Shortgrass steppe in the southern Great Plains: Prescribed fire, drought, production, and grazing

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INTRODUCTION

Rangeland managers promoting sustainable use of semiarid ecosystems in the Southwestern U.S. face numerous complex challenges, including invasions by non-native species, the expansion of woody vegetation, altered fire regimes, and drought.

These challenges are compounded by uncertainty in how these problems will respond to any changes in climate. Decisions that land managers make today will influence landscapes for decades.

Prescribed fire is used in shortgrass steppes to improve wildlife habitat, reduce fuel loading, and restrict spread of shrubs. Fire affects ecosystem structure, composition, and function, and knowledge of fire effects can guide remediation of disturbed lands. The objective of this study was to determine differences in ungrazed grassland productivity related to prescribed burning season and return interval.

LOCATION

This study was conducted in Kiowa National Grassland of northeast New Mexico. The intact, low relief, shortgrass steppe site is dominated by buffalo grass and blue grama sod and has been used as long-term experimental fire research site for over 20 years. Prior to 1990, it was grazed for livestock production.

TREATMENTS

Plots were randomly assigned to following treatments: growing season fire, dormant season fire, and no fire, at 3-, 6-, and 9-year burn intervals. No grazing occurred on the site during the study period.

Figure 1. Sod-forming shortgrasses cover the experimental units.

Plant species richness was measured 6 years post fire using basal transects. Arthropod data were collected year of fire and one year post-fire using pitfall traps. Small mammal trapping occurred during the year of fire and one year post-fire.

Direct and indirect fire effects on plant, arthropod, and small mammal community structure as well as nutrient cycling were measured.

RESULTS

The long-term effects of prescribed burning were neutral for soil fertility and buffalo grass and blue grama basal cover and nitrogen content.

Grass nitrogen content trended higher as fire interval decreased.

Dormant season burn units had grass cover similar to unburned units in as little as 2 months post-fire. Growing season burn units had reduced grass cover for up to 2 years post-fire. Only the dormant-season fire resulted in higher plant species richness.

Figure 2. Plots were burned with either dormant-season (shown here) or growing season fires.

Soil crusts had decreased nitrogen fixation and reduced chlorophyll a content with dormant season fire, but fire effects were of short duration and tied to dry conditions following fire, but the interaction between drought and fire on soil crusts was not tested.

Litter was reduced immediately post-fire on burned plots. While results were inconclusive, shorter (3 years) fire intervals trended towards reduced litter, soil nitrate, and soil ammonium levels as compared to longer (6 year) intervals. On unburned plots during drought periods, grass cover decreased 50% while soil organic matter, bare ground, and litter increased.

Figure 3. Over three million acres of the shortgrass steppe have been identified as at risk for juniper invasion.

Orthopteran (grasshopper, cricket, mantid, and walkingstick) and Coleopteran (beetle) species richness was higher on both fire-treated plots as compared to unburned plots, but overall abundance of both insect orders was unchanged by fire application. Fire effects lasted longer for orthopterans as compared to coleopterans.

Small mammal species responded differently to the fire treatment, with both fire treatments resulting a greater abundance of northern grasshopper mice while abundance of plains harvest mice and thirteen-lined ground squirrely abundance were not affected. Unlike the herbivore plains harvest mouse, the northern grasshopper mouse lives on grasshoppers which are more abundant after fire, and nests in burrows instead of in litter.

Year-to-year fire effects varied based on rainfall, time since fire, and season of fire.

RANGELAND VEGETATION SIMULATOR DECISION TOOL

ST Sim, a state of the art ecological simulation model, coupled with production characteristics from the Rangeland Vegetation Simulator (RVS), was used for examination of various scenarios based on a selection of grazing regimes and land treatments under various climatic conditions.

Model results indicated that increased drought in the U.S. Southwest may lead to shrub encroachment and a vegetative state transition, particularly if grazing adjustments are not made. Overall, length rather than depth of drought had a larger effect on vegetation transitions.

IMPLICATIONS

In semi-arid grasslands a 3-year fire frequency may result in reduced litter and soils nitrogen, while prescribed fires at 6 and 9-year dormant-season intervals show potential for increasing plant cover, and greater insect richness, relative to unburned grassland under ungrazed conditions.

Available moisture will influence both the type and intensity of fire effects in this semi-arid landscape.

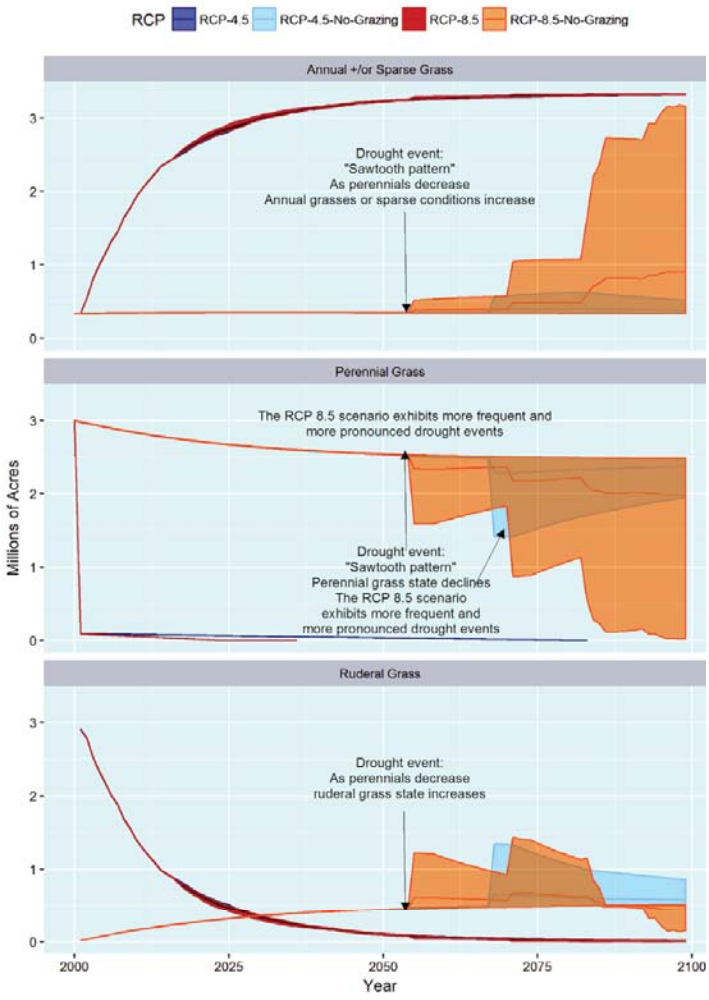

Figure 4. Landscape composition for the Shortgrass Steppe Juniper Potential PVT (Potential Vegetation Type) over time for two RCP (representative concentration pathway) scenarios with and without grazing.

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