Vegetation and Fuel Dynamics During the Restoration of Oak Savannas and Woodlands in the Mid-South USA
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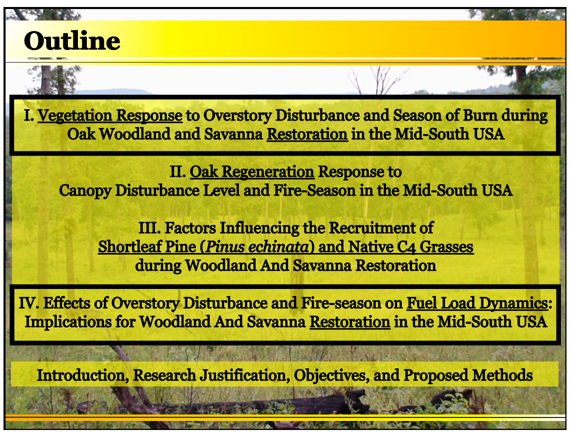
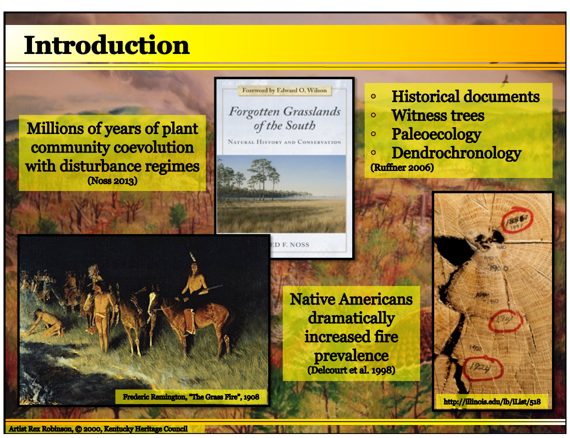
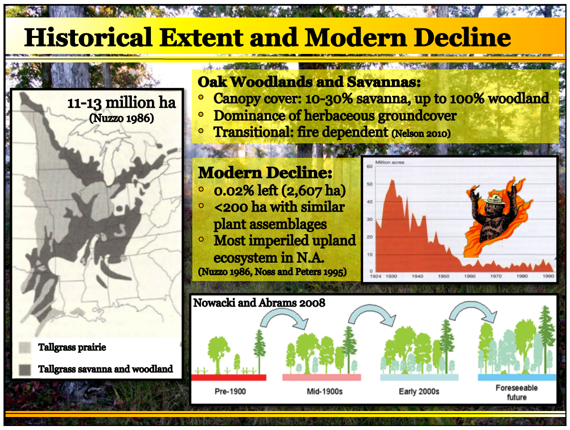
12:20 pm, October 21, 2015, PBB 160
UT FWF Departmental Seminar

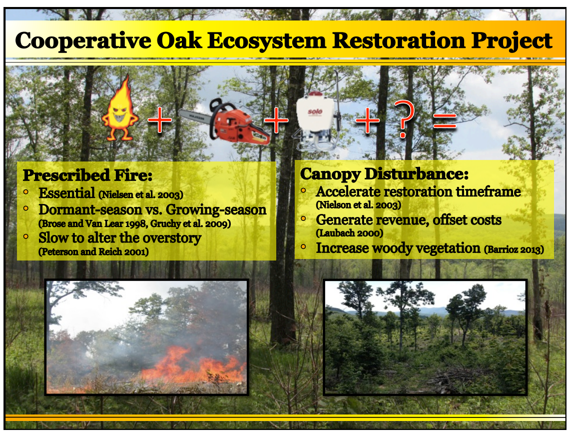


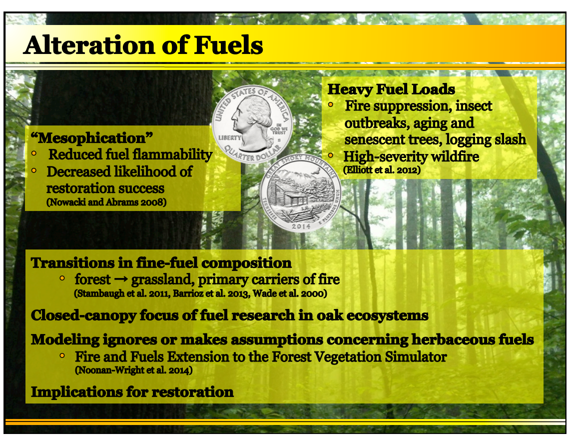
Outline
I. Vegetation Response to Overstory Disturbance and Season of Burn during Oak Woodland and Savanna Restoration in the Mid-South USA
II. Oak Regeneration Response to Canopy Disturbance Level and Fire-Season in the Mid-South USA
III. Factors Influencing the Recruitment of Shortleaf Pine (Pinus echinata) and Native C4 Grasses during Woodland And Savanna Restoration
IV. Effects of Overstory Disturbance and Fire-season on Fuel Load Dynamics: Implications for Woodland And Savanna Restoration in the Mid-South USA
Introduction, Research Justification, Objectives, and Proposed Methods

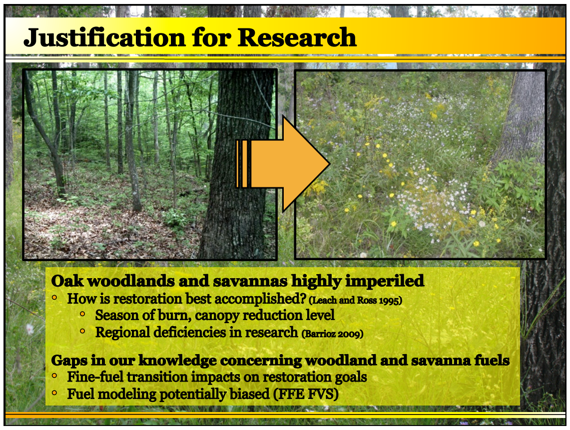


Introduction
Millions of years of plant community coevolution with disturbance regimes
(Noss 2013)
Forgotten Grasslands of the South
Historical documents
Witness trees
Paleoecology
Dendrochronology
(Ruffner 2006)
Native Americans dramatically increased fire prevalence
(Delcourt et al. 1998)
Frederic Remington, "The Grass Fire", 1908
http://illinois.edu/lb/iList/518
Artist Rex Robinson, © 2000, Kentucky Heritage Council

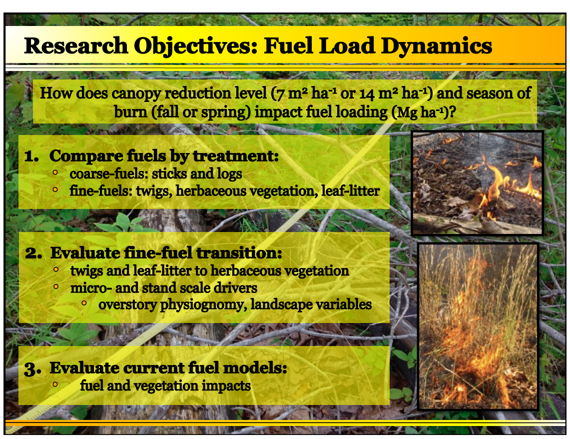

Historical Extent and Modern Decline
11-13 million ha
(Nuzzo 1986)
Tallgrass prairie
Tallgrass savanna and woodland
Oak Woodlands and Savannas:
Canopy cover: 10-30% savanna, up to 100% woodland
Dominance of herbaceous groundcover
Transitional: fire dependent (Nelson 2010)
Modern Decline:
0.02% left (2,607 ha)
<200 ha with similar plant assemblages
Most imperiled upland ecosystem in N.A.
(Nuzzo 1986, Noss and Peters 1995)
Nowacki and Abrams 2008
Pre-1900
Mid-1900s
Early 2000s
Foreseeable future

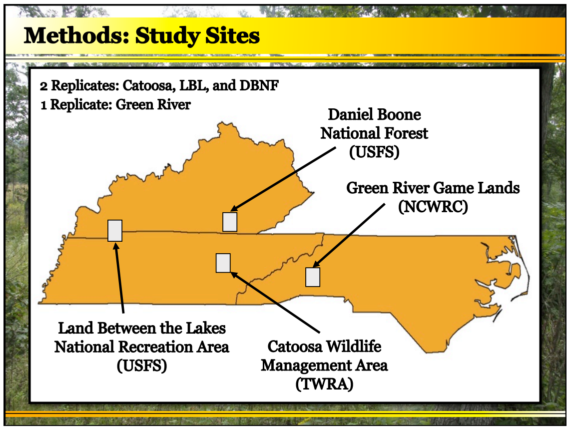

Cooperative Oak Ecosystem Restoration Project
+ + + ? =
Prescribed Fire:
Essential (Nielsen et al. 2003)
Dormant-season vs. Growing-season (Brose and Van Lear 1998, Gruchy et al. 2009)
Slow to alter the overstory (Peterson and Reich 2001)
Canopy Disturbance:
Accelerate restoration timeframe (Nielson et al. 2003)
Generate revenue, offset costs (Laubach 2000)
Increase woody vegetation (Barrioz 2013)

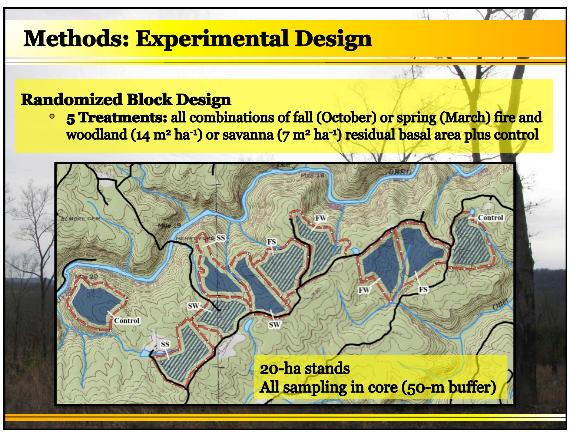

Alteration of Fuels
"Mesophication"
Reduced fuel flammability
Decreased likelihood of restoration success
(Nowacki and Abrams 2008)
Heavy Fuel Loads
Fire suppression, insect outbreaks, aging and senescent trees, logging slash
High-severity wildfire
(Elliott et al. 2012)
Transitions in fine-fuel composition
forest → grassland, primary carriers of fire
(Stambaugh et al. 2011, Barrioz et al. 2013, Wade et al. 2000)
Closed-canopy focus of fuel research in oak ecosystems
Modeling ignores or makes assumptions concerning herbaceous fuels
Fire and Fuels Extension to the Forest Vegetation Simulator
(Noonan-Wright et al. 2014)
Implications for restoration

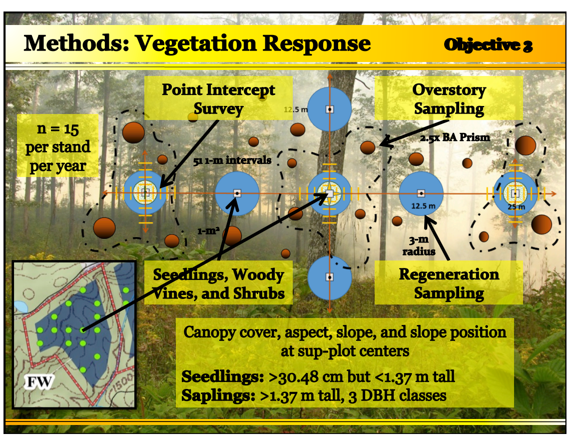

Justification for Research
Oak woodlands and savannas highly imperiled
How is restoration best accomplished? (Leach and Ross 1995)
Season of burn, canopy reduction level
Regional deficiencies in research (Barrioz 2009)
Gaps in our knowledge concerning woodland and savanna fuels
Fine-fuel transition impacts on restoration goals
Fuel modeling potentially biased (FFE FVS)

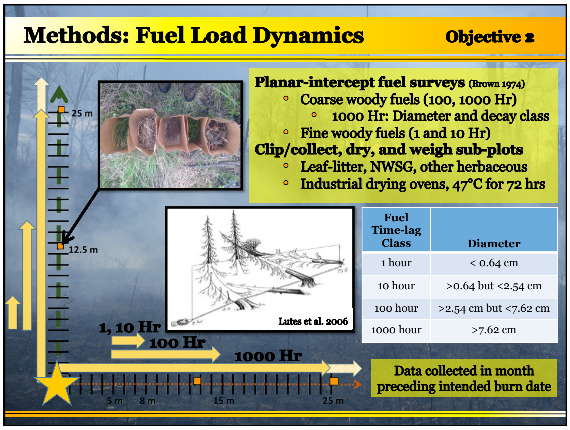

Research Objectives: Vegetation Response
How does canopy reduction level ($7\ m^2\ ha^{-1}$ or $14\ m^2\ ha^{-1}$) and season of burn (fall or spring) impact key measures of restoration success?
1. Herbaceous ground-layer development:
% groundcover (graminoids and forbs)
Richness and diversity
Occurrence of rare, ruderal, and invasive exotics species
2. Woody midstory control:
% woody groundcover (trees, vines, shrubs, and brambles)
size-class and species specific stem densities
3. Microsite drivers of 1 and 2:
overstory physiognomy
landscape variables

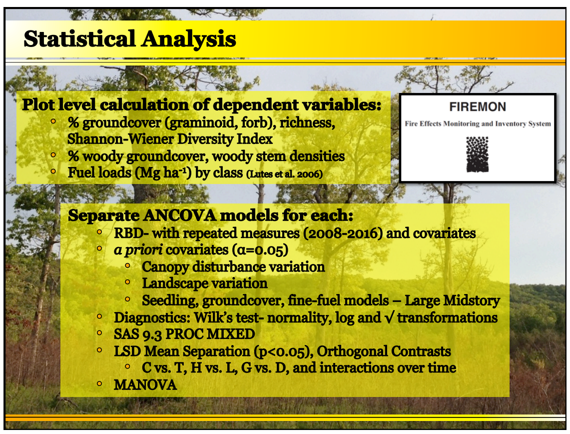

Research Objectives: Fuel Load Dynamics
How does canopy reduction level ($7\ m^2\ ha^{-1}$ or $14\ m^2\ ha^{-1}$) and season of burn (fall or spring) impact fuel loading ($Mg\ ha^{-1}$)?
1. Compare fuels by treatment:
coarse-fuels: sticks and logs
fine-fuels: twigs, herbaceous vegetation, leaf-litter
2. Evaluate fine-fuel transition:
twigs and leaf-litter to herbaceous vegetation
micro- and stand scale drivers
overstory physiognomy, landscape variables
3. Evaluate current fuel models:
fuel and vegetation impacts

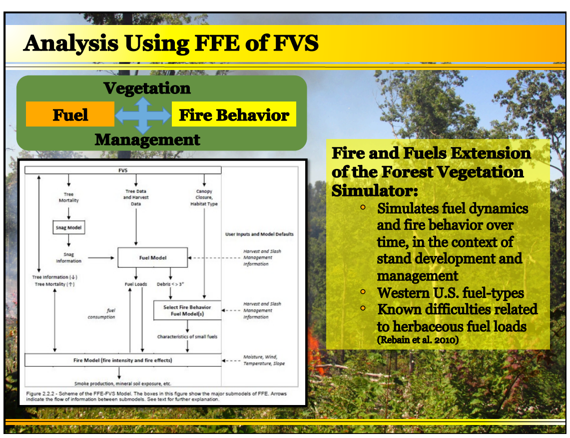

Methods: Study Sites
2 Replicates: Catoosa, LBL, and DBNF
1 Replicate: Green River
Daniel Boone National Forest (USFS)
Green River Game Lands (NCWRC)
Land Between the Lakes National Recreation Area (USFS)
Catoosa Wildlife Management Area (TWRA)

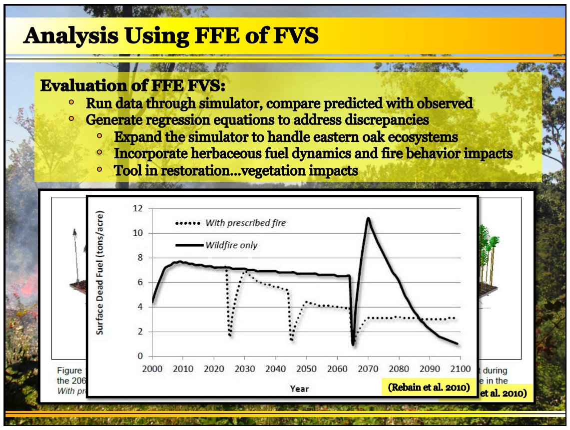

Methods: Experimental Design
Randomized Block Design
5 Treatments: all combinations of fall (October) or spring (March) fire and woodland (14 m² ha⁻¹) or savanna (7 m² ha⁻¹) residual basal area plus control
Control
FW
FS
SS
SW
20-ha stands
All sampling in core (50-m buffer)

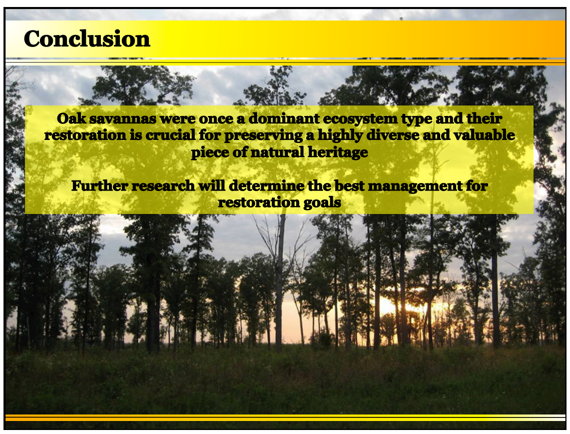

Methods: Vegetation Response
Objective 3
n = 15 per stand per year
Point Intercept Survey
Overstory Sampling
2.5x BA Prism
51 1-m intervals
12.5 m
25 m
1-m²
3-m radius
Seedlings, Woody Vines, and Shrubs
Regeneration Sampling
FW
Canopy cover, aspect, slope, and slope position at sup-plot centers
Seedlings: >30.48 cm but <1.37 m tall
Saplings: >1.37 m tall, 3 DBH classes


Methods: Fuel Load Dynamics
Objective 2
Planar-intercept fuel surveys (Brown 1974)
Coarse woody fuels (100, 1000 Hr)
1000 Hr: Diameter and decay class
Fine woody fuels (1 and 10 Hr)
Clip/collect, dry, and weigh sub-plots
Leaf-litter, NWSG, other herbaceous
Industrial drying ovens, 47°C for 72 hrs
25 m
12.5 m
Lutes et al. 2006
Fuel Time-lag Class | Diameter
1 hour | < 0.64 cm
10 hour | >0.64 but <2.54 cm
100 hour | >2.54 cm but <7.62 cm
1000 hour | >7.62 cm
1, 10 Hr
100 Hr
1000 Hr
Data collected in month preceding intended burn date
5 m
8 m
15 m
25 m


Statistical Analysis
Plot level calculation of dependent variables:
% groundcover (graminoid, forb), richness, Shannon-Wiener Diversity Index
% woody groundcover, woody stem densities
Fuel loads (Mg ha⁻¹) by class (Lutes et al. 2006)
FIREMON
Fire Effects Monitoring and Inventory System
Separate ANCOVA models for each:
RBD- with repeated measures (2008-2016) and covariates
a priori covariates (α=0.05)
Canopy disturbance variation
Landscape variation
Seedling, groundcover, fine-fuel models – Large Midstory
Diagnostics: Wilk's test- normality, log and √ transformations
SAS 9.3 PROC MIXED
LSD Mean Separation (p<0.05), Orthogonal Contrasts
C vs. T, H vs. L, G vs. D, and interactions over time
MANOVA


Analysis Using FFE of FVS
Vegetation
Fuel
Fire Behavior
Management
FVS
Snag Model
Fuel Model
Fire Model (fire intensity and fire effects)
Fire and Fuels Extension of the Forest Vegetation Simulator:
Simulates fuel dynamics and fire behavior over time, in the context of stand development and management
Western U.S. fuel-types
Known difficulties related to herbaceous fuel loads (Rebain et al. 2010)


Analysis Using FFE of FVS
Evaluation of FFE FVS:
Run data through simulator, compare predicted with observed
Generate regression equations to address discrepancies
Expand the simulator to handle eastern oak ecosystems
Incorporate herbaceous fuel dynamics and fire behavior impacts
Tool in restoration...vegetation impacts
With prescribed fire
Wildfire only
Surface Dead Fuel (tons/acre)
12
10
8
6
4
2
0
2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100
Year
(Rebain et al. 2010)


Conclusion
Oak savannas were once a dominant ecosystem type and their restoration is crucial for preserving a highly diverse and valuable piece of natural heritage
Further research will determine the best management for restoration goals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Questions?