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KANSAS STATE UNIVERSITY CATTLEMEN'S DAY

# Effects of Late-Summer Prescribed Fire on Botanical Composition, Soil Cover, and Forage Production in Caucasian Bluestem-Infested Rangeland in the Kansas Smoky Hills: Year 4 of 5

***H.P. Giefer, K.R. Harmoney, M.P. Ramirez, A.J. Tajchman, Z.M. Duncan, J. Lemmon, and K.C. Olson***

## Abstract

The rapid spread of the old world bluestem species *Bothriochloa ischaemum* (yellow bluestem) and *Bothriochloa bladhii* (Caucasian bluestem) is becoming a threat to the natural landscapes of the central and southern Great Plains. While use of non-selective herbicides has been the primary means of controlling these species, this method is costly, and its lethal effects are not limited to old world bluestems. Recent research has shown late-summer prescribed fire has potential for reducing old world bluestem cover without harming native vegetation. Eighteen one-acre plots were studied in a grazed pasture composed of native mixed-grass prairie and containing large amounts of Caucasian bluestem. Plots were randomly assigned to one of three treatments: no burn (control), one burn (August 14, 2019), or two burns (August 14, 2019, and August 11, 2021). In each plot, soil cover, botanical composition, and forage biomass were measured annually. Bare soil increased ($P < 0.01$) in both fire-treated plots. Consequently, after the first burn the litter decreased ($P < 0.01$) in single and double burn plots. Basal plant area did not differ ($P \geq 0.31$) among treatments. Total grass cover tended to differ ($P = 0.07$) between treatments; however, Caucasian bluestem frequency decreased ($P < 0.01$) following application of a second fire treatment. Biomass in the plots burned twice was less ($P < 0.01$) than in non-burned plots and plots burned once. Grass species richness increased (treatment main effect; $P = 0.01$) in all fire-treated plots. Forb species richness increased ($P = 0.02$) in burned plots after the first burn only, with no differences noted among any plots between treatments in years three and four of data collection ($P \geq 0.54$). These data suggest that regular application of late-summer prescribed fire may be an effective method for reducing Caucasian bluestem frequency while improving overall grass-species richness.

## Introduction

Originally viewed as valuable resources for forage and soil-conservation properties, old world bluestems (*Bothriochloa ischaemum* and *Bothriochloa bladhii*) promptly demonstrated chemical and physical abilities of reducing native vegetation and spreading beyond areas of intended cultivation. Due to their tendency to mature more quickly

than other grasses, nutrient quality of old world bluestems rapidly declines, rendering the forage highly unpalatable to grazing animals relatively early in the growing season. Further adding to the complications of containment, these species display great resiliency when grazed, mowed, or burned in a traditional spring season prescribed fire.

Based on promising research reporting a decrease in yellow bluestem (*B. ischaemum*) cover following a late-summer prescribed fire, the objective of this study was to record the effects of similarly timed fires on a pasture infested with Caucasian bluestem (*B. bladhii*), a phenotypically similar species.

## Experimental Procedures

The location of the experiment was Ellsworth County, Kansas, in a privately owned grazed pasture heavily infested with Caucasian bluestem. The pasture was divided into 18 plots, each one acre in size and arranged in a 9 × 2 block fashion with every set of two plots randomly assigned to one of three treatments: no burn, one burn, or two burns. Preliminary assessment of soil cover, botanical composition, and forage biomass was undertaken in July 2019; fire treatments were applied August 14, 2019, and August 11, 2021. Post-fire evaluations were conducted in July each year beginning in 2020.

A modified step point approach was used to measure ground cover and botanical composition along permanent 162-ft transects in each plot. Forage biomass was estimated by clipping vegetation to a height of 0.39-in inside three randomly placed 19.7 × 19.7-in clipping frames in each plot. Litter was manually removed before clipping, and the remaining live vegetation was placed in a forced-air oven for 96 hours at 131°F. The dry material was weighed and used to estimate overall forage biomass. Aerial frequency of Caucasian bluestem was assessed using a 12 × 12-in frame at 50 points along each transect.

## Results and Discussion

Bare soil increased ($P < 0.01$) with each application of fire on burn-treated plots while litter decreased ($P < 0.01$) after each fire treatment (Figures 1 and 2, respectively). This can be attributed to litter consumption by fire. Litter accumulates over the growing season and a late summer fire will eliminate it without leaving time for buildup before growth ceases for the year. In all years after the first burn, basal plant cover did not differ ($P \geq 0.31$) among plots (Figure 3).

In year four, total grass cover did not differ ($P \geq 0.83$; Figure 4) between treatments, Caucasian bluestem frequency was less ($P \leq 0.03$) in plots burned twice compared to non-burned plots and plots burned once (Figure 5). Concurrently, total warm season (C4) grass cover decreased ($P < 0.01$) in both burn treatments after the first burn and was still less ($P = 0.04$) in plots burned twice than in non-burned plots by year four (data not shown). Midgrasses, including Caucasian bluestem, were the only subgroup of the C4 grasses to decline ($P = 0.03$) in plots treated twice (Figure 6). Total cool season (C3) grass basal cover increased ($P < 0.01$) after each burn in fire-treated plots (data not shown). No differences were detected in native or introduced grasses ($P \geq 0.24$) between plots at any time (data not shown). These data were interpreted to suggest late-summer prescribed fire may be an effective means to reduce Caucasian bluestem frequency without negatively affecting populations of desirable grass species. A drop in biomass ($P < 0.01$) in both burn treatments following the first burn and a subse-

quent drop in biomass in plots burned twice following the second burn can likely be attributed to lower frequency of Caucasian bluestem (Figure 7). Grasses, including Caucasian bluestem, noticeably received more grazing pressure in plots burned twice than in other treatments, implying that removal of litter and dead plant material may have resulted in more desirable grazing.

Grass species richness increased (treatment main effect; $P = 0.01$) in both burn treatments after the first burn and continued to be different ($P < 0.01$) between plots burned twice and non-burned plots by year four (Figure 8). Conversely, a drop after year three in plots burned once resulted in only a tendency for difference ($P = 0.07$) from non-burned plots by year four. Decreases in frequency of Caucasian bluestem, along with canopy elimination following fire, may have allowed greater grass germination and tillering in the newly exposed soil.

Total forb cover was greater (treatment main effect; $P < 0.02$) in plots burned twice compared with non-burned plots, whereas forb cover in plots burned once was intermediate to and not different from non-burned plots and plots burned twice (data not shown). Annual forb cover increased ($P < 0.01$) following the first burn in both burn treatments while perennial forb cover was not different ($P = 0.08$) between treatments (data not shown). Nectar-producing forbs similarly increased ($P \leq 0.04$) in burned plots after the first burn only (data not shown). No difference was detected in native ($P = 0.07$) or leguminous ($P = 0.79$) forb populations (data not shown). Corresponding with overall cover, forb species richness increased ($P = 0.02$) in all fire-treated plots following the first burn, while no differences ($P \geq 0.54$) were detected between plots in years three and four (data not shown). This is likely due to the increase in annual forb cover following the first burn and the subsequent decrease to initial levels.

Shrub cover decreased (treatment main effect; $P = 0.01$) in all burned plots after the first burn but did not decrease significantly ($P = 0.91$) in plots burned twice following the second burn application (data not shown). Low levels of shrub cover persisted in fire-treated plots and shrubs were still significantly less ($P < 0.01$) than in non-burned plots by year four. Basal cover of leguminous shrubs was not different ($P = 0.39$) between treatments over time (data not shown). Many woody plants are intolerant to fire, so only resistant shrubs would have remained after the first fire, leaving fewer susceptible species at the time of the second burn. In close association with the decreases in shrub cover, species richness also decreased (treatment main effect; $P = 0.04$) following the first burn in fire-treated plots (data not shown). Unlike trends in shrub cover, richness once again increased in plots burned once in years three and four and was not significantly different ($P = 0.58$) from non-burned plots by year four. This can likely be attributed to post-burn re-infiltration of shrubs not resistant to fire. Richness in plots burned twice, however, did still differ ($P = 0.03$) from non-burned plots.

## Implications

These data suggest application of late-summer prescribed fire may be an effective, low-cost method of reducing old world bluestem frequency while subsequently improving native grass species richness. The project will be concluded following one more year of data collection in July 2023.

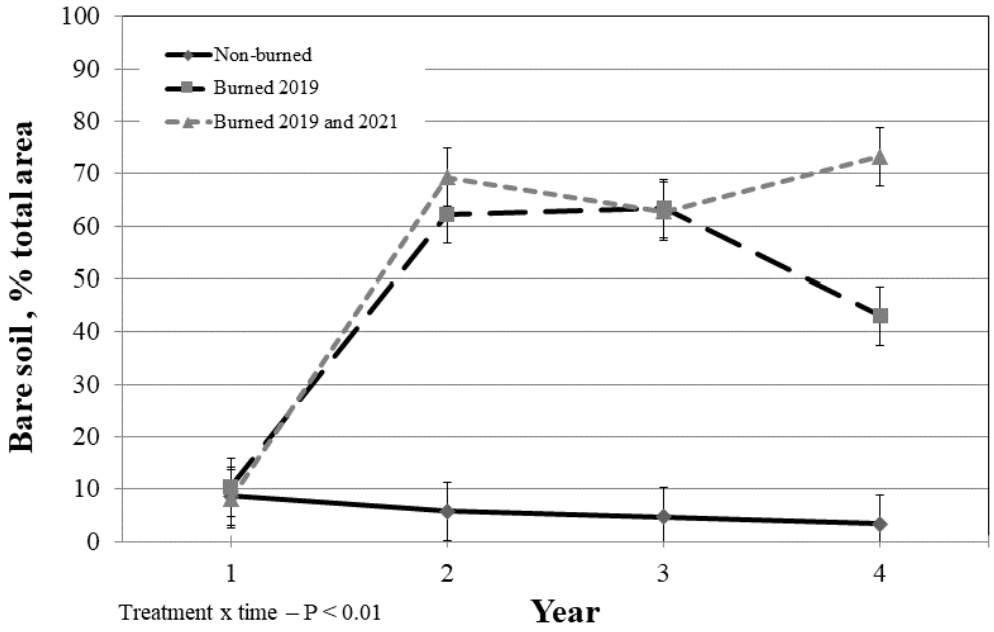


**Figure 1. Effects of late summer prescribed fire on percent bare soil.**

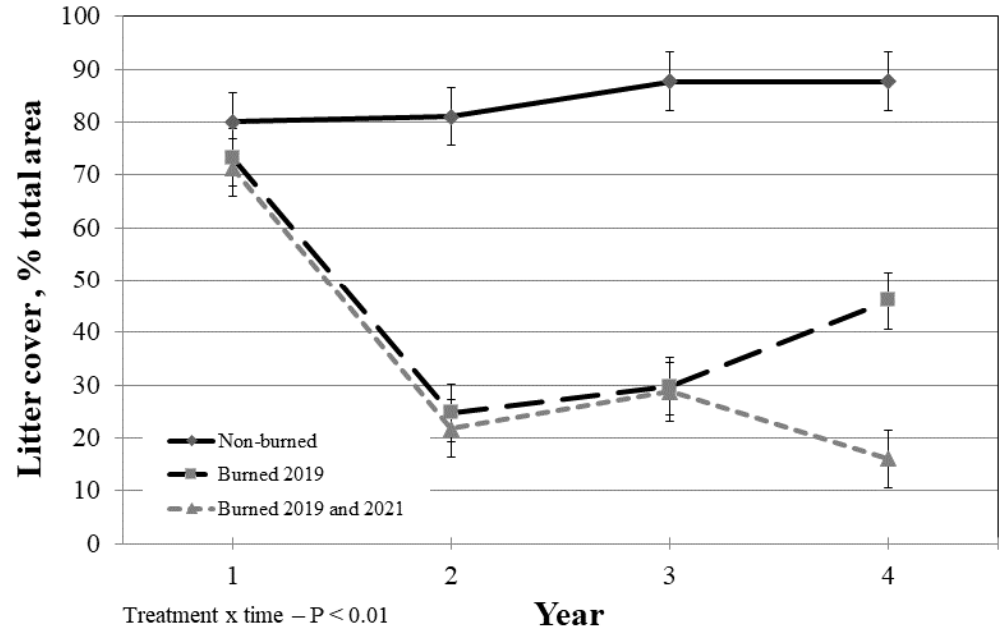


**Figure 2. Effects of late summer prescribed fire on percent litter cover.**

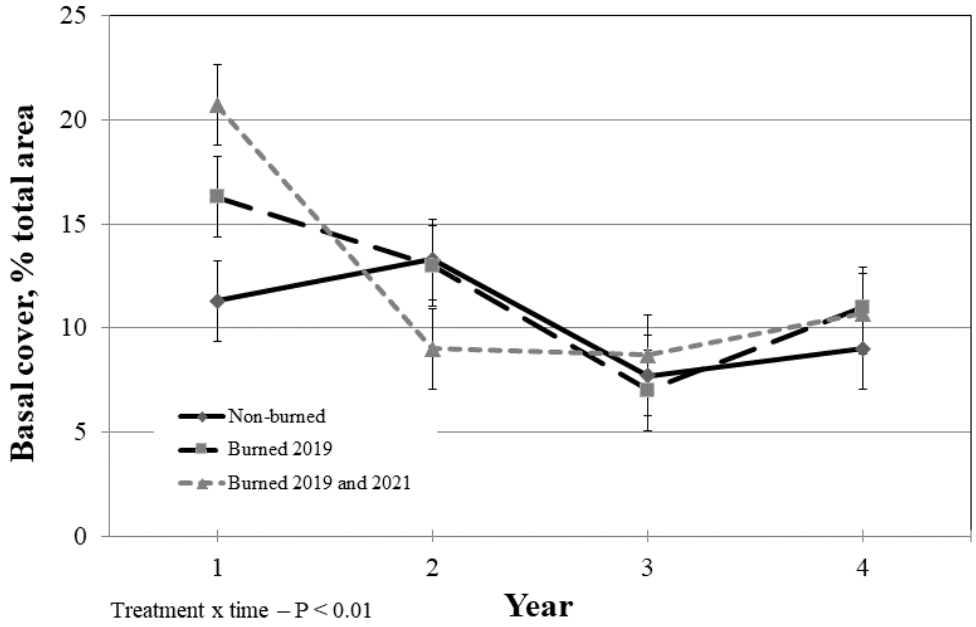


**Figure 3. Effects of late summer prescribed fire on percent basal cover.**

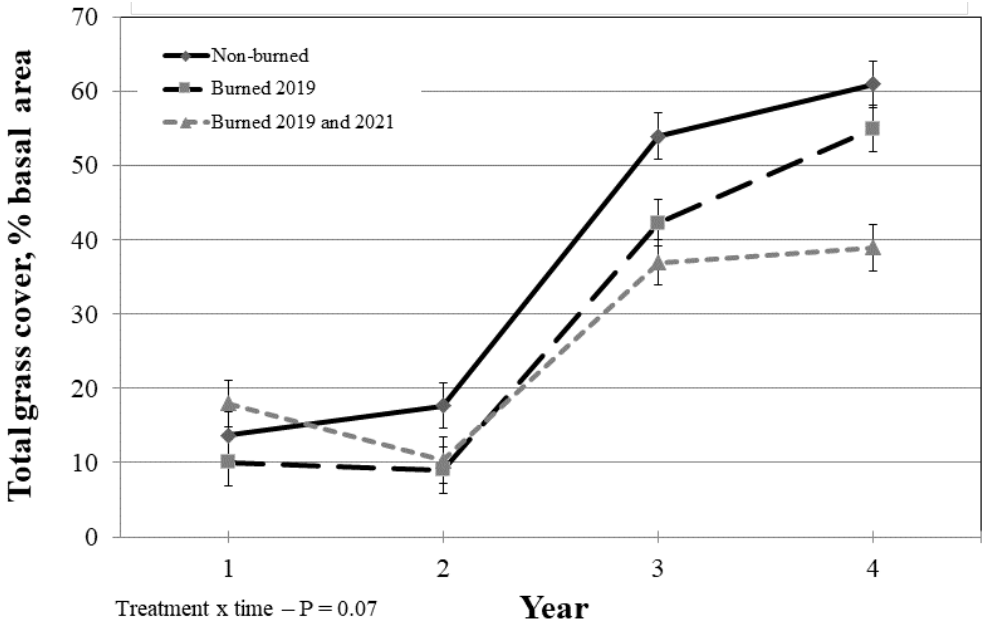


**Figure 4. Effects of late summer prescribed fire on percent total grass cover.**

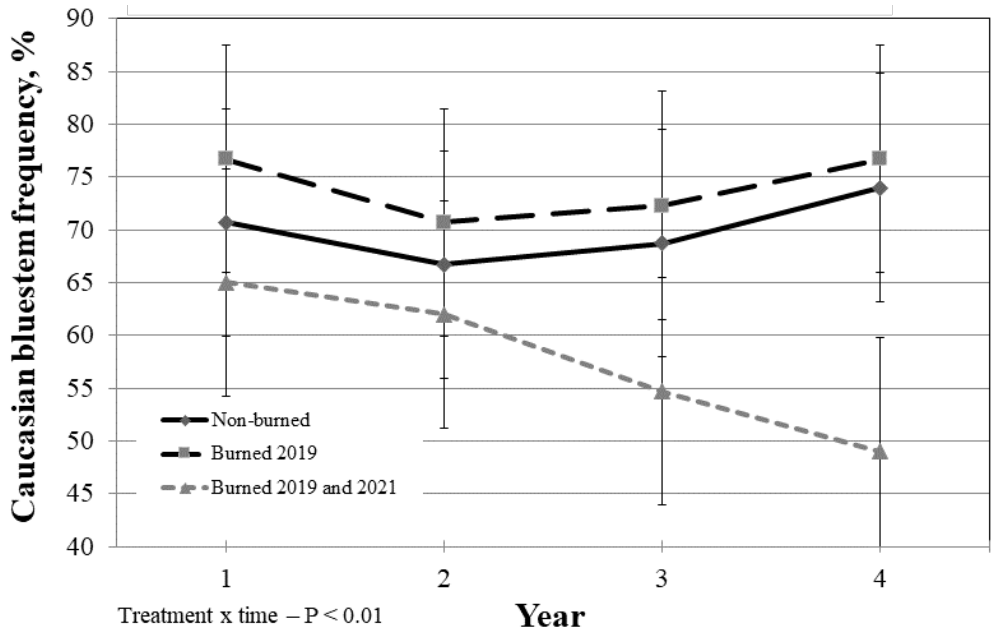


**Figure 5. Effects of late summer prescribed fire on percent Caucasian bluestem frequency.**

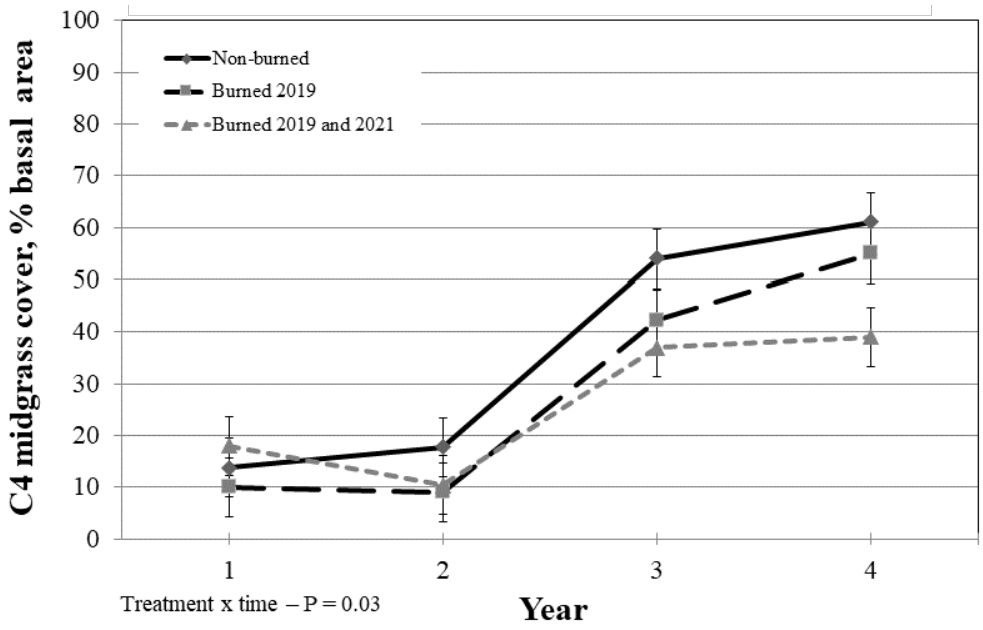


**Figure 6. Effects of late summer prescribed fire on percent C4 midgrass cover.**

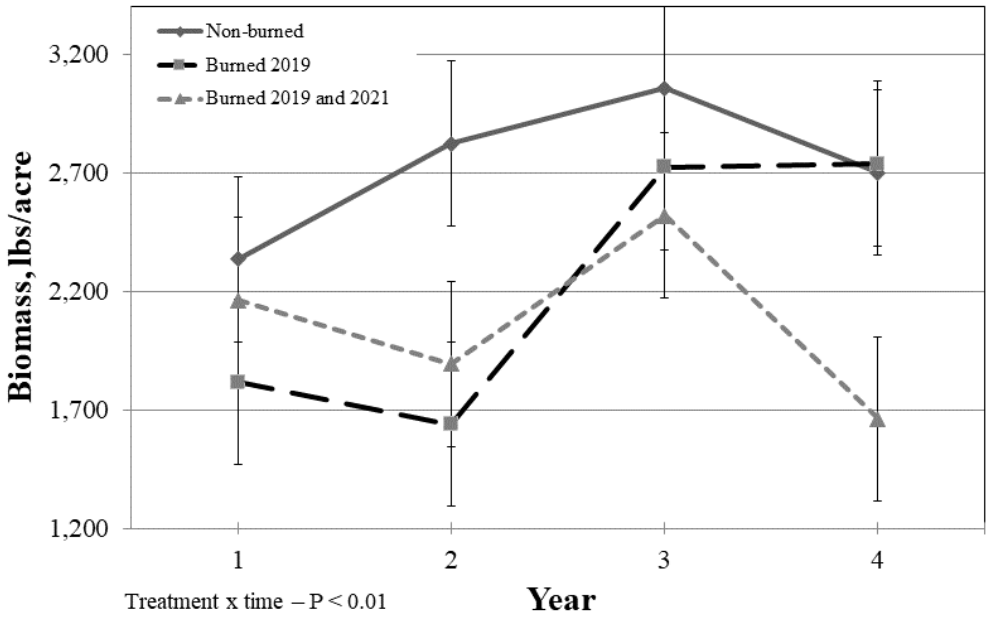


**Figure 7. Effects of late summer prescribed fire on forage biomass.**

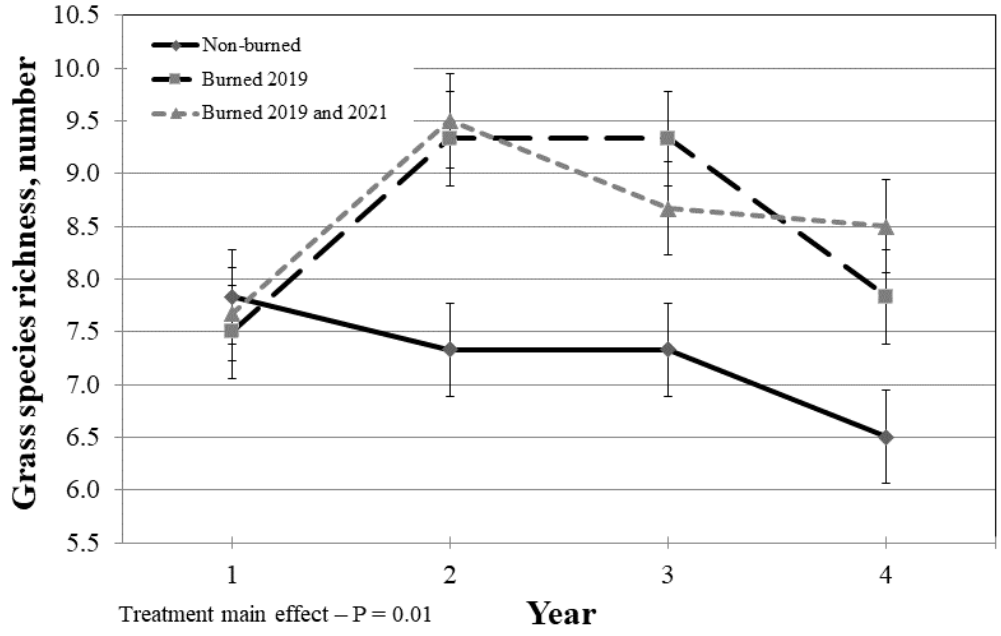


**Figure 8. Effects of late summer prescribed fire on grass species richness.**