Prescribed fire: A proposed management tool to facilitate black-tailed prairie dog (*Cynomys ludovicianus*) colony expansion

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Abstract. Black-tailed prairie dogs (*Cynomys ludovicianus*) are considered a keystone species in grassland ecosystems. Through their burrowing activities, they conspicuously alter grassland landscapes and provide foraging, shelter and nesting habitat for a diverse array of grassland species, in addition to serving as prey for the endangered black-footed ferret (*Mustela nigripes*). Due to a combination of factors, the lands currently occupied by prairie dog colonies are thought to represent less than 10% of their historical range. Black-tailed prairie dogs have difficulty colonizing areas with tall and/or dense plant cover. We examine how manipulations of grassland vegetative structure through fire may be used as a potential management tool for prairie dog colony expansion in shortgrass steppe. The occurrence of fire in grassland ecosystems plays a vital role in maintaining the integrity of grasslands by influencing the rate of nutrient turnover, regulating plant communities, reducing woody species, suppressing the growth of fire-intolerant plants and discouraging invasion of non-native species. Knowledge of how the use of prescribed fire frequency and seasonality affect prairie dog colonization is vital for developing and implementing science-based land management strategies in shortgrass steppe.

Keywords: Keystone species, black- footed ferret, *Mustela nigripes*, shortgrass steppe, Great Plains, fire.

Introduction

Species which through their activities, influence ecosystem structure, composition and function in a unique and significant manner and which can affect the ecosystem disproportionately to their numerical abundance are known as *keystone species* (Paine 1980; Mills *et al*. 1993; Power *et al*. 1996; Kotliar *et al*. 1999). Since its introduction in 1969 by Robert T. Paine, the term keystone species has evolved to describe a species whose presence is crucial in maintaining the organization and diversity of their ecological community and is exceptional to the rest of the community in its importance (Paine 1969; Mills *et al*. 1993). In an effort to maximize biodiversity it has been suggested that keystone species be a top priority for protection and management programs; a necessity in re-establishing and sustaining ecosystem structure and stability (Miller *et al.* 1994).

The black-tailed prairie dog (*Cynomys ludovicianus*) significantly alters grassland ecosystems and is considered by ecologists to be a keystone species that requires active conservation efforts (Miller and Cully 2001). Management for the persistence of prairie dog colonies has been hindered by lack of knowledge regarding the mechanisms for colony expansion. Here, we examine how manipulations of grassland vegetative structure through fire may be used as a management tool for prairie dog colony expansion.

Background

Through their burrowing activities, prairie dogs influence grassland ecosystem structure, composition and function by conspicuously altering landscapes and providing foraging, shelter, and nesting habitat for a diverse array of species. Prairie dogs also affect nutrient cycling rates and serve as prey for a number of predators, including American badgers (*Taxidea taxus*), coyotes (*Canis latrans*), ferruginous hawks (*Buteo regalis*) and the black-footed ferret (*Mustela nigripes*), which is an endangered species (Whicker and Detling 1988; Hoogland 2006). It is estimated that more than 150 different species of vertebrates, arachnids, protozoans, and invertebrates associate and depend on prairie dogs and their colony sites for survival (Hoogland 2006).

Widespread cultivation and grazing of grasslands during settlement by Anglo-Europeans during the late 19th century has had a long lasting effect on the ecological structure of the Great Plains (Brockway *et al*. 2002). Historically, black-tailed prairie dog colonies spanned thousands of square kilometres and occurred from Canada to Mexico and throughout the Great Plains but have declined dramatically over the last 100 years (Northcott *et al.* 2008). The combination of sylvatic plague, sport shooting, fragmentation of the landscape, fears of disease transmission, and grazing competition with livestock precipitated the decline of the prairie dog population, particularly after

government-funded eradication programs came into play. Today, the lands currently occupied by prairie dog colonies are thought to represent less than 10% of their historical range (Anderson *et al*. 1986; Stapp 1998).

Previous studies have shown that manipulations of vegetation by fire are conducive to prairie dog colony expansion, which occurs mainly during the spring in open, flat grasslands with minimal woody vegetation (King 1955; Koford 1958; Butler 1995; Northcott *et al.* 2008). Prairie dog colony expansion occurred, and was directed towards, experimental plots that had been treated by fire (Milne-Laux and Sweitzer 2006; Northcott *et al.* 2008). These previous studies have shown that interaction of fire with shortgrass steppe is important for prairie dog colony expansion because it discourages the growth of dense and tall vegetation. Black-tailed prairie dogs have difficulty colonizing areas with tall and/or dense plant cover (Garrett and Franklin 1988; Wolff 1999).

Fragmentation and habitat loss from agriculture and urban development caused major ecological changes throughout the entire Great Plains, affecting not only prairie dogs, but also the natural fire process in which grasslands evolved (Gottfried *et al*. 1995; Hartnett *et al.* 1997; Frank *et al*. 1998; Brockway *et al.*2002). In grassland ecosystems, fire provides numerous benefits by increasing the rate of nutrient turnover, regulating plant communities, reducing woody species, suppressing the growth of fire-intolerant plants and discouraging invasion of non-native species (Pyne, 1982; McPherson 1997; DeBano *et al*. 1998; Brockway *et al*. 2002). Fragmentation of the grasslands and widespread cultivation and grazing by domestic livestock substantially reduced the amounts of aboveground biomass that normally serves as fine fuel for fire (McGinnies *et al*. 1991; Hart and Hart 1997; Frank *et al*. 1998, Brockway *et al.*2002). Along with fire suppression programs that were implemented in the 1950s, the decrease in standing biomass and fragmented prairie landscape decreased the probability of ignition and spread of grassland fires, virtually eliminating fire in modern prairie ecosystems (Brockway *et al.* 2002). The interaction of fire with grasslands is vital to sustaining ecosystem integrity, however, uncertainty exists concerning the season, frequency and methods that would be most beneficial in restoring fire in shortgrass steppe (Kilgore and Heinselman 1990; Mutch 1994; Brockway *et al.*2002).

Research Needs

The Kiowa and Rita Blanca National Grasslands Ranger District, located in shortgrass steppe in the southern Great Plains, is receiving consideration as a proposed release site for the black-footed ferret. However, prairie dog populations are not currently extensive enough to support a release. The use of prescribed fire in shortgrass steppe for the purpose of encouraging colony expansion of black-tailed prairie dogs is not a process that is well understood. Numerous studies have shown that both the presence of prairie dogs and fire are important to maintaining the integrity of and species diversity in grassland ecosystems. We do not know which season and frequency of fire application would most facilitate prairie dog colony expansion. Research on the 18-year experimental fire research site on the Kiowa National Grasslands has shown that there are significantly different responses by plant and animal species to the season and frequency of fire. Initiated in 1995, the long-term study examines the effects of prescribed fire in shortgrass steppe in northeastern New Mexico (36°31'20"N; 103°3'30"W) (Ford 2007). Although this region has been altered by grazing, fragmentation and fire suppression, it is still dominated by mixed grass or short grass communities (Brown 1994; Ford 2007). The study examined the effects of fire during the growing season and the dormant season at 3, 6, and 9 year intervals. Thus far the study has shown differential responses (positive, negative or unaffected), by small mammals to fire, based largely on life history requirements. Mammals that responded negatively to fire were those that live and forage in dense vegetation and use plant debris for their nests. In this situation, fire removes both their food source and habitat and elicits a negative response (Kaufman et al. 1990; Ford 2007). In contrast, those mammals that respond positively to fire are those that inhabit open areas, feed on insects that are attracted to new vegetation growth, and live in borrows, which offer protection from the fire (Ford 2007).

Methods

Our new research on the long-term experimental fire research site incorporates analysis of the effects of season and frequency of prescribed fire on black-tailed prairie dog colonies. The methods for our future research will involve sampling the plant community and estimating the number of active colonies on each experimental treatment plot. Plots are 140 m x 140 m, with 60 m of unburned buffer areas between each plot (Ford 2007). High resolution satellite imagery will allow us to estimate and track the movement or expansion of the prairie dog colonies by treatment throughout the course of the study. The location, range and pattern of the colonies within the study area will be estimated using remote sensing and GIS technology systems and will be verified by conducting ground surveys and GPS to outline the colonies. Plots with active prairie dog colonies will be distinguished from inactive plots by examining them for the presence of fresh digging, tracks, scat and visual identification. This data will allow us to determine how prairie dogs have responded to the experimental fire treatments, answering the question if manipulations of grassland vegetative structure through fire can be used as a management tool for black-tailed prairie dog colony expansion on the Kiowa National Grassland.

Conclusion

This research may ultimately help to return an endangered species, the black-footed ferret, to a part of its historic range by providing data needed to make science-based management decisions. The research will also aid in the development of site specific recovery plans for both the ferret and the prairie dog. Knowledge of prairie dog response to the seasonality and frequency of fire will allow scientists and resource managers to better prescribe fire regimes that can be used to effectively manage shortgrass ecosystems.

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