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Small Mammal Response to the Gunnison's Prairie Dog Reintroduction

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ABSTRACT: The Gunnison's Prairie Dog (GPD, *Cynomys gunnisoni*) is an herbivorous, burrowing rodent that was extirpated from the Seville National Wildlife Refuge in the 1930's by ranchers to make land available for grazing livestock. Currently, the GPD is the subject of a long-term reintroduction experiment overseen by the U.S. Fish and Wildlife Service. The burrowing and feeding habits of the GPD influences an ecosystem's biotic and abiotic factors significantly, making this species a keystone ecosystem engineer that plays a vital role creating heterogeneous mosaics of habitat. Their presence is correlated with diverse biological communities and maintenance of grassland ecosystems. To better understand the impact of GPDs on small mammal population and diversity, we compared control sites to prairie dog reintroduction sites using a mark-recapture methodology with live trapping of animals on all plots. After placing Sherman traps on all sites over a four-week period, we compared data from previous trapping seasons to measure the long-term effects of the reintroduction on small mammal populations. We hypothesized that sites with reintroduced prairie dogs would have a higher diversity and abundance of small mammals compared to that of the control sites. Our results demonstrate that diversity and abundance is higher overall in treatment plots than in controls over multiple trapping seasons, confirming the importance of a keystone species in an ecosystem.

KEYWORDS: Gunnison's prairie dog, reintroduction, rodents, keystone species

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BACKGROUND

The Gunnison's Prairie Dog (GPD) is commonly found in grassland ecosystems across the western United States, in Colorado, Utah, New Mexico, and Arizona. Once populous and abundant, prairie dog towns could be found from southernmost Canada to northern portions of Mexico (Davidson, Parmenter, & Gosz, 1999). However, as a result of intentional extermination, disease outbreak, and rapid habitat loss, this species of prairie dog was almost entirely eradicated from their range (Davidson et al., 1999). The species' population was reduced by over 90%. Although listed as "least concern" on the International Union for Conservation of Nature's (IUCN) Red List, GPDs consequently became a species of special interest because of reduced colony size and distribution. The other four species of prairie dogs under *Cynomys* have also been categorized as either threatened or endangered (Davidson et al., 2014). The repercussions of exterminating a keystone species were likely never considered, and efforts to restore the grassland ecosystems regulated by GPDs were implemented only recently.

While all species influence their surroundings to some extent, certain species yield greater impact; the GPD, for example, is an essential member of the environment due to its fundamental role as an ecosystem engineer. The presence or absence of a keystone species can also be a major factor in determining the species assemblages that will coexist in an area. With respect to the GPD, there is substantial evidence in the literature to support this notion. Vertebrate species associated with GPDs include a variety of reptiles, birds, and other small mammals, which are found to coexist in higher abundance and richness more often with GPDs than with other species of prairie dog (Clark, Campbell, Socha, & Casey, 1982). GPDs modify their surroundings through grazing, feeding, burrowing, and mound building.

In addition, disturbance to the environment results in an altered landscape; as a result, vegetation density and richness, soil composition, physical landscapes, and affiliated small mammal communities are all impacted by the behavior of GPDs (Bangert & Slobodchikoff, 2000; Davidson & Lightfoot, 2007). Moreover, the presence of this keystone engineer lends to heterogeneous habitats and rich communities by creating distinct patches that differ in their biotic and abiotic constituents relative to that of the surrounding environment (Wagner & Drickamer, 2004). Active prairie dog towns have also been shown to increase landscape fractal dimension across

large geographical scales (Bangert & Slobodchikoff, 2000). (As defined by Krummel et al. [1987], fractal dimension is the quantitative analysis of heterogeneous environmental patches that measures the variability in a landscape and elucidates the driving forces that shape those complex landscapes.) In sum, the GPD plays a key role in shaping grassland community structure (Davidson et al., 2014), and the above-mentioned factors underline the importance of preserving keystone species such as the GPD to sustain an ecosystem's ability to carry out essential functional processes.

When GPD territories and social groups are established, smaller rodent species of the families *Sciuridae*, *Heteromyidae*, and *Muridae* are commonly found coexisting with GPDs (Davidson et al., 1999). Small mammals are useful indicators of an ecosystem's condition because their abundance and diversity are expected to be higher when they co-occur with prairie dogs than if they do not co-occur (Agnew, Uresk, & Hansen, 1986). *Heteromyids* specifically are effective determinants of responsiveness to the GPD, as they too have been shown to affect the environment in ways similar to that of a keystone species (Davidson & Lightfoot, 2008). In one study, the coexistence of these species in grassland systems was shown to increase the number of lizards in an area by twice the amount than when they occurred separately (Davidson et al., 2008). In another paper, the combined effects of prairie dogs and banner-tailed kangaroo rats (*Dipodomys spectabilis*) increased landscape heterogeneity and plant species richness in even greater magnitude, demonstrating the supplementary and interactive impacts these species can have on ecosystems (Davidson & Lightfoot, 2008).

Since the extirpation of the GPD, however, negative repercussions on local biota have become apparent. The affected systems degrade biologically as a result of increased landscape homogeneity, decreased species interactions, and decreased overall biodiversity (Davidson & Lightfoot, 2007). It is for these reasons that this species of prairie dog has gained special attention in recent years and that long-term reintroduction efforts have commenced.

In particular, the relationship small mammal populations have to the GPD is one area of interest in the long-term reintroduction experiment that deserves in-depth investigation. It is important to understand the impact that GPDs can have on small mammal communities because reintroduction projects should be as comprehensive as

possible when attempting to restore a system back to its natural state. Well-informed management techniques and long-term monitoring are crucial to the persistence of a reintroduced species in an environment.

This project's main focus was to quantify the response of small mammal communities to the reintroduced GPD. The project has been ongoing for the last three years and aims to further illustrate the effects species reintroductions can have on established biotic communities. Experimental plots that differed in the presence or absence of prairie dog colonies were used to infer the response by small rodent populations to the GPD. Specifically, this study took place at the Sevilleta National Wildlife Refuge in Socorro, New Mexico during the summer of 2015, from May to August. Our null hypothesis was that GPDs would have no effect on the local small mammal communities. We hypothesized that the population and diversity of small mammals would be higher on the reintroduction sites compared to that of the control sites due to the activity and presence of the GPD.

METHODS

The Sevilleta National Wildlife Refuge in central New Mexico includes over 200,000 acres of natural habitat. It is associated with a large range of biological diversity and houses various types of biomes ranging from mixed shrub desert, to grasslands, to pinyon-juniper woodlands.

This study was conducted near Mackenzie Flats on the east side of the refuge, where short-grass steppe meets the Chihuahuan desert. Prairie dog relocation sites were characterized by blue and black grama (*Bouteloua spp.*) as well as desert cholla (*Opuntia spp.*). High elevation communities, arid desert grassland, and mixed-shrub vegetation were also features of the sites. There are eight 16 hectare (ha) plots established at the study site: A, B, C, D, E, F, G, and H. Each plot is also the site of vegetation surveys, with rows of numbered PVC poles across all plots. Of the eight plots, four are the sites in which individuals of the GPD species have been reintroduced and have established territory (plots B, D, F, and G). The other four plots served as controls, in which GPDs were absent (A, C, E, and H). For this project, we focused on reintroduction plots, B and D, and controls sites, A and C, due to time constraints.

This design allowed us to directly compare small mammal diversity and population size between plot types. We

used these parameters as a measure of response by the rodent communities to the presence or absence of the GPD, and evaluated these responses using a Wilcoxon test in JMP Pro 11 (Jump).

Trapping and processing of rodents was done at one plot per week for four nights. Prior to the first evening of baiting, 169 Sherman traps were set into a thirteen by thirteen grid. A trap, gutter, and flag were set at each vegetation quad, designated by numbered PVCs. This setup was also done in between each vegetation quad PVC, totaling thirteen traps per row. Between each vegetation quad row that ran North/South, thirteen traps were also set (Figure 1). After the plots were set, they were baited with steamed, crimped oats in the evening and left open until processing the following morning.

Processing required walking up and down the rows inspecting traps for a closed door. Any open traps that were encountered were closed, while triggered traps were inspected for animal presence. If an animal was captured, the processor would set the trap upright on the ground, wrap a Ziploc bag over the trap door, and open the trap to release the animal into the bag. Individuals were first checked for any markings or ear tags. Recaptures were recorded, while new captures were processed accordingly. *Dipodomys spp.*, *Onychomys spp.*, *Neotoma spp.*, and *Peromyscus spp.* individuals were given unique ear tags. Species with ears too small to tag were marked with permanent marker on their underside (*Perognathus spp.* and *Sciuridae sp.*), using different colors and sequential numbering to denote the different capture days. Specific measurements to the nearest millimeter were taken for each individual based on the genus: *Peromyscus*, total length, tail, foot, and ear; *Onychomys*, total length, tail, and foot. Sex, reproductive status, weight, and age were also recorded for all captures. After processing, the animals were released on location. Traps then remained closed until baiting the following evening.

RESULTS

Over the summer 2015 trapping season, 203 small mammals were captured and processed. Of these individuals, 133 were captured on treatment plots, whereas the other 70 were found on control sites. In 2014, 435 individuals were captured on treatment sites and 240 from controls (675 captures total). The total numbers of captures in 2015 were significantly different between treatment and controls sites ($p=0.031$), as they also were for 2014 ($p=0.0009$) (Figure 2). For both years,

treatment plots had a higher number of captures overall than did controls. The number of individuals captured in 2015 compared to that of 2014 was significantly different ($p=0.0001$), where the 2015 season had a sharp reduction in the number of captures overall (Figure 2).

The number of banner-tailed kangaroo rats (*D. spectabilis*) was significantly different between treatment and control plots in 2015 ($p=0.01$) but not in 2014 ($p=0.91$) (Figure 3). This was the only species found to have a considerable difference in capture numbers for 2015. Furthermore, there were three more species in 2014 (*D. merriami*, *Perognathus spp.*, and *Onychomys spp.*) that greatly differed in capture numbers between treatments, but not as much in 2015. *Onychomys spp.* captures from 2014 to 2015 were significantly different on treatment plots ($p=0.0016$), but not on control sites ($p=0.45$) (Figure 4). *Perognathus spp.* captures differed substantially on both plot types from 2014 to 2015 ($p=0.0009$, $p=0.0052$) (Figure 5).

The average diversity of small mammal captures in 2015 on treatment plots was 1.33 ± 0.37 (using the Shannon-Wiener Index), while that of the controls was 1.08 ± 0.11 . The average diversity of captures for the 2014 treatment sites was 1.15 ± 0.38 , while control sites had an average diversity index value of 0.93 ± 0.52 (Table 1).

DISCUSSION

Our results support our hypothesis that the presence of GPDs would increase the abundance and diversity of small mammal communities. As expected, there were more captures and higher diversity on reintroduction sites than control sites. Specifically, the presence of banner-tailed kangaroo rats (*Dipodomys spectabilis*) was found to be significantly greater on treatment sites than controls in 2015. This result is notable as it is congruent with the notion that, when these two species co-occur in the same habitat, they lead to more diverse landscapes and animal communities than if they existed separately (Davidson et al., 2008). The greater diversity and overall abundance of small mammals observed on treatment sites compared to controls support this finding. The number of *Onychomys spp.* captures was statistically significant when compared within plot types from 2014 to 2015.

The large difference in the total number of captures within the treatment plots between 2014 and 2015 is likely due to the effects of a prescribed burn that was applied to plot D during the spring of 2015. While the variance in capture numbers was significant for both plots B and D,

plot D had an even greater disparity between trapping seasons: only 16 individuals were caught on plot D in 2015, compared to 216 in 2014.

To avoid having other factors be the potential driver of the observed small mammal abundance and diversity, vegetation cover and precipitation data over the last year were examined for any significant effect they could have had on the results. From 2014 to 2015, treatment sites experienced a 50% increase in vegetation cover while control sites had an increase of 87%, although this difference was not found to have any statistical significance. The increase in cover was likely due to the influx of precipitation from 2014 to 2015 (22mm to 77mm). A large increase in the amount of precipitation, and consequently vegetative cover, could have affected trapping success. Dense cover on the plots could have made it difficult for rodents to find the traps, while the abundance of food sources made it less likely for individuals to actively seek the bait set in the traps. Lower trapping efficiency could have also been the driver behind the drastic decrease in capture numbers during the 2015 summer season compared to 2014. Furthermore, the overall decrease in abundance of small mammals was not exclusive to the study sites, as it was a trend seen across the Sevilleta in 2015. Other species that were commonly encountered included Merriam's kangaroo rats and Ord's kangaroo rats (*Dipodomys spp.*), spotted ground squirrels (*Spermophilus spilosoma*), and woodrats (*Neotoma spp.*), and none of these species were found to have any significant differences between plot types in 2015.

Although not all species increased in abundance on prairie dog plots, there was a discernible trend that showed treatment sites having greater numbers of individuals per species caught than did controls overall. Diversity of the captures in both 2014 and 2015 differed between treatment and control sites, with treatments having a higher average index value in both years. The diversity of the total number of captures also seems to have increased overall from 2014 to 2015.

CONCLUSION

Our results demonstrate that the GPD considerably influences and shapes small mammal communities. Our data may be useful in providing insight to aid wildlife and habitat management plans that aim to preserve, restore, and maintain the natural diversity of flora and fauna that have historically occurred on the refuge.

APPENDIX A

Figure 1: Diagram of how traps were set up on the plots. Vegetation quads (symbolized by a numbered grid) and points between quads depict the placement of a trap. Thirteen traps were placed in each row across thirteen rows. Only the inner grid was used in this study.

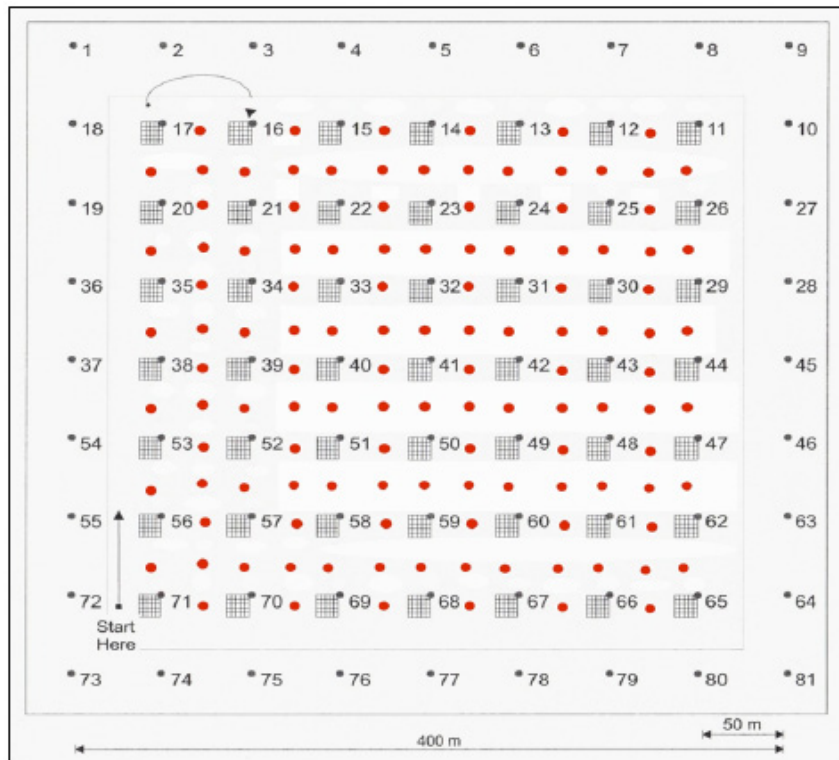


Figure 2: Total number of captures for 2014 and 2015. The number of individuals significantly differed between the two years ($p=0.0001$). Treatment sites in both years had higher numbers of captures than did controls ($p=0.031$, $p=0.0009$, respectively).

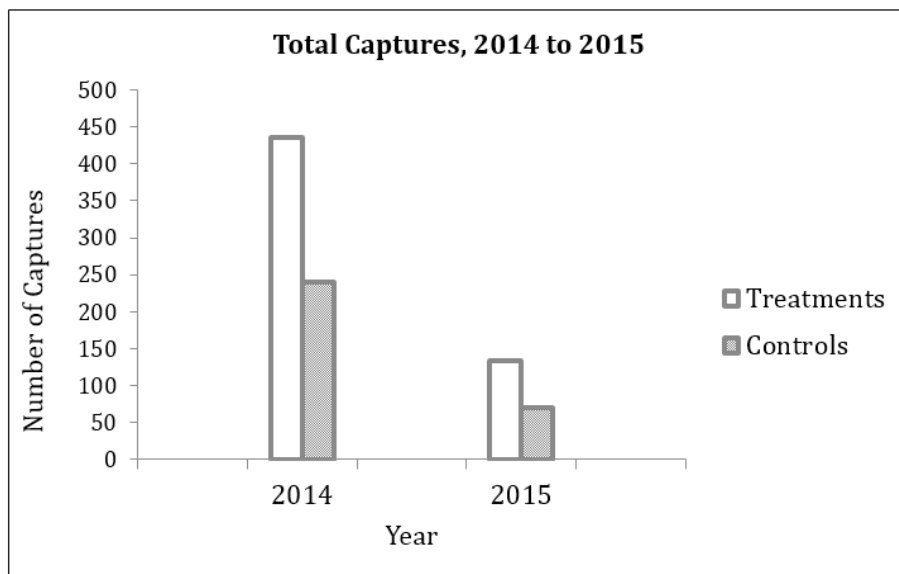


Figure 3: Comparison of the number of captures of *Dipodomys spectabilis* (banner-tailed kangaroo rats) between plot types for the 2015 and 2014 seasons. The number of captured individuals was significantly different in 2015 between treatments and controls ($p=0.01$), but not in 2014.

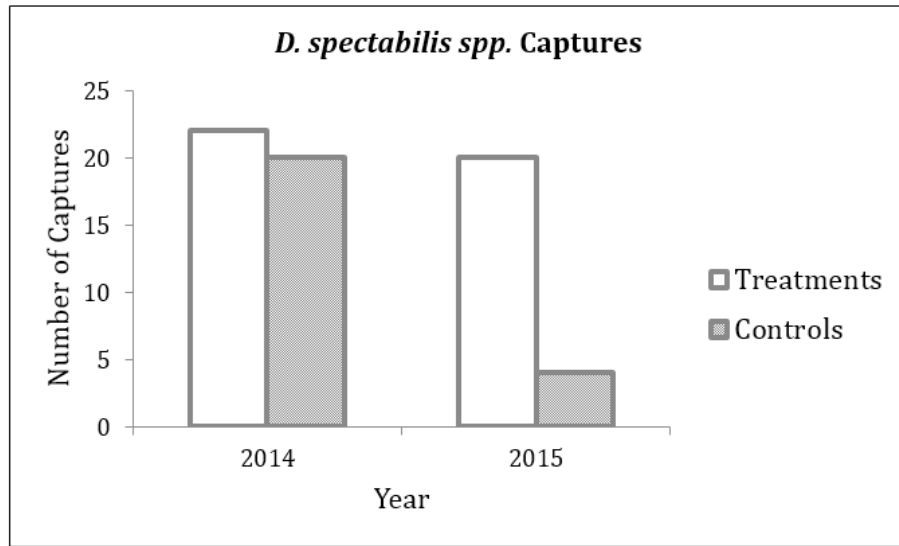


Figure 4: Comparison of the number of *Onychomys spp.* (grasshopper mice) captures between the 2014 season to 2015, based on plot type. The number of individuals was significantly different between treatment sites ($p=0.0016$), but not between control sites ($p=0.45$).

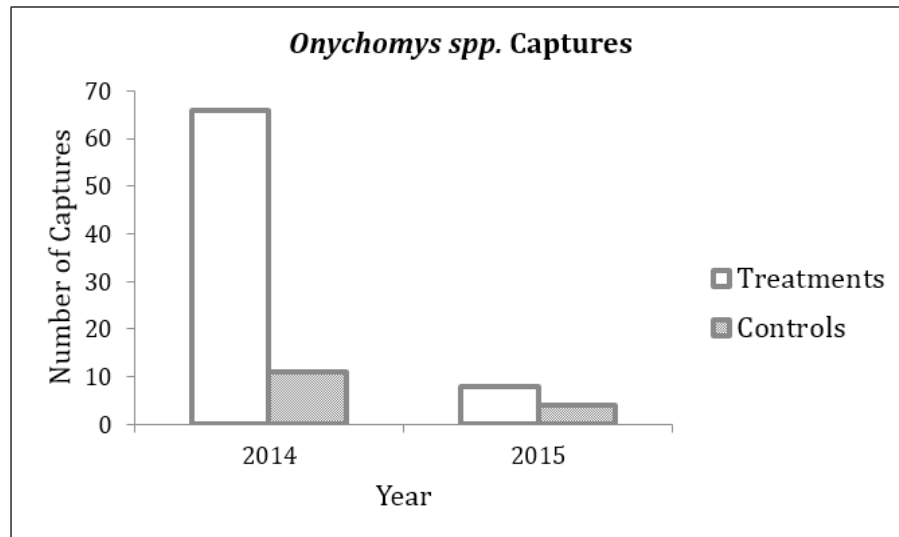
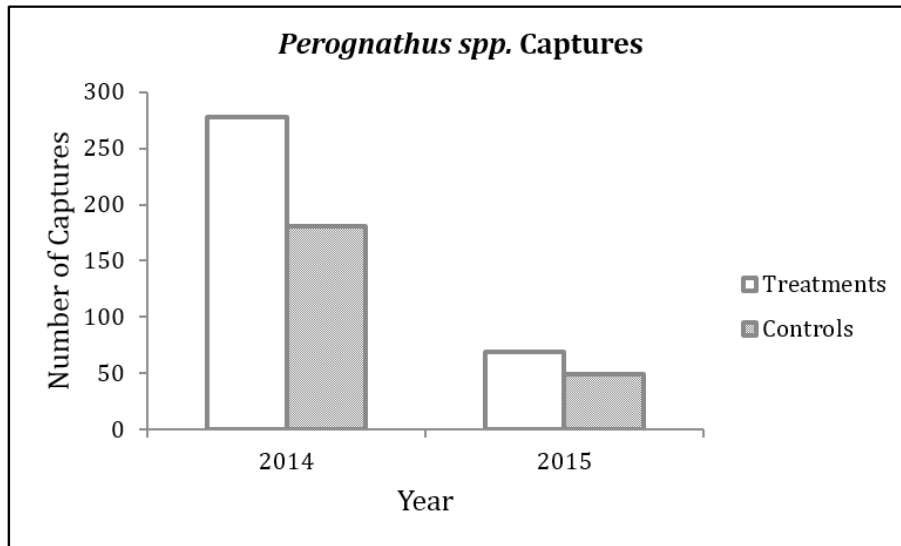


Figure 5: A comparison of *Perognathus spp.* (pocket mice) captures between treatment and control plots from 2014 and 2015. The number of individuals was significantly different between plot types in both years ($p=0.0009$, $p=0.0052$).



APPENDIX B

Table 1: Average diversity (H) between treatment and control plots in 2014 and 2015. Treatment sites had higher diversity values than did controls in both years. The 2015 season had higher values overall in both plot types compared to 2014.

Year	Treatments	Controls
2014	1.15±0.38	0.93±0.52
2015	1.33±0.37	1.08±0.11

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