesis

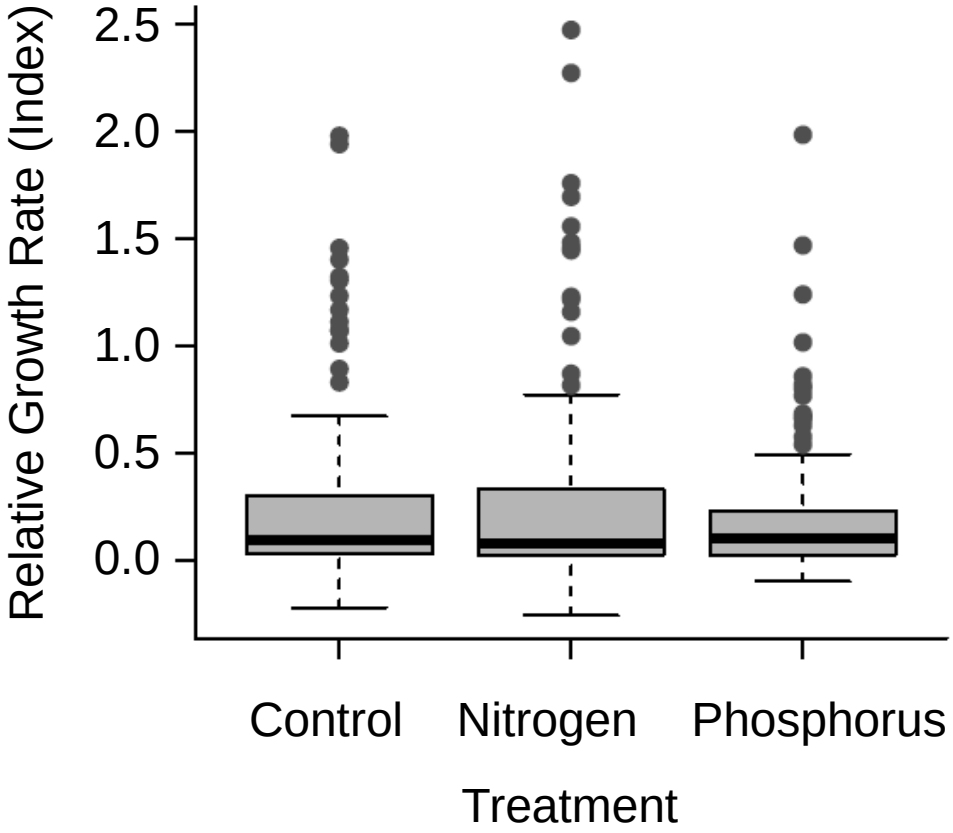


Benning = black
Eglin = green

Soil N mineralization very high, particularly in young stands

Synthesis

Support for "Excess Nitrogen" Hypothesis



N fertilization did not stimulate growth of longleaf pine

Synthesis

- “Excess nitrogen” hypothesis
  - Fire = relief valve for excess N
  - Difficult to explicitly test
- Longleaf may be experiencing novel N environment
  - Hard to assess response to historical fire regime

Benefits to DoD

- No evidence that sandhill longleaf pine are N-poor
  - Fire can be prescribed to meet management objectives
  - Fire can remove excess N
- Diverse N-fixing organisms
  - Under extreme disturbances, N-fixers have the potential to replace N to ecosystem

Acknowledgements

- Stephen Hudson, James Parker, Kevin Hiers, Scott Pokswinski and Brett Williams
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Mike Ament, M.S.


Julie Tierney, M.S.

For additional information, please visit https://www.serdp-estcp.org/Program-Areas/Resource-Conservation-and-Resiliency/Natural-Resources/Ecological-Forestry/RC-2328

Speaker Contact Information

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Q&A Session 1

Exploiting Theory To Guide Practice: Using Mechanistic Models to Streamline Monitoring and Inform Longleaf Pine Management

Joseph O'Brien, Ph.D.
United States Department of Agriculture Forest Service

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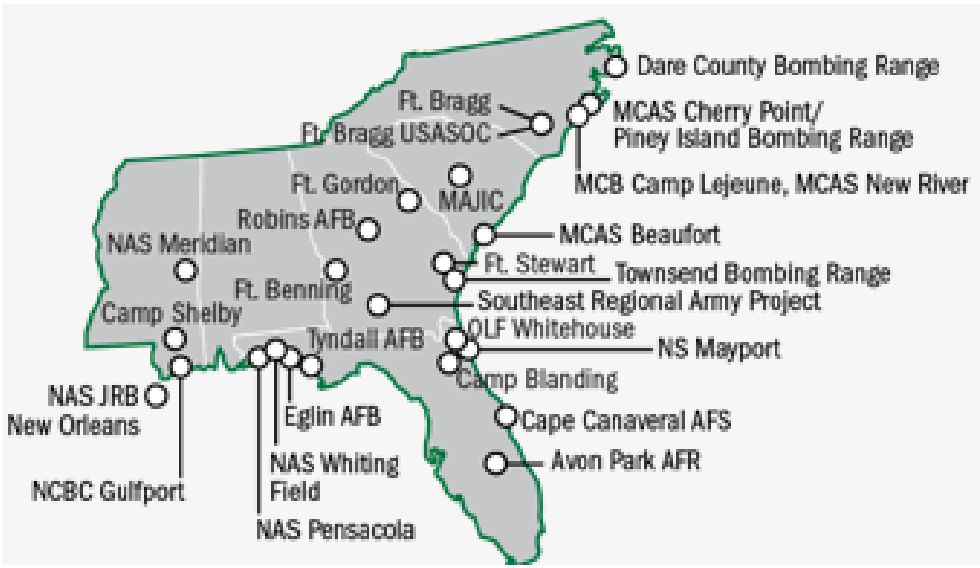
Agenda

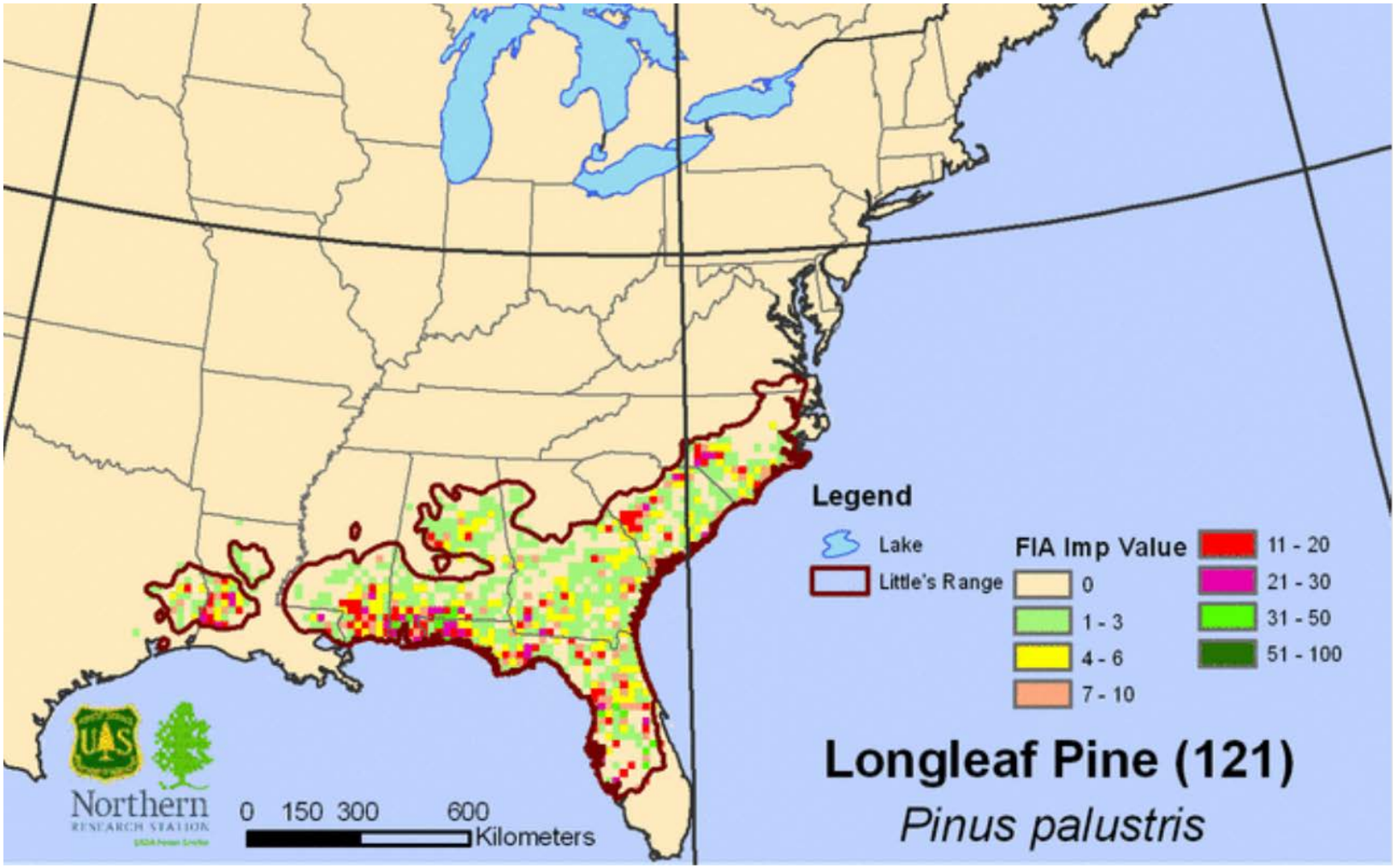
- Theory and relevance
- How is diversity maintained?
- Monitoring diversity
- Applicability of knowledge
- Next steps

Background

- Southeastern Longleaf Sandhills and Flatwoods
  - Critical for DoD testing and training
  - Biodiversity hotspot



Background


Legend
Lake
Little's Range
FIA Imp Value
0
1 - 3
4 - 6
7 - 10
11 - 20
21 - 30
31 - 50
51 - 100
Longleaf Pine (121)
Pinus palustris
Northern
RESEARCH STATION
0 150 300 600
Kilometers

Benefits to DoD

- Understand mechanisms driving forest function
- Increase monitoring accuracy and efficiency
- Discover more sensitive metrics for monitoring

Patterns and Processes of Diversity

Making Theory Relevant to Practitioners

PATTERNS

- How does a base resource manager keep track of ecosystem health?
- Distribution through space and time
- Capturing ecosystem health
- Sensitivity of measures

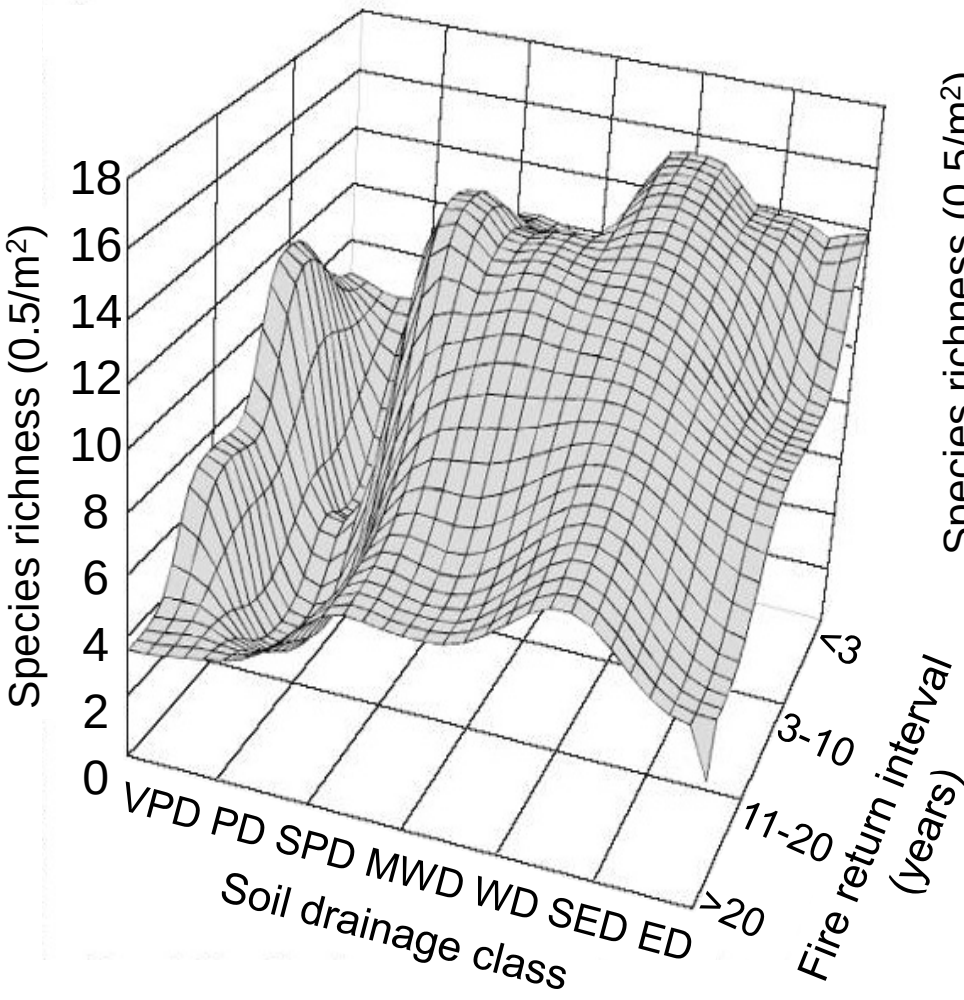
PROCESSES

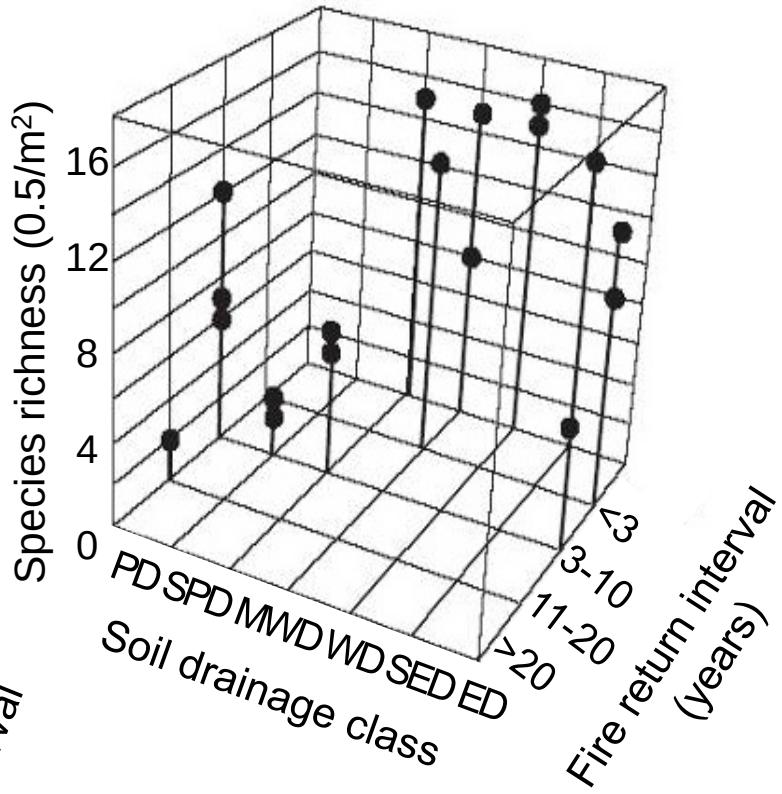
- How does fire work?
- Connecting forest structure to fire ecology
- Transmitting information to managers

Frequent Fire = High Diversity

Frequent Fire = High Diversity

More Species Richness with Higher Return Interval





ED: Excessively drained
SED: Somewhat excessively drained
WD: Well drained
MWD: Moderately well drained
SPD: Somewhat poorly drained
VPD: Very poorly drained

How?

Ecological Theory

- Explain how nature functions in *testable ways*
  - Understanding needed for maintenance
  - Community assembly
  - Organization of biological diversity

"*There is nothing so practical as a good theory*" - Kurt Lewin

Continuum Hypothesis Theory

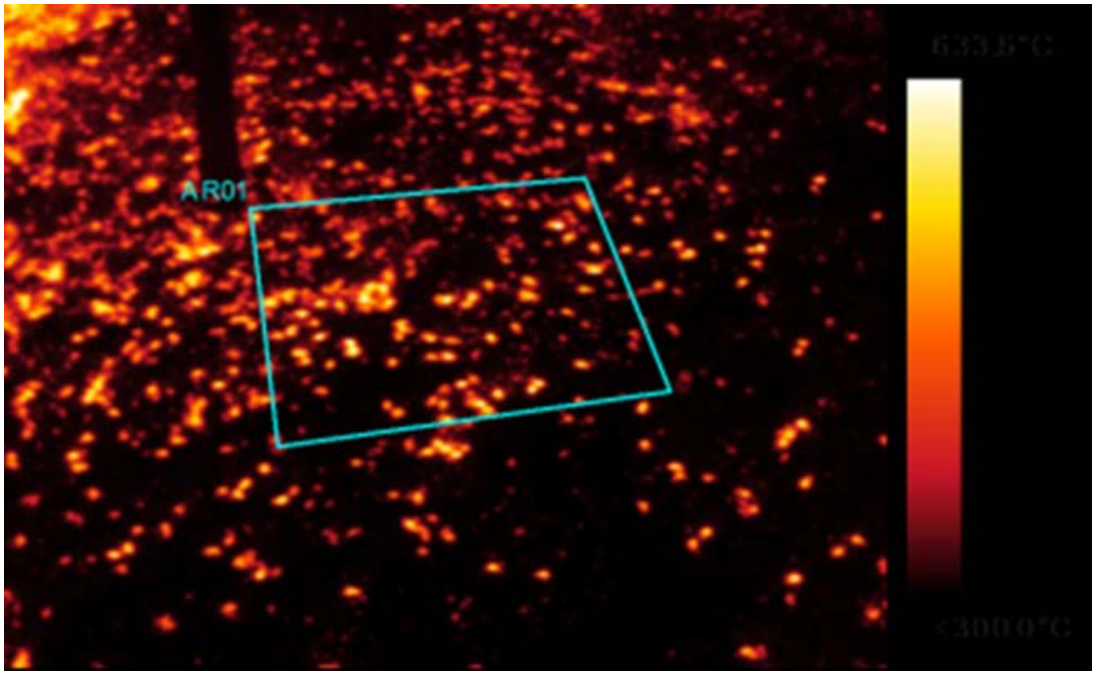
Strongly Supported by Study

Coexistence of many species

Dominance of a few species

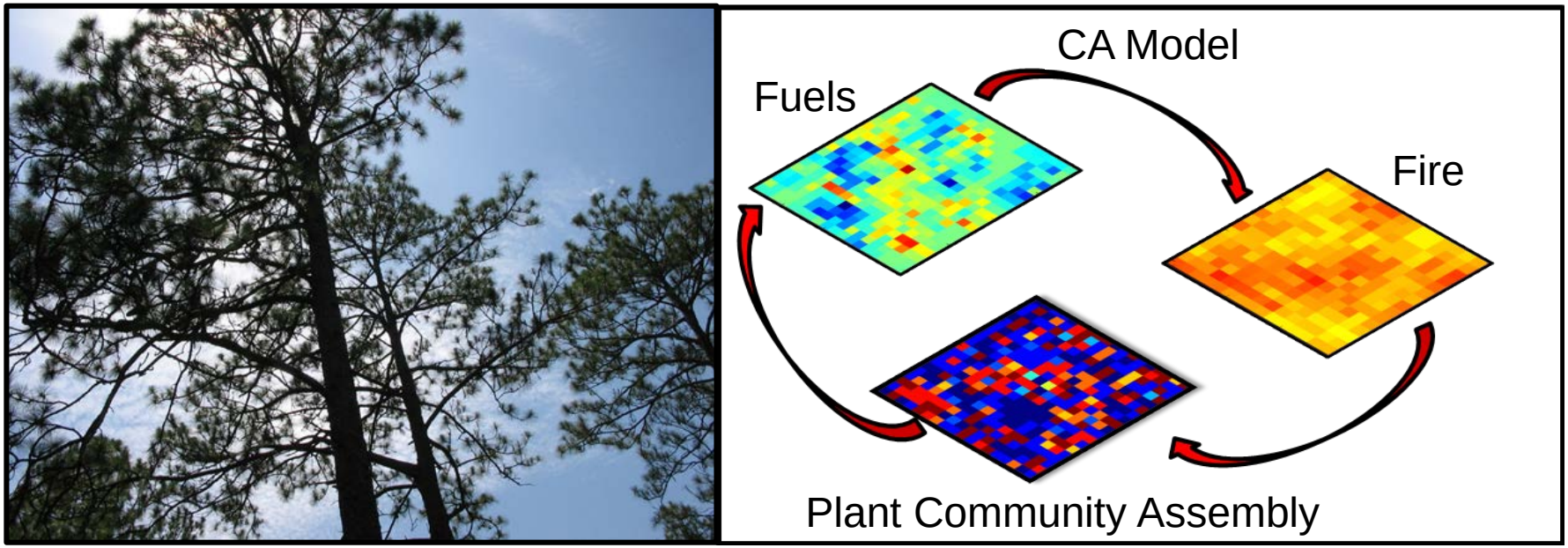
How Does Fire Maintain Diversity?

- Limits competition, prevents exclusion
- Random plant mortality from small hot spots lets rare species persist



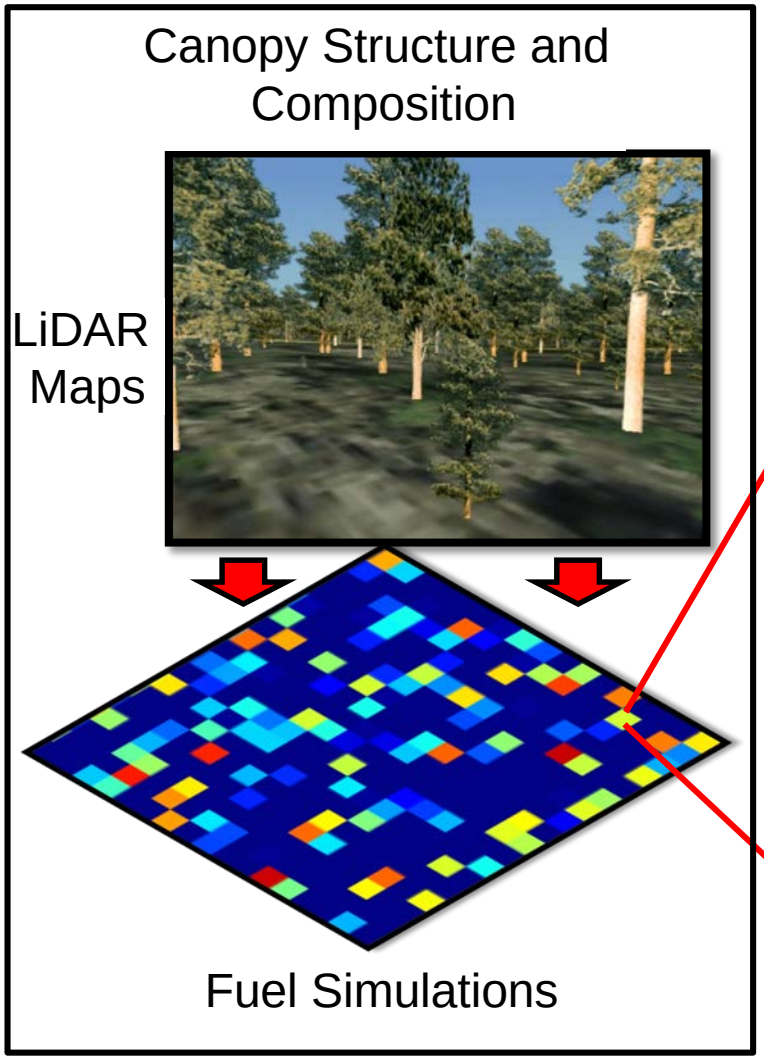
Small Scale Variability in Fuels

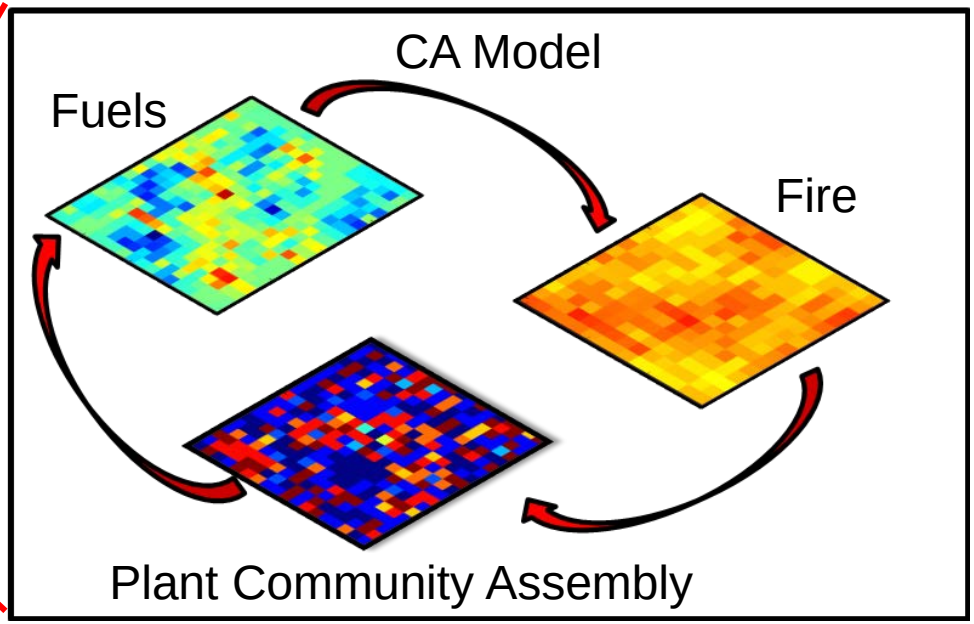
Drives Plant Community Dynamics



Note: CA = cellular automata

Making It Relevant

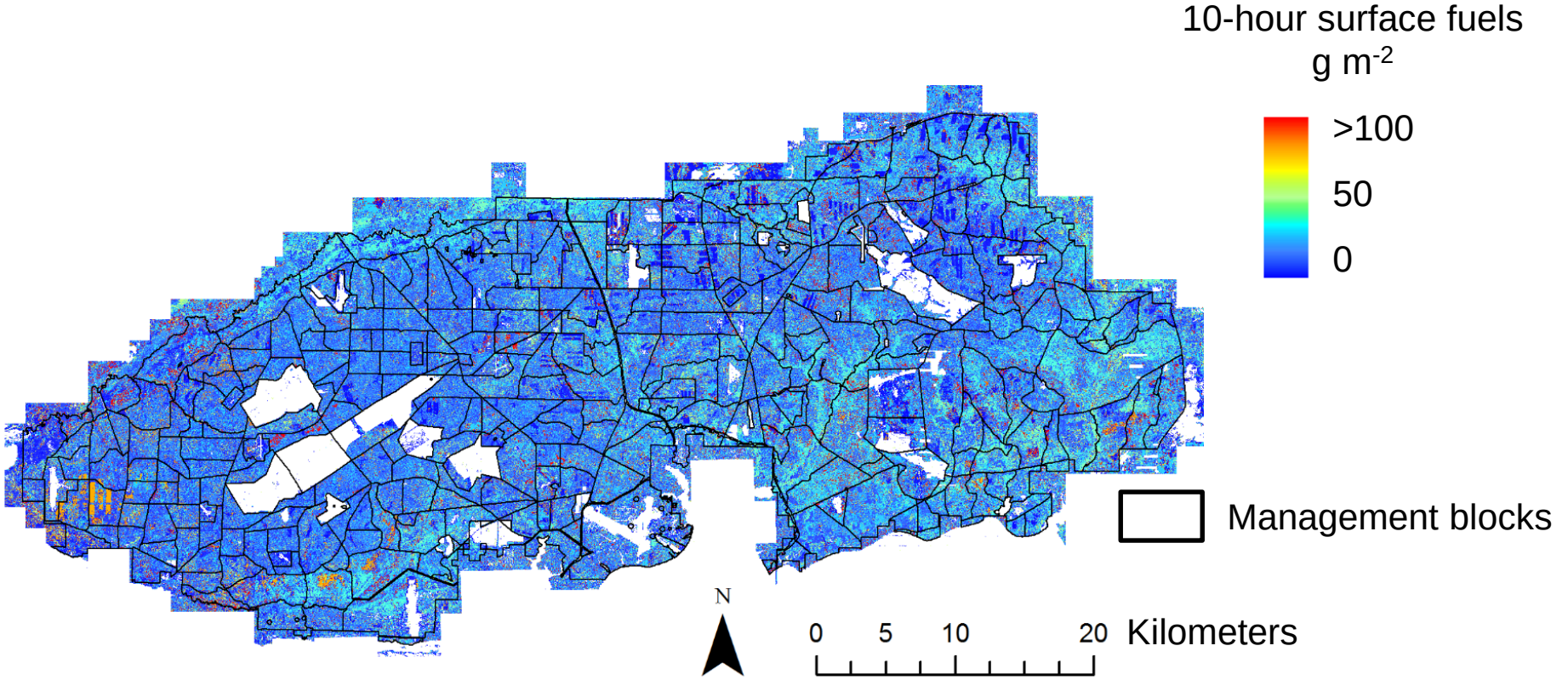




Note:
LiDAR = light detection and ranging

Fuel Mapping

Fuels Can Now Be Mapped Over Entire Landscapes

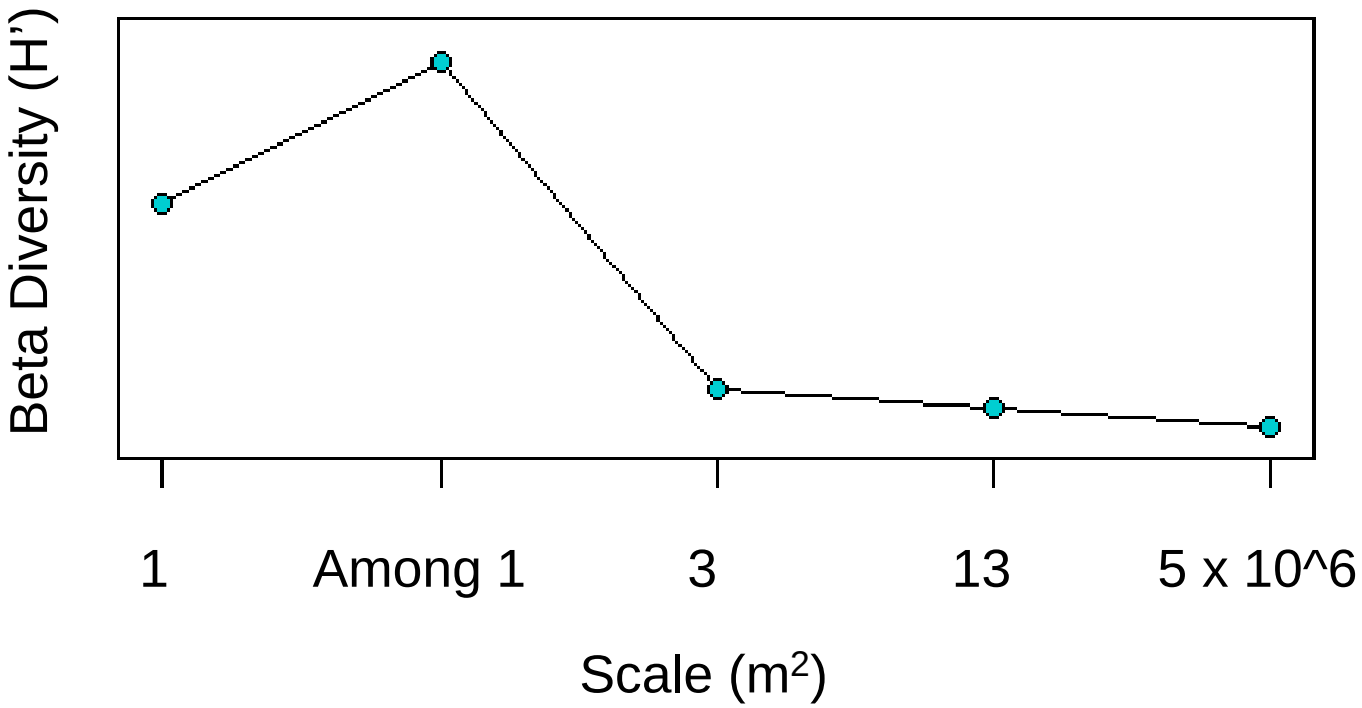


Monitoring Your Management

- Critical but costly
- Theory identified most efficient ways to track forest health
- Biodiversity changes in space and time:
  - Local level (α), stand level (β), landscape level (γ)
  - Can be partitioned to understand how best to monitor management

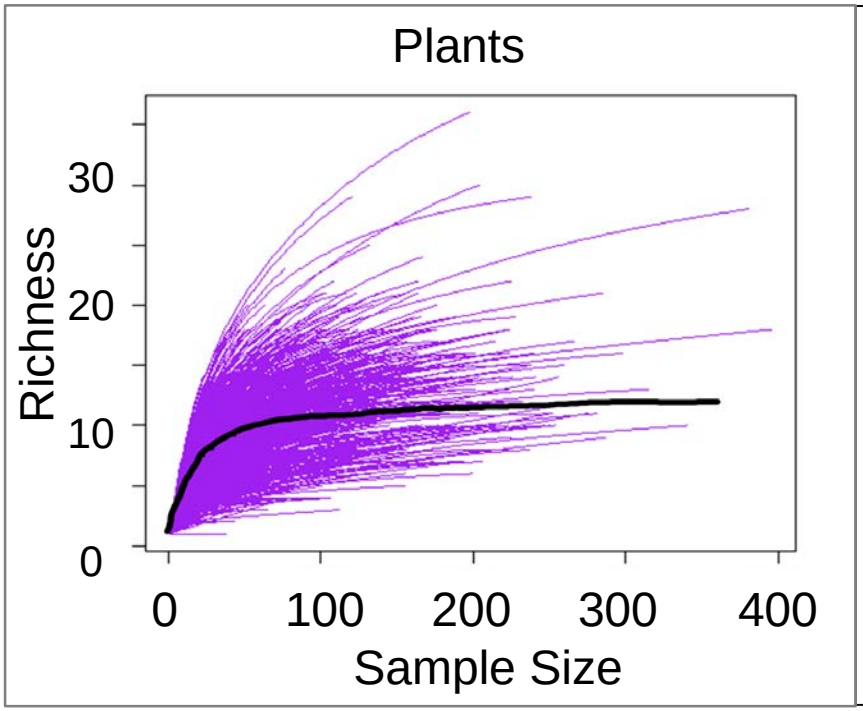
What Size Plots for Plants?

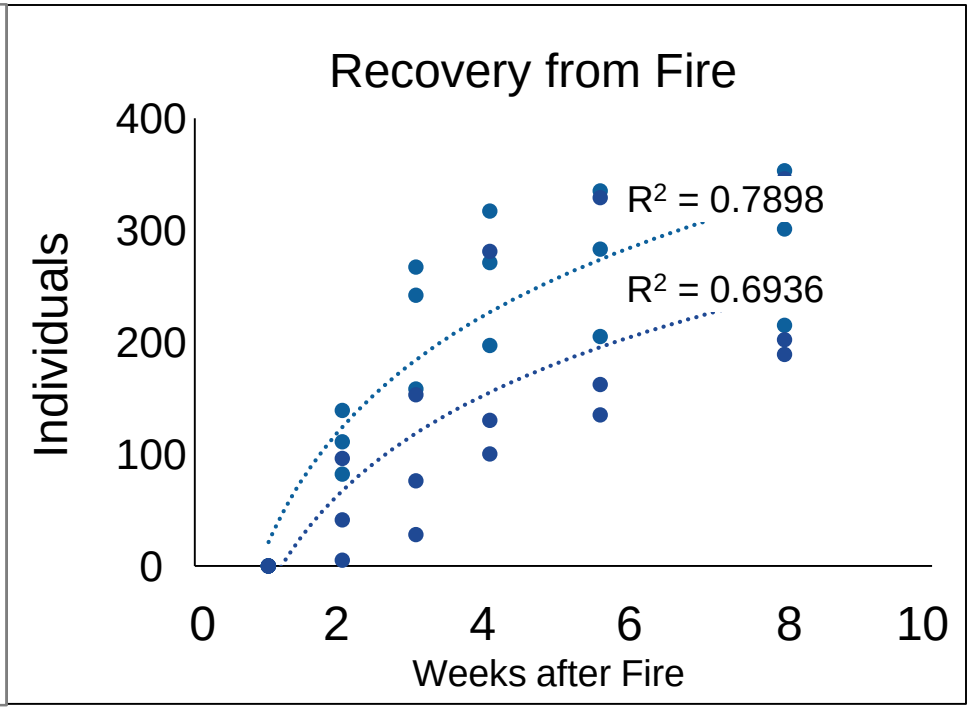
1-m² Plots Replicated within Habitat Types



Notes: H' = Shannon entropy; m^2 = meters squared

How Many Plots and When to Sample?

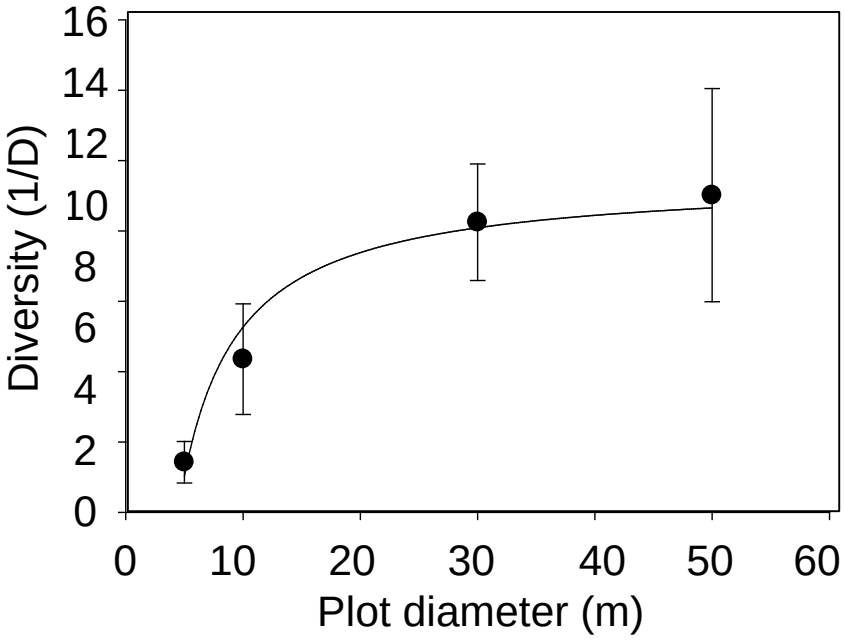


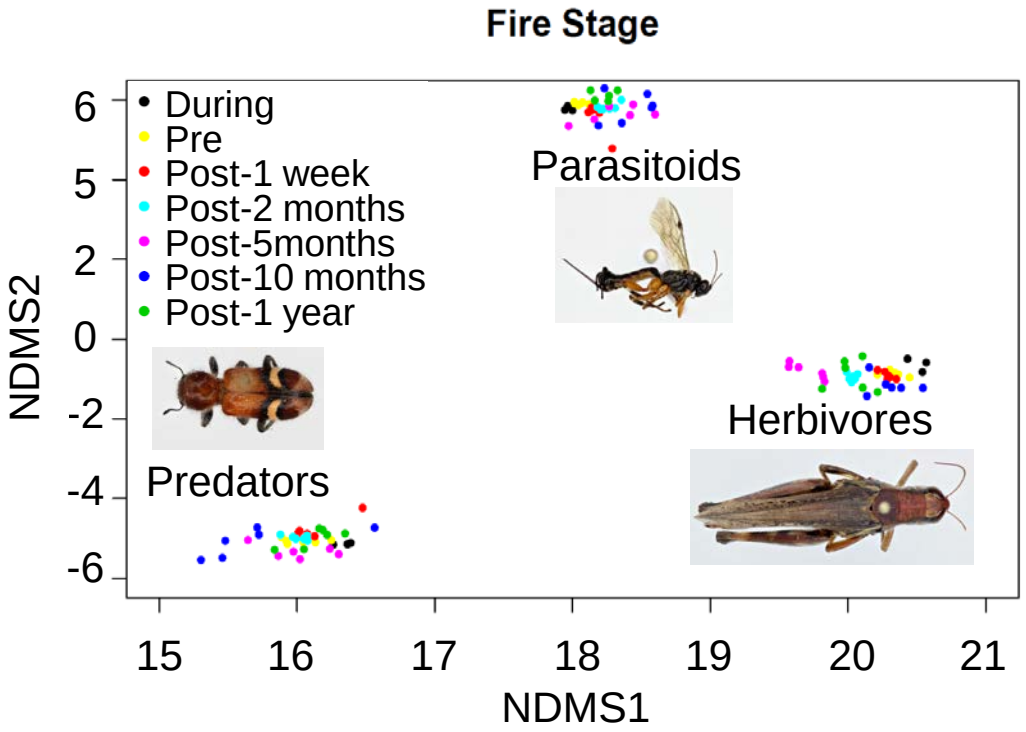


- How many: 50 plots among representative habitats
- When: 8+ weeks after fire (August or September)

Arthropod Monitoring

Returns to Pre-Fire Structure After 1 Year





- Appropriate scale: 30-m diameter circular plots

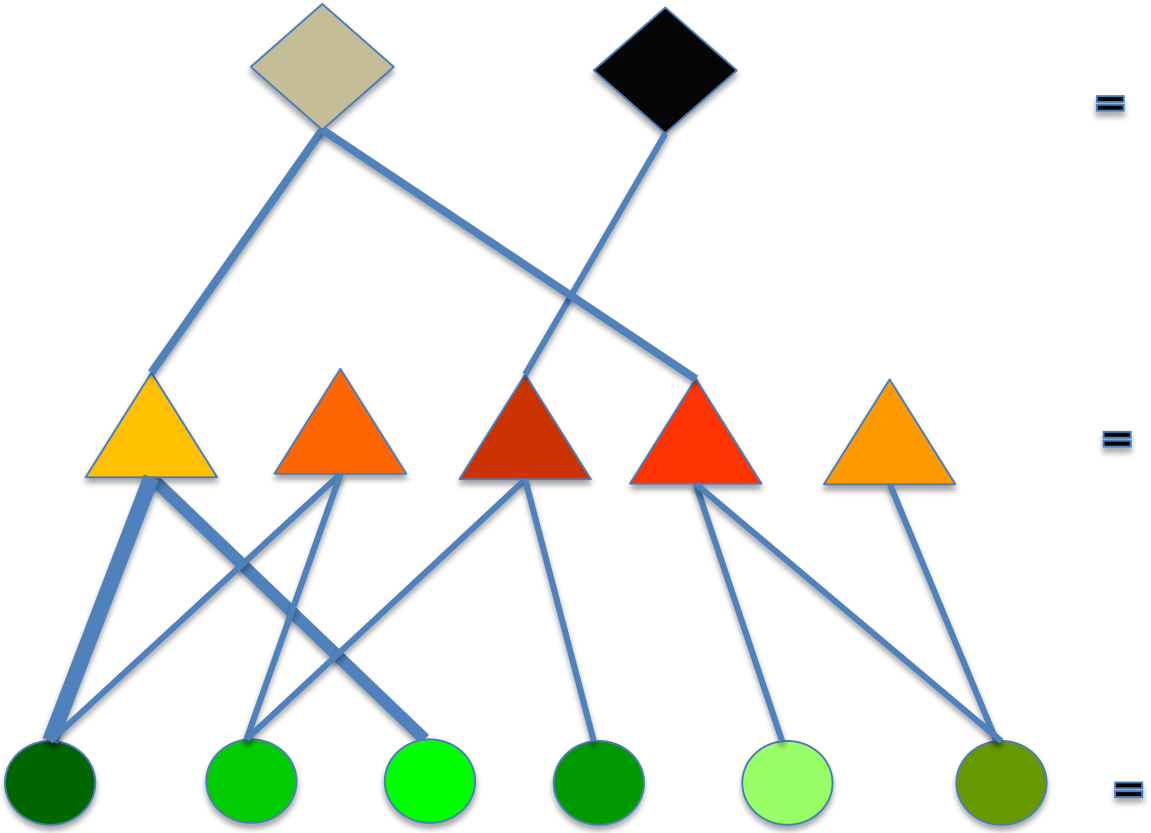
Notes: 1/D = Simpson's Reciprocal Index; NDMS = non-metric multidimensional scaling

More Sensitive Measures

- Diversity of interactions among species
  - Plants, herbivores, predators form networks of interactions
  - Complexity of networks can predict susceptibility to pathogen outbreaks
  - More sensitive indicator of ecosystem health

Interaction Diversity

More Sensitive Metric of Diversity



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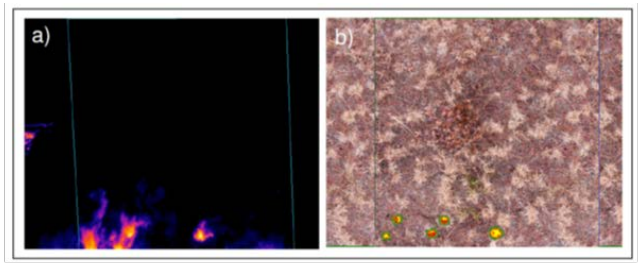
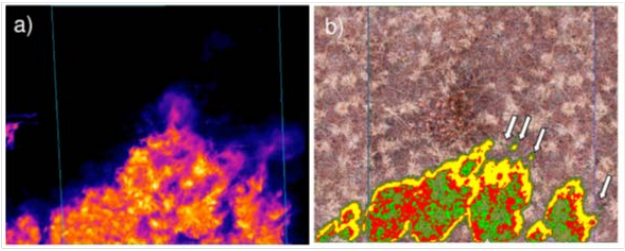
Effectively sampled in 10 plots stratified by management type

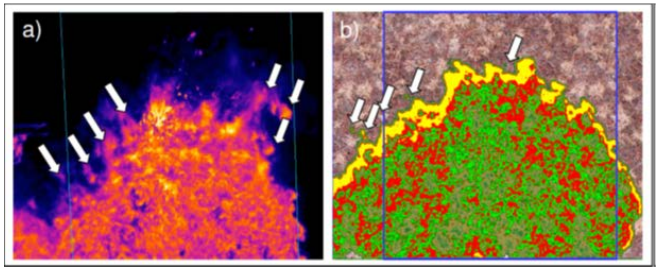
Next Steps

A "Grand Unification Model of Prescribed Fire"

- How silviculture influences fire
- Ignition pattern strategies
- Other disturbance effects



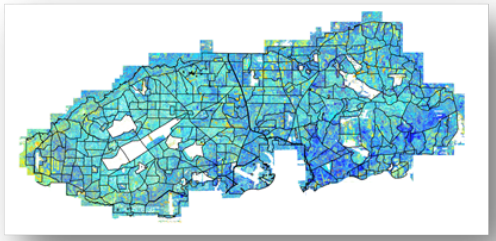




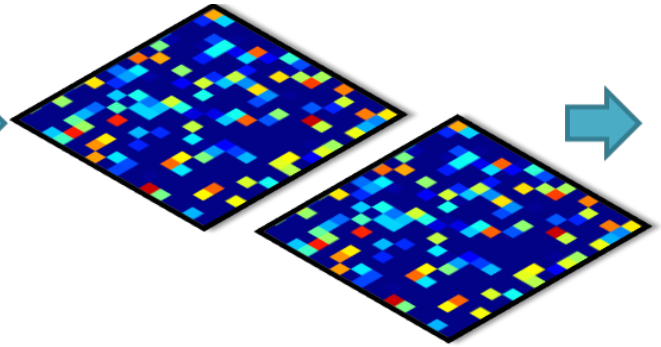
Next Steps

A "Grand Unification Model of Prescribed Fire"

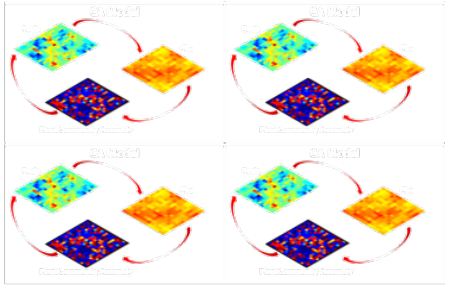
Landscape-Level



Stand-Level



Plot-Level



Conclusions

- Frequent fire and woody fuels are critical
- Mechanisms linking fire and ecological effects are understood
- Improved monitoring efficiency by understanding diversity patterns
- Interaction diversity is a more sensitive indicator

For additional information, please visit
https://www.serdp-estcp.org/Program-Areas/Resource-Conservation-and-Resiliency/Natural-Resources/Ecological-Forestry/RC-2243

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Q&A Session 2

The next webinar is on October 4, 2018

Chlorinated Solvents Workshop Overview and Feature Projects

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Survey Reminder

Please take a moment to complete the survey that will pop up on your screen when the webinar ends