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Viewpoint: The black-tailed prairie dog—headed for extinction?

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Abstract

The black-tailed prairie dog (*Cynomys ludovicianus*) is 1 of 5 western prairie dog species, and the only species found on the Great Plains. Some authorities believe the black-tailed prairie dog may have been the most numerous of mammalian herbivores found on the plains—with some estimates placing their historic numbers as high as 5 billion. Due to a combination of factors including habitat destruction, hunting, plague, and poisoning programs, the black-tailed prairie dog may now be threatened with extinction across its entire range. In this paper, a tentative prairie dog conservation strategy consisting of core reserves, buffer areas, and corridors is proposed.

Key Words: Great Plains, rangeland policy, extinction, prairie dog conservation strategy

We tend to think of extinction as affecting only species that are numerically rare, with narrow habitat preferences, or limited distribution. Yet, the black-tailed prairie dog (*Cynomys ludovicianus*), a species that once numbered in the "billions" of individuals, and ranged from Mexico to Canada, may be heading toward extinction. Due to human-caused factors, black-tailed prairie dog populations are now highly fragmented, and isolated (Miller et al. 1994). Most colonies are small and subject to potential extirpation due to inbreeding, population fluctuations, and other problems that affect long term population viability (Primack 1993, Meffe and Carroll 1994, Noss and Cooperrider 1994). An additional threat is posed by sylvatic plague (Cully 1989) which, combined with other human-caused mortality, may hasten the extirpation of the rodent from the Great Plains. Since the turn of the century, it is estimated that prairie dog numbers have been reduced by 98–99% of their former numbers across the West (Miller et al. 1994). Furthermore, the loss of the prairie dog, a keystone species, may accelerate the extinction of a host of other dependent species (Reading et al. 1989, Miller et al. 1994, Knowles and Knowles 1994). Even if small populations of black-tailed prairie dogs manage to persist, their ecological-evolutionary influence on grassland ecosystems is now greatly diminished. Although a number of studies document the ecological influence of prairie dogs upon grassland ecosystems (Coppock et al. 1983a, 1983b, Hansen and Gold 1977, Koford 1958, Krueger 1986, O'Meilia et al. 1982, Whicker and Detling 1988, Reading et al. 1989, Knowles and Knowles 1994), it is difficult to quantify how much the present decline in prairie dog numbers has negatively affected Great Plains ecosystem function in terms of nutrient cycling, and plant community structure. Given their past numbers, prairie dogs must have been an ecological disturbance factor at least equal to that attributed to wildfire and bison.

Noss and Cooperrider (1994) suggest that preventing "biological impoverishment" is the goal of biological diversity preservation. They define biodiversity as the variety of life and its processes. Biodiversity includes the variety of living organisms, the genetic differences among them, the communities and ecosystems in which they occur, and the ecological and evolutionary processes that keep them functioning, yet ever changing and adapting. Preservation of biodiversity emphasizes native species over exotics, and preservation of biodiversity is more than preserving some representative individuals of a species (Noss and Cooperrider 1994). Species must be protected in such numbers so as to ensure they can function and participate in maintaining evolutionary and ecological processes. By this definition of biodiversity, black-tailed prairie dog ecosystems are already endangered, and if current trends are not reversed, the potential even exists for the extinction of the species altogether. Clearly, then, the diminishment of the rodent's influence upon the Great Plains landscape is contributing to the biological impoverishment of these grassland ecosystems. To ensure the continuing ecological influence of prairie dogs upon grassland ecosystems, and long-term viability of black-tailed prairie dog populations and associated species, I propose the establishment of a prairie dog reserve system network consisting of cores, buffers, and linkage corridors.

Basic Ecology and Description

The black-tailed prairie dog is a burrowing rodent that feeds primarily on grasses. It is 1 of 5 prairie dog species in North America. The 4 other species include the Mexican prairie dog (*Cynomys mexicanus*), white-tailed prairie dog (*Cynomys leucurus*), Gunnison's prairie dog (*Cynomys gunnisoni*), and Utah prairie dog (*Cynomys parvidens*). Of the 5, the black-tailed prairie dog is the only one found on the short and mid-grass

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plains east of the Rockies. Black-tail prairie dogs avoid areas with tall grass, heavy sagebrush, and other thick vegetative cover which interfere with detection of predators (Krueger 1986, Clark and Stromberg 1987). Historically, the species ranged from the southern Alberta and Saskatchewan in Canada south through the plains states to northern Mexico (Clark and Stromberg 1987).

Black-tailed prairie dogs live in family groups, protecting individual group territories within a larger colony matrix. Although most prairie dogs are somewhat colonial, black-tailed prairie dogs form the largest colonies, and achieve the highest densities of the 5 species (Knowles and Knowles 1994).

Burrows are the key to prairie dog survival. They provide protection from weather, predators, and a den for young. Most social interactions center on burrows. Burrows tend to be regularly spaced within a colony (Knowles 1982). Prairie dog burrows are also an extremely valuable resource for other species including swift fox (*Vulpes velox*), black-footed ferret (*Mustela nigripes*), burrowing owl (*Athene cunicularia*), among others, providing shelter from weather and protection from predators. Indeed, the occurrence of prairie dog burrows may be a key element for the survival of many other species (Knowles and Knowles 1994).

Historical Accounts

Early historical records suggest black-tailed prairie dogs may have been the most abundant mammals in North America at the time of first Euro-American explorations of the West. In 1805, while skirting the Missouri River near its confluence with the Marias River, Meriwether Lewis, crossed a town of "barking squirrels" or prairie dogs more than 7 miles wide. The expedition leaders described prairie dog numbers encountered along their journey as "infinite" (Coues 1893). Messiter (1890), traveling through northern Montana, recorded a prairie dog colony he estimated to be 30–40 miles long. One colony in the Texas panhandle reported by Vernon Bailey of the U.S. Biological Survey was an estimated 250 miles long by 100 miles wide, and may have been home to more than 400 million prairie dogs (Davis 1974). Merriam calculated that prairie dogs occupied some 700 million acres of the West in the late 1800's (Cully 1989). Seton (1929) judged that the combined North American population of all prairie dogs exceeded 5 billion individuals. As late as 1900, 100 million acres were occupied by prairie dogs (Knowles and Knowles 1994).

Whether all of these estimates are accurate is not important. Almost no one disputes that prairie dogs were once extremely common, and found throughout the plains. And today, in many parts of the West you can survey hundreds of miles of potential prairie dog habitat, and never see a single individual.

Relationships to Other Herbivores

Prairie dogs are considered "pests" by some agricultural interests. They qualify as "varmints" in nearly all states where they are found, and most states provide no legal protection. Thus far, 2 of the 5 prairie dog species have achieved some protection under the Endangered Species Act, but only after they had approached the brink of extinction.

Ever since Merriam (1902) estimated that prairie dogs reduced range productivity 50–75%, there has been a perception among livestock producers that prairie dogs compete with domestic livestock for forage (Clark 1989). Areas in and around prairie dog colonies often look "overgrazed" with an abundance of bare soil, little litter, and a carpet of short, heavily cropped vegetation. Long term occupancy on a site by prairie dogs can shift vegetative communities from dominance by climax perennial grasses to early serial stages characterized by forbs and annuals. This contributes to the impression among livestock operators that prairie dogs degrade rangelands (Knowles and Knowles 1994).

Ironically, heavy grazing by livestock, as well as some facets of livestock production, can lead to an expansion in prairie dog numbers (Knowles 1985, Knowles 1986a). The shorter grasses and bare dirt that result from heavy grazing favors prairie dog colony enlargement by removing tall vegetation which otherwise limits the rodent's ability to see predators (Coppock et al. 1983a, 1983b).

However, even where prairie dog numbers do increase, they may not pose a threat to livestock production as presumed. Continual cropping by prairie dogs, particularly on recently colonized sites, tends to maintain high forage quality, and produces plants with greater palatability than non-prairie dog sites (Krueger 1986, Whicker and Detling 1988). Such sites are attractive to cattle as well as a host of other grazing species such as bison (Bison) elk (*Cervus elaphus*), and antelope (*Antilocapra americana*) (Coppock et al. 1983a, 1983b, Knowles 1986a, Krueger 1986).

Whether or not prairie dogs are actually competitors with domestic animals, there is overlap in diet. Under normal circumstances, prairie dogs consume 18–37% of the vegetation in the immediate vicinity of their colonies (Hansen and Gold 1977, O'Meilia et al. 1982, Knowles 1986a), although there are a few cases where herbivory can reach 80% vegetation loss by the end of the summer (Knowles and Knowles 1994). In extreme cases, cattle herbivory, combined with cropping of plants by prairie dogs, can remove a substantial portion of the vegetation on small vegetation patches, achieving a utilization level of 90% by the end of a growing season (Knowles 1986a). Other studies have shown that forage consumption of 300 prairie dogs equal that of 1 cow and calf (Miller et al. 1994). Hansen and Gold (1977) concluded prairie dogs within a short grass ecosystem may depress habitat suitability for cattle grazing. Although there may be less forage left on a prairie dog town, the higher nutritional level typically results in no net loss of weight or decline in weight gains among livestock utilizing such areas (O'Meilia et al. 1982).

In a review of prairie dog literature, Knowles and Knowles (1994) could find no documented evidence that prairie dogs compete with domestic livestock under densities typically encountered on the Great Plains (<10% of the area occupied), and they conclude that competition in rangeland situations would be minor.

Whatever forage competition may exist between prairie dogs and domestic livestock must be balanced against the fact that the plains once supported an untold number of bison, antelope, elk, deer (*Odocoileus* sp.), and bighorn sheep (*Ovis canadensis* sp.), not to mention other smaller herbivores, in spite of, or perhaps because of, the presence of billions of prairie dogs.

Prior to their eradication from the plains, there appears to have been a mutually beneficial relationship between bison and prairie dogs, and to a lesser degree, antelope (Krueger 1986), and elk (Knowles 1986a). Bison tend to forage on the edges of active prairie dog towns (Krueger 1986) where they focus grazing on

the succulent, nutritious growth found there (Coppock et al. 1983b), while antelope selected the centers of dog towns (Krueger 1986), thus spatially dividing up forage resources. The grazing of coarse tall grasses by bison on the fringes of colonies increased prairie dog habitat and aided dispersal (Coppock et al. 1983b). There is even evidence that suggests the decline of bison brought about a reduction and even extirpation of some prairie dog colonies in tall grass locations (Osborn and Allan 1949). However, on short-grass plains, prairie dogs persist even in the absence of cattle or bison.

Trampling and grazing of taller vegetation by livestock can aid dispersal and expansion of prairie dog colonies (Knowles 1985, Knowles 1986a). Livestock are not, however, an ecological analogue for bison under most conditions. Bison utilize the landscape in profoundly different ways than cattle. Bison move more frequently (Norland 1984), and are less likely to spend time in riparian areas (Van Vuren 1984). Bison originally ranged in huge herds over vast areas, thus distributing grazing pressure differently than continuous, confined grazers can. Bison tend to utilize dry uplands—the preferred habitat of prairie dogs—more than cattle, and wander further from water supplies (Plumb and Dodd 1993, Peden et al. 1974, Lott 1991). Hence, bison may create more prairie dog habitat than water-dependent cattle in the prairie dog's preferred short-grass environment as well as aid in creation of dispersal corridors. A shifting mosaic of disturbed habitat patches created by the interaction of periodic wildfires, often combined with intense localized grazing by bison and prairie dogs most likely existed in the pre-settlement era (Coppock and Detling 1986) that is not emulated by most current livestock grazing systems.

Factors Responsible for Prairie Dog Decline

There are 3 major factors implicated in prairie dog decline across their range: rodent poisoning programs, habitat loss, and sylvatic plague. In many areas, all 3 work synergistically to place prairie dog populations at risk.

Control Programs

The widespread perception among livestock operators that prairie dogs compete with domestic animals for forage has led to control programs throughout their range for nearly a century. The primary control mechanism is poisoning, however, there is evidence to suggest such control programs are not cost-effective (Collins et al. 1984).

In the past the favored control method was the use of grain soaked in strychnine. Between 1903 and 1912, strychnine soaked grain reduced Colorado's prairie dog population by an estimated 91% (Clark 1989). But that was just the beginning of extermination efforts. Clark (1989) recounts that ranchers in Colorado distributed enough poison between 1912 and 1923 to kill an additional 31 million prairie dogs. More than 400,000 ha of prairie dog colonies were poisoned in eastern Wyoming between 1915 and 1927 (Clark 1989).

The favored poison of today is zinc phosphide. After treatment with zinc phosphide, a 95% reduction in active prairie dog burrows was achieved in one South Dakota study (Apa et al. 1990) and in Montana Knowles (1986b) reported an 85% reduction in prairie dog numbers after poison treatment.

In some states such as Nebraska and Kansas, landowners are forced to carry out control efforts or suffer fines. Poisoning is usually carried out under supervision of Animal Damage Control (Animal Damage Control Program 1990). Control is pursued on both private lands as well as federal holdings. Prairie dog extirpation efforts are not confined to multiple use BLM and Forest Service lands. Poisoning is also common on Indian reservations, wildlife refuges, and in some national parks. For example, between 1980 and 1984 some 185,600 ha of prairie dog towns on the Pine Ridge Indian Reservation in South Dakota were poisoned (Hansen 1988). Poisoning programs are also an on-going effort in national park units such as Wind Cave, Devil's Tower, and others (NPS personal comm. 1994). Prairie dogs were poisoned in Badlands National Park until 1993—the year prior to the recent reintroduction of the black-footed ferret (Wilkinson 1994).

Habitat Losses

The plowing of millions of acres of the plains for wheat and other grain production has also destroyed prairie dog colonies (Knowles and Knowles 1994). For example, in Montana approximately 18 million acres, much of it former grassland, is reported as cropland (Montana Ag. Statistics 1992). Similar habitat losses have occurred in other Great Plains states as a consequence of farming.

Sylvatic Plague

A third factor contributing to population decline has been sylvatic plague (*Yersinia pestis*). Fleas carry the bacterial disease and spread it through prairie dog colonies. Deer mice, among other species, are suspected to be the maintenance host for the disease (Cully 1989).

The disease was first documented in the United States in 1899 (Cully 1989). Prairie dogs are highly susceptible to the plague (Lechleitner et al. 1968). Even isolated colonies can suffer substantial declines as a consequence of plague (Zeveloff and Collett 1988, Clark 1989, Cully 1989). There appears to be little or no immunity to the disease among prairie dogs and mortality is nearly 100% (Knowles and Knowles 1994).

Consequences of Population Fragmentation and Potential Extinction

Not only is the long term viability of black-tailed prairie dog in jeopardy, but due to the close dependency of a host of other species, the demise of the prairie dog could bring about the reduction or even extinction of many associated species (Knowles and Knowles 1994, Biodiversity Legal Foundation 1994, Miller et al. 1994).

Many other species are dependent upon prairie dogs and their burrow systems for habitat (Clark et al. 1982). Clark (1989) reports that more than 163 vertebrate wildlife species depend on, or are found in close association with prairie dog colonies. No one has yet attempted to determine how many invertebrate species also depend upon prairie dog ecosystems, although 1 study concluded that harvester ants appeared to be slightly

favored by the presence of prairie dogs (O'Meilia et al. 1982). Grasslands ecosystems with prairie dogs had higher numbers of small mammals, more terrestrial predators, higher avian species diversity, and higher avian density than found on grasslands without (Hansen and Gold 1977, O'Meilia et al. 1982, Reading et al. 1989, Miller et al. 1994). Thus the documented extirpation and/or decline of prairie dog populations across the West has resulted in a significant biological impoverishment and loss in the biological diversity of grasslands ecosystems.

Of even greater concern, is the mounting evidence that prairie dogs are a "keystone species". Their decline and potential extinction may cause secondary extinctions among other species whose existence hinges on maintaining viable prairie dog populations throughout its range (Knowles and Knowles 1994, Miller et al. 1994).

Among the most endangered of prairie dog dependent species is the black-footed ferret (*Mustela nigripes*), classified as an endangered species and 1 of the rarest mammals in the world. Today fewer than 400 ferrets remain. To give an indication of how severe the decline in ferrets has been, Clark (1989) estimates that given the population densities found in relict wild populations in the early 1980's, as many as 1 million ferrets may have lived on the plains at the turn of the century.

The ferret is intricately tied to prairie dogs. Prairie dogs make up 90% of the ferret's diet (Knowles and Knowles 1994). Equally important for black-footed ferret survival are the availability of prairie dog burrows as shelter from the weather and as escape cover. The ferret is totally dependent upon a high density of burrows for escape from other predators (Clark 1989).

A similar decline has occurred in swift fox, once common on grasslands throughout the plains. The fox is now extinct in Montana, and rare in much of its former range (Knowles and Knowles 1991). Poisoning programs aimed at coyotes (*Canis latrans*), along with the conversion of native habitat to croplands, are likely the major factors originally responsible for the foxes' decline (Knowles and Knowles 1991), but the loss of prairie dogs has had ecological consequences for the fox as well. Foxes consume prairie dogs, and rely upon the abundance of burrows to hide from predators such as coyotes. In areas where prairie dogs or other burrowing animals are absent, reintroduced swift foxes have never successfully maintained themselves (Knowles and Knowles 1994).

Burrowing owls also depend upon prairie dogs not only for food, but their burrows for shelter. Early travelers on the Great Plains continuously remarked about the abundance and close association between these small owls and prairie dog colonies. Owl numbers have declined significantly throughout the region where prairie dogs have disappeared (Knowles and Knowles 1994).

Mountain plover (*Charadrius montanus*), currently a candidate for listing under the Endangered Species Act (ESA), relies upon prairie dogs for creation of the short grass nesting habitat (Knowles and Knowles 1994). Knowles and Knowles (1984) found that the continued existence of the mountain plover in Montana was dependent upon availability of native grasslands with areas of low growing vegetation such as that afforded by prairie dog towns. There also may be a relationship between the insects this bird consumes and dog colonies. Some scientists speculate that insect abundance is greater, or insects are more easily captured by mountain plover due to high visibility on prairie dog colonies (Olson 1985).

The ferruginous hawk (*Buteo regalis*) is another ESA category 2 candidate species linked to prairie dogs. The hawk specializes in hunting ground dwelling rodents including prairie dogs. The hawk sits next to a burrow waiting for an animal to emerge and then captures it (Knowles and Knowles 1994).

Current Status of Prairie Dogs

The most southerly species is the Mexican prairie dog (*Cynomys mexicanus*). It is distributed south of the border in Mexico. Little is known of its status.

The Utah prairie dog (*Cynomys parvidens*), found only in southwest Utah, historically had the most restricted distribution. In 1920 there was an estimated population of 95,000 of this species. However by 1976 poisoning programs, along with disease, had reduced them to only 3,500 individuals (Zeveloff and Collett 1988).

Gunnison's prairie dog (*Cynomys gunnisoni*), has a center of distribution located in the Four Corner's region of New Mexico, Colorado, Utah and Arizona. Due to poisoning programs and plague, their numbers also have declined precipitously (Zeveloff and Collett 1988).

The white-tailed prairie dog (*Cynomys leucurus*), is the largest of the prairie dogs. It sports a short, white-tipped tail that looks as if it were "dipped in paint." The white-tailed prairie dog inhabited much of western Wyoming and adjacent portions of northeast Utah and northwest Colorado. A small part of its range also extended into southern Montana just south of Billings, Montana (Zeveloff and Collett 1988).

Status of the Black-tailed Prairie Dog by State

Arizona

The black-tailed and Gunnison's prairie dogs both inhabited Arizona. Historically, the black-tailed prairie dog ranged from the Sulphur Springs Valley to the Mexican border in the southeast corner of the state. Black-tailed were completely extirpated from the state by 1938. The Arizona Game and Fish has considered reintroduction of the species, but thus far has been stymied in its efforts by opposition from the livestock industry (Biodiversity Legal Foundation 1994).

Colorado

Colorado was one of the few western states to have 3 of the 5 species of prairie dogs recorded within its borders. The white-tailed prairie dog was found in the northwest part of the state, Gunnison's was distributed in the southwest corner, and black-tailed prairie dogs were found on the eastern plains (Zeveloff and Collett 1988, Clark 1989).

According to Clark (1989) poisoning efforts were widespread and successful in Colorado. In 1903 an estimated 1.2 million ha of the state's plains were inhabited by black-tailed prairie dogs. By 1912, the prairie dogs were reduced by 91%. There are no current state-wide population estimates, although it is thought that prairie dog numbers are significantly reduced from earlier estimates (Biodiversity Legal Foundation 1994).

Colorado still allows recreational and competition shooting of prairie dogs, and provides directions to prairie dog towns (Biodiversity Legal Foundation 1994). Poisoning efforts continue in the state as well (Miller et al. 1994).

Kansas

Prairie dogs once ranged across most of western Kansas. However their numbers have been severely reduced. Vanderhoof and Robel (1992) report: "Lantz (1903) estimated that prairie dog towns covered 1 million ha of Kansas in 1902 whereas Henderson and Little (1973) estimated that only 15,000 ha of prairie dog towns existed in Kansas in 1973. Despite this decline some Kansas counties still conduct mandatory control programs (Kansas Dept. Wildlife and Parks 1994).

Montana

In Montana the black-tailed prairie dog was once found throughout the high plains east of the Continental Divide. Populations have been significantly reduced throughout the state, although there are no current estimates of numbers. The largest prairie dog complex in the state lies north of the Missouri River on the Charles M. Russell National Wildlife Refuge, and adjacent BLM lands. However, the recent spread of plague throughout the state has led to documented declines in affected colonies (Knowles and Knowles 1994).

Nebraska

Prairie dogs once ranged across most of Nebraska and today are found in the western half. Prairie dogs are found in 60 of Nebraska's 93 counties (Nebraska Game and Parks Commission 1993). Conversion of lands to crops, as well as poisoning efforts, have drastically reduced their numbers.

New Mexico

Both the Gunnison and black-tailed prairie dog are found in New Mexico. The Gunnison is confined to the northwest corner, while the black-tailed was found across the eastern and southern portions of the state and was particularly numerous east of the Rio Grande River. In 1908, Vernon Bailey, working for the US Biological Survey traveled between Deming and Hachita, by way of the Animas and Playas valleys, and reported encountering 1 continuous prairie dog town. Bailey estimated the town contained 6.4 million animals (Findley 1987). In numerous trips through the region between 1955 and 1972, biologists working for the Museum of Southwestern Biology failed to record a single prairie dog (Findley 1987).

The species is still found in northeastern New Mexico in small numbers, but has apparently been extirpated from southwestern New Mexico due to poison programs (Biodiversity Legal Foundation 1994).

North Dakota

Prairie dogs once were numerous across North Dakota. Control efforts began in the early 1900's and have continued into the present. Bishop and Culbertson (1976) conducted a study of prairie dog town size in the western part of the state between 1933 and 1972 using air photos and reported an 89% decline during this period. The largest prairie dog populations are centered on the Little Missouri National Grassland and adjacent parts of Theodore Roosevelt National Park.

Oklahoma

Prairie dogs once ranged throughout the western half of the state, although today most towns are in the panhandle region. Conversion of lands to crops, along with poisoning programs and plague, are the main threat to prairie dogs in the state (Oklahoma Dept. of Wildlife Conservation 1993).

South Dakota

Prairie dogs once occupied millions of hectares in South Dakota and currently occupy about 100,000 ha in the state (South Dakota Dept. of Game, Fish and Parks 1993). The largest colonies are found on the Buffalo Gap National Grassland and adjacent parts of Badlands National Park. Sizable colonies also exist on the Pine Ridge Indian Reservation.

In South Dakota, prairie dogs are classified as a "pest" and if a colony expands onto adjoining lands, the owner of the spreading colony can be forced to poison the prairie dogs (Biodiversity Legal Foundation 1994).

Texas

Prairie dogs were found across the Trans Pecos, Edwards Plateau, and Panhandle regions of Texas. Vernon Bailey recorded a nearly continuous prairie dog town at the turn of the century that stretched for 100 miles by 250 miles that had an estimated 400 million inhabitants (Davis 1974). In total, Bailey thought there might be 800 million of the rodents in Texas (Biodiversity Legal Foundation 1994). By 1975 approximately 2.2 million black-tailed prairie dogs were estimated to remain in Texas.

Wyoming

The original range of the black-tailed prairie dog in Wyoming encompassed most of the eastern portion of the state. Cheyenne is built on an old prairie dog colony (Clark and Stromberg 1987). According to the Bureau of Land Management, the black-tailed prairie dog still occurs throughout its historic range but in significantly reduced numbers (Biodiversity Legal Foundation 1994). Clark and Stromberg (1987) estimated that black-tailed prairie dogs had been reduced by 80% across their Wyoming range. The largest prairie dog colonies are found on the Thunder Basin National Grassland. The state of Wyoming manages the black-tailed prairie dog as a regulated non-game species.

Protection Efforts

Some biologists are speculating that without remedial action, the black-tailed prairie dog may be headed towards extinction (Miller et al. 1994). In late 1994, the Biodiversity Legal Foundation, and wildlife biologist Jon Sharp, filed a petition with the U.S. Fish and Wildlife Service to list the black-tailed prairie dog as a category 2 Candidate species under the Endangered Species Act (Biodiversity Legal Foundation 1994). The USFWS recently rejected the petition listing, however, the petitioners plan to challenge the finding in court (Per. com. Biodiversity Legal Foundation 1996).

The black-tailed soon may join the fate of the other 4 prairie dog species, which are already so reduced in numbers and distribution that both the Mexican and the Utah prairie dogs are listed under the Endangered Species Act, and some biologists believe the white-tailed and Gunnison's also qualify for listing

(Biodiversity Legal Fund 1994). Even if the species doesn't dwindle to extinction, given their past influences upon grasslands ecosystems, it can be argued that the dramatic decline of black-tailed prairie dogs across their formal ranges has already led to biological impoverishment of the grassland ecosystem.

Conservation Strategies

Traditionally we have focused our wildlife conservation efforts on too small temporal and spatial scales. This wasn't a problem when human influences on the ecosystem and wildlife numbers were minimal. However, human impacts now limit the number and size of prairie dogs populations. Many barriers prevent dispersal. This, coupled with continued prairie dog control, has resulted in population fragmentation that now threatens black-tailed prairie dog viability across its historic range (Miller et al. 1994).

Small, isolated populations are more susceptible to a variety of extinction factors, including decreased genetic variability (Wilcove et al. 1986, Schonewald-Cox and Bayless 1986, Noss and Cooperrider 1994, Meffe and Carroll 1994). Small populations, because of random variability in demographics are more likely to become extinct than larger populations (Meffe and Carroll 1994). The cumulative effects of all these variables increases the likelihood of extinction (Noss and Cooperrider 1994).

At present there is no coordinated effort to preserve prairie dogs. Indeed, most current public policy can be characterized as detrimental to the long-term viability of prairie dog ecosystems. An important immediate research need is the development of population viability analysis for prairie dogs, as well as dependent species like the black-footed ferret (Meffe and Carroll 1994). Determination of a "minimum dynamic area" (Noss and Cooperrider 1994) defined as the smallest area which maintains internal recolonization sources, should be defined for colony complexes.

It would be prudent to develop a system of biological reserves across the prairie dog's historic range modeled after Noss and Cooperrider (1994). A reserve system of prairie dog colony complexes may reverse the downward decline of black-tailed prairie dog populations, avoiding ecological "train wrecks" in the future. Implementation of such a reserve system would be a pro-active response to the current threats to the species population viability, and may preclude future listing of the black-tailed prairie dog under the ESA.

Core Reserves

A conservation strategy for black-tailed prairie dog should include protected core reserves as described by Noss, (1992) consisting of several interconnected prairie dog colony complexes. Core reserves must be of sufficient size to maintain viable populations of prairie dogs as ecologically and evolutionary functional units over a time frame of at least a hundred years (Meffe and Carroll, 1994.) Core areas should be maintained in their natural state with natural disturbance events permitted or mimicked through management (Noss and Cooperrider 1994). This will require core reserves large enough to maintain a minimum dynamic area of continuously shifting patches of disturbance associated with wildfire, heavy grazing by large herbivores like bison, prairie dog colony abandonment, expansion, and colonization.

Size and density of colonies is critical. Large colony complexes should be encouraged. Research has demonstrated a direct correlation between species richness among associated vertebrate species and colony size. Regional colony density also influences the abundance of prairie dog associated species (Reading et al. 1989). For example, more bird species were sighted on larger colonies than smaller ones, and among higher density colony complexes (Reading et al. 1989).

Core reserves should be located within national parks, wildlife refuges, BLM lands, National Forest lands, National Grasslands, and other federal and state holdings. Coordination and cooperation between various agencies will be necessary.

Given the reciprocal relationship between prairie dogs and larger native herbivores, reintroduction of associated ungulates like bison, elk, and antelope should be given serious consideration. By definition the absence of these important ecological processes and species from most grasslands equates to a loss in biodiversity (Noss and Cooperrider 1994).

We should eliminate all poisoning programs or other human-caused sources of mortality until populations recover to viable levels for prairie dogs and dependent species.

The needs of dependent species such as the black-footed ferret must be considered. Colony complexes large enough to maintain metapopulations of prairie dogs, may not be of sufficient size to maintain viable populations of predators like black-footed ferrets. Predators occur at much lower densities than herbivores like prairie dogs, and maintaining viable populations may require core areas much larger than all but a few remaining natural grassland ecosystems in the West.

Buffer Areas

Core areas should be surrounded by appropriately managed buffer zones (Noss and Cooperrider, 1994). Some human-activities, such as limited livestock production, oil and gas development, and other human resource use may be permitted in buffer zones, but should be compatible with the long term viability of prairie dog populations and native biodiversity concerns. Under certain circumstances, grazing by livestock may be used as a tool to enhance prairie dog colony expansion (Knowles 1986b).

Noss (1992) identified 4 major functions for buffer zones.

1. Ameliorate physical and biotic edge effects.
2. Protect core reserves from hunting, poisoning, and other harmful human activities that would otherwise be intense near reserve boundaries.
3. Provide supplementary habitat to native species to increase population size and viability.
4. Provide connectivity for movement among reserves.

Even within buffer zones, prairie dog control efforts and other negative human intrusions should be limited.

Connecting Linkages

Corridors are designed to provide dispersal and movement between core areas. They may also provide critical habitat requirements. Prairie dogs typically use trails, roadways, and other linear pathways for dispersal (Knowles 1985, Knowles 1986b). Ideally, some corridors will be maintained by native species such as bison whose trails historically facilitated movement between prairie dog colonies. However, roadways with mowed right-of-ways may also serve as functional dispersal corridors.

Table 1 Potentially suitable for black-tailed prairie dog core reserve complexes.

A.	Little Missouri National Grasslands and Theodore Roosevelt National Park, North Dakota.
B.	Buffalo Gap National Grassland, Badlands National Park, and Pine Ridge Indian Reservation, South Dakota.
C.	Wind Cave National Park, Custer State Park, Black Hills National Forest, South Dakota.
D.	Thunder Basin National Grasslands, Black Hills National Forest, and Devil's Tower National Monument, Wyoming.
E.	Oglala National Grassland and Nebraska National Forest in Nebraska.
F.	Pawnee National Grassland, Colorado.
G.	Comanche National Grassland, Colorado.
H.	Cimarron National Grassland, Kansas.
I.	Kiowa National Grassland, Colorado and Rita Blanca National Grassland, Texas.
J.	Black Kettle National Grassland, Oklahoma.
K.	Charles M. Russell National Wildlife Refuge, adjacent BLM lands, and Fort Belnap Indian Reservation in central Montana.
L.	Ashland District of Custer National Forest, adjacent BLM lands, Crow Indian Reservation, and Northern Cheyenne Indian Reservation in Southeast Montana. M. Wichita Mountains National Wildlife Refuge, Oklahoma. Cooperation of individual Indian Tribes would be necessary on reservation lands.

Major highways and interstates present a significant barrier to dispersal. At present, the amount of traffic on most of the region's interstate highways may not hinder movement by rodents. Nevertheless, it is possible that the day will come when even the wide-open spaces of the plains will experience increased traffic. The placement of bridges over suitable natural habitat may permit continued movement, despite the barrier posed by highways as has been done in Florida to allow for movement of the Florida panther and other wildlife. However, in some areas it may be necessary to physically transport prairie dogs across such barriers to facilitate genetic exchange between metapopulations.

While linkages between major prairie dog colonies is generally desirable, corridors can also facilitate the transfer of sylvatic plague from colony to colony. Thus, maintaining some physically isolated colonies within core reserves and buffer zones may be desirable. There is also value in maintaining some isolated populations which may have genetic and evolutionary significance for the species (Noss and Cooperrider 1994).

In order to create such a reserve network, all existing public and private lands should be inventoried for the existence of prairie dog colonies, and/or their potential ability to support viable prairie dog populations. Suitable buffer zones and corridors should be mapped and protected. Since concerns over the effect of prairie dogs upon private lands is a major driving force behind control programs, checkerboard ownership patterns of mixed public and private lands hinder conservation efforts. Acquisition of critical private holdings within or adjacent to large public land by trade or from willing sellers should be pursued.

All of this will require a change in current prairie dog management including the elimination of most poisoning programs, a reduction in hunting, and protection of suitable habitat in core and buffer areas from further destruction by agriculture, highway construction, and other unsuitable development.

There is evidence that some other rodent species have developed resistance to plague (Cully 1989). It may be possible to hasten the evolution of plague-immune prairie dogs through laboratory intervention and captive breeding programs. Due to the rapid reproduction capacity of prairie dogs, the introduction of genetically immune individuals into prairie dog populations would eventually confer a degree of resistance to this disease to prairie dog populations throughout the West. This, more than any other factor, might be key to protecting the long-term viability of prairie dog ecosystems in the West.

Given the current status of the black-tailed prairie dog, failure to act will likely result in the extirpation of the species across most of its range, not to mention the extinction of numerous dependent species. A pro-active establishment of a reserve network can reverse this trend, and ultimately provide for the preservation of the Great Plains Ecosystem.

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