

Initial Results of Experimental Studies of Prairie Dogs in Arid Grasslands: Implications for Landscape Conservation and the Importance of Scale

(invited paper)

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Introduction

Numerous ecologists and conservationists believe that prairie dogs increase ecosystem diversity and preserve the function of grasslands (Whicker and Detling 1988, Miller et al. 1994, Jones et al. 1994, Power et al. 1996, Weltzin et al. 1997, Miller et al. 2000), yet this perspective is controversial (Stapp 1998). In contrast, many ranchers and land owners view prairie dog conservation and restoration as a threat to their livelihoods because they believe that prairie dog holes pose a threat to livestock and the prairie dogs consume forage. While numerous studies of prairie dogs have been completed, few comprehensive experimental studies of the ecological effects of prairie dogs have been conducted and none of these studies have been completed in arid grasslands. Since 1999 we have been conducting experimental studies of the interaction of Black-tailed prairie dogs (*Cynomys ludovicianus*) with conservation and lands management. In this paper two fundamental questions are addressed. First, are ranching and other pastoral land uses compatible with the reintroduction of prairie dogs? Second, are the patterns of diversity and ecosystem composition noted from studies of the central and northern Great Plains relevant for desert grasslands?

In addition to an examination of the inherent conflict between conservationist and land manager perceptions of prairie dogs, we also undertake this study because experimental studies of herbivory by small mammals and cattle have convinced us that under current climatic conditions in the Mexico/U.S. borderlands (wet winter and dry summers over much of the past 25 years), herbivory can play a critical role in reducing climatically driven vegetation change and sustaining the biodiversity of arid grasslands (Brown et al. 1997, Curtin et al. 2000, Curtin and Brown 2001).

Experimental Design

In June 1999 we introduced 102 Black-tailed prairie dogs from the Turner Vermijo Park Ranch into four re-search pastures (25 animals per town) on the Gray Ranch in southwestern New Mexico. We have superimposed our reintroduction efforts on the experimental design of grazing and fire studies being conducted in the 8,870 acre (3,696 ha) McKinney Flats research area allowing us to contrast the major driving variables in southwestern grasslands (climate, fire, prairie dogs, and cattle grazing). Within each 2,200-acre (917-ha) sub-pasture is a 1-km² study area that contains four 500 x 500-m treatment areas composed of fire/grazing, fire/no-grazing, no-fire/no-grazing, and no-fire/grazing plots. Within each treatment area and on the prairie dog towns is a 200 x 200-m study area. Plant and animal density and diversity is sampled along five 150-m lines in the center of these study areas. Vegetation is sampled at two meter intervals within 40-cm quadrats for frequency and cover once a year in the fall. At every 30 m along the 150-m lines we have placed a stake resulting in a 5 x 6-m stake grid where lizard and mammal censuses occur. Lizards are sampled three times a summer using pit-fall traps located at the sampling stakes. Small mammal sampling is conducted at the sampling stakes using Sherman live traps. Prairie dogs were translocated into four colonies through the creation of artificial burrows using techniques developed by Dr. Joe Truett and the Turner Foundation. The prairie dogs have subsequently expanded into their own natural burrows. Current analysis involves contrasts of each prairie dog town, with the grazed-unburned plot within the same sub-pasture. We subjected data to paired analysis using a T-Test within the statistical program Statview TM.

Since initiating our study we have found that the prairie dog town in the northwest pasture, in addition to being isolated from the other colonies, is also considerably drier

(8 inches of precipitation annually versus 10 inches in the other towns) and thus is not a true replicate. Therefore for this analysis we will focus on the three towns with comparable conditions in the southwest, southeast, and northwest pastures.

Results

In 2000 and 2001 cover of shrubs, grasses, and bare ground were not significantly different on prairie dog colonies versus control plots ($p = 0.05$). Vegetation diversity was significantly lower ($p < 0.03$) on the prairie dog towns. Vegetation biomass in 2000 ($p < 0.002$) and 2001 ($p = 0.04$) were significantly higher on the prairie dog towns with a mean in 2000 of 56.6 (sd = 12.5) versus a control plot mean of 41 (sd = 3.6).

Measurement of small mammals from 1999 through 2001 ($n = 3$) did not differ significantly between prairie dog and control plots. The mean number on the prairie dog towns was 9.7 (sd = 9.7), while on the controls the number were 9.5 (sd = 9.6). The species numbers on the towns were 3.6 (sd = 2.1) compared to 3.4 (sd = 2.2) off the towns. Biomass on the prairie dog towns was 331.5 (sd = 402.2), while off the towns 351.7 (sd = 288.3).

In contrast to the mammals, the lizards showed a positive response to the prairie dogs. The number of lizards on the prairie dog towns was significantly higher on the towns than off ($p < 0.01$). The biomass was higher on the prairie dog towns, though this difference was marginally non-significant ($p < 0.06$). The lizard diversity was also higher on the prairie dog towns, but like the biomass was also marginally non-significant ($p < 0.07$).

Discussion

In response to the first question (Are ranching and other pastoral land uses compatible with the reintroduction of prairie dogs?), the increased vegetation biomass documented here, and higher nutrient content documented in numerous studies (Coppock et al. 1983, Krueger 1986, Whicker and Detling 1988, Delting 1998), suggests that prairie dog reintroductions can actually have positive benefits for ranchers, and that these patterns are in many ways more tangible than the benefits to conservation. This information, coupled with the disproportionate use of the prairie dog towns by cattle on the pasture, suggests there can be a positive feedback loop between cattle and prairie dogs. The prairie dogs increase forage quality and potentially increase biomass, while the cattle by grazing in the vicinity of the towns mow the grass short thereby reducing the prairie dogs

susceptibility to predators. Because the cows focus their foraging activities in an area about 40 percent larger than the actual prairie dog town, they in turn are expanding the area of potential prairie dog colonization, which in turn can lead to increased amounts of rich forage for the cattle. In addition, the hoof action and intense foraging of the cattle appears to have an effect of increased the micro-topography and habitat diversity on the landscape that is comparable to the effects of the prairie dogs. These observations suggest that much of the system diversity ascribed to many prairie dog towns is a reflection of not just the work of prairie dogs, but an interaction between prairie dogs and large ungulate species including not just native species such as antelope, bison, and deer, but also domestic species such as cattle.

In response to the second question (Are the patterns of diversity and ecosystem composition noted from studies of in the central and northern Great Plains relevant for desert grasslands?), the initial results of this long-term study indicate that prairie dog reintroductions have diverse impacts on ecological systems. At a local scale it is too simplistic to state that prairie dogs have a blanket positive impact on local biodiversity; rather, there are winners and losers. While the prairie dogs did not significantly alter vegetation composition, they did increase vegetation biomass, but decreased species richness. Small mammals show a negative or neutral response to prairie dog reintroduction, while lizards had a positive response. Yet crucial to any discussion of the biodiversity of prairie dogs is consideration of scale. At the scale of a single plot (Alpha diversity – Whittaker 1975) differences between prairie dog and non-prairie dog plots following two years were subtle. Yet the conservation value of prairie dogs lies not in their localized impacts, but in their overall contribution to landscape diversity (Beta and Gamma diversity – Whittaker 1975). This is because the ecological footprint of prairie dog towns extends well beyond their colony boundaries to regional contributions to overall species diversity and shifts in landscape function. For example, cattle and other grazers frequently travel long distances to prairie dog towns to forage, transporting nutrients into the vicinity of the towns (C.G. Curtin, Unpublished). Birds such as burrowing owls (*Athene cunicularia*) rapidly inhabit areas where they were previously scarce (C.G. Curtin, Unpublished). In summary, from both a conservation and management perspective, prairie dog contribution to biological diversity and landscape function lies not at the scale of discrete localized patches, but rather in the matrix of diverse habitats generated by prairie dogs through their activities, and their interaction with other biotic and abiotic patterns and processes.

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Resultados Iniciales de Estudios Experimentales en Perros Llaneros de Pastizales Áridos: Implicaciones Para la Conservación del Paisaje y la Importancia de Escala

(resumen)

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Introducción

Hay numerosos ecologistas con la convicción de que los perros llaneros aumentan la diversidad del ecosistema y preservan la función de los pastizales (Whicker and Detling 1988, Miller et al. 1994, Jones et al. 1994, Power et al. 1996, Weltzin et al. 1997, Miller et al. 2000), aunque esta perspectiva es controvertida (Stapp 1998). En contraste, muchos terratenientes piensan que la restauración y la conservación del perro de las praderas es una amenaza porque creen que las madrigueras de esos animales presentan un riesgo para el ganado, además de que consumen forraje. Se han llevado a cabo muchos estudios sobre los perros llaneros, pero pocos trabajos experimentales existen en relación a los efectos ecológicos de los perros llaneros, y ninguno de estos estudios se ha realizado en pastizales áridos. Desde 1999 estamos llevando a cabo estudios sobre la interacción entre el perro de la pradera de cola negra (*Cynomys ludovicianus*) y la conservación y manejo de tierras. En el presente trabajo se abordan dos cuestionamientos fundamentales. Primero, ¿son compatibles los usos pastorales de la tierra con la reintroducción de perros llaneros? Segundo, ¿son relevantes los patrones de diversidad y de composición de ecosistemas tomados de los estudios de las zonas Centro y Norte de las Grandes Praderas para los pastizales desérticos? Nosotros quisimos realizar este estudio ya que varios estudios experimentales sobre herbivoría ocasionada por pequeños mamíferos y el ganado nos han convencido de que bajo las condiciones climáticas actuales en la región fronteriza México/USA, la herbivoría puede jugar un papel crítico al reducir los cambios en la vegetación producidos por el clima y, además, en sostener la biodiversidad de los pastizales áridos (Brown et al. 1997, Curtin et al. 2000, Curtin and Brown 2001).

Diseño Experimental

En Junio de 1999 introducimos 102 perros llaneros de cola negra provenientes del Turner Vermijo Park Ranch, en 4 pastizales de investigación del Gray Ranch en el suroeste de Nuevo México. Tomamos como modelo los estudios de pastoreo y de quema llevados a cabo en el área de investigación de McKinney Flats, para contrastar las variables más importantes en los pastizales del suroeste (clima, fuego, perros llaneros y ganado). Dentro de cada sub-pastizal hay un área de 1 km² dividida en 4 lotes experimentales de 500 x 500 m para separar los tratamientos fuego/pastoreo, fuego/no pastoreo, no fuego/no pastoreo y no fuego/pastoreo. Dentro de cada área de tratamiento y población de perros llaneros existe un área de estudio de 200 x 200 m. La densidad y diversidad de plantas y animales se muestrea a lo largo de 5 líneas de 150 metros en el centro de esas áreas de estudio. La vegetación se muestrea usando cuadrados de 40 cm de lado una vez al año en el otoño, para medir frecuencia y cobertura. Con el fin de censar lagartijas y mamíferos, a cada 30 metros a lo largo de las líneas, se colocó una estaca formando una red de estacas de 5 x 6. Las lagartijas se muestrearon tres veces en el verano usando trampas localizadas en las estacas de muestreo. El muestreo de pequeños mamíferos se realizan en las estacas de muestreo usando trampas vivas de Sherman. Los perros llaneros se colocaron en cuatro colonias, mediante la creación de madrigueras artificiales, usando las técnicas desarrolladas por el Dr. Joe Truett y The Turner Foundation. Esos animales se han expandido a sus propias madrigueras naturales.

Los análisis actuales involucran contrastes de cada colonia de perros llaneros con el tratamiento no fuego/pastoreo dentro del mismo sub-pastizal. Procesamos los datos en un análisis pareado usando una prueba de T dentro del programa de estadística StatviewTM.

Debido a que al encontrar que la colonia de perros llaneros del pastizal noroeste, además de estar aislada de las otras colonias es considerablemente más seca (2 pulgadas de precipitación menos que las otras), consideramos que no es una buena réplica para el experimento, por lo que decidimos enfocar nuestro análisis a las tres colonias con condiciones comparables.

Resultados

En el 2000 y 2001, la cobertura de vegetación y suelo desnudo no fue significativamente diferente entre las colonias de perros llaneros y los lotes de control ($p = 0.05$). La diversidad de la vegetación fue significativamente más baja ($p = 0.03$) en las colonias. La biomasa de la vegetación en el 2000 ($p < 0.002$) y 2001 ($p = 0.04$) fue significativamente más alta en las colonias con una media en el 2000 de 56.6 (sd = 12.5) contra la media del control de 41 (sd = 3.6).

El número de mamíferos pequeños de 1999 a 2001 ($n = 3$) no fue diferente entre las colonias y los lotes de control. La media en las colonias fue de 9.7 (sd = 9.7), mientras que en el control de 9.5 (sd = 9.6). El número de especies en las colonias fue de 3.6 (sd = 2.1) comparada con 3.4 (sd = 2.2) fuera de ellas. La biomasa en las colonias fue de 331.5 (sd = 402.2) mientras que fuera de las colonias 351.7 (sd = 288.3).

En contraste a los mamíferos, las lagartijas mostraron una respuesta positiva a los perros llaneros. El número de lagartijas en las colonias de perros llaneros fue significativamente más alto que afuera de ellas ($p < 0.01$). La biomasa fue más alta en las colonias, aunque la diferencia no fue significativa ($p < 0.06$). La diversidad de las lagartijas también fue más alta en las colonias pero sin diferencia significativa ($p < 0.07$).

Discusión

En respuesta al primer cuestionamiento, el aumento de la biomasa de la vegetación documentado aquí y el aumento en el contenido de nutrientes citado en numerosos estudios (Coppock et al. 1983, Krueger 1986, Whicker and Detling 1988, Delting 1998), sugieren que la reintroducción de perros llaneros puede tener beneficios positivos para los terratenientes y que esos patrones son, en muchas formas, más tangibles que los beneficios que ofrece la conservación. Esto sugiere que puede darse una retroalimentación positiva entre el ganado y los perros llaneros. Los perros llaneros aumentan la calidad del forraje e incrementan la biomasa, mientras que el ganado, al pastar en la cercanía de las colonias, reduce la altura del pasto y así también la susceptibilidad de los perros

llaneros a los depredadores. Puesto que las vacas se enfocan en comer en un área más grande que la colonia, expanden el área potencial de colonización de los perros llaneros, lo que a su vez lleva a un aumento en la calidad del forraje. Además, la actividad del ganado al pisar y pastar intensamente en el área, parece tener como efecto un aumento en la microtopografía y la diversidad del hábitat, comparable a los efectos de los perros llaneros.

En respuesta al segundo cuestionamiento, los resultados iniciales de este estudio indican que la reintroducción de perros llaneros tiene impactos diversos en los sistemas ecológicos. En una escala local es muy simplista afirmar que los perros llaneros tienen un impacto positivo en la biodiversidad local. Aunque los perros llaneros no alteraron significativamente la composición de la vegetación, sí incrementaron su biomasa, pero también redujeron la diversidad de especies. Sin embargo, el valor de conservación del perro de la pradera no se ubica en su impacto localizado sino en su contribución general a la diversidad (diversidad Beta y Gama – Whittaker, 1975). Esto es porque la influencia ecológica de las colonias se extiende mucho más allá de la frontera de la colonia y contribuye regionalmente a la diversidad de las especies.

En resumen, desde una perspectiva de conservación y manejo, la contribución del perro de las praderas a la diversidad biológica y al funcionamiento del paisaje se da no solo a escala de manchones localizados y discretos, sino en una matriz de hábitats diversos generados por los perros de las praderas mediante sus actividades y su interacción con otros patrones y procesos bióticos y abióticos.

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