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Here are my comments on the Thunder Basin National Grassland DEIS and associated documents. I had previously commented on the Scoping Document on May 18, 2019 (copy of those comments attached).

Black-footed Ferret

For many years, the USDA Forest Service's planning rule has required a land and resource management plan to include components that provide the ecological conditions necessary to contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern. Moreover, the current Thunder Basin National Grassland (TBNG) plan direction responds correctly to the National Forest Management Act, the Endangered Species Act (ESA), and even the Bankhead-Jones Farm Tenant Act. A viable population of the endangered black-footed ferret needs what the current TBNG plan allows, that is, a large expanse of prairie dog colonies. The current plan devotes an area to black-footed ferret reintroduction and promises black-footed ferret reintroduction. The proposed plan amendment eliminates the black-footed ferrets, and makes no real commitment to black-footed ferret reintroduction.

The current black-footed ferret reintroduction area, Management Area 3.63, is a small segment of TBNG, a very tiny area in relation to the historic range of the black-footed ferret. Who can begrudge that? The preferred alternative in the Draft Environmental Impact Statement (DEIS) effectively prioritizes livestock grazing for Management Area 3.63 instead of black-footed ferret recovery. The two need not be mutually exclusive. Black-footed ferret recovery has been difficult, and progress is slow. Yes, prairie dogs and black-footed ferret conservation and management are socially challenging but that's no reason to give up.

Although the DEIS lists black-footed ferret recovery as an issue to address (page ii), Table 1 (Comparison of effects of alternatives related to the issues raised during the scoping period) (page iii) does not mention the black-footed ferret as an issue. Amazingly, human exposure to plague, a miniscule issue as indicated to me by the Wyoming Department of Health (Scoping Comments attached), is listed as an issue and the effects of each alternative stated regarding this issue, but black-footed ferret recovery (large areas of prairie dog colonies required), is absent. Viability of sensitive species and potential species of conservation concern is an issue in Table 1, but black-footed ferret recovery is not addressed in Table 1 even though the ferret is an actual listed species in serious trouble.

Regarding black-footed ferret recovery, the DEIS just states that all alternatives incorporate 1,500 acres. I recommend a more thorough effects analysis than what is presented in the DEIS. Afterall, the elimination of the black-footed ferret Management Area 3.63 (large acreage of

prairie dog colonies) is a central reason for and outcome of the proposed plan amendment. I recommend that under "Issue" in Table 1 black-footed ferret recovery be listed and the effects of each alternative described in terms of required prairie dog colony parameters for a black-footed ferret reintroduction site, including but not limited to: inter-colony distances, colony acreages, and the site's ability to support 30 and 100 black-footed ferrets.

Comment on Nonessential Experimental Population of Black-footed Ferrets in Wyoming under section 10(j) of the ESA

The DEIS barely mentions the 10(j) rule which is designed to make black-footed ferret reintroductions and management easier. The 10(j) rule recognizes the need to control unwanted prairie dog colony expansion from federal lands to non-federal lands. It gives great flexibility to management:

The Service and the WGFD recognize that local involvement is important to the success of recovery efforts and the long-term conservation of the black- footed ferret in Wyoming. Consequently, as required in the 2013 MOU, the Service and WGFD will coordinate to ensure local communities, including potentially affected landowners, stakeholder groups, local governments, and Tribes are fully engaged in any future black-footed ferret reintroduction efforts. Future management plans may contain provisions similar to the following, although the specific content and details will vary by reintroduction site. Public involvement may include but is not limited to the following: (1) Public meetings to outreach to all interested parties on determining potential reintroduction sites; (2) Coordination with all interested parties after a reintroduction site is determined; (3) Direct involvement of management plan development which could include state and federal agencies, County Commissioners, landowners, companies, academia, and other stakeholders, and tribes; (4) Allowing landowners and land managers the opportunity to cooperatively decide the number and distribution of prairie dogs (and correspondingly black-footed ferrets) that may occur on privately owned and leased lands; (5) Annually obtaining landowner approval of human activity necessary for actions specified in a plan; (6) Biannual review of the progress of ongoing activities by all concerned parties; (7) Direct involvement any interested parties in monitoring activities on reintroduction sites.

Evidently, the DEIS disagrees and concludes that neither the 10(j) rule, or the 2001 plan, or the 2009 and 2015 plan amendments make it possible to have a black-footed ferret reintroduction site (large complexes of prairie dog colonies). However, the DEIS is not explicit in quantitative or qualitative terms why the above documents are a failure regarding black-footed ferret reintroduction.

I recommend that any plan amendment make full use of the 10(j) rule so that a black-footed ferret reintroduction site can be established at TBNG. The 10(j) rule states that *Recovery of the species is a dynamic process that requires adaptive management*. There are currently only a few hundred acres of prairie dog colonies on TBNG. New techniques against plague are being developed. Allow the colonies to expand, control the boundaries, adjust grazing and much more. Listen to the words of the 10(j) rule:

One of the benefits of an NEP designation is that it provides flexibility in the regulatory requirements in the area where the reintroduction occurs. This regulatory relief is important

because, prior to reintroduction, these sites had no regulation related to the subject species because the species was not present. Thus, State, tribal, and private landowners typically resist endangered species reintroductions that bring with them new Federal regulation. This resistance can be nearly insurmountable. Fewer black-footed ferret reintroductions would have been initiated during the past 20 years without the added flexibility of nonessential experimental designations. Fewer black-footed ferret reintroductions would have been initiated during the past 20 years without the added flexibility of nonessential designations. To date, 11 black-footed ferret reintroductions have occurred through use of section 10(j) designated NEP areas in the United States...

Comment on Section 7(a)(1) Responsibilities for the Black-footed Ferret

As indicated above, my major concern about the DEIS is the effective elimination of TBNG as a site to aid the recovery of the black-footed ferret. There is presently a definitive site to aid black-footed ferret recovery, Management Area 3.63, under the existing TBNG land and resource management plan. That dedicated site is replaced with a weak future "maybe" for ferrets as stated in Table 6 (Comparison of alternatives and the effects to potential reintroduction of the black-footed ferret) of the Biological Evaluation of Animal Species and Potential Animal Species of Conservation Concern Report and elsewhere: *Meets the minimum requirement (1,500 active acres of black-tailed prairie dogs) for a site to be considered for reintroduction of ferrets.* This is hardly the kind of species conservation commitment required of all federal agencies by the ESA.

The purposes of the ESA are to provide a means for conserving the ecosystems upon which endangered and threatened species depend and a program for the conservation of such species. All federal agencies have a proactive responsibility for the conservation of endangered and threatened species listed under the ESA. Section 2(c)(1) states:

[i]t is further declared to be the policy of Congress that all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of this Act. Conserve is defined by the ESA: "the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to the Act are no longer necessary.

Section 7(a)(1) of the ESA mirrors and expands upon this statutory requirement:

The Secretary shall review other programs administered by him and utilize such programs in furtherance of the purposes of this Act. All other Federal agencies shall, in consultation with and with the assistance of the Secretary, utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species listed pursuant to section 4 of this Act.

Essentially, Section 7(a)(1) expresses a strong assertion that all federal agencies do their best for the conservation of species listed under the ESA. The ESA directs all federal agencies to participate in conserving these species. Again, section 7 (a)(1) of the ESA charges federal

agencies to aid in the conservation of listed species, and section 7 (a)(2) requires the agencies, through consultation with the U.S. Fish and Wildlife Service, to ensure their activities are not likely to jeopardize the continued existence of listed species, or destroy or adversely modify their critical habitat. Section 7(a)(1) conservation is not a novel approach, and its potential and under-utilization to create effective species recovery programs has been recognized by a variety of legal scholars (Eider-Orley 1978; Ruhl 1995; O'Neill 1999-2000; Wood 2004; Gersen 2009) and by the U.S. Fish and Wildlife Service. Agencies are supposed to be proactive for species conservation and not just review their proposed actions under Section 7(a)(2) consultation (see https://www.fws.gov/midwest/endangered/section7/s7process/7a2process.html).

Section 7(a)(1) provides a path to identify and focus listed species conservation efforts across each federal agency's entire authority and/or program footprint, which together will cumulatively promote proactive recovery of listed species. The conservation mandate of section 7(a)(1) has most recently been confirmed by the 2008 11th Circuit Court finding that "...while agencies might have discretion in selecting a particular program to conserve...they must in fact carry out a program to conserve, and not an 'insignificant' measure that does not, or is not reasonably likely to, conserve endangered or threatened species" (emphasis added; Florida Key Deer v. Paulison, 522 F. 3d 1133 (11th Cir. 2008)). Therefore, while implementation of specific conservation actions under section 7(a)(1) may be discretionary, the duty of all federal agencies to develop programs and implement significant actions for the conservation of listed species is not discretionary. In my opinion, the DEIS's elimination of the black-footed ferret reintroduction Management Area 3.63, paltry 1,500 acres of prairie dog colonies in the proposed Management Area 3.67 for a viable black-footed ferret population, and non-committal language for black-footed ferret reintroduction fail to live up to Section 7(a)(1). The above is an insignificant measure that does not conserve an endangered species.

All the courts that have examined section 7(a)(1) have concluded that federal agencies have an affirmative duty to develop and implement programs for the conservation of listed species. In 1998, the U.S. Court of Appeals for the 5th Circuit found that "section 7(a)(1) contains a clear statutory directive requiring the federal agencies to consult and develop programs for the conservation of each of the endangered and threatened species listed pursuant to the statute." *Sierra Club v. Glickman*, 156 F.3d 606, 617 (5th Cir. 1998). The court clarified that "under section 7(a)(1), each federal agency must consult with U.S. Fish and Wildlife Service and develop programs for the conservation of each endangered species that it can affect within its authorities." *Sierra Club at* 606, 618 FN 7.

Other courts have come to the same conclusion. See, e.g., *Defenders of Wildlife v. Gutierrez*, 532 F.3d 913 (D.C. Cir. 2008) (section 7(a)(1) gives the Coast Guard duties regarding the right whale); as mentioned above, *Florida Key Deer v. Paulison*, (11th Cir. 2008) (Section 7(a)(1) imposes a judicially reviewable obligation to carry out programs for the conservation of listed species); *Wyoming Farm Bureau Federation*, 199 F.3d 1224 (10th Cir. 2000) (Section 7(a)(1) authorizes the trapping and transplanting of rare species in order to conserve them); *Pyramid Lake Paiute Tribe v. Navy*, 898 F.2d 1410 (9th Cir. 1990). More recently, the District Court for the District of Nevada stated "[t]hus, the ESA required (and requires) that the USDA take *some* action in an effort to actually conserve the flycatcher" and "[i]n short, the USDA has not adequately demonstrated how its termination policy satisfies its affirmative duty to adopt a

'conservation' policy as required under Section 7(a)(1). *Center for Biological Diversity, et al., v. Vilsack, et al.*, (D. Nev. 2017) (--F. Supp.3d --; No. 2:13–cv–01785–RFB–GWH).

USDA Forest Service was following the law (Section 7(a)(1) in 2001 with the establishment of a black-footed ferret reintroduction area (Management Area 3.63) on TBNG. However, USDA Forest Service in 2020 is now abrogating its responsibilities for the black-footed ferret under Section 7(a)(1) by dissolving MA 3.63. From a large area consecrated to black-footed ferrets to 1,500 acres of habitat and a non-committal "to be considered for reintroduction of ferrets", the USDA Forest Service is no longer following the law and fulfilling its responsibilities under the ESA.

I urge the Forest Service in the EIS or SDEIS to consider its obligations under Section 7(a)(1). Any plan amendment should include a robust contribution to black-footed ferret recovery.

Comment on No Effect Determinations for the Black-footed Ferret

The DEIS delivers "no effect" determinations for the black-footed ferret for the purposes of Section 7(a)(2) consultation. In my judgement, there is an effect because a recovery site, Management Area 3.63, is effectively being eliminated. 10(j) sites count towards recovery. Removal of Management Area 3.63 area hampers recovery. The 10(j) rule contains an entire section called *Relationship of the Experimental Population to Recovery Efforts*.

The 10(j) rule states:

We have determined that the issuance of this rule will advance the recovery of the endangered black-footed ferret. Specifically, this rulemaking will facilitate the establishment of free-ranging populations of ferrets within the species' historical range in Wyoming, thereby contributing to the numerical and distributional population targets laid out in the recovery plan's delisting and downlisting (reclassifying from endangered to threatened) criteria (U.S. Fish and Wildlife Service 2013a, p. 6).

We believe that recovery can be achieved through a combination of expansion of ferret populations at existing reintroduction sites and reintroduction of ferrets at new sites, both of which are possible if conservation of prairie dog occupied habitat and disease management are aggressively pursued.

Under the revised Black-footed Ferret Recovery Plan, the species may be downlisted from endangered to threatened when at least 10 ferret populations, each with at least 30 breeding adults, are established. Thus, downlisting is based on biological parameters (e.g., number of breeding adults, number of successful sites). The recovery plan makes no distinction as to how these populations are designated once biological criteria are satisfied; each population will contribute toward recovery of the species whether it is designated as endangered, essential experimental, or nonessential experimental. The importance of future reintroduction sites to recovery, however, does not mean these populations are ''essential'' under section 10(j) of the Act. All reintroduction efforts are undertaken with the primary goal to move a species toward recovery.

Comment on Black-footed Ferret Reintroduction Sites and TBNG

The U.S. Fish and Wildlife Service has always ranked TBNG as a priority BFF recovery site.

- 1) In the 1990s, the BFF Interstate Coordinating Committee (precursor to the BFFRIT) identified TBNG as one of the highest priority recovery sites in the nation.
- 2) In an August 2, 2000 letter from the USFWS BFF Recovery Coordinator, J. Michael Lockhart, to Forest Supervisor, Jerry Schmidt, USFWS stated: The Cheyenne River area of TBNG is one of the top two, if not the best potential ferret reintroduction site in North America today.
- 3) In 2002, the USFWS ranked TBNG 7th overall in a list that included active BFF recovery sites.
- 4) In a March 16, 2007 letter from USFWS to USDA Forest Service, the need for National Grasslands to contribute to BFF recovery was reinforced.
- 5) In 2008, the USFWS ranked TBNG as 6th in North America for potential reintroduction sites, despite a recent plague epizootic that drastically reduced habitat.
- 6) A BFF Species Status Assessment for Wyoming (Esch et al. 2005) suggested the blacktailed prairie dog complex at TBNG represented a significant site for potential BFF recovery.
- 7) Luce, a former BFF biologist for WGFD, identified TBNG as an immediate potential BFF reintroduction site and WGFD had assessed BFF habitat at TBNG in 2003.
- 8) The Multi-State Conservation Plan for the Black-Tailed Prairie Dog specified a target objective of a prairie dog complex >5,000 acres for conservation of prairie dogs.
- 9) Others have identified TBNG as a priority site for prairie dog ecosystem conservation (Wuerthner 1997, Buseck et al. 2005, Johnsgard 2005, Proctor et al. 2006, Sidle et al. 2006).
- 10) In Wyoming, BFFs are considered a species of Greatest Conservation Need by WGFD State Wildlife Action Plan (2017) and the Wyoming BFF Management Plan (2018) calls for at least one BFF recovery site in the black-tailed prairie dog range. The most obvious black-tailed prairie dog site in Wyoming for a viable reintroduced BFF population is on TBNG. BFFs are native to Wyoming and occupied TBNG likely into the 1970s, with a BFF skull found in 1979 suggesting the recent occupation (Anderson et al. 1986).

The DEIS does not explain why TBNG has gone from a definite reintroduction site to a "perhaps" site. What is the justification? The EIS or SDEIS should make such an assessment. Otherwise, the proposed plan amendment appears arbitrary and capricious.

Finding suitable black-footed ferret recovery sites, that is, extensive areas of prairie dog colonies is difficult. Given the limits of social acceptance of prairie dog colonies on private land, many have viewed federal lands in the western Great Plains as ideal locations for prairie dog conservation and the conservation of associated species such as the black-footed ferret (Proctor et al. 2006, Sidle et al. 2006, Wuerthner,1997). That said, even federal lands can be very fragmented, a land ownership pattern that creates major challenges for the conservation of controversial species such as prairie dogs.

The thrust of the DEIS strongly suggests that extensive areas of prairie dog colonies, black-footed ferret habitat, can no longer be countenanced on federal lands. The DEIS aims for the bare minimum of 1,500 prairie dog colony acres for black-footed ferrets and states:

According to the 10(j) rule, a minimum of 1,500 acres of black-tailed prairie dog colonies is required for a reintroduction site (80 FR 66824); the recovery plan also states approximately 4,500 acres of colonies are expected to be necessary to support at least 30 breeding adult ferrets and more than 15,000 acres are likely needed to support at least 100 ferrets (USFWS 2013).

The U.S. Fish and Wildlife Service developed the minimum 1,500 acres to accommodate a black-footed ferret nursery. The 1,500 acres does not convey: That's all you need for a reintroduction site! TBNG was a suitable site because it had a history of large prairie dog colony complexes. The 1,500-acre minimum is to get ferrets started and expanding acres would eventually allow a viable population of black-footed ferrets. I recommend that any chosen plan amendment clearly state that there will be a black-footed ferret reintroduction site and that TBNG will proceed to 1,500 acres of prairie dog colonies and then 4,500 acres and then 15,000 acres.

Recently, scientists at the USDA's Agricultural Research Service (ARS) examined the challenges and opportunities for biodiversity conservation across the Great Plains that center on the capacity for fire and fauna to move across broad, spatially diverse landscapes and for prairie dogs to play their keystone role (Augustine et al. In Press; copy attached to these comments). They examined the fragmentation of rangeland and the fragmentation of land ownership throughout the Great Plains. Northeast Wyoming, including TBNG, contains one of the least areas of fragmented grassland (see Figure 4 in Augustine et al. In Press). That's one reason why TBNG has been an attractive option for prairie dogs and black-footed ferrets. I recall the 107-page 2000 12-month administrative finding on the black-tailed prairie dog by the U.S. Fish and Wildlife and summarized in the Federal Register. Most of the large prairie dog complexes identified in the finding are gone. Losing TBNG as a black-footed ferret reintroduction site is yet another blow to black-footed ferret recovery. There is no indication in the DEIS that the USDA Forest Service has assessed how the agency's elimination of MA 3.63 affects overall recovery potential throughout the black-footed ferret's historic range and among other federal land management agencies and other organizations.

USDA ARS research (Augustine et al. In Press; copy attached to these comments) states:

The need to coordinate management objectives and practices across property boundaries and jurisdictions to conserve Great Plains fauna has been recognized by many authors, organizations, managers, and agencies (e.g., Samson and Knopf 2004; Fuhlendorf et al. 2012; NRCS 2016). Yet cross-jurisdictional management remains a major challenge within a region that is predominantly private land intermingled with public lands managed by 11 states, 3 provinces, > 1 000 counties and administrative divisions, and at least 4 different federal agencies in the United States alone. Samson and Knopf (2004) proposed that establishment of more meaningful state and federal agency designs is necessary to advance Great Plains grassland conservation. In particular, they suggested that consolidation or realignment of federal agencies and improved state-federal collaboration would reduce conflicting approaches to species conservation and enhance conservation cost-effectiveness. Progress in this regard has been limited over the past 15 yr, but the history of efforts to conserve the Lesser Prairie-Chicken in the southern Great Plains suggests some opportunities to advance cross-boundary management efforts. In some cases, even small nature reserves or other public lands, when managed in a manner that includes effective outreach and interactions with surrounding private landowners, can serve as catalysts for landscape-scale conservation and directly enhance wildlife conservation (Miller et al. 2012). Success in such efforts relies on application of novel advances in the science and practice of engaging landowners...

Boundary management for BTPDs can be an especially significant source of conflict, as their colonies can frequently expand across distances of 800 m in 1-2 yr (Augustine et al. 2008), and management options to prevent such movement can be expensive and contentious (Luce et al. 2006; Miller et al. 2007). It is notable that the Buffalo Gap National Grassland currently has the greatest proportion of its land base occurring in contiguous blocks of grassland distant from property boundaries (see Table 3). This resulted from a program to conduct land exchanges (i.e., exchanges of National Forest System and private land of equal value) to reduce boundary complexity over the past 2 decades. This effort, combined with portions of Buffalo Gap National Gap occurring adjacent to the Badlands National Park and the Pine Ridge Indian Reservation, has facilitated the recovery of BTPD in this landscape and supports the most successful BFF reintroduction site in the Great Plains (US Fish and Wildlife Service 2013).

Those engaged in prairie dog/black-footed ferret management and conservation recognize the challenges indicated by the USDA ARS. The DEIS does not indicate what actions have been taken in the past on TBNG to overcome conflicts. Before and during prairie dog colony increases, what actions were taken to curtail plague, control boundaries, and otherwise act in a preemptive or strategic manner? The DEIS does not quantify complaints registered, actions taken, etc. I recommend that any plan amendment take an adaptive management approach that does not necessarily lock the USDA Forest Service into a hard number of prairie dog colony acres.

Comment on Black-footed Ferret Recovery Plan's Relation to TBNG

The DEIS states:

In regard to species recovery, recovery plans are not regulatory documents, but are instead intended to provide guidance to the U.S. Fish and Wildlife Service, other federal agencies, States, tribes and other partners on methods of minimizing threats to listed species and on criteria that may be used to determine when recovery is achieved. The recovery of a species may be achieved without all criteria being fully met. The proposed Thunder Basin National Grassland 2020 Plan Amendment was developed intentionally to provide design features or plan components that could create ecological conditions necessary for the reintroduction of blackfooted ferrets. Regulatory or not, Section 4 of the ESA clearly authorizes recovery plans for listed species. No, they are not subject to a formal rulemaking process, but recovery plans are a substantive document with full ESA statutory backing. The above quote from the DEIS appears to minimize the importance of the recovery plan and its content. The DEIS rather highlights the Wyoming black-footed ferret management plan instead. The Wyoming plan incorporates many aspects of the federal recovery plan, but is the Wyoming plan regulatory?

Yes, the black-footed ferret recovery plan contains the standard recovery plan disclaimer:

Recovery plans delineate reasonable actions for the conservation and survival of listed species, based upon the best scientific and commercial data available. Plans are published by the U.S. Fish and Wildlife Service (Service or USFWS), and often prepared with the assistance of recovery teams, contractors, State agencies, Tribes and others. Recovery plans are guidance and planning documents and do not necessarily represent the views, official positions, or approval of any individuals or agencies involved in the plan formulation, other than the Service. Although this black-footed ferret recovery plan represents the official position of the Service, identification of an action to be implemented by any public or private party does not create a legal obligation beyond existing legal requirements.

The recovery plan also states:

This revised recovery plan was prepared through collaborative efforts among the U.S. Fish and Wildlife Service (Service) National Black-footed Ferret Conservation Center, the Service's South Dakota Ecological Services Office, the Service's Mountain-Prairie Regional Office, and many other Service offices. We especially thank the members of the Black-footed Ferret Recovery Implementation Team for their review of the plan and their on-the-ground ferret recovery efforts over the past 16 years, as well as their predecessors who initiated conservation actions in 1981 to save this species from extinction.

The recovery plan benefits from four decades of knowledge and experience in black-footed ferret conservation and should have been highlighted and referred to frequently in the DEIS. The EIS or SEIS should assess how any plan amendment contributes to the strategy, goal, objectives and criteria in the 2013 recovery plan for the black-footed ferret. Let's give due credit to both the federal and state black-footed ferret plans.

Other Comments

Public Health and Safety

You have seen my Scoping Document comments. I was critical that the Scoping Document began with:

The Forest Service proposes to amend prairie dog management direction in the Thunder Basin National Grassland land and resource management plan to place greater emphasis on control and active management of prairie dog colonies to address significant concerns related to health, safety, and economic impacts on neighboring landowners. Comment: The Scoping Document provided no data on public health, public safety and economic impacts on neighboring landowners. Although the DEIS does not begin with a strident concern about public health, public safety and economic impacts to landowners, the DEIS equivocates on these matters with words such as could and can no matter how remote the possibility of a concern. I notice that the phrase "economic impacts to landowners" does not appear in the DEIS.

Prairie dog burrowing and clipping habits and the variable nature of their colony extent can have negative effects on forage availability for domestic livestock; infrastructure such as dams, cemeteries, corrals, and buildings; and the monetary value of pasture, residential, and other lands. Prairie dog burrows can also create a tripping hazard horses, cattle, or humans and prairie dogs can pose a risk for transmission of plague-causing bacterial to humans and domestic animals.

Burrows in prairie dog colonies could create safety hazards for permittees, workers, visitors, and livestock on NFS land and where encroachment has occurred on state and private lands.

Comment: During the life of the current plan and even before, how many structures (*dams, cemeteries, corrals, and buildings*) on and off TBNG were compromised by prairie dogs? How many reports of people and animals tripping in burrows? To what extent did land values change during the same period? To what extent have adjacent landowners been harmed during 2001-2019. Let's put some numbers to these matters.

Safety of humans and livestock is another concern related to prairie dog management. Commenters raised the issue that burrows in prairie dog colonies create safety hazards for permittees, workers, visitors, and livestock. Very few safety issues have been reported to the Thunder Basin National Grassland personnel. Of greatest concern is the risk of horses stepping in burrow holes, especially when moving quickly and when carrying a rider. This risk can increase in abandoned prairie dog colonies or following a plague event when taller vegetation may conceal inactive burrows.

Comment: "very few have been reported" says the above, but the Forest Service then equivocates with words such as could and can. This is not an issue and the DEIS provides no quantification of public health and safety issues occurring since 2001 or even before.

Rangeland vegetation and livestock management would be affected by the extent of prairie dog colonies in all four alternatives. The no-action and prairie dog emphasis alternatives would result in the greatest potential occupancy by prairie dogs and the largest negative effects on forage availability and authorized use due to the higher target acreages for prairie dog occupancy.

Comment: Since 2001, when the plan came into effect, what has been the effect of expanding prairie dog colonies on permitted livestock AUMs and actual AUM use? Please present data on authorized AUMs and actual AUMs on the TBNG.

At target acreages, and depending on colony distribution, availability of forage on Federal allotments could cause grazing association members to change grazing management, perhaps by grazing for longer periods on their private properties, finding and securing other private pasture and rangeland leases during summer months, or purchasing more hay and grains to replace forage in winter, early spring, or late fall. While individual replacement costs would depend on ranch-level decisions to mitigate forage availability, additional range or supplemental feed would likely be purchased at prices higher than the cost of grazing on Federal allotments.

Comment: Please give examples of those higher costs. Please present quantitative data on the impacts to AUMs on TBNG during 2001-2019 and even before. If neighboring landowners have been adversely affected during 2001-2019, one would think that they would come forward with information or that the DEIS would display Forest Service AUM information on TBNG. Rangeland management is about manipulating livestock herds and grazing management for many reasons. The TBNG cannot provide a guaranteed steady-state AUM amount.

Livestock production from the national grasslands is very important to local agricultural families with national grassland grazing permits. Many grazing permittees have an interdependent relationship with the national grasslands. Therefore, any increase or decrease in forage for permitted livestock on the national grasslands may cause adjustments in herd size or other ranch operations.

Comment: "any increase or decrease" in the last sentence. This is simply not true. The use of the word, any, is troubling. If the amount of forage in a permittee's allotment decreased or increased by one pound that would not trigger any adjustment in herd size or other ranch operation. These types of exaggeration or bias or poor writing occur in the DEIS.

Competition between livestock and prairie dogs has long been a concern of livestock operators. Direct forage competition has been estimated by numerous studies, and several studies have attempted to estimate how many prairie dogs or what extent of prairie dogs are equivalent to one cow or one animal unit month. Varying densities of prairie dogs, ecological site characteristics, and levels of predation and disease make these estimates difficult.

The DEIS should attempt to define the ecological term, competition. Competition in nature can be very complex involving numerous parameters. In one's vegetable garden different vegetable species co-exist because there are enough soil nutrients and water to go around. In a given area on TBNG where prairie dogs and livestock occur, prairie dogs eat grasses and forbs and livestock eat grasses and forbs. However, eating the same thing does not mean that competition is occurring. Competition occurs, in general, when one species is adversely affected by another species. Livestock may be affected in terms of weight gain as the DEIS indicates. TBNG staff are probably familiar with the research conducted by USDA ARS in Fort Collins, Colorado. Fence management should be explored. A 50-acre prairie dog colony on a 100-acre pasture may affect livestock weight gain but if removal of a fence creates a 200-acre pasture, the effect of the colony on livestock weight gain is likely negligible.

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Yours truly,

May 18, 2019

Mr. Russell Bacon Forest Supervisor Medicine Bow-Routt National Forests and Thunder Basin National Grassland 2648 Jackson ST Laramie, WY 82070

Dear Mr. Bacon,

Thank you for the opportunity to comment on the proposed action to change prairie dog management on Thunder Basin National Grassland (TBNG). I formerly worked for the USDA Forest Service as the Endangered Species Coordinator for Great Plains National Grasslands. My office was in Chadron, Nebraska. So, I have some familiarity with prairie dog and black-footed ferret matters. I worked on black-footed ferret recovery and prairie dog conservation at multiple levels, from field work to administrative responsibilities.

Please accept my comments as stated below on the 2020 Thunder Basin National Grassland Plan Amendment Scoping Document and Proposed Action: Changes to Grassland Plan Direction (Scoping Document).

First, the Scoping Document states: *The Forest Service will prepare an environmental impact statement to inform the responsible official's decision. If the responsible official decides to amend the grassland plan, it will be amended under provisions of the 2012 Planning Rule.* So, according to the above statement in the Scoping Document, it is possible that the USDA Forest Service responsible official will decide not to amend the plan and the 3.63 prescription will remain as is. However, it seems as if the decision to remove the 3.63 black-footed ferret (BFF) area has already been made. On August 14, 2018, the Wyoming Game and Fish Department produced the Thunder Basin and Black-footed Ferrets Talking Points (copy attached) which reads in part:

- In November 2017 the USFWS, USFS and the Department signed an Interagency Statement that the reintroduction of ferrets was not appropriate at that time and that the agencies should continue to focus prairie dog management actions on boundary control and disease control. Copy of statement is attached.
- November 2016, the Governor of Wyoming and the Directors of the Wyoming Game and Fish Department, Wyoming Office of State Lands and Investments and the Wyoming Department of Agriculture sent letters informing the USFS that agencies did not support reintroduction and current prairie dog management implementation.
- The Department, the Wyoming Department of Agriculture, the Service, and USFS publically [sic] stated that they do not support ferret reintroduction until ongoing public issues are resolved.

Add to the above the following quote from a Casper Star Tribune article, Forest Service Urged to Drop Ferret Hopes, dated September 3, 2018: *Tyler Abbott, USFWS supervisor for the Wyoming office, said Wednesday there is no possibility of ferrets being reintroduced until there is greater*

community support and improvement of the habitat. (<u>https://trib.com/news/state-and-regional/forest-service-urged-to-drop-ferret-hopes/article_92450ad4-8423-59f5-b6f9-e4ea7904d44f.html</u>).

Is it reasonable that the USDA Forest Service responsible official is going to go against the Governor of Wyoming, the Wyoming Game and Fish Department, Wyoming Office of State Lands and Investments, the Wyoming Department of Agriculture and the above-mentioned signed statement?

Scoping Document and Cover Letter

The Scoping Document and accompanying April 11, 2019 Cover Letter state: *Comments on this project are requested for a period of 30 days to help identify issues related to the proposed action and develop alternatives. Comments that address specific aspects of the proposed action, identify alternative ways of meeting the purpose and need for the project, or provide suggested language for grassland plan direction will be most useful.*

I believe that there are major issues related to the premises (public health, safety and economic damages) of the proposed action. The premises are stated in the Cover Letter and Scoping Document but there is nothing in the Scoping Document and supporting information on the USDA Forest Service web site to substantiate "significant health, safety and economic impacts on neighboring landowners", the very reasons given in the Scoping Document for the proposed action.

The first paragraph of the Cover Letter states:

The Forest Service proposes to amend prairie dog management direction in the Thunder Basin National Grassland land and resource management plan to place greater emphasis on control and active management of prairie dog colonies to address significant concerns related to health, safety, and economic impacts on neighboring landowners. The proposed action includes changes to management area boundaries and changes to grassland-wide, geographic area, and management area plan direction that pertains to prairie dogs, short-stature prairie habitat, and associated species management (e.g., mountain plover, burrowing owl, and swift fox).

The first paragraph of page 1 of the Scoping Document states:

The Forest Service proposes to amend prairie dog management direction in the Thunder Basin National Grassland land and resource management plan¹ ("grassland plan") to place greater emphasis on control and active management of prairie dog colonies to address significant concerns related to health, safety, and economic impacts on neighboring landowners. This scoping document describes the project location, the purpose and need for the project, and a preliminary proposal so that you can provide comments and help to improve the project.

So, significant public health and safety issues and economic impacts are occurring on and in the vicinity of TBNG and these matters will be resolved by a proposed action that includes *changes to management area boundaries and changes to grassland-wide, geographic area, and*

management area plan direction that pertains to prairie dogs, short-stature prairie habitat, and associated species management (e.g., mountain plover, burrowing owl, and swift fox).

Public Health

What is Public Health?

Although the Scoping Document does not define public health (I assume public health refers to plague), any forthcoming environmental impact statement should define Public Health. According to the Centers for Disease Control and Prevention (CDC) (https://www.cdcfoundation.org/what-public-health), public health is "the science of protecting and improving the health of people and their communities. This work is achieved by promoting healthy lifestyles, researching disease and injury prevention, and detecting, preventing and responding to infectious diseases.

The CDC is "the nation's leading public health agency, dedicated to saving lives and protecting the health of Americans. CDC keeps America secure by controlling disease outbreaks; making sure food and water are safe; helping people avoid leading causes of death such as heart disease, cancer, stroke and diabetes; and working globally to reduce threats to the nation's health. When a national health security threat appears, CDC may not know right away why or how many people are affected, but the agency has world-class expertise to find out what is making people sick and what to do about it.

CDC is ready 24/7 to respond to any natural or manmade event. By connecting state and local health departments across the nation, CDC can discover patterns of disease and respond when needed. CDC monitors health, informs decision-makers, and provides people with information so they can take responsibility for their own health. CDC also trains and guides state and local public health laboratory partners to ensure that labs can safely detect and respond to dangerous health threats."

Public Health as a Widespread and Significant Concern on the TBNG

The Scoping Document specifically mentions public health as a "widespread and significant concern" (page 2) and a prime reason for pursuing the TBNG amendment. Again, health is featured prominently by being mentioned in the second sentence of page 1 of the Scoping Document as well as in the second sentence of the Cover Letter. Public health is mentioned again on pages 2, 6, and 7 of the Scoping Document. This suggests that something serious regarding the public health of neighboring landowners and users of the TBNG has changed since the 2002 record of decision and that an amendment is now necessary. Is this true? Typically, land management agencies amend management plans because something substantial has changed, and a proposed amendment is required.

Page 1 - The Forest Service proposes to amend prairie dog management direction in the Thunder Basin National Grassland land and resource management plan¹ ("grassland plan") to place greater emphasis on control and active management of prairie dog colonies to address significant concerns related to health, safety, and economic impacts on neighboring landowners."

- Page 2 Despite the ecological significance of prairie dogs, the animals cause widespread and significant concern related to public health, safety of humans and livestock, agricultural production, land values, and facilities.
- Page 6 The 2001 Thunder Basin National Grassland revised land and resource management plan ("grassland plan") and the 2002 record of decision limit use of prairie dog rodenticides to situations involving public health and safety risks and damage to facilities.
- Page 7 More effectively manage prairie dog colony encroachment from the Thunder Basin National Grassland onto private and state land. Encroachment concerns include public health, agricultural production, land values, facilities, and serving as a good neighbor as described in the record of decision for the grassland plan.

The second sentence on Page 1 of the Scoping Document is inconsistent with the "Purpose and Need" section (page 7) of the Scoping Document which briefly mentions public health. It is simply difficult for the reader to reconcile the elevated importance of "public health" in the opening statement of the Scoping Document with the Purpose and Need section of the Scoping Document. I make the same comment in other sections of this letter regarding "public safety and economic damages", items not even mentioned in the Purpose and Need section.

Nevertheless, let's explore the "widespread and significant" public health issue. Although many pages in the Scoping Document are devoted to various chronologies about black-tailed prairie dogs, virtually no information is provided about any declining public health or increasing public health risks and threats on the TBNG, specifically on and in the vicinity of the 3.63 area and the proposed 3.67 area. For example, as the extent of prairie dog colonies increased on and in the vicinity of TBNG what changed in the arena of public health? Is there a linear relationship between prairie dog colony acreage expansion and public health?

Considerable resources were likely spent to map tens of thousands of acres of prairie dog colonies. Were resources dedicated to understanding public health changes?

The Scoping Document states:

In 2018, the Wyoming Department of Agriculture convened a collaborative stakeholder group that included private landowners, non-governmental organizations, and government representatives to find a lasting solution to balance multiple uses on the grassland. The group worked together over a 6-month period on some of the most controversial issues related to prairie dog management, and in December 2018 they provided a recommendation that has served as the basis for this proposed action.

If public health (plague) is a "widespread and significant concern" as stated in the Scoping Document, were the Centers for Disease Control and Prevention (CDC) and/or the Wyoming Department of Health's Public Health Division contacted for their input during the 6 months of work by the group convened by the Wyoming Department of Agriculture? Assuming that public health in the Scoping Document means plague (the Document is not explicit on this matter), did the USDA Forest Service consult with public health officials and epidemiologists prior to making the claim in the Scoping Document that plague is a "widespread and significant concern"? Did the CDC or Wyoming Department of Health conclude that plague is a widespread and significant concern on the Thunder Basin National Grassland? I called the Wyoming Department of Health on May 8, 2019, and was referred to the Department's Clay Van Houten who indicated that plague was not a widespread and significant concern. The TBNG Working Group Summary Letter of December 28, 2018 (89 pages) was copied to numerous Wyoming organizations and agencies but not to the Wyoming Department of Health:

Wyoming Association of Conservation Districts Wyoming County Commissioner's Association Wyoming Farm Bureau Federation Wyoming Game and Fish Department Wyoming Mining Association Wyoming State Grazing Board Wyoming Stock Grower's Association Wyoming Weed & Pest Council Wyoming Wool Grower's Association

If public health (plague) is a valid premise for the proposed action, why didn't the Wyoming Department of Health receive the summary letter?

Referring to prairie dogs, the Thunder Basin National Grassland Situation Assessment and Process Recommendations states:

- Their association with the plague is also considered a hazard to human health by the State and others
- Another concern was that prairie dog plague will affect humans
- Two prairie dog plague-related issues that were raised include plague mortality in prairie dog populations and the worry that prairie dogs constitute a health hazard due to possibly carrying this disease
- Specific issues raised included prairie dog encroachment on private and state lands, boundary control, plague as a human health concern...

None of the above mere statements is substantial enough to warrant a plan amendment. What is meant by the above *by the State*?

People have many concerns about a lot of things but whether those concerns should be acted upon by an agency requires a close examination. The USDA must look to public health authorities. I would like to see information from public health officials confirming that there is an existing or potential widespread and significant public health problem on and in the vicinity of TBNG that warrants the USDA Forest Service's proposed "greater emphasis on control and active management of prairie dog colonies." The environmental impact statement that will be prepared for this plan amendment needs to thoroughly analyze the public health problem by contacting the CDC and the Wyoming Department of Health. By statute and regulation, those agencies are charged with determining whether or not there is a human infectious disease problem, not the USDA Forest Service.

Regarding public health, specifically human infectious diseases, CDC typically uses the word, widespread, to describe an ongoing infectious human disease. A search for "widespread" on the CDC web site (<u>https://search.cdc.gov/search/?query=widespread</u>) reveals some examples:

Notes from the Field: Widespread Transmission of Circulating Vaccine-Derived Poliovirus Identified b

This report discusses increased poliovirus surveillance in the Horn of Africa.

- Investigating Liver Disease in Ethiopia | Sharing Our Stories | NCEH This story explains an epidemiological investigation into the cause of widespread deadly liver disease in Ethiopia, featuring a team of epidemiologists from CDC/NCEH, Ethiopia health...
- Update: Influenza Activity --- United States, September 30, 2007--February 9, 2008 was 3.5%, ¶¶ which was above the national baseline of 3.2% (Figure 2). State-Specific Activity Levels Until the week ending January 5, widespread*** influenza activity had not been reported in any state
- Progress Toward Poliomyelitis Eradication -- Pakistan, 1994-1998 In 1997, Pakistan reported 1147 polio cases, representing widespread poliovirus circulation nationally and constituting 22% of cases reported worldwide.
- Pertussis | Outbreaks | PEP Postexposure Antimicrobial Prophylaxis | CDC Pertussis Outbreaks. With increasing incidence and widespread community transmission of pertussis, extensive contact tracing and broad scale use of PEP among contacts may not be an effective use...
- Strategies to Reduce Person-to-Person Transmission during Widespread Escherichia coli 0157:H7 Outbre

What is the History of Public Health on and in the Vicinity of the 3.63 Area and Proposed 3.67 Area on TBNG?

- Page 6 The 2001 Thunder Basin National Grassland revised land and resource management plan ("grassland plan") and the 2002 record of decision limit use of prairie dog rodenticides to situations involving public health and safety risks and damage to facilities.
- Some questions:
 - What has changed during 2002-2019 such that there are now widespread and significant concerns for public health, concerns that were not addressed in 2002?
 - Are more human residences in the vicinity of the 3.63 area and proposed 3.67 area closer to prairie dog colonies today in 2019 than in 2002?
 - During 2002-2019, how many interventions were made by the USDA Forest Service to control prairie dogs because of the potential spread of plague to humans?
 - During 2002-2019, how many cases of plague in humans have occurred in the vicinity of the 3.63 area and proposed 3.67 area? How many Thunder Basin staff, livestock permittees, hunters, hikers, birders, etc. have contracted plague?

• While epizootic plague reduced prairie dog colony acreage from 48,000 acres on TBNG and 27,000 acres on private land to 600 and 500 acres, respectively, how many humans contracted plague?

Likelihood of a Public Health Issue on TBNG

The last time a human in Wyoming contracted the plague was in 2008, one of six cases since 1978 (https://health.wyo.gov/publichealth/infectious-disease-epidemiology-unit/disease/plague/). The six cases occurred in Fremont, Goshen and Laramie counties, a long distance from the Thunder Basin National Grassland (Figure 1). Nationwide, there were 105 cases (12 fatalities) of plague in humans during 2000-2017.

I understand the need to eliminate prairie dog colonies or control fleas in the "immediate" vicinity of a human residence. However, any largescale elimination, including one-mile buffer zones from residences, of prairie dog colonies ostensibly to reduce the risk of plague in humans cannot be substantiated.

Plague prevention should be consistent with CDC recommendations for plague prevention in humans (<u>https://www.cdc.gov/plague/prevention/index.html</u>):

- 1. Reduce rodent habitat around your home, workplace, and recreational areas. Remove brush, rock piles, junk, cluttered firewood, and possible rodent food supplies, such as pet and wild animal food. Make your home and outbuildings rodent-proof.
- 2. Wear gloves if you are handling or skinning potentially infected animals to prevent contact between your skin and the plague bacteria. Contact your local health department if you have questions about disposal of dead animals.
- 3. Use repellent if you think you could be exposed to rodent fleas during activities such as camping, hiking, or working outdoors. Products containing DEET can be applied to the skin as well as clothing and products containing permethrin can be applied to clothing (always follow instructions on the label)
- 4. Keep fleas off of your pets by applying flea control products. Animals that roam freely are more likely to come in contact with plague infected animals or fleas and could bring them into homes. If your pet becomes sick, seek care from a veterinarian as soon as possible.
- 5. Do not allow dogs or cats that roam free in endemic areas to sleep on your bed.

To further explain my point about plague, let me briefly discuss the mosquito-borne West Nile virus. In stark contrast to the very small number of plague cases in the United States (2000-2017), during a similar period, 1999-2017, there were 48,183 cases (2,163 fatalities) of West Nile in the United States. Wyoming, especially northeast Wyoming, the location of TBNG, has one of the nation's highest average annual incidences of West Nile virus neuroinvasive disease (Figure 2).

One is far more likely to contract West Nile virus, a potentially debilitating or fatal disease, than plague on and in the vicinity of the TBNG. There are no vaccines to prevent or medications to treat West Nile virus in humans (<u>https://www.cdc.gov/westnile/</u>) but plague in humans is easily

treated. Are there widespread and significant public health concerns about the impacts of West Nile virus on and in the vicinity of TBNG? Is the USDA Forest Service contemplating the elimination or vast curtailment of stock tanks, stock ponds and other standing water sources harboring breeding mosquitos on TBNG? Is the widespread application of larvicides being contemplated? Will there be a plan amendment to address West Nile virus? Probably not; rather, the USDA Forest Service would likely advise its staff and the public to follow various prevention measures recommended by public health agencies (example below from the Wyoming Department of Health). Similarly, any plague prevention should follow the above modest CDC recommendations.

Another illustration of this issue is lightning. Citizens of Wyoming are much more likely to be killed by lightning than by plague. According to the National Weather Service: "From 1996 to 2013, lightning has been attributed to 8 fatalities and 70 injuries across Wyoming. Wyoming is 1st in number of lightning deaths & injuries per capita (1959 to 2012)." (https://www.weather.gov/cys/severe_weather_awareness_week_thurs)

4 D's of West Nile Virus prevention (<u>https://health.wyo.gov/publichealth/infectious-disease-epidemiology-unit/disease/west-nile-virus/</u>):

- 1. DAWN & DUSK When possible, avoid spending time outside at dawn and dusk
- 2. DRESS– Wear shoes, socks, long pants, and a long-sleeved shirt when outdoors for long periods of time or when mosquitoes are most active. Clothing should be light colored and made of tightly woven materials to keep mosquitoes away from the skin.
- 3. DRAIN Reduce the amount of standing water in or near your property by draining and/or removing it. Mosquitoes may lay eggs in areas with standing water.
- 4. DEET For additional protection from mosquitoes, use an insect repellent containing DEET (N,N-diethyl-m-toluamide) or picaridin (KBR 3023). Other insect repellents such as oil of lemon eucalyptus and IR3535 are also registered by the EPA but may be less effective than products containing DEET. It is important to follow the product guidelines when using insect repellent.

What is Really Meant by Widespread and Significant Concern for Public Health?

In addition to the comments in the Thunder Basin National Grassland Situation Assessment and Process, the TBNG Working Group Summary Letter of December 28, 2018 (89 pages) cites only two references to plague:

- 1) Page 25 protecting residences where health and safety Issues are a concern with a onemile prairie dog free and prescribed fire free buffer zone
- 2) Page 54 Prairie dogs are a medical hazard because they carry the plague, which is zoonotic.

Again, is the above enough for the USDA Forest Service to use public health as a premise for the proposed action and ignore actual public health information? Although the USDA Forest Service is obligated to listen to people's concerns, perception and unwarranted fear about plague should not be a premise for proposed actions by agencies.

Twenty years after a controversial and later retracted paper in the medical journal, Lancet, hypothesized a link between the measles, mumps, rubella (MMR) vaccine and autism, there is still public concern about MMR even though observational studies have not been able to identify an increased risk for autism after MMR vaccination. However, public health agencies have continued the important task of vaccinating children because they know how deadly several vaccine-preventable childhood diseases can be if vaccination coverage is insufficient. Worldwide, vaccinations have eliminated or drastically reduced contagious diseases and each year they prevent more than 3 million childhood deaths from diphtheria, tetanus, pertussis, to name a few.

Still, public perceptions, myths and fear of vaccination and other health treatments persist in some areas. Mistrust in the current fight against Ebola in the eastern Democratic Republic of Congo today has led to the murder of some public health care responders and the destruction of some health care facilities. A lack of institutional trust and widespread misinformation are factors that undermine control efforts. Today's social media can easily magnify perception and fear, making the separation of fact and fiction more difficult today than in the past in any part of the world.

Has the USDA Forest Service failed in some measure here? There are not many people who live in the vicinity of the TBNG 3.63 area. The USDA Forest Service could easily partner with staff of the CDC and Wyoming Department of Health to explain key points about plague. Meetings could be held to lay out the facts about plague. There is no justification to premise a plan amendment based on public health.

I make the above comments about public health because I believe that the Scoping Document's premise about public health (plague in humans) is not substantively based and cannot be used to justify wholly or in part the proposed plan amendment. The USDA Forest Service should hear directly from public health agencies and their epidemiologists (CDC and Wyoming Department of Health) before stating that public health (plague) is a widespread and significant concern on TBNG as stated in the Scoping Document. By statute and regulation, determinations related to infectious diseases in humans are the responsibility of the above state and federal agencies and not the USDA Forest Service.

Figure 1. Since the mid–20th century, plague in the United States has typically occurred in the rural West. The case shown in Illinois was lab-associated (<u>https://www.cdc.gov/plague/maps/</u>).



Figure 2. Average annual incidence of West Nile virus neuroinvasive disease reported to CDC by county, 1999-2017 (<u>https://www.cdc.gov/westnile/statsmaps/cumMapsData.html#five</u>)



Public Safety Issue

The Cover Letter and Scoping Document indicate that one of the premises for the proposed action is widespread and significant concern for public safety of humans and livestock:

The Forest Service proposes to amend prairie dog management direction in the Thunder Basin National Grassland land and resource management plan1 ("grassland plan") to place greater emphasis on control and active management of prairie dog colonies to address significant concerns related to health, safety, and economic impacts on neighboring landowners.

Despite the ecological significance of prairie dogs, the animals cause widespread and significant concern related to public health, safety of humans and livestock, agricultural production, land values, and facilities.

I do not see any information in the Scoping Document about changes in public safety that have occurred since the 2001 TBNG plan. As the extent of prairie dog colonies expanded and contracted what changes to public safety occurred? How many roads, bridges, dams, cemeteries, and other facilities were undermined by prairie dogs? The USDA Forest Service and private landowners must have some record of damages to expensive facilities. What safety issues identified in the 2001 plan rose to such new heights during 2001 -2019 that a plan amendment is required? Did new safety issues arise during this period to warrant the proposed amendment?

What is meant by safety of livestock? Although public safety appears in the 2001 TBNG management plan, livestock safety does not appear. The Scoping Document is likely referring to livestock breaking their legs by stepping into prairie dog burrows? How often has this occurred and was it so widespread and significant during 2001-2019, even when the extent of prairie dog colonies reached 75,000 acres, as to warrant the Scoping Document's proposed action? The Thunder Basin National Grassland Situation Assessment stated that *Some also mentioned holes prairie dogs make which are considered hazardous to livestock and wildlife*. However, I was struck by the comment of Ty Checketts in the report of the Collaborative Working Group:

Prairie dogs are a physical danger to my family. I have witnessed two of my children and their horses trip in a prairie dog hole and fall. One daughter was smashed by the horse, but my son was thrown clear. Words do not express the feeling of a dad watching this happen. I have also had two other neighbors helping me that had the same experience.

In almost 20 years on the national grasslands from Texas to North Dakota, I asked countless stockmen whether their livestock were injured by prairie dog burrows. No one ever said yes. Finally, Mr. Checketts provides a yes. However, I do not believe that safety of livestock is a widespread and significant concern to serve as a premise for the proposed action. I can envision a galloping horse tripping in a burrow but slow lumbering cattle are not likely to stumble into burrows.

Have broken legs on bison been a problem at Wind Cave National Park where bison have grazed since 1914? As an aside, I have often wondered if broken legs were a major mortality factor

among bison when bison numbered in the tens of million and prairie dog colonies covered 100 million acres.

Economic Impacts

Again, the Scoping Document does not provide any quantitative or qualitative information on "widespread and significant" economic impacts ("agricultural production, land values, and facilities") that occurred during prairie dog colony expansion and contraction (2001 - 2019). One should be able to ascertain what facilities were damaged and whether agricultural production increased or decreased. It is, however, important to separate the effects of drought and the effects of prairie dog colonies.

Just as there are photographs of prairie dogs and denuded grassland in the Scoping Document, there should also be photographs of injured or dead livestock, damaged or destroyed facilities, testimonials of economic losses, changed realty appraisals, and so forth in order to adequately substantiate the premises of the Scoping Document.

The Collaborative Working Group presents a few qualitative statements about economic impacts:

- Campbell County Board of Commissioners
 - Portions of the TBNG are located in all three counties, with the majority located in Converse and Weston Counties, and this area has a significant impact on our economies. Prairie dog densities have historically been cyclical with times of moderate populations to extremely high densities to virtually decimated populations once the plague has occurred. It is in times of high density that is the most concerning as the prairie dog eliminates any existing usable forage leaving the landscape void of value for Animal Unit Month's (AUM's) available for grazing operations, minimal habitat for wildlife use and high potential for erosion. This ultimately negatively affects the socio economics of the counties and our residents.
- > Thunder Basin Grassland Ecosystem Association
 - We encourage the Forest Service to consider livestock forage needs as well, since economic viability of ranching enterprises is a critical component in maintaining healthy and productive rangelands.

A Casper Star Tribune article, Forest Service Urged to Drop Ferret Hopes, dated September 3, 2018, stated: *The prairie dog infestation means a loss of forage and Budd-Falen said landowners have drastically reduced their livestock herd as result. In 2016 and 2017, Budd-Falen estimates the Thunder Basin prairie dogs cost ranchers \$1.4 million* (https://trib.com/news/state-and-regional/forest-service-urged-to-drop-ferret-hopes/article_92450ad4-8423-59f5-b6f9-e4ea7904d44f.html).

Perhaps Budd-Falen is correct at \$1.4 million, and \$1.4 million just might be the amount the USDA Forest Service will have spent on this entire plan amendment process. I recommend that the USDA Forest Service pull together the economic impacts, check its veracity, and present that to the public.

In summary, I view the premises for the proposed action as very weak to non-existent based upon what is presented in the Scoping Document and other information on the Medicine Bow Routt web site. The Scoping Document should have at the very least presented a level of detail on public health, safety and economic impacts similar to the detail presented for prairie dogs. There are tables and chronologies of prairie dog petitions for listing, history of prairie dog management, maps and so forth. Where is the detail for public health, safety and economic impacts?

If the premises of widespread and significant concerns for public health, public safety and economic impacts are fundamentally flawed, how can this proposed action proceed?

Black-footed Ferret

- For a Scoping Document whose major purpose is to eliminate a BFF recovery site (item 1 under the Proposed Action), there is almost no information presented on the BFF, not even an acknowledgment that the species once occurred on TBNG (see Anderson et al. 1986). Instead of a table on prairie dog petitions which is of no value to the Scoping Document, the Scoping Document should put into perspective how few BFFs remain in the wild and how few reintroduction sites exist and how difficult it is to establish a reintroduction site. It's not as if there is an abundance of such sites and eliminating one site is of no consequence.
- 2) Page 4: These and any future ferret populations are managed by the Wyoming Game and Fish Department under the Wyoming Black-footed Ferret Management Plan.
 - a. The Wyoming Game and Fish Department (WGFD) already manages two BFF sites in Wyoming. BFF recovery efforts are more than grateful for that. If the WGFD does not want to manage a BFF population on TBNG that does not negate the USDA Forest Service's mandate to recover endangered species. Other organizations and agencies could contribute to the cost. A BFF recovery site on the Buffalo Gap National Grassland, South Dakota operates without the involvement of South Dakota Game, Fish and Parks. In any case federal agencies do have responsibilities under Section 7(a)(1) of the Endangered Species Act to do their utmost for the recovery of listed species.
- 3) The issue of BFF reintroduction onto TBNG should be discussed. The Scoping Document does not disclose why a ferret reintroduction in the 3.63 area has not already been formally evaluated, proposed or initiated. This information is basic and relevant to understanding the proposed amendment and needs to be disclosed and discussed in any forthcoming DEIS, FEIS and Record of Decision. It's been 18 years since the 2001 TBNG plan.

- 4) The Scoping Document states: *Active prairie dog colonies within management area 3.67 will be managed toward a target of 10,000 acres to support associated species such as mountain plover (figure 6), burrowing owl, and swift fox.*
 - a. At the time of the 2001 TBNG plan, there were 12,000 acres of prairie dog colonies and that was viewed as adequate for a BFF recovery site. Indeed, Appendix H of the plan states: *Groves and Clark (1986), using data from the Meeteetse ferret population, suggested that a MVP of 214 breeding adult ferrets would be needed to maintain an effective population of 50 adults. Using the area requirements of ferrets in the Conata Basin/Badlands reintroduction area, a minimum complex size of 7,490 to 12,840 acres would be needed to support 214 adult ferrets. Harris et al. (1989) used demographic data from both South Dakota and Wyoming ferret populations in a computer simulation model and suggested that 90 to 100 ferrets would have a 95% probability of surviving 50 to 100 years.*
 - b. So, given that the amendment will allow 10,000 acres of prairie dog colonies, I recommend maintaining the 3.63 designation and keeping the door open for BFFs. At the same time, TBNG should pursue a vigorous boundary control protocol for prairie dogs.
 - c. Yes, the Purpose and Need states: *Ensure management direction identifies habitat requirements needed to support viable populations of prairie dogs and associated species, such as mountain plover, burrowing owl, and swift fox, and that management would not preclude future reintroduction of black-footed ferret.* However, eliminating the 3.63 designation sends the opposite message. The "don't worry we may still have BFFs" tone of the above quote is not at all encouraging.
 - d. I recommend citing USDA Agricultural Research Service research to substantiate the 10,000 acres for associated species.
- 5) Comment: The EIS process should use the best available scientific information (36 CFR 219.3) to evaluate the impacts of plague and the proposed amendment on the ability of the prairie dog ecosystem in the existing 3.63 area to support future BFF reintroductions. The results of this evaluation should be compared to the BFF family/breeding adult ratings documented in the Biological Assessment and Evaluation supporting the 2002 FEIS. These results should also be compared to any BFF family/breeding adult rating assessments conducted during the preparation of the 2015 and earlier LRMP amendments to prairie dog management direction on TBNG.
- 6) Comment: I suggest an alternative that modifies the proposed amendment to leave the 3.63 management area prescription for BFFs in place but allows greater facilitation of prairie dog management to more effectively reduce unwanted colony expansion onto adjoining private and state lands. Currently, there are less than 1,000 acres of prairie dog colonies in the 3.63 area leading anyone to question the urgency for a proposed action in the Scoping Document. The apparent urgency needs to be fully disclosed so the broader public can better understand all the relevant issues.
- 7) An important issue is the obvious disconnect between the purpose and need(s) identified in the Federal Register notice and the proposed amendment. Specifically, the notice identified the need to refocus management of the 3.63 management area and to delineate more logical boundaries for Management Area 3.63. Yet, the proposed action is to eliminate the 3.63 designation. The notice also identifies the need to align with the 2018

Wyoming Black-footed Ferret Management Plan. Again, the proposed amendment takes TBNG and USFS in the opposite direction. The Wyoming BFF plan has an objective of at least one reintroduction site in black-tailed prairie dog colonies, and it also identifies the need to identify and evaluate potential future reintroduction sites, following a protocol described in Wyoming BFF plan. In fact, the state BFF plan specifically states that the new ESA 10j statewide designation paves the way for establishing additional reintroduction sites within the state. USDA Departmental Regulation 9500-004 specifically states that the Department will conduct its activities and programs in a manner that assists in the identification and recovery of threatened and endangered species. By leaving the 3.63 designation in place, TBNG and USFS are compliant with this Departmental regulation by formally identifying the 3.63 area as a potential BFF reintroduction site for further evaluation. At a minimum, USDA Forest Service should not eliminate the 3.63 designation before further evaluations can be completed by the Wyoming Game and Fish Department and other cooperating agency personnel with BFF expertise.

- 8) Notwithstanding the importance of the Wyoming BFF Plan, would the USDA Forest Service, a federal agency, please acknowledge any importance or relevance of the federal BFF recovery plan and the draft revision of that plan?
- 9) Issue: The Scoping Document did not mention the new tools being developed to better manage plague in the future both in prairie dogs and BFFs. This new information is relevant to the proposed amendment and should be included, evaluated and documented during the EIS process as it relates to future management of prairie dogs and, potentially, BFFs in TBNG. The best available scientific information (36 CFR 219.3) related to the potential significance of these new tools should also be disclosed and used in the forthcoming EIS and supporting Biological Assessment and Evaluation.
- 10) Page 8: The Forest Service proposes the following: 1. Change the existing Thunder Basin National Grassland management area 3.63, "black-footed ferret reintroduction habitat," to a new management area 3.67, "rangelands with short-stature vegetation emphasis." Adopt management area themes, desired conditions, standards, and guidelines to de-emphasize reintroduction of black-footed ferret and emphasize short-stature vegetation as a key component of a mosaic of vegetation communities across the management area to provide habitat for a variety of associated species. Update grassland-wide and geographic area direction for consistency with management area 3.67 (see "Proposed Action: Changes to Grassland Plan Direction," available on the project website: http://www.fs.fed.us/nepa/nepa_project_exp.php?project=55479).
 - a. I oppose the elimination of the 3.63 BFF management area because it removes emphasis for endangered BFFs. Fifteen FS units contain some level of prairie dog occupancy (Sidle et al. 2006) but only 3 units have large enough prairie dog complexes to contribute towards BFF recovery (Buffalo Gap, Little Missouri, and Thunder Basin National Grasslands), and thus a portion of those units were designated in 2001 for 3.63 BFF management to contribute towards recovery of the species as mandated by the Endangered Species Act. There are no other Forest Service units that have enough prairie dog colonies to contribute a viable BFF population to recovery. The above three Forest Service lands represent a fraction of their units and all FS lands in total. Of the 30 BFF reintroduction sites in North

America, only 15 are occupied and one (Conata Basin on the Buffalo Gap National Grassland) currently has a BFF population that meets U.S. Fish and Wildlife Service (USFWS) recovery goals. Recovery of BFFs will require a viable population on TBNG.

- b. The USFWS has always ranked TBNG as a priority BFF recovery site.
 - i. In the 1990s, the BFF Interstate Coordinating Committee (precursor to the BFFRIT) identified TBNG as one of the highest priority recovery sites in the nation.
 - ii. In an August 2, 2000 letter from the USFWS BFF Recovery Coordinator, J. Michael Lockhart, to Forest Supervisor, Jerry Schmidt, USFWS stated: *The Cheyenne River area of TBNG is one of the top two, if not the best potential ferret reintroduction site in North America today.*
 - iii. In 2002, the USFWS ranked TBNG 7th overall in a list that included active BFF recovery sites.
 - iv. In a March 16, 2007 letter from USFWS to USDA Forest Service, the need for National Grasslands to contribute to BFF recovery was reinforced.
 - v. In 2008, the USFWS ranked TBNG as 6th in North America for potential reintroduction sites, despite a recent plague epizootic that drastically reduced habitat.
 - vi. A BFF Species Status Assessment for Wyoming (Esch et al. 2005) suggested the black-tailed prairie dog complex at TBNG represented a significant site for potential BFF recovery.
 - vii. Luce (2006), a former BFF biologist for WGFD, identified TBNG as an immediate potential BFF reintroduction site and WGFD had assessed BFF habitat at TBNG in 2003 (WGFD 2003).
 - viii. The Multi-State Conservation Plan for the Black-Tailed Prairie Dog (Luce 2003, Luce et al. 2006) specified a target objective of a prairie dog complex >5,000 acres for conservation of prairie dogs.
 - ix. Others have identified TBNG as a priority site for prairie dog ecosystem conservation (Wuerthner 1997, Buseck et al. 2005, Johnsgard 2005, Proctor et al. 2006, Sidle et al. 2006).
- c. In Wyoming, BFFs are considered a species of Greatest Conservation Need by WGFD State Wildlife Action Plan (2017) and the Wyoming BFF Management Plan (2018) calls for at least one BFF recovery site in the black-tailed prairie dog range. The most obvious black-tailed prairie dog site in Wyoming for a viable reintroduced BFF population is on TBNG. BFFs are native to Wyoming and occupied TBNG likely into the 1970s, with a BFF skull found in 1979 suggesting the recent occupation (Anderson et al. 1986).
- 11) Page 8: 2. Draw the boundaries for management area 3.67 to use natural barriers to minimize prairie dog movement, such as the Cheyenne River and Rochelle Hills. Ease conflicts in management by reducing overlap with sage-grouse priority habitat management areas, redrawing the Cheyenne River Special Interest Area to focus on riparian biotic communities, excluding any areas within 1 mile of residences, and reducing boundaries with state and private properties (figure 4 and figure 5). Reassign areas that are removed from the existing management area 3.63 using adjacent

management area prescriptions (see "Proposed Action: Changes to Grassland Plan Direction," available on the project website:

http://www.fs.fed.us/nepa/nepa_project_exp.php?project=55479).

- *a.* I support using natural barriers and obstacles to delineate boundaries between management areas.
- *b.* One-mile buffer from residences is excessive and arbitrary. It cannot be substantiated.
- 12) Page 8: 3. Eliminate use of the Black-tailed Prairie Dog Conservation Assessment and Management Strategy for the Thunder Basin National Grassland (2015 update, available on the project website: http://www.fs.fed.us/nepa/nepa_project_exp.php?project=55479), including categories 1, 2, and 3 prairie dog management areas and decision screens.
 - a. <u>Comments:</u> I oppose eliminating use of the 2015 Prairie Dog Assessment and Management Strategy. It appears that this strategy was not implemented in any meaningful way and the efficacy of the strategy has yet to be assessed. I would like to see the Forest Service fully fund implementation of the current strategies and management as intended. The need for a new prairie dog management strategy is unwarranted when the previous strategy, barely a few years old, was never implemented.
- 13) Page 8: 4. Establish a minimum quarter-mile boundary management zone where management area 3.67 shares a border with private or state property. Within the boundary management zone, control of prairie dogs using rodenticides will be prioritized to reduce impacts to surrounding landowners (figure 5). Treatment within a boundary management zone will be in collaboration with adjacent landowners for private lands or the lessee for state lands. For control on National Forest System lands to proceed within a boundary management zone, the landowner or lessee will need to engage in concurrent control on the adjacent private or state lands. If the Forest Service finds that certain colonies cause chronic encroachment problems, the Forest Service will work with partners through a third-party collaborative stakeholder group (see number 7 below) to determine appropriate actions. Landowners experiencing persistent or imminent encroachment after treatment may request consideration of a temporary three-quartermile boundary management zone. All tools not otherwise restricted by the grassland plan will be available for use in the boundary management zone at any time.
 - *a.* <u>Comments:</u> I support aggressive prairie dog control on private land borders when undesired encroachment is occurring or imminent. I also support the notion of concurrent control on private lands. I do not support the use of a third-party collaborative stakeholder group to determine the appropriate actions. The Forest Service should not cede management authority or decisions to any third party.
- 14) Page 9: 5. Where possible, adopt use of the Natural Resources Conservation Service's Ecological Site Descriptions in management area 3.67 as the basis to describe plant communities, evaluate current and desired conditions, and maintain or improve native vegetation and wildlife habitat.
 - a. <u>Comments:</u> I oppose the designation of management area 3.67 and the use of NRCS Ecological Site Descriptions to guide management, particularly in areas with prairie dogs. The NRCS guides are designed for livestock forage production and do not accurately account for wildlife such as prairie dogs. The use of NRCS

guides is an overt prioritization of plants and forage, not functioning wildlife communities.

- 15) Page 9: 6. Establish the following parameters for prairie dog colony management: a. Active prairie dog colonies within management area 3.67 will be managed toward a target of 10,000 acres to support associated species such as mountain plover (figure 6), burrowing owl, and swift fox.
 - *a.* <u>Comments:</u> Please provide the analysis and citations that justify a 10,000-acre target for the above associated species. The work of USDA Agricultural Research Service is relevant. I also strongly suggest a Population Viability Analysis that uses the best science available for each species to determine the appropriate amount of prairie dog acreage for the long-persistence of these species on TBNG, incorporating the effects of plague, drought, livestock grazing, shooting and other factors that may influence these populations.
- 16) Page 9: b. Active prairie dog colonies should be distributed across the landscape and vary in size, up to approximately 1,000 acres, with an emphasis on colonies of 100 to 400 acres. At least one complex in management area 3.67 will be managed for at least 1,500 acres of active prairie dog colonies.
 - a. <u>Comments:</u> I oppose limits of prairie dog colony size and emphasis for a particular size class. These numbers seem to have no basis in science regarding viability of prairie dogs, mountain plover, burrowing owl, swift fox, and BFFs. The 1,500 acre-complex appears to be a minimal attempt to provide BFF habitat that will not result in a viable population of BFFs that contributes towards recovery goals. The USFWS in the 2015 decision regarding the Wyoming 10j non-essential experimental statewide designation mistakenly stated: *The main requirements for BFF reintroduction are: (1) An area of occupied prairie dog habitat that is purposefully managed and of sufficient size to support a viable population of ferrets (a minimum of 1,500 ac (608 ha) of black-tailed prairie dog occupied habitat.*
 - *b.* No black-footed ferret recovery site to date has supported a viable population of BFFs on 1,500 acres of black-tailed prairie dogs and best available science does not support this number. I suggest a larger complex.
 - c. If this proposed 1,500-acre complex is intended to potentially support BFFs, then it is vastly different than the area suggested by the 2015 TBNG Black-Tailed Prairie Dog Conservation Assessment and Management Strategy where the Forest Service wrote (page 12): It is anticipated that 18,000 acres will be sufficient habitat to allow ferrets to persist through a plague epizootic and recover naturally along with the prairie dog populations. The proposed fifteen hundred acres would be 92% less habitat than the Forest Service asserted only 4 years ago. The only BFF population that is currently viable occurs on the Buffalo Gap NG (Conata Basin/Badlands NP), South Dakota. There, a prairie dog colony complex, made up of large, closely spaced colonies, and varying in size from 10,000-40,000 acres due to plague, has maintained a BFF population whose minimum of 30 breeding adults meets the USFWS recovery criteria.
 - *d.* The WGFD State Wildlife Action Plan (2017) affirms: *Consequently, the size of prairie dog colonies and density of burrows are the most important factors in the success of reintroduction sites" and "Perhaps the greatest threat to the*

persistence of Black-footed Ferret is the availability of large prairie dog colonies for food and shelter.

- e. When the Black-Tailed Prairie Dog Multi-State Working Group was developing guidelines for prairie dog management, group Chair, Bob Luce, solicited input from the USFWS regarding desired prairie dog colony size for BFF reintroduction. USFWS BFF Recovery Coordinator, J. Michael Lockhart, responded to Luce in a March 16, 2001 letter that was copied to the BFF Recovery Implementation Team and outlined the best knowledge regarding colony size and reintroduction success. Lockhart summarized the 6-page letter by writing: *Put into simplest terms the only true measure of ferret reintroduction success to date suggests that high density, plague-free, black-tailed prairie dog complexes in excess of 10,000 acres, with large core colonies, and which are not subject to artificial perturbations (e.g. shooting/poisoning) are needed to reestablish wild ferret populations. Conversely, ferret reintroductions into smaller, more isolated, prairie dog complexes with relatively high prairie dog densities.*
- f. More recently, an analysis of BFF reintroduction sites by Jachowski et al. (2011), including a co-author from WGFD, concluded: *The most important factor related to ferret reintroduction success was a cumulative metric incorporating both size of the area occupied by prairie dogs and density of prairie dog burrows within that area. Each of the four successful sites had prairie dog populations that occupied an area of at least 4300 ha. No sites with <4300 ha of prairie dogs were successful in maintaining P30 adult individual ferrets over multiple years without augmentation even if they had a high prairie dog burrow density. The overarching importance of the availability of high-quality habitat suggests managers should prioritize actions that maintain and enhance the availability of large areas with high prairie dog burrow density, which are becoming increasingly rare due to anthropogenic impacts and disease outbreaks.*

Black-tailed Prairie Dog

- 1) Issue: The Scoping Document did not adequately identify or discuss why the 2015 and earlier LRMP amendments for prairie dog management were not effective in controlling prairie dog expansion onto adjoining private and state lands. These reasons need to be thoroughly and clearly disclosed so the broader public can better understand all the relevant issues.
- 2) Page 5: *Mapping efforts during these years showed that active prairie dog colonies expanded to over 75,000 acres, more than doubling the previous record for mapped acres.*
 - a) The issue of prairie dog colony expansion should come as no surprise. The maximum future acreage of prairie dog colonies on TBNG (federal land only) predicted in the 2002 FEIS and supporting Biological Assessment and Evaluation was 48,000 acres, an estimate derived from habitat modeling. The maximum acreage mapped on TBNG since the 2002 FEIS was 48,000 acres as indicated in the Scoping Document. As a result, the more current 48,000 acre maximum does not constitute unexpected growth or new

information from that originally predicted in the 2002 FEIS and supporting Biological Assessment and Evaluation.

- 3) Page 5: Comprehensive mapping efforts were constrained by time and funding; however, it was estimated that actual acreage impacted by prairie dog expansion significantly exceeded the 75,000 acres recorded.
 - a) I am concerned that rigorous efforts to assess the status of prairie dogs was not made and likely overestimated by third party stakeholders. While I do not argue that significant colony growth may have occurred, I suspect there may be large exaggerations or inaccuracies of estimated prairie dog colony acreage. Mapping prairie dog colonies and estimating occupied acres is of considerable importance. Many trained wildlife biologists have studied and developed techniques for estimating prairie dog colonies (Biggins et al. 2006), including several FS biologists (Schenbeck and Myhre 1986, Sidle et al. 2001, 2002, 2012), and while these techniques can be applied by technicians and other practitioners, they are rooted in scientific rigor and require proper funding and timing.
 - b) The above issue is not a trivial point because the essence of this contentious issue is "how many prairie dogs are there?" It is even more important in the context of BFF recovery because we tend to assume that every acre of a prairie dog colony is equivalent to BFF habitat. That likely is not the case as multiple studies demonstrated that BFFs select for high densities of prairie dogs/burrows within a prairie dog colony (Biggins et al. 2006b; Livieri 2007, 2012; Jachowski et al. 2010, 2011; Eads et al. 2011).
 - c) The use of the phrase, "Active Colonies" Although I have used this phrase in the past, it is inaccurate. A colony of animals (birds, mammals and others) is only a colony if the animals are present. There really is no such thing as an active or inactive colony, just colony.
- 4) Page 5: Figure 3 implies that the "denuded" area depicted was a result of drought and prairie dog colony expansion. Was this area closed to livestock grazing at that time? Such photographic documentation should be labeled to include livestock grazing when appropriate. If cattle concurrently grazed this area depicted in the photograph, was livestock grazing reduced during the drought? Direction and guidance in the current LRMP for TBNG calls for reducing livestock grazing during drought. If there were no adjustments in livestock grazing during the drought, perhaps it would be appropriate to reiterate the drought direction in the LRMP in the forthcoming LRMP amendment.
- 5) The Scoping Document states that *In the State of Wyoming, prairie dogs are classified as an agricultural pest [W.S. 11-5-102 (a)(xii)]*. In the interest of fair play, the Scoping Document should have mentioned that the Wyoming State Wildlife Action Plan lists the black-tailed prairie dog as one of the state's Species of Greatest Conservation Need (WGFD: NSS4 (Cb), Tier II).
- 6) Some speculate that there can not be a BFF reintroduction at TBNG because of the wild swings in prairie dog populations due to plague. However, prairie dog management is evolving, and a new sylvatic plague vaccine is proving effective (Abbott et al. 2012, Rocke et al. 2017). The planned DEIS associated with the proposed action should thoroughly discuss prairie dog management tools and not foreclose on BFF reintroduction.

Short-Stature Grassland Vegetation

The Scoping Document does not define "short-stature vegetation" and I cannot find that term in any range management or ecology text. I assume that the Scoping Document is referring to short statured shortgrass prairie species.

The proposed action is to *emphasize short-stature vegetation as a key component of a mosaic of vegetation communities across the management area to provide habitat for a variety of associated species*. However, such an emphasis already exists under the current plan. Extensive prairie dog habitat provides for the variety of associated species that the proposed action mentions. Because the proposed action will manage for only 10,000 acres of prairie dog colonies to support associated species such as mountain plover, burrowing owl, and swift fox, then the proposed action will be supporting associated species to a far lesser extent than the current plan. Indeed, one associated species

Many scientists have noted the link between prairie dog colony short stature vegetation and associated species. Indeed, you already know that the matter has been the subject of research by USDA Agricultural Research Service.

- Bird communities on prairie dog colonies have significantly greater densities of burrowing owls, mountain plovers, killdeer, horned larks, McCown's Longspurs than bird communities off colony sites. The strength of prairie dog effects is consistent across the northern Great Plains. Vegetation modification by prairie dogs sustains a diverse suite of bird species in these grasslands. Areas in the North American Great Plains with prairie dog colonies support higher densities of at least 9 vertebrate species than sites without colonies. Prairie dogs affect habitat for these species through multiple pathways, including creation of belowground refugia, supply of prey for specialized predators, modification of vegetation structure within colonies, and increased landscape heterogeneity.
- The mountain plover is a good example of a grassland species adapted to living in very sparse and prostrate vegetation (see the mountain plover research at Pawnee National Grassland by Dan Uresk of the USDA Forest Service). Like the piping plover nesting on almost barren sandbars and alkali wetland shorelines, and the snowy plover on barren lake shorelines in the Great Plains, the mountain plover is another bare ground plover. What the Scoping Document illustrates as *Denuded grassland following drought conditions and the prairie dog population expansion of 2016-2017* is mountain plover habitat.

Other

Issue: FSH 1909.21.3 and the 2017 amendment to the 2012 planning rule directs LRMP amendments prepared after 5/9/15 to conform to the 2012 planning regulations. Given this direction, how can this proposed amendment and EIS process proceed and be completed without having the TBNG Species of Conservation Concern (36 CFR 219.9) identified, approved, and available at the onset of this amendment process?

During the May 8, 2019 webinar, I asked if the comments in response to this Scoping Document could be made public. I was told no by Monique Nelson. The Wyoming Department of Agriculture Collaborative Working Group made its findings and comment letters public. The USDA Forest Service should also make public the comments it receives in response to the Scoping Document.

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Yours truly

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Interagency Statement U.S. Forest Service, U.S. Fish and Wildlife Service, and Wyoming Game and Fish Department December 4, 2017

Over the past several years, the Thunder Basin Working Group and the Thunder Basin Learning Series has provided county representatives, non-governmental organizations, permittees, and the public with opportunities to discuss ecological conditions and related management issues on the Thunder Basin National Grassland (Grassland). Several themes emerged from these discussions, including grassland restoration, prairie dog management, and the reintroduction of black-footed ferrets.

The U.S. Forest Service, U.S. Fish and Wildlife Service, and Wyoming Game and Fish Department recognize the value of further collaboration and public engagement on grassland restoration and wildlife management strategies. A joint examination of the guiding documents that influence and direct management of the Grasslands will identify any potential adjustments necessary based on science, social and economic issues, and altered conditions. The primary documents for review include: 1) Thunder Basin Land and Resource Management Plan (2001); and 2) Prairie Dog Conservation Assessment and Management Strategy (2015). Ecological conditions, including occupied prairie dog habitat and grassland conditions, have changed over time necessitating this review.

We cooperatively agree that the reintroduction of black-footed ferrets on the Grassland is not appropriate at this time. Instead, the current focus surrounds prairie dog management actions, including boundary control and disease control. The U.S. Forest Service will monitor ecological progress and grassland restoration activities on the Grassland. Interaction with stakeholders will continue on these important issues.

We appreciate the time and dedication of those involved in the collaborative efforts to improve our shared asset in the Thunder Basin National Grassland.

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- In 1994, the black-footed ferret captive breeding program was turned over to the USFWS (Service). The Service proposed that ferret reintroductions be suspended in white-tailed prairie dog colonies and that future reintroductions focus on black-tailed prairie dog colonies. This put the Shirley Basin reintroductions on hold and made releases on the Thunder Basin National Grasslands (TBNG) a priority.
- The Wyoming Game and Fish Department (Department) disagreed with this approach but coordinated with TBNG to ensure adequate ground work was conducted for potential ferret reintroduction. At that time, the Department terminated development of additional black-footed ferret release sites in Wyoming due to differences in opinion.
- Since 2001, when the Land and Resource Management Plan for Thunder Basin National Grasslands (TBNG) was finalized, there have been numerous conflicts regarding implementation of the plan with regard to black-tailed prairie dog management and black-footed ferret reintroduction.
- As detailed in the Land and Resource Plan, areas of the grasslands were managed specifically for black-tailed prairie dogs
 - This action resulted in landowner dissatisfaction due to a lack boundary control and the degradation of leased grazing allotments.
 - Thunder Basin instituted a shooting ban on key areas in March 2002 to maintain prairie dog populations
- In 2016 the USFS hired the Ruckelshaus Institute to moderate workshops to discuss prairie dog management issues.
 - These workshops had little public or landowner support.
 - A summary of these meetings can be found at: <u>http://www.uwyo.edu/haub/ruckelshaus-institute/collaborative-</u> <u>solutions/thunder-basin/index.html</u>
- November 2016, the Governor of Wyoming and the Directors of the Wyoming Game and Fish Department, Wyoming Office of State Lands and Investments and the Wyoming Department of Agriculture sent letters informing the USFS that agencies did not support reintroduction and current prairie dog management implementation.
- In 2017 Plague reduced prairie dog numbers. Before the Plague outbreak, prairie dog densities were very high and considered to be at socially unacceptable levels.

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- In November 2017 the USFWS, USFS and the Department signed an Interagency Statement that the reintroduction of ferrets was not appropriate at that time and that the agencies should continue to focus prairie dog management actions on boundary control and disease control.
- Currently the USFS is working with the Wyoming Department of Agriculture to take further steps on this issue by holding monthly meetings to discuss a forest plan revision before the end of 2018.
 - NGOs support ferret reintroduced on the TBNG.
 - While ferrets have been associated with "unacceptable" prairie dog management, there is still some landowner support for ferret reintroduction.
- The Department, the Wyoming Department of Agriculture, the Service, and USFS publically stated that they do not support ferret reintroduction until ongoing public issues are resolved.
 - Currently there are no plans to reintroduce ferrets to Thunder Basin Grasslands. The draft ferret management plan developed by the WGFD calls for a population of ferrets in black-tailed prairie dog habitat. The location of this population is not predetermined.
 - While the TBNG contains high quality ferret habitat, reintroductions will not occur until social concerns are resolved.
 - Should ferret populations be released, dedicated funding is essential for boundary and plague control.
 - Any releases should be conducted with community support.

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Thinking Like a Grassland: Challenges and Opportunities for Biodiversity Conservation in the Great Plains of North America[★]

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ABSTRACT

Fauna of North America's Great Plains evolved strategies to contend with the region's extreme spatiotemporal variability in weather and low annual primary productivity. The capacity for large-scale movement (migration and/or nomadism) enables many species, from bison to lark buntings, to track pulses of productivity at broad spatial scales (> 1000 km^2). Furthermore, even sedentary species often rely on metapopulation dynamics over extensive landscapes for long-term population viability. The current complex pattern of land ownership and use of Great Plains grasslands challenges native species conservation. Approaches to managing both public and private grasslands, frequently focused at the scale of individual pastures or ranches, limit opportunities to conserve landscape-scale processes such as fire, animal movement, and metapopulation dynamics. Using the US National Land Cover Database and Cropland Data Layers for 2011-2017, we analyzed land cover patterns for 12 historical grassland and savanna communities (regions) within the US Great Plains. On the basis of the results of these analyses, we highlight the critical contribution of restored grasslands to the future conservation of Great Plains biodiversity, such as those enrolled in the Conservation Reserve Program. Managing disturbance regimes at larger spatial scales will require acknowledging that, where native large herbivores are absent, domestic livestock grazing can function as a central component of Great Plains disturbance regimes if they are able move at large spatial scales and coexist with a diverse array of native flora and fauna. Opportunities to increase the scale of grassland management include 1) spatial prioritization of grassland restoration and reintroduction of grazing and fire, 2) finding creative approaches to increase the spatial scale at which fire and grazing can be applied to address watershed to landscape-scale objectives, and 3) developing partnerships among government agencies, landowners, businesses, and conservation organizations that enhance cross-jurisdiction management and address biodiversity conservation in grassland landscapes, rather than pastures.

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Introduction

In his eloquent essay "Thinking Like a Mountain," Aldo Leopold discussed his experiences in the mountains of the southwestern United States, where he had "watched the face of many a newly

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wolf-less mountain, and seen the south facing slopes wrinkle with a maze of new deer trails ...," leading him to "suspect that just as a deer herd lives in mortal fear of its wolves, so does a mountain live in mortal fear of its deer" (Leopold 1949). Here, we apply a similar perspective to the grasslands of central North America, arguing that "thinking like a grassland" entails recognition that grasslands live in mortal fear of anthropogenic activities that eliminate the disturbance regimes essential to sustaining grassland ecosystems. The loss of these disturbances, such as fire and grazers, ultimately leads to landscape-scale homogenization and loss of biodiversity. We examine challenges and opportunities for biodiversity conservation across the Great Plains that center on the capacity for fire and fauna to move across broad, spatially diverse landscapes and for prairie dogs to

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play their keystone role (Fuhlendorf et al. 2009; Davidson et al. 2012; Fuhlendorf et al. 2017). In this paper, we first review the paleoecology of Great Plains flora and fauna since the last ice age and discuss how large-scale movements of some species, as well as metapopulation dynamics of others, contribute to their persistence in the Great Plains. We then present an analysis of the contemporary degree of grassland fragmentation across the Great Plains, to illustrate the scale, distribution, and extent of grassland alteration by croplands, woody plant encroachment, and urban expansion. Finally, we conclude with a discussion of recent successes and potential opportunities for defragmentation of these grasslands. Large, connected landscapes are critical to restoring ecosystem integrity, natural disturbance regimes, and biodiversity of the Great Plains; here we aim to illuminate both the current magnitude of Great Plains grassland fragmentation and ways forward to reconnect these grasslands.

Great Plains Paleoecology

The central grasslands of North America emerged from the last glacial period ~12 000 yr ago (Walker et al. 2009), as glaciers that covered modern-day Canada and portions of the northern United States retreated and substantial shifts in climatic conditions began to shape the flora and fauna of the region. Before this glacial retreat, today's southern Great Plains supported hardwood forests in the east and coniferous parklands in the west, intermingled in a patchy mosaic with sagebrush shrublands (Porter 1983). During the glacial retreat, many North American large mammals became extinct for reasons we do not debate here and extensive grasslands supporting lower-quality forage replaced the former mosaic of plant communities. The shift from the Pleistocene to the Holocene (~14 000-10 000 yr ago) entailed dramatic climatic changes that reorganized ecosystems and gave rise to floral and associated faunal communities that coevolved over the next 12 000 yr. These communities experienced another dramatic change in ecosystem organization initiated by the Homestead Act in 1862, which encouraged the first large-scale conversion of grasslands and landscape fragmentation.

From ~12 000 to 8 000 yr ago, drought-resistant grasslands expanded and lake levels declined across the Great Plains, favoring C₄-dominated grasslands in the south and mixed C₃/C₄ grasslands farther north (Baker et al. 2000; Woodburn et al. 2017). Drier conditions 9 000-8 500 yr before present (BP) eliminated upland and riparian forests in the eastern Plains and increased C₄ grass dominance, with the driest conditions likely occurring 8 500 to 5 800 yr BP (Baker et al. 2000; Mandel et al. 2014). Bison (Bison bison) evolved as the primary large grazer in the region and declined in body size during the early Holocene, ultimately reaching their modern form in the Great Plains ~6 500 yr ago (Hill et al. 2008; Lewis et al. 2010). Black-tailed prairie dogs (Cynomys ludovicianus; hereafter, BTPDs) occupied the nonglaciated portions of the Great Plains throughout the last glacial maximum and expanded into the northern Great Plains as the glaciers receded ~12000 yr ago, at which time they had already reached their modern body size (Goodwin 1995). Genetic analyses of the mountain plover (Charadrius montanus), which nests on BTPD colonies, indicate their population underwent a significant expansion during this period of glacial retreat (Oyler-McCance et al. 2005), coincident with the northward expansion of BTPD. Fossil remains show other grassland birds currently endemic to the Great Plains including lark buntings (Calamospiza melanocytes), longspurs (Calcarius spp.), western meadowlark (Sturnella neglecta), and upland sandpipers (Bartramia longicauda) already occurred in their modern form in the central Great Plains ~26000 yr BP (Downs 1954; Emslie 2007). Over the past 2 700 yr, plant communities of the Great Plains have resembled those present at the time of European settlement but experienced periodic extreme droughts that were likely similar to or more severe than the drought of the 1930s (Baker et al. 2000). Collectively, these paleoecological studies indicate the flora, fauna, and associated disturbance regimes that are the focus of conservation efforts in the Great Plains have been present and interacting for thousands of years. As we move into a new era of climate changes (USGCRP 2017) layered on all of the other anthropogenic alterations that Great Plains grasslands have experienced since European settlement, conserving the region's flora and fauna is clearly a major challenge.

Movement and Metapopulations

North America's Great Plains once rivaled Africa's Serengeti. Large, migratory herds of herbivores, including bison, elk (Cervus elaphus), deer (Odocoileus spp.), and pronghorn (Antilocapra amer*icana*), moved at varying and largely unquantified spatial scales across North America's prairies in the millions (Samson et al. 2004; Sanderson et al. 2008). Through grazing, browsing, trampling, wallowing, and defecating, large herbivores altered vegetation composition, habitat structure, soils, nutrient cycling, and fire regimes, creating heterogeneous landscapes that included suites of grassland species that associate with open and intensively grazed habitats (Knapp 1999; Fuhlendorf and Engle 2001; Sanderson et al. 2008; Derner et al. 2009). Opportunities exist for livestock to continue to provide the ecological functions that sustain heterogeneity and many components of Great Plains biodiversity, although domestic livestock in the Great Plains are typically constrained to move over far smaller spatial scales than native herbivores did in the past (Towne et al. 2005; Derner et al. 2009; Allred et al. 2011). In addition, bison have been restored to limited portions of their historic range (Sanderson et al. 2008). Efforts to restore native wildlife populations are unlikely to be successful from an ecological and functional perspective without providing large, connected landscapes that support migratory movements so that animals can track resource availability (Berger 2004; Samson 2004; Fuhlendorf et al. 2017a).

Movements of Great Plains fauna occur at a wide range of spatial scales in response to spatiotemporal variation in weather, seasons, fire patterns, and vegetation dynamics. The Great Plains encompass a temperature gradient extending across nearly 3 000 km from north to south and a precipitation gradient extending nearly 1 500 km from northwest to southeast (Lauenroth et al. 1999). In any given location, precipitation and temperature fluctuate dramatically over temporal scales from days to seasons, years, and decades (Knapp and Smith 2001; Chen et al. 2018). This large geographic area and extreme temporal variability combined with the limited vertical structure of the vegetation create a challenging environment shaping the regions' fauna over ecological and evolutionary time scales. As a result, many species depend on the capacity for large-scale movements (over hundreds to thousands of kilometers) to track resources and avoid inclement weather. Bison, elk, and pronghorn, the historically most abundant large herbivores on the Great Plains, are all well known for their ability to undertake longdistance migrations to track forage resources (Lott 2002; Berger 2004).

For many bird species, multiple scales and patterns of mobility are an important component of their strategies for survival in the Great Plans. Birds of conservation concern that migrate from breeding grounds in the Great Plains to overwintering locations farther south include passerines such as McCown's and chestnutcollared longspurs, Sprague's Pipit (*Anthus spragueii*), grasshopper, Henslow's and Baird's sparrows (*Ammodramus savannarum, A. bairdii*, and *A. henslowii*), and lark buntings (Rosenberg et al. 2016), grassland-breeding shorebirds such as mountain plovers, upland sandpipers and long-billed curlews (*Numenius americanus*) (Page et al. 2014; Pierce et al. 2017), and raptors such as burrowing owls (*Athene cunicularia*), ferruginous

hawks (Buteo regalis), and golden eagles (Aquila chrysaeitos; Watson et al. 2018). Individuals of some migratory species may return to consistent locations within their breeding grounds year after year, but recent studies show substantial capacity for withinand among-year movements in response to spatially variable resources or habitats. For example, dense concentrations of breeding lark buntings track those portions of the Great Plains with recent high precipitation (Wilson et al. 2018). Mountain plovers may move > 2 km in just the first 2 d after a brood hatches (Knopf and Rupert 1996) and > 20 km between two successive nesting attempts in a given breeding season (Skrade and Dinsmore 2010). Once brood rearing is complete, they migrate long distances from breeding grounds to late-summer staging grounds in the southern Great Plains (Pierce et al. 2017). Other migratory shorebirds move opportunistically to recently burned areas during migration (Hovick et al. 2017). Similarly, individual ferruginous hawks exhibit long-distance, post-breeding movements within the Great Plains to track availability of prey resources (Watson et al. 2018). All of these examples emphasize the importance of large-scale mobility for survival and persistence of many Great Plains organisms.

Even for sedentary species that both breed and overwinter within year-round territories (e.g., < 10 km²), extensive, connected landscapes can be critical for maintaining populations. Local extirpations of a species can occur as a result of multiple factors, including shifting habitat conditions as vegetation responds to disturbances (e.g., wildfires or woody plant encroachment locally eliminating nesting habitat for prairie grouse; Fuhlendorf et al. 2017), disease outbreaks (e.g., epizootic plague affecting local BTPD populations; Cully et al. 2010), or extreme weather events (e.g., hail and ice storms or heat waves killing local breeding bird populations; Ross et al. 2016; Carver et al. 2017). Recolonization of an area that experienced a local extirpation depends on metapopulation dynamics, which require connectivity and dispersal among portions of the landscape operating as population sinks versus sources (Hanski 1994).

One keystone species that has experienced dramatic declines throughout its range and relies strongly on metapopulation dynamics for persistence in the western Great Plains is the BTPD. BTPDs occur in complexes of spatially distinct colonies that typically support hundreds to thousands of individuals, and these colonies are interconnected via occasional dispersal (Hoogland 2006; Davidson et al. 2012). BTPD colonies are well-known to create habitat for numerous associated species, such as burrowing owls and mountain plovers, and they attract large herbivores, such as bison and cattle, that prefer the higher quality forage found on their colonies during periods of rapid plant growth (Kotliar et al. 2006; Bayless and Beier 2011; Augustine and Baker 2013). A diverse array of predators also rely on prairie dogs as a primary food source, including multiple raptor species, American badgers (Taxidea taxus), coyotes (Canis latrans), and the endangered black-footed ferret (Mustela nigripes) (Goodrich and Buskirk 1998, Cook et al. 2003; Biggins and Eads 2018). Since the introduction of sylvatic plague to North America in the early 1900s, BTPD populations have been regulated by periodic plague outbreaks that cause dramatic (> 95%) local population collapses (Cully et al. 2010). Field research linked with population modeling analyses reveal how BTPD persistence over broad landscapes depends on metapopulation dynamics, as populations in varying phases of collapse or recovery from plague exchange individuals and genetic diversity (Antolin et al 2006; Snall et al. 2008; Savage et al. 2011; George et al. 2013). As a result, associated species that rely on prairie dog colonies for habitat also depend on the metapopulation dynamics that sustain prairie dogs over broad spatial and long temporal scales.

Metapopulation dynamics are also increasingly recognized as essential to the persistence of sedentary bird species, such as the Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*), which has experienced dramatic population declines and range contraction within the increasingly fragmented landscapes of the southern Great Plains. For example, prairie chicken populations can undergo steep declines in response to extreme drought (Ross et al. 2016) or woody plant encroachment (Fuhlendorf et al. 2017b), while landscapes containing more connected patches of grasslands, including those restored through the Conservation Reserve Program (CRP), can serve as population sources (Spencer et al. 2017). Although Prairie-Chickens are frequently sedentary, occupying year-round home ranges, Global Positioning System telemetry reveals they undertake occasional long-distance movements, which can connect populations across distances of ~5–25 km (Earl et al. 2016). Analyses to project long-term persistence of Lesser Prairie-Chickens rely on metapopulation models and emphasize the need to sustain connectivity among regions and core areas containing source populations in order to conserve the species (Hagen et al. 2017). These examples illustrate that even for birds and mammals, in which long-distance movement is not central to their strategy for living in the Great Plains, population dynamics occur across broad landscapes and extend far beyond the typical size of individual pastures or ranching operations.

Grassland Loss and Fragmentation

Today, extensive portions of the US Great Plains have been converted into some of the most productive croplands in the world. Conversion of native grassland to cropland combined with additional losses to woody plant encroachment, urban expansion, and energy extraction are widely recognized as major challenges for grassland species conservation (Samson et al. 2004; Williams et al. 2011). Widespread grassland to cropland conversion was precipitated by the Homestead Acts beginning in 1862 and new technologies like central pivot irrigation, with varying economic forces and national policies driving continued conversion for more than a century (Wright and Wimberly 2013). Samson et al. (2004) estimated that by 2003, tallgrass, mixedgrass, and shortgrass provinces of the Great Plains were reduced to 13%, 29%, and 52% of their historic extent, respectively. More recent analyses suggest that 22.1 million ha (54.7 million acres) of grassland were converted to cropland in the northern Great Plains during 2009-2017 (2018 Plowprint Report). At the same time, beginning in the 1980s, extensive amounts of cropland have been restored back to grasslands of varying composition through the Conservation Reserve Program in the United States and the National Soil Conservation Program in Canada. Although these restored grasslands can in some cases provide valuable wildlife habitat and serve to reestablish grassland connectivity, their value is often limited due to the dominance of non-native grasses and lack of diverse forb communities. Here, we use recent data layers compiled by the National Agricultural Statistics Service (NASS) on cropland distribution (2011-2017) combined with the 2011 National Land Cover Database (NLCD) to quantify the current status of Great Plains grasslands in terms of amount and distribution.

Methods

Quantifying Rangeland Loss and Fragmentation in the Great Plains

To define subregions of the Great Plains, we used a revised version of Kuchler's (1964) map of the potential natural vegetation of the United States. The map was digitized from the 1979 physiographic regions map produced by the Bureau of Land Management, which added 10 physiognomic types. All analyses are based on data sources specific to the United States; hence, we only analyze the portion of the Great Plains occurring in the United States. Similar contemporary analyses are needed for the Canadian

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Figure 1. Potential natural vegetation of US portion of the North American Great Plains, adapted from Kuchler (1964).

portion of the Great Plains, but for a relatively recent and comprehensive overview of anthropogenic alterations to the Canadian Great Plains, see Williams et al. (2011). We extracted all of the grassland, shrubland, savanna, and forest communities in the US Great Plains from the revised Kuchler natural vegetation map (Fig. 1). Following Lauenroth et al. (1999), we refer to the northern portion of Kuchler's "Shortgrass Prairie" region (the grama/needlegrass/wheatgrass community) as "Northern Mixed Grass" types and the southern portion (the grama/buffalograss community) as "Shortgrass Steppe."

We sought to quantify the current amount of rangeland in the US Great Plains converted due to 1) woody plant encroachment; 2) urban, exurban, and other forms of development (e.g., energy infrastructure); and 3) cultivation of cropland. At the time of this analysis, the most contemporary measure of land cover across the United States was the 2011 NLCD (Homer et al. 2015). One limitation of the NLCD is that some grasslands with high rates of productivity, such as herbaceous wetlands or grasslands along riparian zones, are misclassified as cropland. A second limitation is the inability to capture cropland conversion occurring after 2011 (Lark et al. 2015). Beginning in 2009 (and retroactively for 2008), the US Department of Agriculture-NASS has annually produced a Cropland Data Layer (CDL) for the United States from satellite imagery, which maps individual crop types at a 30-m spatial resolution. Since 2009, methods were refined and improved, such that caution is recommended in using early years of CDLs for any analysis of land cover change (Lark et al. 2015, 2017). At the same time, using as many years of CDL data as possible can assist in identifying classification errors and delineating individual field boundaries (Lark et al. 2017). We used the annual CDLs from 2011 to 2017 to map the distribution of cropland in the Great Plains as follows. After constraining each layer to the boundaries of the Great Plains (see Fig. 1), we generated a layer with all cropland types (excluding grassland, grass-based pasture, and hay) in one class and all noncropland as a second class for each of the 7 yr. For each pixel, we calculated the number of years (out of 7) that it was classified as cropland. Pixels classified as cropland for ≥ 2 yr were classified as cropland in our final 7-yr integrated CDL layer (iCDL). This procedure eliminated pixels that likely were misclassified in 1 yr due to factors such as variable phenology of grasslands but still retained pixels with crop rotations that may result in classification as noncropland in some years. As a final step, we applied a minimum area filter, where any contiguous cluster of < 10 cropland pixels (i.e., 0.9 ha) was reclassified as noncropland. This step was important for screening out small strips of productive grassland along pond edges or lowlands that were misclassified in the CDL as cropland, common in certain landscapes such as the Sandhills of Nebraska. Note that our approach seeks to quantify the amount and distribution of all grasslands, regardless of whether or not they have a history of being plowed and then restored, and hence differ from the approach of Olimb et al. (2018) and the Plowprint Report produced by the World Wildlife Fund (2019).

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Table 1

Estimated extent of 5 major ecoregions of the US Great Plains, subdivided into 14 vegetation communities as mapped by Kuchler (1964; see Fig. 1). For each community, we present the estimated percent of the landscape in each of 10 land cover types based on an integration of cropland data layers (2011–2017) with the 2011 National Land Cover Database (see Fig. 2).

	Potential natural	Percent of potential natural vegetation occurring as:									
	vegetation (km ²)	Cropland	Forest	Water	Developed	Barren	Grassland	Shrubland	Pasture/ Hay	Developed open space	Uncertain grass/crop
Tallgrass prairie types											
Bluestem Prairie	259 802	68.5	3.5	1.7	1.4	0.0	14.1	0.0	2.8	4.2	3.8
Bluestem Savanna Mosaic	186 969	11.0	21.4	1.7	3.3	0.2	41.3	5.1	8.1	5.6	2.3
Blackland and Cross Timbers Prairie	83 275	9.1	1.1	1.1	0.2	0.1	86.5	0.0	0.3	0.9	0.7
Juniper/Oak and Oak Savanna	31 581	58.8	10.9	0.8	3.7	0.1	4.0	0.2	13.6	4.2	3.7
Nebraska Sandhills	58 439	29.4	16.2	3.2	1.3	0.1	24.2	13.1	3.6	4.6	4.3
Northern mixed-grass types											
Grama/Needlegrass/Wheatgrass	202 299	22.4	4.3	0.4	0.2	0.3	53.9	14.7	0.2	0.8	2.7
Needlegrass/Wheatgrass	246 531	32.5	2.0	1.5	0.4	0.9	53.2	4.4	1.2	1.9	2.0
Bluestem/Needlegrass/Wheatgrass	134 408	62.7	1.4	2.0	0.6	0.0	23.6	0.0	3.7	3.4	2.6
Southern mixed-grass types											
Bluestem/Grama	150 323	46.4	2.6	0.8	1.2	0.1	37.4	3.1	0.5	3.5	4.3
Sandsage/Bluestem	42 569	35.9	1.1	0.6	0.5	0.2	49.5	4.2	0.9	3.2	4.0
Shinnery	22 061	5.8	0.9	0.3	0.6	0.3	48.7	40.8	0.0	1.5	1.1
Shortgrass steppe											
Grama/Buffalograss	299 951	34.9	1.1	0.2	1.2	0.1	46.8	9.5	0.5	2.7	3.2
Desert savanna											
Mesquite/Buffalograss	68 800	23.6	2.8	0.4	0.7	0.4	20.4	47.2	0.1	3.1	1.3
Mesquite savanna	10 578	7.9	2.8	0.3	0.9	0.0	7.7	76.8	0.0	3.3	0.2
Total	1 797 586	40.6	4.4	1.0	1.2	0.2	36.3	7.5	2.9	3.0	3.0

We merged the iCDL layer with the 2011 NLCD, using NLCD to classify all "noncropland" pixels in the iCDL layer into one of nine land cover types (Table 1): 1) Forest (a combination of Deciduous, Evergreen, and Mixed Forest and Wooded Wetlands); 2) Open Water; 3) Developed Land (a combination of Low-, Medium-, and High-Intensity Developed land from NLCD); 4) Barren Land; 5) Grassland; 6) Shrubland; 7) Improved Pasture/Hay; 8) Developed Open Space (primarily rural roads); and 9) Uncertain Grass/Cropland (hereafter UGC). The UGC category consisted of lands classified as cropland in the NLCD, but as noncropland in the iCDL, and represented 3% of the total area of the Great Plains (Table 1). Given the more contemporary methods used to create the 2011–2017 CDLs, as well as their reliance on methods designed to specifically identify croplands, the UGC category likely represents lands misclassified as cropland by NLCD, including productive and/or restored grasslands, such as lands enrolled in the CRP. We refer to this fusion of NLCD and iCDL as fNLCD-CDL.

We used the fNLCD-CDL product to analyze rangeland fragmentation in the Great Plains based on two sets of assumptions concerning which land cover categories constitute "rangelands" and which cover types fragment rangelands. For each analysis, we used the fNLCD-CDL to calculate the distance from each rangeland pixel to the nearest fragmenting land cover type, with all nonrangeland pixels set to a value of zero. We then calculated the total area within each of the 14 vegetation subregions (see Fig. 1) consisting of rangeland occurring at varying distances from fragmenting land cover types.

In the first analysis (the "best case scenario"), we assumed that 1) rangelands consist of grasslands, shrublands, improved pasture/ hay, and the UGC category; 2) fragmenting land cover types consist of cropland, forest, and developed land; and 3) the remaining land cover types (developed open space, open water, and barren lands) are not rangeland but also do not fragment rangelands. In the second analysis (the "worst case scenario") we assumed that 1) rangelands consist only of grasslands and shrublands; 2) fragmenting land cover types consist of cropland, forest, developed land, developed open space, improved pasture/hay, and UGC; and 3) open water and barren lands are not rangeland but do not fragment rangelands. The "best case" scenario was intended to provide an index of current rangeland fragmentation for organisms that may be capable of inhabiting land cover types dominated by any type of grass and are not strongly impacted by rural roads (e.g., pronghorn antelope) and optimistically assumes that discrepancies in cropland mapping by NLCD versus iCDL represent primarily restored grassland (e.g., CRP fields) or simply grasslands misclassified as cropland. The "worst case" scenario is intended to provide an index of rangeland fragmentation for organisms that do not inhabit grasslands dominated by non-native plant species and pessimistically assumes the additional lands classified as cropland by NLCD are indeed croplands.

Results

The fNLCD-CDL product estimates that 43.7% of the Great Plains still consists of grasslands and shrublands, with the remainder consisting of 40.6% cropland, 4.4% forests, 3.0% UGC, 3.0% developed open space, 2.9% improved pasture or hay fields, 1.2% developed land, 1.0% water, and 0.2% barren land, with important regional and subregional variation in the extent of rangeland loss to cropland, forests, and developed land (Table 1; Fig. 2; maps accessible at https://gpsr.ars.usda.gov/greatplainslandcover/).

Tallgrass prairie vegetation types have undergone the most extensive losses, particularly in the bluestem prairie and oak savanna mosaic types, where only 4.2-14.1% remain as grassland and shrubland. As much as 46% of the blackland and cross timbers prairie types and 37.3% of juniper and oak savannas remain as grassland or shrubland. At the same time, these types are highly fragmented by a combination of cropland conversion and forest encroachment, with < 1% of their total area occurring > 800 m (0.5 mi) from fragmenting land cover types. Similarly, only 1% of original bluestem prairie and none of the bluestem savanna mosaic occurs > 800 m from fragmenting land cover. A notable amount (2.3-4.3%) of all tallgrass prairie types other than the Nebraska Sandhills is classified as cropland by NLCD but not by iCDL, suggesting much of this could be restored grasslands. These landscapes also contain the greatest amount of developed open

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Figure 2. Land cover of the US portion of the North American Great Plains derived from a combination of the 2011 National Land Cov4.er Database (NLCD; Homer et al. 2015), and the 2011–2017 Cropland Data Layers (US Department of Agriculture–National Agricultural Statistics Service [NASS]). The orange cover type represents areas classified as non-cropland by NASS, but cropland by NLCD.

space, reflecting the dense network of rural roads. Outside of the Nebraska Sandhills, patches of contiguous rangeland that include areas > 1.6 km from a fragmenting cover type under the "best case" scenario are most widespread in the Flint Hills of Oklahoma and Kansas and in northeastern Oklahoma, with smaller and more isolated patches occurring in the counties of Archer, Clay, Jack, and Shackelford in Texas; Pontotoc and Murray in Oklahoma; Marshall, Roberts, and Grant in South Dakota; and Marshall in Minnesota. Portions of the Sheyenne National Grassland in Ransom County, North Dakota are > 800 m from fragmentation, but no part of this grassland was identified as > 1.6 km from fragmenting land uses, even under the "best case" scenario. In contrast to the remainder of the tallgrass prairie types, the Nebraska Sandhills are one of the least fragmented vegetation types within the entire Great Plains (Figs. 3-5). Portions of the southern and central Sandhills contain extensive, contiguous rangelands including areas > 6.4 km (4 mi) from any fragmenting land cover, and 50% of the entire region consists of rangelands > 800 m from any fragmenting land cover (Table 2; see Figs. 3-5).

In northern mixed prairie types, conversion to cropland has been especially severe in the eastern portion (bluestem/ needlegrass/wheatgrass type), with only 23.6% (and potentially an additional 2.6%) in grassland (see Table 2 and Figs. 3-5) and only 1% occurring in patches > 800 m from fragmenting land cover. Encouragingly, at least 57.6% and 68.6% of the two more arid vegetation types remain in grassland (see Table 2), but only 11% of the needlegrass/wheatgrass type and 5% of the grama/needlegrass/ wheat grass types occur > 1.6 km from fragmenting land cover. Within these latter two vegetation types, the largest areas of contiguous rangelands in South Dakota are on and around Badlands National Park, Buffalo Gap National Grassland, and the Pine Ridge Indian Reservation; on the Cheyenne River Indian Reservation and adjacent private lands in Stanley County; and in Harding and Butte Counties north of the Black Hills. In Montana, contiguous mixedgrass rangelands > 1.6 km from fragmentation occur on intermingled private, state, and Bureau of Land Management (BLM)-administered lands across Phillips, Valley, Garfield, Rosebud, Custer, and Carter Counties. In Wyoming, contiguous rangelands > 1.6 km from fragmentation are most prevalent on and near the Thunder Basin National Grassland, plus extensive portions of Johnson, Campbell, and Converse Counties. The least fragmented mixed grass rangelands in North Dakota occur on and near the Little Missouri National Grassland and Theodore Roosevelt National

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Figure 3. Variation in the degree of fragmentation of Great Plains measured in terms of distance to cropland, forest, or developed lands. This map depicts a "best case" scenario in which 1) croplands are mapped based only on the US Department of Agriculture–National Agricultural Statistics Service Cropland Data Layers (2011–2017), 2) all grass-dominated cover types including hay fields and improved pasture are considered rangelands, and 3) developed open space (as defined by the National Land Cover Database) are assumed to not be a fragmenting land cover type.

Park, but areas > 1.6 km from fragmenting land cover are relatively rare due to the prevalence of cropland near and forest within this landscape.

In the southern mixed prairie, > 40% of the bluestem/grama vegetation type is rangeland, but this region has been extensively fragmented by cropland and woody plant encroachment (see Figs. 3–5). Only 2% of the region occurs > 800 m from fragmenting land cover. Remaining contiguous rangeland within the bluestem/ grama type is concentrated in south-central Kansas and on the border between Oklahoma and the Texas Panhandle, especially in Collingsworth County. We note that this region has been strongly affected by juniper encroachment (Scholtz et al. 2018), which our analysis does not fully capture because we included shrublands as rangeland, and only assessed woody encroachment via the development of forest. In contrast to the bluestem/grama region, extensive portions of the shinnery and sandsage/bluestem vegetation types persist as large, contiguous rangeland patches containing areas > 1.6 km from fragmenting land covers (see Figs. 3-4), due to sandy soils minimizing conversion to cropland. The shinnery

type still retains 33% of the area as rangelands > 1.6 km from any fragmenting land cover, primarily along the Canadian River corridor in the Texas Panhandle. Large, contiguous areas of sands-age/bluestem occur on and around the Comanche National Grass-land in southeast Colorado and across intermingled private and state lands in northeastern Colorado. In the mesquite savanna vegetation types, large patches of rangeland > 1.6 km from fragmentation (which comprise ~5% of the total landscape) occur primarily on privately owned lands in the western half of the region (see Figs. 2–4).

In the shortgrass steppe (grama/buffalograss type), at least 56% remains as rangeland, with 13% in areas > 1.6 km from fragmenting land cover. Large, unfragmented rangelands occur in southeastern Colorado, northeastern New Mexico, the western fringe of the shortgrass steppe in east-central New Mexico, and in Andrews County, Texas (see Figs. 2–4). Portions of these landscapes are associated with the Comanche, Kiowa, and Rita Blanca National Grasslands and BLM-administered lands in New Mexico, but most is privately owned. A smaller region of shortgrass rangeland

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Figure 4. Variation in the degree of fragmentation of Great Plains measured in terms of distances to cropland, forest, or developed lands. This map depicts a 'worst case' scenario in which 1) croplands are mapped based on the US Department of Agriculture–National Agricultural Statistics Service Cropland Data Layers (2011–2017) and the 2011 National Land Cover Database (NLCD), 2) hay fields and improved pasture are not included as rangelands, and 3) developed open space (as defined by NLCD) is included as a fragmenting land cover type.

containing areas > 1.6 km from fragmentation occurs on and around the Pawnee National Grassland in Colorado and adjacent private lands surrounding Cheyenne, Wyoming.

The contrast between our "best case" and "worst case" scenarios was most notable in the tallgrass prairie (other than the Nebraska Sandhills), as well as in the bluestem/needlegrass/wheatgrass type of the northern mixed prairie, the bluestem/grama and sandsage/ bluestem types of the southern mixed prairie, and in the shortgrass steppe (grama/buffalograss) (see Table 2). The estimated amount of rangeland in the tallgrass prairie types decreased by 7–17% when improved pasture and hay and UGC categories were excluded from the definition of rangeland, and the amount of rangeland > 800 m from fragmenting land cover declined by > 50%. The latter change was due to the inclusion of rural roads as a fragmenting land cover in the "worst case" scenario. Finally, the amount of shortgrass steppe as rangeland increased by 3.6% under the "best case" scenario, and the amount of rangeland > 800 m from fragmentation declined by a third (see Table 2).

In addition to the direct loss and fragmentation of rangelands by land conversion, the conservation of pattern and process in rangelands (sensu Fuhlendorf et al. 2012) is compromised by the complex land ownership patterns that characterize much of the region. Landownership boundaries within contiguous areas of rangelands can impede movements of both fire and grazers, via fences (Jakes et al. 2018) and via differences in management objectives and practices among landowners. A full quantification of these sources of fragmentation is beyond the scope of this paper, but we illustrate the complexity of land ownership patterns in Weld County, Colorado (Fig. 6), which is one of the largest counties in the western Great Plains and encompasses the Pawnee National Grassland. Although the majority of Weld County consists of large contiguous areas of rangeland (see Fig. 6a), these contiguous areas are characterized by a highly complex land ownership pattern, which affects wildlife populations. For example, black-tailed prairie dogs are controlled on the lands represented in black and on many of the private lands of varying colors in Figure 6b, whereas control

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Distance to fragmenting land cover type

Figure 5. Variation in the degree of fragmentation of US Great Plains rangelands based on two different assumptions concerning which land cover types cause fragmentation. In both cases, we calculated the total area in each ecoregion within varying classes of distance to cropland, forest, or developed lands, but the two different scenarios made different assumptions about how croplands are mapped and which land cover types constitute "rangelands" (see Figs. 3 and 4 and methods for details).

is limited or prohibited on lands depicted in light blue (Pawnee National Grassland).

Discussion

Grassland Loss and Fragmentation

Previous analyses have reported on the extreme degree of grassland conversion in the Great Plains, particularly in the eastern ecoregions (e.g., 13.4% of the tallgrass prairie [excluding Nebraska's

sandhills] remaining; Samson et al. 2004; see also Comer et al. 2018). These estimates expressed grassland loss in terms of "percent of historic vegetation remaining," where lands converted to cropland but then restored to grassland and lands managed as pasture or hay fields were considered to be converted grassland. Our analyses show substantially more grassland and shrubland remaining in many of these ecoregions. For example, we estimate that 35.1% of tallgrass prairie (excluding the Nebraska Sandhills) currently occurs as grassland or shrubland, and an additional 2.8% remains in the "uncertain grass or crop" category (see Table 1). At

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Table 2

Percentage of total area in each of 14 major vegetation types in the US portion of the Great Plains (see Fig. 1) estimated to occur as nonrangeland or as rangeland of varying distances to a fragmenting land cover type (see Figs. 3 and 4). Numbers to the left of each slash symbol show results from a "best case" scenario (see Fig. 3), and numbers to the right of each slash symbol are the estimate from a "worst case" scenario (see Fig. 4), which made different assumptions about the definition of rangeland cover types and the definition of fragmenting land cover types (see methods).

Potential natural vegetation type	Percentage of area occurring as rangeland of varying distances to fragmenting land cover types						
	Nonrangeland	0.01-0.8 km	0.81-1.6 km	1.61-3.2 km	3.21-4.8 km	4.81-6.4 km	> 6.4 km
Tallgrass prairie							
Bluestem Prairie	79.3/85.9	19.8/13.7	0.8/0.3	0.2/0.1	0/0	0/0	0/0
Bluestem Savanna Mosaic	78.5/95.8	21.4/4.2	0.1/0	0/0	0/0	0/0	0/0
Blackland and Cross Timbers Prairie	43.2/53.6	55.9/46.1	0.8/0.2	0/0	0/0	0/0	0/0
Juniper/Oak and Oak Savanna	54.8/62.7	44.9/37.2	0.3/0.1	0/0	0/0	0/0	0/0
Nebraska Sandhills	12.4/13.4	37.1/39.5	23.5/22.7	20.3/18.8	5.2/4.5	1.1/0.9	0.3/0.2
Northern mixedgrass							
Grama/Needlegrass/Wheatgrass	28.5/31.4	47.6/46.1	13.0/12.2	8.3/7.9	2/1.8	0.5/0.5	0.1/0.1
Needlegrass/Wheatgrass	39.2/42.3	48.0/46.0	7.9/7.2	4.1/3.7	0.7/0.7	0.1/0.1	0/0
Bluestem/Needlegrass/Wheatgrass	70.1/76.4	28.4/22.9	1.3/0.6	0.2/0.1	0/0	0/0	0/0
Southern mixedgrass							
Bluestem/Grama	54.6/59.5	42.6/39.6	2.4/0.8	0.3/0.1	0/0	0/0	0/0
Sandsage/Bluestem	41.5/46.3	44.7/50.3	10/2.6	3.5/0.6	0.3/0.1	0.1/0	0/0
Shinnery	9.4/10.5	38.8/45.1	19/17.4	20/17.4	8.5/6.4	3.1/2.3	1.1/1
Shortgrass steppe							
Grama/Buffalograss	40.1/43.7	36.1/40.4	11.6/7.3	7.9/5.2	2.5/1.9	1.1/0.8	0.8/0.6
Mesquite savanna							
Mesquite/Buffalograss	31.1/32.5	55/57.1	10/7.8	3.6/2.6	0.3/0.1	0/0	0/0
Mesquite savanna	15.3/15.5	66.9/69.2	11.8/10	4.9/4.3	0.9/0.7	0.2/0.2	0/0

the same time, our fragmentation analysis for tallgrass prairie shows that aside from the Nebraska Sandhills, at most 0.2% of tallgrass prairie occurs in locations > 1 600 m (1 mi) from a fragmenting land cover type, similar to the conclusions based on minimum dynamic areas of remaining prairie (see Fig. 1 in Samson et al. 2004). Thus, our land cover analyses (see Tables 1 and 2) reveal that more of the eastern Great Plains remains in rangeland cover than previously thought, but that remaining rangelands still predominantly occur in small, highly fragmented patches that likely contain substantially altered plant species composition relative to the historic condition. Fragmentation of this magnitude clearly has the potential to alter movements and metapopulation dynamics of a broad range of fauna in the region. Linking these patterns more directly to the ecology of specific species will require more detailed analyses of specific regions and landscape than we can provide here, but our land cover and fragmentation results are available to support such efforts (https://gpsr.ars.usda.gov/ greatplainslandcover/). At broader spatial scales, we emphasize that even in the western Great Plains, where > 50% of the mixedgrass, shortgrass, and mesquite savanna regions persist as rangeland, the spatial distribution of rangelands is still highly fragmented. In both northern and southern mixed grass, < 6% of the

Figure 6. The distribution of large, contiguous areas of rangeland in Weld County, Colorado when viewed as a single land cover type (green polygons in map A) or when viewed in terms of individual landowners (polygons of varying colors in map B). In map B, each color represents a different landowner, where *light blue* represents federal ownership (Pawnee National Grassland) and *black* represents lands owned by the state of Colorado. Although the northeastern portion of Weld County appears to contain the largest contiguous blocks of rangeland under a single ownership are located in the northwestern and southcentral portion of the county. Land ownership patterns are a potential additional source of fragmentation for some native species. For example, black-tailed prairie dogs are controlled on the lands represented in *black* and on many of the private lands of varying colors, whereas lands depicted in *light blue* are managed in the opposite manner.

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Table 3	3
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Amount and percentage of area of each of 9 National Grasslands occurring > 800 m (0.5 mile) from a property boundary.

National grassland	State	Total area (ha)	Area (ha) > 800 m from property boundary	% of Area $>800~m$ from property boundary
Buffalo Gap	SD	265 102	98 007	37.0
Little Missouri	ND	451 319	142 859	31.7
Sheyenne	ND	33 200	8 554	25.8
Thunder Basin	WY	224 005	56 023	25.0
Rita Blanca	OK/TX	38 119	8 900	23.3
Comanche	CO	179 662	38 160	21.2
Grand River	SD	75 800	15 174	20.0
Pawnee	CO	77 954	9 468	12.1
Black Kettle	OK	13 464	46	0.3

entire landscape consists of rangeland > 1.6 km (1 mi) from a fragmenting land cover type. Only in the shortgrass steppe and Nebraska Sandhills do we begin to identify some larger, contiguous rangeland landscapes, with 12% and 27% of the region > 1.6 km from fragmenting land cover, respectively. These findings indicate that efforts to restore rangelands in a manner that enhances native plant diversity and does so in a spatial context that enhances connectivity among conserved and restored rangelands are central to conserving Great Plains biodiversity.

Differences between the results of our "best case" versus "worst case" scenario analyses also support this conclusion. For example, the estimated total extent of rangeland in the bluestem/needle/ wheatgrass, bluestem/grama, and sandsage/bluestem vegetation types declined by 6.3%, 4.8%, and 4.9%, respectively, under our worst relative to best case scenarios. Furthermore, in all three aforementioned vegetation types, the amount of rangeland > 800 m from fragmentation was more than halved under the worst relative to best case scenario. These results indicate that the inclusion of the UGC category, which likely includes CRP and other restored grasslands, in the definition of "rangeland" substantially reduced fragmentation, such that both the amount and spatial location of restoration efforts are important in reconnecting existing rangelands. In addition, we note that improvements in remote sensing and ground-based mapping of rangeland composition and conservation value could reveal new opportunities to enhance landscape connectivity. Hereafter, we highlight several potential opportunities to reverse the pattern of rangeland loss and fragmentation illustrated in Figures 2 and 3.

Opportunities: Stitching Grasslands Back Together

Incentive Programs to Restore Grasslands and Native Wildlife

The CRP, signed into law as part of the Food Security Act of 1985, is the largest voluntary, private-lands conservation program in the United States and represents a key mechanism for grassland restoration in the Great Plains. CRP enrollment in the Great Plains reached a peak of 10.6 million ha (26.3 million acres, or 5.5% of the Great Plains) in 2007 and has since declined annually, with 6.7 million ha (16.5 million ac; 3.2%) of the Great Plains enrolled in 2017. Although we have not conducted a spatial analysis, the 3.2–4.5% of the Great Plains enrolled in CRP over the past decade likely comprises much of the area mapped as "uncertain grassland or cropland" by the fNLCD-CDL product (see Table 1) and likely contributes to the substantial difference in degree of rangeland fragmentation quantified by our best case versus worst case scenarios (see Table 2 and Figs. 3–4).

Over time, the focus of CRP has shifted from primarily a soil erosion and land retirement program to one that targets a combination of water quality improvement, soil erosion prevention, and wildlife habitat improvement on environmentally sensitive agricultural lands, via enrollment in a ten- or fifteen-year contract. The early days of CRP saw 9.4 million ha (23.2 million ac) enrolled in the Great Plains by 1990, most planted to grass monocultures, often using non-native grass species whose seeds could establish quickly and were inexpensive. Furthermore, these grasslands remained ungrazed and unburned in most years, in part due to the program's focus on prevention of soil erosion, thereby suppressing the historic disturbance regime and limiting the value of CRP grasslands to native wildlife (King and Savidge 1995; McCoy et al. 1999).

Importantly, 46 different practices are now eligible for application to lands enrolled in either a general (competitive enrollment) or continuous (noncompetitive) signup nationwide, with priority being placed on the types that offer the highest diversity of native grasses, forbs, and shrubs. As of July 2018, 5.6 million ha (14.0 million acres) nationwide were enrolled in general CRP and an additional 3.3 million ha (8.1 million acres) were enrolled in continuous and other targeted contracts, with most of these acres being in the Great Plains. Thus, CRP practices have substantial potential to influence patch size and connectivity of rangeland habitats.

Recognizing opportunities for improvement to biodiversity, the CRP program later placed priority on enrollment offers that targeted establishing or improving stand diversity. Midcontract management practices (disturbance, such as high-intensity grazing, prescribed fire, or tillage, often followed by interseeding additional grass and/or forb species) were originally optional but have now become required practices. Such management can shift lowdiversity CRP stands toward more diverse grasslands and enhance opportunities for grazing and fire to become functional processes within CRP grasslands. Unfortunately, the types of practices applied and the frequency of midcontract management varies substantially from state to state and often does not include prescribed burning (FSA 2018a). We suggest that a major opportunity for increased conservation of pattern, process, and biodiversity is the broader incorporation of fire and grazing into midcontract CRP management in all Great Plains states.

Another underused opportunity is transitioning of lands enrolled in CRP to working rangelands that will not be recultivated when CRP contracts expire. One recent advance is the CRP Grasslands signup opportunity, authorized by the 2014 Farm Bill, which allows landowners and operators to protect grassland, including rangeland and pastureland, while maintaining the areas as working lands through 14- or 15-yr contracts (FSA 2018b). CRP Grasslands emphasizes support for grazing operations to maintain and/or improve plant and animal biodiversity. Participants retain the right to conduct common grazing and haying practices within the parameters set forth in the conservation plan developed with assistance from NRCS. CRP lands with contracts nearing expiration are targeted for enrollment, and cost share is available for infrastructure such as fencing and water development to maintain the grass cover, which aids in incorporating these lands into a grazing program.

One example of an advance in grassland landscape restoration comes from a grass-roots effort, Preserving CRP Grassland Benefits in Western Nebraska, which could serve as a model for broader 12

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application in the Great Plains. This locally led effort sought to convert lands expiring from CRP in the early 2010s into grazed grasslands. At the time, 106 800 of the 154 600 ha of CRP in the Nebraska Panhandle were set to expire between 2009 and 2012, with no option for CRP contract renewal. Recognizing the threat that these lands could revert to cultivated cropland, the three Natural Resource Districts (NRDs) in the Panhandle, the Natural Resources Conservation Service (NRCS), the Nebraska Game and Parks Commission (NGPC), and several other conservation entities developed a partnership to promote the maintenance of expiring CRP as grassland using livestock grazing. Cost-share incentives for grazing infrastructure and education on grazing management were components. A Nebraska Environmental Trust Fund Grant was secured to help with these efforts. Even though CRP enrollment was reauthorized during the project, 8 321 ha (on 102 different projects) benefitted over a 6-yr period as producers chose to convert them to working grasslands rather than entering into another CRP contract.

The Lesser Prairie-Chicken is one species that has benefitted dramatically from CRP grasslands. One key to this success was the spatial targeting of CRP enrollments with appropriate vegetation diversity in counties with both existing Prairie-Chicken habitat and populations and where CRP could enhance connectivity and size of grassland patches (Spencer et al. 2017; Sullins et al. 2018). Recent work shows that annual survival of Prairie-Chickens is greater in landscapes with larger grassland patch size and greater patch richness, as well as in portions of those landscapes farther from fences (Robinson et al. 2018). Given that new enrollment of lands into the CRP program is limited, targeting enrollment in locations that increase grassland patch size is important (Robinson et al. 2018). In addition, as discussed by Spencer et al. (2017) "one approach to retain CRP fields as grassland, but in the face of reduced CRP contract enrollment, is to retain the primary land use of these as working grasslands (NRCS 2016)." The use of the Environmental Quality Incentives Program (EQIP) to share the costs of necessary infrastructure such as boundary fencing and water sources can enhance the conversion of these lands to working grasslands (NRCS 2016), while also recognizing the need to consider the potential effects of fencing density and type on wildlife (Patten et al. 2005; Jakes et al. 2018; Robinson et al. 2018). Similar efforts facilitated by nongovernmental organizations that address other grasslandbreeding birds (e.g., Ducks Unlimited) enhance these types of transitions. Habitat modeling for other grassland birds can also help guide the selection of localities where transitions of CRP to working grassland should be emphasized (e.g., Lipsey et al. 2015; Niemuth et al. 2017). For example, spatial targeting of CRP enrollment in landscapes with existing tallgrass prairie can enhance habitat and abundance of Henslow's sparrow, another grassland bird of conservation concern (Herse et al. 2017).

Another innovative application of the EQIP program is the NRCS Black-Footed Ferret Special Effort, which provided technical assistance and direct financial support to ranchers who agree to manage a portion of their land to maintain BTPD populations and allow the reintroduction of black-footed ferrets (BFFs). The program's goal was to promote voluntary, incentive-based conservation of these species on private and tribal lands. This program was particularly valuable in that it changed the management objectives (and associated practices) on a property, without necessarily adding fragmenting infrastructure such as fencing. A key limitation is uncertainty in how to maintain contracts over longer time scales than a single contract. To the extent that such programs can be implemented across multiple adjacent landowners, or with landowners adjacent to other lands managed for prairie dog conservation, there is great potential to increase the size of grassland patches managed in a common framework. Continued modifications that allow the CRP and EQIP programs to address landscapescale habitat needs of Great Plains fauna are needed, particularly through spatial targeting of key locations or landscapes in order to link together existing grasslands, rather than simply addressing field- or pasture-scale soil and water conservation.

Landownership Patterns and Cross-Boundary Management

The complexity of the land ownership pattern displayed for grasslands in Weld County, Colorado (see Fig. 6) is typical of many Great Plains counties. The coordination of management objectives across property boundaries and reductions in the ratio of boundary length to the area of properties managed for biodiversity conservation will clearly enhance the capacity for grazers and fire to move across broader landscapes and interact with the inherent variability in soils, topography, and weather patterns. Most public lands within the Great Plains currently occur in highly fragmented spatial patterns. For example, analysis of boundary patterns in nine National Grasslands managed by the US Department of Agriculture–Forest Service extending from North Dakota to New Mexico shows that only two (Buffalo Gap and Little Missouri National Grasslands) have > 30% of their land base occurring in areas > 800 m (0.5 mi) from a National Forest System property boundary (Table 3). This land ownership pattern creates major challenges for the conservation of controversial species such as BTPDs and mobile species such as elk, for which adjacent private and state lands can have nearly opposite management objectives.

Boundary management for BTPDs can be an especially significant source of conflict, as their colonies can frequently expand across distances of 800 m in 1-2 yr (Augustine et al. 2008), and management options to prevent such movement can be expensive and contentious (Luce et al. 2006; Miller et al. 2007). It is notable that the Buffalo Gap National Grassland currently has the greatest proportion of its land base occurring in contiguous blocks of grassland distant from property boundaries (see Table 3). This resulted from a program to conduct land exchanges (i.e., exchanges of National Forest System and private land of equal value) to reduce boundary complexity over the past 2 decades. This effort, combined with portions of Buffalo Gap National Gap occurring adjacent to the Badlands National Park and the Pine Ridge Indian Reservation, has facilitated the recovery of BTPD in this landscape and supports the most successful BFF reintroduction site in the Great Plains (US Fish and Wildlife Service 2013). Similarly, lands originally granted from the federal government to the states upon their creation were in the form of two sections (2.56 km² properties) within each township of the Great Plains, creating a fragmented state land ownership pattern. Ongoing efforts to conduct land exchanges in states such as Colorado have enhanced the development of landscape-scale Stewardship Action Plans for many properties and allowed for creation of Stewardship Trust Lands that are subject to a higher standard of care, planning, and management by both the State Land Board and lessees. Such plans and trust lands address habitat needs of species of conservation concern and enhance livestock and native grazer movement, as well as metapopulation dynamics of sedentary species, at spatial scales far larger than the original 2.56 km² properties.

Finally, the vast majority of Great Plains grasslands are privately owned and managed by people who care deeply about conservation of the land but also need to make a living. Managers of private rangelands often acknowledge the importance of wildlife conservation but place this as a far lower priority than livestock production (Kachergis et al. 2014; Sliwinski et al. 2018). Engaging these people to manage disturbance regimes at larger spatial scales will require acknowledging that domestic livestock grazing can function as an essential rather than a degrading component of Great Plains disturbance regimes. Programs and strategies to enhance livestock movement at greater spatial scales and increase spatiotemporal variability in grazing intensity can enhance contributions to wildlife conservation (Fuhlendorf et al. 2006; Derner et al. 2009; Toombs et al. 2010). Purchases of contiguous rangelands by nongovernmental organizations and/or establishment of conservation easements to consolidate private properties and connect existing public lands has also made important contributions to the conservation of native grazers (and in some cases increased utilization of prescribed fire) and has increased notably in use and scale nationwide over the past decade (Owley and Rissman 2016).

The need to coordinate management objectives and practices across property boundaries and jurisdictions to conserve Great Plains fauna has been recognized by many authors, organizations, managers, and agencies (e.g., Samson and Knopf 2004; Fuhlendorf et al. 2012; NRCS 2016). Yet cross-jurisdictional management remains a major challenge within a region that is predominantly private land intermingled with public lands managed by 11 states, 3 provinces, > 1 000 counties and administrative divisions, and at least 4 different federal agencies in the United States alone. Samson and Knopf (2004) proposed that establishment of more meaningful state and federal agency designs is necessary to advance Great Plains grassland conservation. In particular, they suggested that consolidation or realignment of federal agencies and improved state-federal collaboration would reduce conflicting approaches to species conservation and enhance conservation cost-effectiveness. Progress in this regard has been limited over the past 15 yr, but the history of efforts to conserve the Lesser Prairie-Chicken in the southern Great Plains suggests some opportunities to advance cross-boundary management efforts. In some cases, even small nature reserves or other public lands, when managed in a manner that includes effective outreach and interactions with surrounding private landowners, can serve as catalysts for landscape-scale conservation and directly enhance wildlife conservation (Miller et al. 2012). Success in such efforts relies on application of novel advances in the science and practice of engaging landowners. Outright purchase of private ranches and conversion to conservation-oriented operations can in some cases also produce valuable outcomes for wildlife conservation that include increasing the scale and pattern of grazing by both livestock and bison (e.g., Kohl et al. 2013), but such efforts will be enhanced where they are linked with an understanding of current economic, political, and cultural issues within the landscape (Miller et al. 2012; Davenport 2018).

The need for cross-boundary management frameworks in the Great Plains was formally recognized > 20 yr ago, when in 1997 the US Fish and Wildlife Service (USFWS) announced an initiative called the High Plains Partnership for Species at Risk (HPP). This initiative encouraged landowners, agricultural organizations, and conservation groups in actions to benefit the Lesser Prairie-Chicken and other declining wildlife species in the southern Great Plains. The initiative was born out of the five state wildlife agencies forming the Lesser Prairie-Chicken Interstate Working Group (LPCIWG), which developed a region-wide conservation strategy for this species and many other species associated with LPC habitat. The group worked with the Great Plains Partnership of the Western Governors' Association and received funding from the National Fish and Wildlife Foundation to coordinate a partnership of diverse stakeholders to advance region-wide, proactive, voluntary solutions to the decline of the Lesser Prairie-Chicken. The Initiative identified measures that would benefit the Lesser Prairie-Chicken and promote voluntary participation in habitat restoration projects, including a series of demonstration projects in Lesser Prairie-Chicken range, technical and financial assistance to landowners for habitat restoration and improvement projects, and research into the relationship between Lesser Prairie-Chicken habitat needs and range management practices.

From 1998 to 2003, momentum for this effort grew. Letters to the USFWS Director at the time highlighted the accomplishments,

which included > 36 000 ha of conservation efforts across the five states within the range of the Lesser Prairie-Chicken. While initial efforts demonstrated interest by a broad spectrum of stakeholders, it lacked participation from the energy development and delivery sectors and eventually dissolved due to a lack of dedicated funding. Although conservation opportunities were directed at landowners, proponents did not engage with oil and gas companies, rural electrical cooperatives, and wind-power companies. Another limitation of the initiative was to clearly demonstrate how the funds invested would mitigate the need to list the Lesser Prairie-Chicken under the Endangered Species Act. Proponents did not present a strategic conservation plan that would clearly allow for other economically important industries to continue across the landscape and contribute to the conservation of the species. Finally, promotional materials about the effort displayed the action area as being the entire Great Plains, giving the impression that local actions would have minimal contribution to initiative goals while potentially restricting developmental activities.

Over the next decade, the LPCIWG transitioned from collecting information on Lesser Prairie-Chicken ecology, as it had done during the HPP, to evaluating conservation actions benefitting Lesser Prairie-Chickens. This ultimately led to the Lesser Prairie-Chicken Range-wide Conservation Plan (LPCRWP; Van Pelt et al. 2013) developed by the LPCIWG and collaborators, which incorporated several lessons from the HPP experience. One important modification was to evaluate the location and juxtaposition of potential habitat, with the intent that restoration would be implemented in the same habitat types being impacted by management or development activities and would enhance habitat connectivity. Also, measures were developed to ensure the quality of the habitat being managed or restored was equal to or better than the area being impacted. Finally, the LCPRWP conservation effort was depicted visually using the Western Association of Fish and Wildlife Agencies' Crucial Habitat Assessment Tool (CHAT), allowing land managers to target their activities and visualize the contribution to the broader landscape. Finally, there was recognition for the need for a shifting mosaic of grassland conservation efforts across the landscape to address changing precipitation patterns and prolonged droughts, instead of focusing investments on permanently protected areas, which could become unsuitable with changing climate. We suggest that efforts to restore working rangelands in portions of the Great Plains outside the LPC range be spatially targeted in a similar manner and use visualization tools that enhance communication of broader, landscape-scale conditions, and goals among agencies, landowners, businesses, and the public. The development of rangewide plans with similarly associated institutions as the LPCRWP for species such as BTPD and other prairie grouse (Greater Prairie-Chicken, Sharp-Tailed Grouse, and Greater Sage-Grouse) would be one potential means to enhance collaboration and coordination of grassland restoration in the remainder of the Great Plains. Consistent funding sources and commitments at federal, state, and local levels may help ensure such plans and institutions do not follow the fate of the HPP.

Management Implications

Across the Great Plains, conservation of native fauna is constrained by the loss and fragmentation of rangelands, as well as the limited spatial scales over which fire and fauna can move, interact, and influence Great Plains vegetation. Here, we quantified contemporary patterns of rangeland patch size and fragmentation across all the major historic grassland, shrubland, and savanna vegetation types in the US portion of the Great Plains (https://doi. org/10.1016/j.rama.2019.09.001). Our maps and analyses identify significant opportunities for landscape-scale conservation and restoration in the western half of the Great Plains. Continued

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restoration of marginal croplands to grassland, in spite of declining opportunities for enrolling lands in CRP, will depend on expanding innovative programs that transition existing CRP to working rangelands, managed with grazing and fire to support enhanced plant and habitat diversity. Most public land in the Great Plains remains highly fragmented and intermingled with private lands that often have conflicting goals for biodiversity conservation. Coordination of management objectives across broader landscapes, as has occurred in South Dakota on portions of Buffalo Gap National Grassland adjacent to the Badlands National Park and the Pine Ridge Reservation, is critically needed in additional portions of the Great Plains to facilitate conservation of the full suite of native grazers, including prairie dogs and their associated species. In addition, our land cover analyses identify many key areas of contiguous rangeland in predominantly private ownership, where conservation may be enhanced through voluntary incentive programs that provide compensation for harboring species or creating habitats that conflict with traditional livestock production objectives. The development of adequately funded institutions to facilitate cross-boundary management and restoration within broad landscapes could rely on lessons learned in the ongoing efforts to conserve landscapes for the Lesser Prairie-Chicken. All of these efforts rely on accelerating the slow but ongoing shift from thinking about and managing grasslands at the scale of individual pastures to focusing restoration and conservation efforts at the scale of dynamic grassland landscapes.

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Appendix A. Supplementary data

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