Effects of different fire-grazing regimes on soil physical properties in tallgrass prairie rangelands

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Soil Physics Measurement Techniques – Soil 5583

Overview and Objectives

Fire and grazing are historical interactive disturbance processes that are important to the structure and function of grassland ecosystem and hence able to affect soil physical properties. Patch burning is a management strategy used to mimic these interactions and also has been adopted to bring heterogeneity and native biodiversity to the tallgrass prairie rangeland. This strategy allows cattle to freely select the most recently burned part of the grassland and spend almost of their time on these burned areas. The reason is because these recently burned areas have high productivity, quality and availability of forage. Thus, both fire and grazing impacts vegetation and soil structure, which will influence soil physical properties. Moreover, many studies have found that overgrazing leads to increases in runoff and soil erosion .Others have found that fire alter several soil properties and its effects varies according of its intensity and frequency. However, what is not known is how the interaction of these two processes will change soil physical properties such as: total porosity, bulk density, aggregate stability and infiltration of tallgrass prairie rangelands.

The long term goal related to the proposal is to train students from SOIL 5583 in several laboratory and field techniques, and data processing tasks required soil physics measurement. The objective of this proposal is improve our understanding of soil physics measurement technique. Further, explore how soil physical properties may be altered by "years since focal disturbance" (YSFD), using the ongoing patch burning experiment at the Tallgrass Prairie Preserve in Oklahoma. The rationale for the proposed research is to provide knowledge on soil properties to landowners and government agencies and then improve their patch burning management strategy focusing on heterogeneity, native biodiversity, healthy and sustainability within the tallgrass prairie rangeland. The proposal Principal Investigator is well prepared to succeed with this project due the use of well-known soil physics measurement techniques, and also because the PI has a vast experience in soil analysis methods, experiment design, field research and project management.

The following research approach aims are proposed for the project:

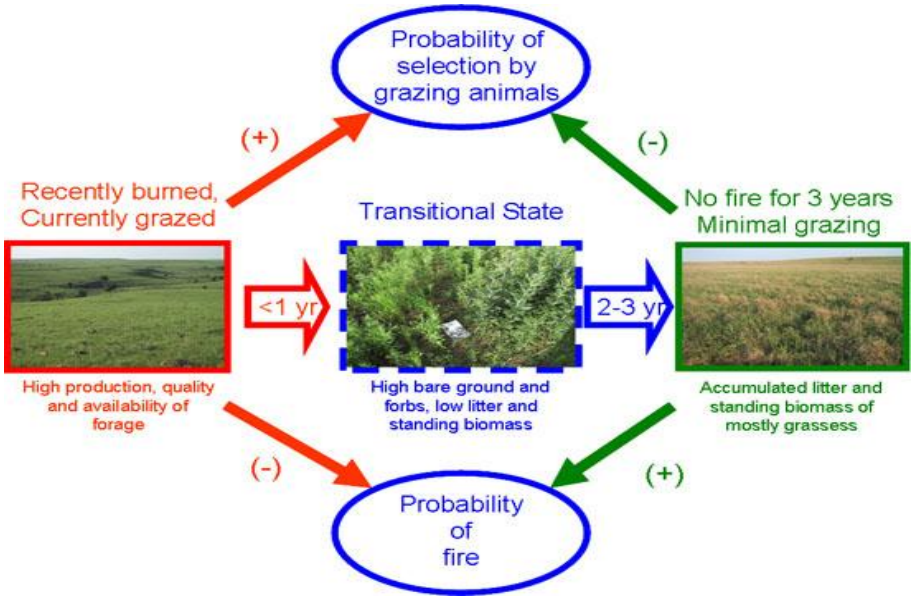
Specific aim #1: Determine how soil properties change in different fire-grazing regime (YSFD) in tallgrass prairie rangelands. Field sampling will be collecting randomly to represent the general conditions throughout the rest of the area of interest, and analyzed to see differences in total porosity, bulk density, and aggregate stability along areas with distinct "years since focal disturbance" (YSFD). Infiltration rate will be measurement in situ.

This proposal project will bring benefits to the students enrolled at Soil 5583 towards hands on training on specific soil physics measurement techniques. Fire-grazing disturbance processes have been studied in Tallgrass prairie rangelands on different approaches. However, there is a lack in the soil science context, overall in soil physical properties. The proposal study combined with previous research in this ecosystem will improve our insights about fire-grazing regimes

and soil physics properties. Understanding the relationships between fire-grazing regimes and soil properties will help better manage and preserve Tallgrass prairie ecosystems.

Significance

Grasslands are unique ecosystems historically maintained primary by disturbance of fire-grazing (Anderson et al., 2006). The interaction between fire and grazing is organized by positive and negative feedbacks that produce spatial and temporal variability across the landscape and has been described as a shifting mosaic (Fuhlendorf and Engle 2001, 2004). With patch burning, fire occurs on a portion of the landscape and the probability of grazing increases as animals graze the burned area heavily, because the presence of cattle in these burned area of high productivity, quality and availability of forage, allowing previously burned areas relief from heavy grazing pressure. It has been shown that fire intensifies water repellency and erosion (DeBano, 1966). These effects reduce infiltration and create overland flow. Grazing increase soil compaction and it has important hydrologic implications such as: decreasing plant growth and infiltration rates, and increasing runoff potentials (Gifford et al., 1977). As we can see most studies of grazing and fire have focused separately on their main effects (Fuhlendorf & Smeins 1997; Engle & Bidwell 2001).The fire-grazing model predicts that the interaction of these two factors is more important than the sum of their main effects because of spatially controlled feedback mechanisms (Fuhlendorf et al., 2004). The proposal project is significant because is going to analyze the relationship between soil physical properties and the interaction of fire-grazing at different regimes "year since focal disturbance" (YSFD) with the goal better preserve and manage Tallgrass prairie system in Oklahoma.



Material and Methods

The area where this project will be conducted is located on the Nature Conservancy' 16 000-ha Tallgrass Prairie Preserve (TGPP), the last remaining extensive tallgrass prairies in North America. It is located in northeastern Oklahoma at the southern edge of the Flint Hills in the tallgrass prairie region of central North America. Topography is gently rolling with soils derived from shale, limestone, and sandstone. Soil samples and infiltration analysis will be performed in the follow areas: annually burn patch and one through three "year since focal disturbance" (YSFD) patches with three replicate sites. Different soil types among the patches are known (soil survey) and will be included in the data analyses. All burns included in this study were conducted just prior to the growing season in March.

Bulk density and Porosity: 20 samples from each patch will be collect randomly to represent the general conditions of the area. A 3-inch Ring will be used as a container of known volume into the soil. After the collection, samples will be placed into plastics bags, labeled, dry oven and weigh. Bulk density indirectly provides a measure of others soil properties. Thus, soil sample from bulk density will be used for calculate soil porosity and water content.

Aggregate stability: 20 samples from each patch will be collect randomly to represent the general conditions of the area. Soil samples will be collected from top soil and 5 cm depth. Field moist soils will be sieved through an 8 mm through a 4 mm sieve; the aggregates that remain on the 4 mm sieve will be used for analysis. Fifty grams of air-dried soil will be placed in the top sieve of the wet-sieving apparatus that contains 5 sieves. Samples will be lowered into water and sieves will be lifted into and out of the water at a rate of 30 rotations per minute. Aggregate stability/size distribution (dry weight of soil remaining in each sieve / total dry weight of initial soil sample) will be calculated.

Infiltration: 20 points from each patch will be choice randomly to represent the general conditions of the area. Two concentric, solid cylinder rings will be used. Then, they will be placed and drive a minimum of 2-inches into the soil. Both cylinders will be filling with water to indicator mark. The drop in water level will be obtain and record in the inner ring at the appropriate interval. The drop that occurs in the inner ring during the final interval, averaged with the 20 points of the test areas shall represent the average infiltration rate for that patch burning area.

Budget

Transportation = $540.00
Daily Rental 12 passenger van: $45.00
Total: 4x45= $180.00
Mileage: $ 0.50 per mile
Total Mileage: 720 mile
Total: $360.00

Field Supply and Equipment =$0.00
Minidisk infiltrometer
Two concentric and solid cylinders
Sand, Water
GPS
Sieve (8mm, 4mm, 2mm, 1mm, 0.5mm, and 0.25mm)
3-inch diameter ring
Hand sledge, Flat-bladed knife, Sealable bags, Market pen

Total Project: $540.00

Timeline

Week 1		
24-Sep	26-Sep	27-Sep
Soil Sample collections *Bulk Density and Total Porosity*	Lab analysis Bulk Density and Total Porosity	Lab analysis Bulk Density and Total Porosity

Week 2		
1-Oct	3-Oct	4-Oct
Soil Sample collections *Aggregate stability*	Lab analysis *Aggregate stability*	Lab analysis *Aggregate stability*

Week 3	
8-Oct	9-Oct
Infiltrometer measurements	Infiltrometer measurements

References

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Oklahoma State University, *Fire ecology*, retrieved from http://fireecology.okstate.edu/

Savadogo, P. Savadogo, L. Savwadogo, D. Tiveau. 2007. Effects of grazing intensity and prescribed fire on soil physical and hydrological properties and pasture yield in the savanna woodlands of Burkina Faso. Agriculture, Ecosystems and Environment, 118 (2007), pp. 80–92

Vermeire, L.T. Vermeire, D.B. Wester, R.B. Mitchell, S.D. Fuhlendorf. 2005. Fire and grazing effects on wind erosion, soil water content, and soil temperature. Journal of Environmental Quality, 34 (2005), pp. 1559–1565

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Stillwater, OK 74074

Education and Training

Institution	*Major*	*Degree*	*(Year)*
Oklahoma State University	NREM- Forest Resources	M.S.	(cand.)
Sao Paulo State University	Forestry	B.S	(2010)

Professional Experience

Graduate Research Assistant
Oklahoma State University, Natural Resource Ecology and Management, Stillwater, OK 74074
Responsible for field and lab operations involving restoration ecology in prairie and pine-oak savanna systems, belowground dynamics, tree-grass interactions and effects of silivcultural treatments on growth, productivity, and physiology of forest stands.
Supervisor: Dr. Duncan Wilson, 2011-present

Research Assistant
Oklahoma State University, Natural Resource Ecology and Management, Stillwater, OK 74074
Responsible for field operations, forest inventory and analysis.
Supervisor: Dr. Rodney Will, Jul-2010 through Nov-2010

Research Assistant
Oklahoma State University, Department of Plant and Soil Sciences, Stillwater, OK 74074
Responsible for field operations and soil chemical analysis.
Supervisor: Dr. Chad J. Penn, Jan-2010 through Jun-2010.

Visitor Research Scholar
Moi University, Eldoret, Kenya.
Responsible for field operations, laboratory analysis, prepare soil and plant corn for greenhouse experiments.
Supervisor: Dr. Saulo Guerra and Dr.R.K. Mibey, Aug-2009 through Nov-2009.