

Archbold-UF LTAR Project:
Manipulating fire and grazing to enhance the delivery of ecosystem services from subtropical humid grasslands

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Broad network goals – sustainable intensification of US Agriculture

Strategic Goals

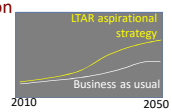
- Feed and clothe the world
- Stewardship of resources/environment
- Prosperity of rural communities
- https://ltar.ars.usda.gov/

Inform strategies for sustainable intensification by…

1. ***Assessing*** current condition of US agriculture

2. ***Testing*** alternative technologies and strategies

3. ***Forecasting*** outcomes of intensification strategies over short, middle and long terms

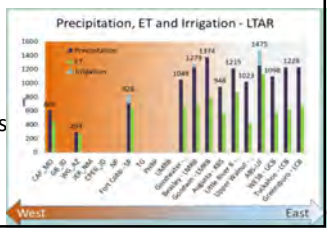


Archbold-UF LTAR Research Focus

- Factors that drive agriculture productivity and environmental impacts in **subtropical grazing ecosystems**
- **Tradeoffs and synergies among production and ecosystem services**: productivity, GHG, soil/water quality, biodiversity
- **Experimental assessment** of management strategies (grazing, fire, fertilization, mechanical treatment, forage planting, manipulating hydrology, conservation easements/restoration)
- Working with stakeholders to address socioeconomic barriers to **sustainable intensification**

Current LTAR network initiatives

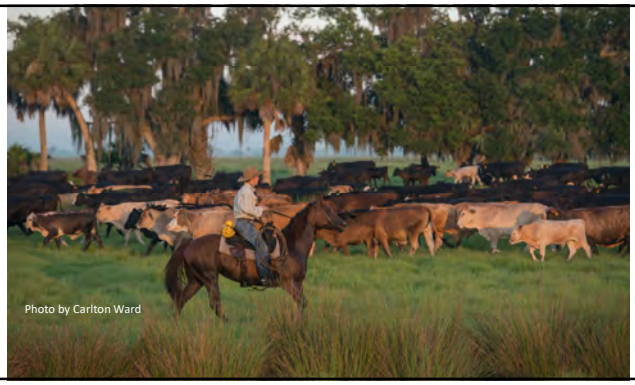
- Regionalization
- Livestock behavior and utilization
- Nutrient and Water Budgets
- Water quality
- Phenology
- Biodiversity
- Sustainability of Grazing lands
- Common Experiment



LTAR Common Experiment

Each site is implementing an experiment to ***compare "business as usual" and an "aspirational" management***

Spiegal et al. 2018
Kleinman et al. 2018



Tropical and subtropical grazed pastures and grasslands

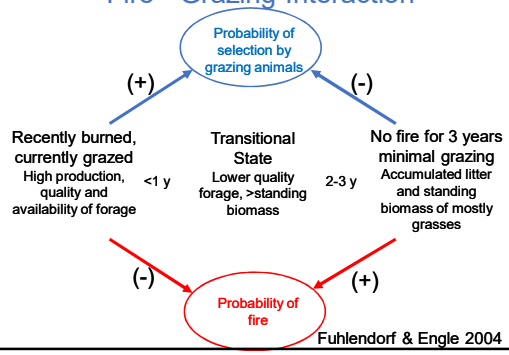
- *Understand how traditional and alternative regimes of grazing and fire management affect ecosystem services, including greenhouse gas regulation*

- 20-30% of total land area in tropical and subtropical regions of the Americas and Africa
- High carbon sequestration potential, store >10% of global terrestrial net productivity and contain 30% of the world's organic C in soils
- >35% of global CH_4 from natural sources is emitted from soils of the Tropics.
- Enteric ruminant fermentation makes a significant contribution to global CH_4
- Important role of fire
- Most common landuse in the Headwaters of the Everglades (~35% of the 1.1 million ha watershed)
- Overlap of agriculture and T&E species habitat

Fire and Grazing

- Previous studies compared just ungrazed vs. grazed
  - Greater carbon uptake in grazed pastures compared to ungrazed (Gomez-Casanovas et al. 2018)
- Fire and grazing interact
  - Animals prefer recently burned areas (Archibald and Bond 2004; Allred et al. 2011)
  - Greater N input in recently burned/grazed areas
  - May accelerate soil N cycling, enhancing plant nutrient uptake

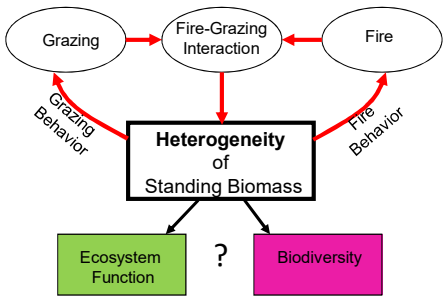
Fire - Grazing Interaction



Fuhlendorf & Engle 2004

Heterogeneity Paradigm

Fuhlendorf et al. 2008



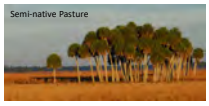
Fire-grazing interaction = Patch burn grazing (PBG)

1) create heterogeneous vegetation structure (Fuhlendorf and Engle, 2004) important to biodiversity (Fuhlendorf et al., 2006),
2) alter fire behavior (Kirkpatrick et al., 2011),
3) reduce invasive species (Cummings et al., 2007),
4) enhance animal populations (Fuhlendorf et al., 2010)
5) increase soil nitrogen (Anderson et al., 2006).




Archbold-UF LTAR Common Experiment at Buck Island Ranch:

- Assess how patch burn grazing (aspirational) compared to traditional full burn (BAU) management affects ecosystem processes
- Cattle Behavior, Forage productivity and quality, Vegetation Structure & Diversity, Soil carbon, GHG exchange



Research Questions

- How do cattle respond to patch burns in subtropical grasslands?
- How does patch burning affect forage quality and productivity compared to full burns?
  - We expect forage quality and productivity to be higher in burned patches, but how long does this affect last?
- Does patch burning increase vegetation diversity and heterogeneity compared to full burns?
- How does patch burning affect carbon fluxes?

Experimental Design

16 40 acre pastures
8 Full Burn, 8 Patch Burn

- Paired based on topography
- Half in improved pastures/Half in semi-native pastures
- Four eddy flux towers, CO2/CH4
- 30 head of cattle per improved pasture; 4 GPS collars
- 15 head of cattle per semi-native pasture; 4 GPS collars
- Prescribed fires, 8 LRG complete Jan 2017; 8 PBG 1/3 Jan 2017; next 1/3 PBG 2018, etc.

Patch burn - Heterogeneity Treatment

Fence ---------Mowed line

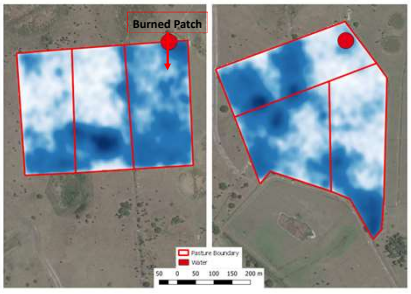
Full Burn - Homogeneity Treatment

Winter 2017

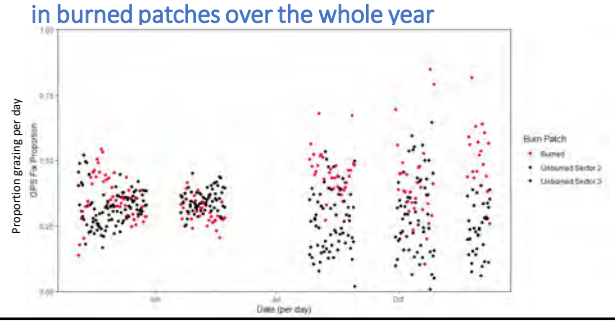
- based on the prominent type of local management
- Maintain the same amount of grazing and fire as the heterogeneity treatment. e.g., burn the entire pasture once every three years when patch burning is burn one-third each year

Fence

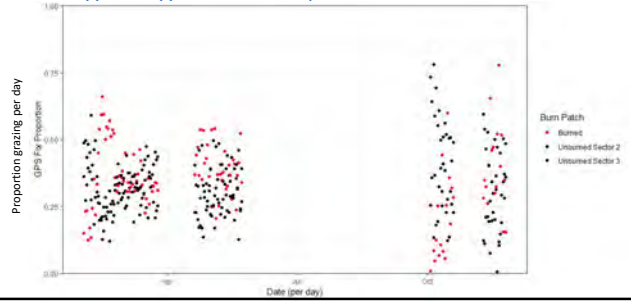
Cattle grazing in PBG vs. Full Burn



Improved Patch Burn : Cattle spent more time grazing in burned patches over the whole year



Semi-native Patch Burn: Cattle spent more time grazing in burned patches for 4 months

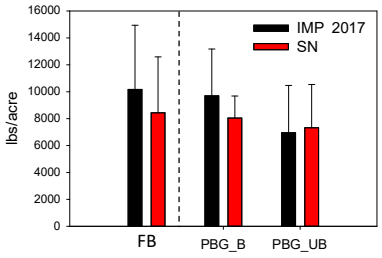


How does patch burn grazing affect forage production and quality?

- Moveable exclosures and grazed paired plots (McNaughton 1985, Knapp et al. 2012)
  - 9 in PBG, 3 in LRG
  - Aboveground Net Primary Productivity = $\Sigma\ \mathrm{ME}(T_2) - \mathrm{PP}\ (T_1)$
- Lab analyses conducted at the UF Forage Evaluation Support Laboratory
  - Total N %
  - Total P %
  - In vitro organic matter digestibility

Annual Forage Production (growth) tends to be lower in unburned patches

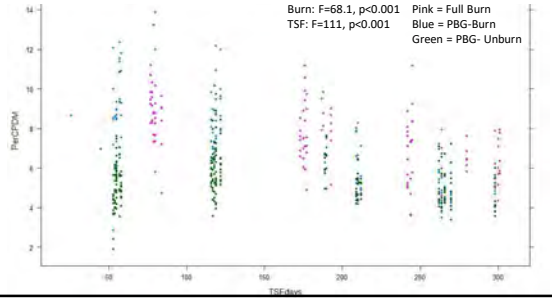
Burn: F=2.6, p=0.08



Positive effect of fire on crude protein lasts for approximately 200 days after fire

Burn: F=68.1, p<0.001
TSF: F=111, p<0.001

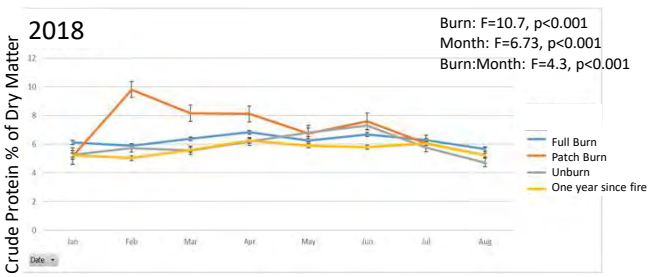
Pink = Full Burn
Blue = PBG-Burn
Green = PBG- Unburn



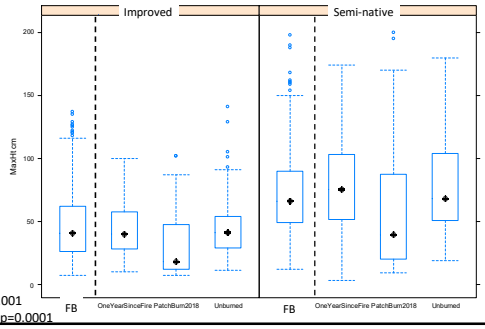
Greater crude protein available on recently burned patches
3-4 months of higher crude protein in burned patches

2018

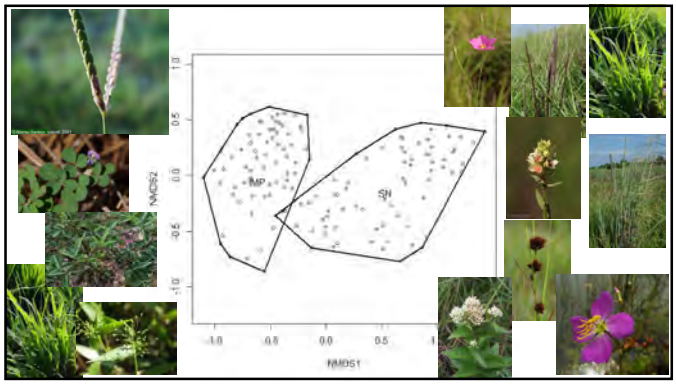
Burn: F=10.7, p<0.001
Month: F=6.73, p<0.001
Burn:Month: F=4.3, p<0.001



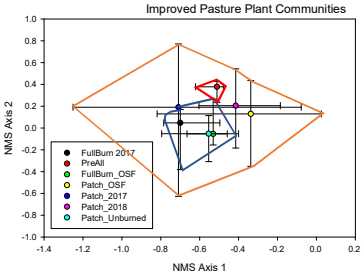
Increased heterogeneity of standing biomass in PBG



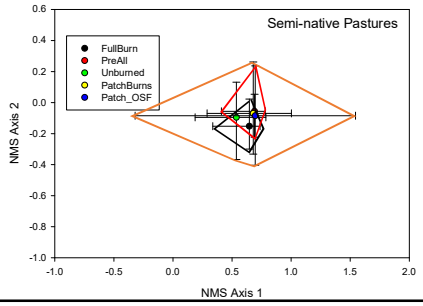
Pasture Type F=35.1, p<0.001
BurnTreatment, F=10.13, p=0.0001



Patch Burning increases plant composition heterogeneity in improved pastures



Patch Burning Increases plant composition heterogeneity in semi-native pastures

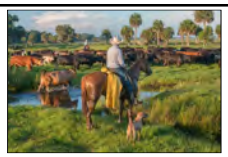


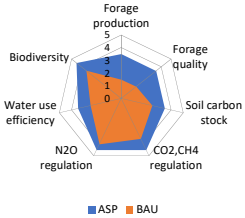
Summary

- Patch burns modified cattle behavior as expected, cattle grazing was more evenly distributed on burned patches and cattle spent more time on burned areas. This effect lasted the whole year in improved pastures.
- Growth of forage tends to be higher in burned areas
- Crude protein is higher in burned patches for at least 3-4 months and may last longer. In 2017 crude protein higher for ~200 days after fire
- Patch burning resulted in greater heterogeneity in species composition and plant heights – with potential implications for grassland bird habitat, plant diversity, and ecosystem function

Next Steps:

- Continue the experiment for one more year
- Analyze greenhouse gas regulation
- Economic impact analysis
- Assess trade-offs and synergies among ES
- DayCent modeling – projecting into future with climate change





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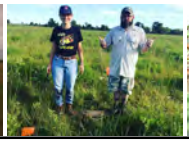
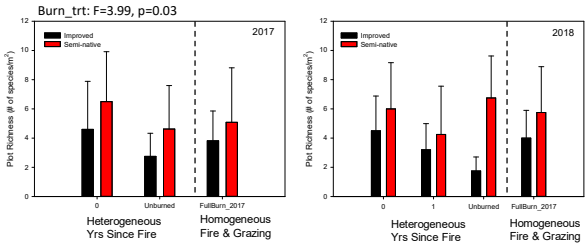



Plant Richness tends to be greater in burned patches



Average Annual %Crude Protein (DM) in burn treatments: 2017