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A review of ecological consequences of shifting the timing of burning tallgrass prairie[1]

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INTRODUCTION

Prescribed burning is widely accepted as a critical management tool in the tallgrass prairie, however, the ecological effects of burning at different times of the season are poorly understood. In the Kansas Flint Hills, timing of fire is an important management issue that carries socio-economic as well as ecological implications. Early studies on the effects of early spring burning suggest reductions in total bio- mass production, increases in C3 grasses and undesirable forbs, and little success in controlling woody species. These findings have led land managers and local ranchers in the Flint Hills to burn almost exclusively in late spring to maintain high quality forage production and control undesirable plant species. Despite the myriad of benefits these fires have on agricultural sustainability and ecological function, nearby cities experience a sharp decline in air quality due to the release of concentrated smoke that facilitates tropospheric ozone production. This facilitation is exacerbated in late spring, relative to early spring and winter, due to higher temperatures and insolation.

Towne and Craine 2014 point to possible misinterpretations of earlier studies dealing with early spring burning in the tallgrass prairie and suggest that a more recent 8 year study (Towne and Kemp 2003) provides evidence that burning can occur earlier in the year without the negative repercussions. The authors' goal was to expand on this 8-year study to more thoroughly examine the long-term effects of burning in different seasons. They tested whether the timing of burning effects 1) total grass, forb, and woody species productivity, 2) relationships between grass biomass production and precipitation at different times of year, 3) flowering culm production of the dominant grasses, and 4) changes in plant community composition by analyzing 20 years of data on annual burning in different seasons (fall, winter, spring) from replicated ungrazed watersheds on the Konza Prairie Biological Station.

TOTAL GRASS, FORB, AND WOODY SPECIES BIOMASS

A primary concern for rangeland managers using fire as a management tool is its effects on forage biomass for livestock production. Annual net primary production (ANPP) of grass and forbs, as well as effects on woody species encroachment, may be the most important indicators of success of fire treatments. Across the 20 years of this study, there was no difference in average grass production or change in the difference in grass biomass over time for watersheds burned in autumn, winter, or spring in either up- land or lowland sites.

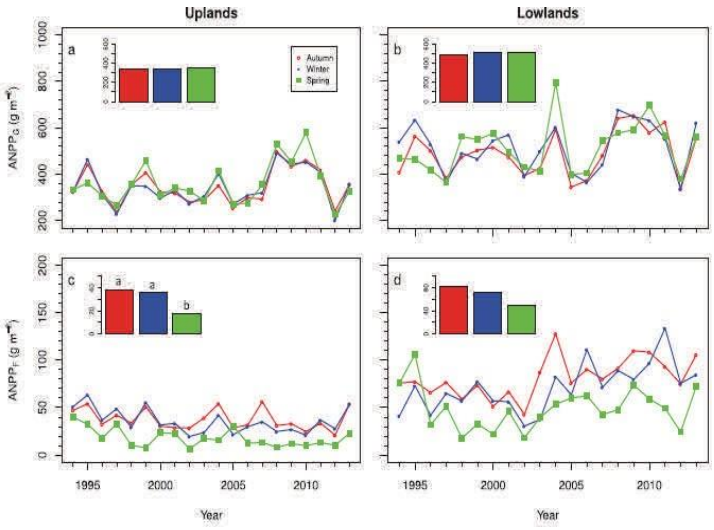

Figure 1. Changes in upland and lowland grass (a,b) and forb (c, d) productivity over time for autumn-, winter-, and spring-burned watersheds on upland (a, c) and lowland (b, d) positions. *Reprinted with permission*.

Forb biomass was greater in autumn and winter burns compared to spring in the upland sites; however, there was no difference among burns in the lowlands. Over time, forb biomass decreased for both winter and spring burns on the upland sites with no change in forb biomass for the autumn

burns. In the lowland sites, forb biomass increased over time for the winter and autumn burns, but no change was detected for the spring burns. Woody species biomass increased across all burn treatments in the upland sites, but no significant change was seen in the lowland sites.

RELATIONSHIPS BETWEEN GRASS PRODUCTION AND PRECIPITATION

A key advantage of long-term data sets, such as this 20-year study, is the ability to examine how differently managed grasslands respond to climatological factors, like precipitation, that are out of a land manager's control. Critical periods of precipitation can determine the perceived failure or success of management strategies such as fire. Towne and Craine 2014 found that grass production levels increased with greater mid-season precipitation for both uplands and lowlands. However, winter and autumn burns showed a longer critical response period to precipitation than did spring burns. Across watersheds, the period when springtime precipitation affected grass productivity was extended under autumn and winter burns compared to spring and precipitation later in the year was more effective for autumn compared to winter and spring burns.

FLOWERING CULM PRODUCTION IN DOMINANT GRASS SPECIES

Fire's effects on the ANPP of the dominant grass species is important in determining the overall effect on total forage available, however, managers should also consider the effects on forage plant productivity. In this study, ne method for determining the forage quality differences between similar measurements of forage quantity is to measure the proportion of lower quality flowering culms (stems) in the dominant grasses. In this study, the authors found that flowering culm (stem) production was greater in spring burns compared to winter and autumn burns in both upland and lowland sites. Over time, no difference was found in culm or grass leaf production in all burn treatments across all sites. However, it is important to note that these results are based on plant responses to fire in the absence of grazing, and that grazers can alter the proportion of total grass productivity made by flowering culms.

SPECIES COMPOSITION

A mix of cool season and warm season grasses and forbs is a critical part of managing rangelands for sustained livestock production and wildlife habitat. These functional groups are vulnerable to the direct and indirect effects of fire at different times of the year, and are affected by the activities of grazers. In late spring, when cool season grasses are starting to grow above ground, the direct effects of fire (heat) can damage or kill individual plants. This can have the negative indirect effects of reducing important cool season species. In both upland and lowland sites in this study, the authors found that autumn and winter burns promoted a broader phenological diversity of species than spring burns. Spring burned sites showed an increase in cover of warm season species compared to winter and autumn burned sights. Two cool season graminoids, *Koeleria macrantha* and *Carex spp.*, increased the most in abundance with autumn or winter burning. In contrast the warm season grass, *Sorghastrum nutans*, increased in cover with spring burning compared to winter and autumn.

CONCLUSION

This study shows that fall and winter burning in ungrazed watersheds of the Kansas Flint Hills can be conducted with little adverse effect on desirable forage species. The authors emphasize three key results from the experiment as evidence to support this case. First, end-of-season grass biomass in ungrazed prairie was not significantly different between autumn, winter or spring burns. Second, autumn and winter burns increased the window of opportunity for grasses to take advantage of spring precipitation for productivity compared to spring burns. Lastly, changes in plant composition from autumn and winter burns favor cool season grasses without negative impacts on warm season grasses, improving overall forage quality and potentially allowing for a longer grazing season. Further studies are needed to assess whether these responses to different sea- son of fire are modified by the activities of grazers.

REFERENCES

[1]Towne, E.G., and J.M. Craine. 2014. Ecological Consequences of Shifting the Timing of Burning Tallgrass Prairie. PLoS ONE 9 (7): e103423. doi:10.1317/journal.pone.0103423.

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