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First name: Richard
Last name: Reading
Organization: Colorado State University
Title: Director of Research and Conservation
Comments: We are scientists with decades of experience studying prairie dogs (Cynomys spp.) and prairie dog associated species. In this letter, we provide an overview of relevant science that demonstrates the essential role black-tailed prairie dogs play as native keystone species and ecosystem engineers in the Great Plains, including Thunder Basin National Grassland. We are concerned the proposed "2020 Amendment" Draft Environmental Impact Statement does not fully take this into account in its analysis of prairie dog impacts to rangeland vegetation.

This letter is in response to notice 84 Federal Register 54899.

The Portrayal of Black-tailed Prairie Dog Activity in the Draft Environmental Impact Statement for Thunder Basin National Grassland's 2020 Plan Amendment

Thunder Basin National Grassland's Draft Environmental Impact Statement (DEIS) for the "2020 Plan Amendment" does not fully incorporate the role of black-tailed prairie dog (Cynomys ludovicianus; hereafter simply "prairie dog") activity as a natural disturbance process essential to the grassland ecosystem of the Thunder Basin and the wildlife this ecosystem supports. Though the DEIS acknowledges that prairie dogs are keystone species, the analysis of the effects of prairie dogs on rangeland vegetation in the DEIS makes the assumption that prairie dog activity is not part of the reference condition for the ecosystem. This assumption is wrong, yet underlies the analysis and conclusions, as evident in the following excerpts from the DEIS.

* DEIS, page 70: For this analysis, the "representative value" for production of each ecological site's reference plant community was compared to the representative value for production of the vegetative state expected from long-term prairie dog occupation, commonly the "increased bare ground" state or plant community with short-stature vegetation based on target acres for prairie dog occupancy. The reference state and increased bare ground state were chosen for analysis purposes to estimate differences in forage availability among alternatives. (emphasis added; footnote omitted)

This statement indicates that the "bare ground state" is not considered part of the "reference state." Prairie dogs can create areas of sparse vegetation and bare ground. We emphasize that these conditions are within the natural range of variation of the grassland ecosystem. Prairie dog colonies can occur in a given area for thousands of years (White 1985); thus, the colony is within the natural range of grassland variation.

* DEIS, page 80: Plant communities change as prairie dog colonies become more established through time and as population density grows and forage needs increase. In areas recently colonized (less than 10 years), there may be little difference in species composition and production, whereas repeated heavy grazing on older colonies often results in lower overall plant productivity and change in species composition (Johnson and Collinge 2004). Removal of prairie dogs following short-term prairie dog occupation may allow the community to shift back toward the reference plant community, as long as a disturbance threshold has not been crossed.

(emphasis added)

Additionally, tables 11, 12, 13, and 14, include the "Indicator or Measure": "Target acres occupied by prairie dogs that would transition away from the vegetation reference state."

As native species, by definition, prairie dogs and their activities must be treated as essential components of the natural range of variation for Thunder Basin's grassland ecosystem. Prairie dog disturbance does not lead to departure from reference conditions. The following scientific overview supports this assertion.

The Essential Role of Black-tailed Prairie Dogs as

Ecosystem Engineers and Keystone Species

It is hard to overstate the importance of prairie dogs to the ecology of grasslands. The role of prairie dogs as a keystone species is now well-established scientifically (Kotliar et al. 1999; Kotliar 2000; Miller et al. 2000, 2007; Reading 2009; Slobodchikoff et al. 2009; Ceballos et al. 2010; Cully et al. 2010; Davidson et al. 2012; Mart[iacute]nez-Est[eacute]vez et al. 2013; Lacher et al. 2019, Augustine et al. In press). See our attached Table 1. Prairie dogs probably qualify under multiple categories of keystone species[mdash]as prey and for their modification of habitat (Mills et al. 1993, Davidson et al. 2012). The grassland areas that prairie dogs inhabit should probably be considered ecosystems unto themselves (Clark et al. 1989).

Keystone species enrich ecosystem function uniquely and significantly through their activities, and their impact is larger than predicted relative to their biomass (Paine 1980; Terborgh 1988; Mills et al. 1993; Power et al. 1996; Kotliar et al. 1999; Miller et al. 1998/1999). Prairie dogs are functionally unique; they perform roles within their ecosystem not performed by other species or processes (Kotliar 2000). The scientific literature clearly supports the argument that prairie dogs fulfill all the requirement of keystone species (Coppock et al. 1983a, b; Detling and Whicker 1988; Whicker and Detling 1988a, b; 1993; Reading et al. 1989; Kotliar et al. 1997; 1999; Wuerthner 1997; American Society of Mammalogists 1998; Kotliar 2000, Miller et al. 2000; Slobodchikoff et al. 2009; Ceballos et al. 2010; Cully et al. 2010; Delibes-Mateos et al. 2011; Davidson et al. 2012; Mart[iacute]nez-Est[eacute]vez et al. 2013; Lacher et al. 2019; Augustine et al. In press).

Prairie dog activities and the changes made by these activities create a unique ecological system known as the "prairie dog ecosystem" (Clark et al. 1989; Miller et al. 1996). Over 200 vertebrate species have been observed on prairie dog colonies (Table 1) (Koford 1958; Tyler 1968; Campbell and Clark 1981, Clark et al. 1982; O'Meilia et al. 1982; Agnew et al. 1986; Reading et al. 1989; Sharps and Uresk 1990; Mellink and Madrigal 1993; Hoogland 1995; Barko 1996; Manzano 1996; Ceballos and Pacheco 1997; Ceballos et al. 1999; Kotliar et al.

1999, Reading 2009; Davidson et al. 2012, Lacher et al. 2019). Some of these species depend on prairie dog colonies for their survival and many appear to benefit, at least seasonally or opportunistically from their existence (Table 1) (Reading et al. 1989; Hoogland 1995; Manzano 1996; Ceballos et al. 1999; Kotliar et al. 1999; Reading 2009; Ceballos et al. 2010; Cully et al. 2010).

Prairie dogs and other animals inhabiting prairie dog colonies represent a rich prey patch for a large number of predators (Table 1) (Reading et al. 1989; Miller et al. 1996; Plumpton and Anderson 1997; Berry et al. 1998; Kotliar et al. 1999; Reading 2009). A rich diversity of predators including prairie rattlesnakes (Crotalus viridis), golden eagles (Aquila chrysaetos), great horned owls (Bubo virginianus), weasels (Mustela frenata), bobcats (Lynx rufus), coyotes (Canis latrans), and others prey on prairie dogs and small mammals that have a higher abundance on prairie dog colonies (Agnew et al. 1986). Some predators, especially endangered black-footed ferrets (Mustela nigripes), are completely dependent on prairie dogs (Clark 1989; Miller et al. 1996, Jachowski et al. 2011a, b, Eads et al. 2014). Other species, such as badgers (Taxidea taxus), swift foxes (Vulpes velox), and ferruginous hawks (Buteo regalis), benefit substantially from the presence of prairie dogs as prey (Uresk and Sharps 1986; Sharps and Uresk 1990; Allison et al. 1995; Plumpton and Andersen 1997, 1998; Berry et al. 1998; Goodrich and Buskirk 1998).

The benefits of prairie dogs extend well beyond simply being food for predators (Table 1) (Reading et al. 1989; Ceballos et al. 1999; Kotliar et al. 1999). Prairie dogs also substantially alter their environment, although the extent and nature of those changes vary by region and prairie dog species (Mart[iacute]nez-Est[eacute]vez et al. 2013; Baker et al. 2013). Since prairie dogs excavate more burrows than they regularly utilize[1], they create hibernacula, dens, and nests for many animals, such as black-footed ferrets, swift foxes (Vulpes velox), American badgers (Taxidea taxus), cottontails (Sylvilagus spp.), burrowing owls (Athene cunicularia), shrews, other rodents, and several species of reptiles and amphibians (Reading et al. 1989; Sharps and Uresk 1990; Plumpton and Lutz 1993; Fitzgerald et al. 1994; Desmond et al. 1995; Kretzer and Cully 2001; Shipley and Reading 2006; van Nimegen et al. 2008; Reading 2009). These species and more also use the burrows as refugia from predators or temperature extremes. As a result, researchers have found that desert cottontails (S. audonbonii) and northern grasshopper mice (Onychomys leucogaster) exist in higher numbers on prairie dog colonies than in surrounding grasslands (O'Meilia et al. 1982; Agnew et al. 1988; Dano 1952 in Stapp 1998, Cully et al. 2010). Similarly, studies in Mexico found higher rodent species richness, density, and diversity, and higher avian species richness on prairie dog colonies compared with surrounding grasslands in Chihuahua, Mexico (Manzano 1996; Ceballos and Pacheco 1997; Ceballos, et al. 1999; Ceballos et al. 2010). Most of the research to date has focused on birds and mammals. Considerably less research has examined reptile and amphibian associations with prairie dogs, but those findings were similar; namely, that some species appear to benefit from prairie dog activities, while others are harmed, but overall richness is greater across the landscape (Kretzer and Cully 2001; Shipley and Reading 2006; and Shipley et al. 2008). Similarly, little is known about prairie invertebrates (but see Bangert and Slobodchikoff 2004, 2006; Davidson and Lightfoot. 2007; and Kenney et al. 2016), yet the burrows and altered vegetation in a prairie dog colony should offer habitat advantages to some invertebrates as well. Indeed, having both colonized and uncolonized areas of grasslands most likely increases beta diversity in nearly all taxa, creating a more biodiverse landscape (Goguen 2012).

Prairie dogs also have a large effect on vegetation structure, productivity, nutrient cycling, and ecosystem processes (Coppock et al. 1983a,b; Detling and Whicker 1988; Shalaway and Slobodchikioff 1988; Whicker and Detling 1988a, b; 1993; Weltzin et al. 1997a; Stapp 1998, Ceballos et al. 2010; Baker et al. 2013; Connell et al. 2019; Gervin et al. 2019; Geaumont et al. 2019). The activities of prairie dogs, especially their grazing and

clipping of tall vegetation, result in changes in plant composition (Bonham and Lerwick 1976; Coppock et al. 1983a, Detling and Whicker 1988; Whicker and Detling 1988a, b; 1993, Weltzin et al. 1997a; Detling 1998; Ceballos et al. 2010; Gervin et al. 2019). In general, the vegetation on prairie dog colonies is characterized by lower biomass and a greater preponderance of annual forbs and short grasses compared to tall grasses and shrubs, but is higher in nitrogen (crude protein) concentration than vegetation from surrounding areas (Bonham and Lerwick 1976; Coppock et al. 1983a, Weltzin et al. 1997a; Detling 1998, Baker et al. 2013; Connell et al. 2019; Gervin et al. 2019). Several species benefit from these changes and preferably use prairie dog colonies (Table 1), especially due to the short stature of the plants on them, such as Mountain Plover (Charadrius montanus) and Horned Larks (Eremophila alpestris) (Dinsmore et al. 2005).

Prairie dogs negatively impact some plant and animal species (Table 1), reducing the prevalence and controlling the spread of taller grasses and several shrubs, such as mesquite (Prosopis spp.), sagebrush (Artemisia spp.), and longleaf jointfir (Ephedra trifurca) (Bonham and Lerwick 1976; Coppock et al. 1983; List 1997; Weltzin et al. 1997b; Ceballos et al. 2010; Baker et al. 2013; Gervin et al. 2019). Ironically, prairie dogs are poisoned for livestock interests, but these shrubs reduce grass available for cattle, and mesquite makes roundups more difficult (Miller 1991).

Prairie dogs provide a number of ecosystem services. In northern Mexico, Mart[iacute]nez-Est[eacute]vez et al. (2013) found consistently higher ground water recharge, lower rates of soil erosion, increased soil carbon storage, improved soil water potential, and higher forage availability compared with surrounding areas. Prairie dog burrowing activities modify ecosystem processes such as water, mineral and nutrient cycling. Prairie dogs turn over approximately 225 kg of soil per burrow system, which translates to several tons of soil per hectare (Whicker and Detling 1993). By mixing in nutrient-rich urine and manure, prairie dog digging can change soil composition, chemistry, and microclimate, facilitate below-ground herbivory, increase porosity of soil to permit deeper penetration of precipitation, and increase the incorporation of organic materials into the soil (Ingham and Detling 1984; Whicker and Detling 1988 a, b; Munn 1993; Outwater 1996; Mart[iacute]nez-Est[eacute]vez et al. 2013). As a result, prairie dog colonies support higher numbers of nematodes and higher levels of soil nitrogen (Ingham and Detling 1984, Detling 1998). All of these processes contribute to aboveground plants with a higher nutritional content, greater digestibility, and a larger live plant to dead plant ratio, creating favorable feeding habitat for other herbivores (Whicker and Detling 1993; Connell et al. 2019). Indeed, pronghorn (Antilocapra americana) and bison (Bison bison) preferentially graze on prairie dog colonies (Coppock et al. 1983; Krueger 1986; Detling and Whicker 1993, Detling 1998). Some evidence also suggests that cattle use prairie dog colonies for grazing (on the edges) and resting (centers) (Guenther and Detling 2003; Sierra-Corona et al. 2015). Foraging models predict that bison can gain weight faster by grazing on pastures with prairie dog colonies than on grasslands without prairie dogs (Vanderhyde 1985 in Whicker and Detling 1993).

Finally, burrowing owls, and likely other species, benefit from the vigilance of prairie dogs, who issue alarm calls when they spot potential predators (Bryan and Wunder 2014).

Kotliar et al. (1999:177) concluded that collectively these functions are large, not wholly duplicated by other species (either in form or extent), and that the loss of prairie dogs would lead to "substantial erosion of biological diversity and landscape heterogeneity across the prairie." They concluded that the prairie dog therefore fulfills the definition of keystone species (see also Kotliar 2000). We agree. The structure, form, and function of prairie dog

colonies provide a keystone role in the prairie, and the role is large. Despite the difficulty in quantifying a role, we contend that existing evidence indicates prairie dogs (and other associated species) provide important prey to predators, and their grazing and burrowing activities modify the environment in a manner beneficially used by numerous other prairie organisms (Whicker and Detling 1993; Kotliar et al. 1999, Reading 2009; Cully et al. 2010). Most importantly, those grazing and burrowing activities affect vegetative composition, vegetation quantity and quality, productivity, nutrient cycling, and soil quality (Bonham and Lerwick 1976; Coppock et al. 1983; Detling and Whicker 1988; Whicker and Detling 1988 a, b; 1993; Connell et al. 2019). Prairie dog declines and reintroduction attempts into certain regions, for example southern New Mexico (Facka et al. 2010, Davidson et al. 2014, 2018), are problematic owing to arid conditions exacerbated by drought (i.e., climate change). Consequently, maintaining existing prairie dog colonies in their native range is crucial to maintaining prairie dogs, the ecosystems they create, and the species that depend upon them.

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See Letter Submission: page 16 of 24, Table 1. Animal Species cited as associated with prairie dogs and evidence of this association. Updated from Kotliar et al (1999).