INTERAGENCY MANAGEMENT PLAN FOR GUNNISON'S PRAIRIE DOGS IN ARIZONA

Jared Underwood, Nongame Small Mammals Program Coordinator

In cooperation with the
Arizona Gunnison's Prairie Dog Working Group

Nongame and Endangered Wildlife Program
Program Chief: Eric Gardner
Arizona Game and Fish Department
5000 West Carefree Hwy
Phoenix, Arizona 85086

December 2007

Civil Rights and Diversity Compliance

The Arizona Game and Fish Commission receives federal financial assistance in Sport Fish and Wildlife Restoration. Under Title VI of the 1964 Civil Rights Act, Section 504 of the Rehabilitation Act of 1973, Title II of the Americans with Disabilities Act of 1990, the Age Discrimination Act of 1975, Title IX of the Education Amendments of 1972, the U.S. Department of the Interior prohibits discrimination on the basis of race, color, religion, national origin, age, sex, or disability. If you believe you have been discriminated against in any program, activity, or facility as described above, or if you desire further information please write to:

Arizona Game and Fish Department
Office of the Deputy Director, DOHQ
5000 West Carefree Hwy
Phoenix, Arizona 85086

And

The Office for Diversity and Civil Rights
U.S. Fish and Wildlife Service
4040 North Fairfax Drive, Room 300
Arlington, Virginia 22203

Americans with Disabilities Act Compliance

The Arizona Game and Fish Department complies with all provisions of the Americans with Disabilities Act. This document is available in alternative format by contacting the Arizona Game and Fish Department, Office of the Deputy Director at the address listed above or by calling (602) 789-3290 or TTY 1-800-367-8939.

RECOMMENDED CITATION

Underwood, J. 2007. Interagency Management Plan for Gunnison's Prairie Dogs in Arizona. Nongame and Endangered Wildlife Program. Arizona Game and Fish Department, Phoenix, Arizona.

ACKNOWLEDGMENTS

We thank the members of the Arizona Gunnison's Prairie Dog Working Group for participation in development of this plan. Large sections of this plan are directly taken from the following plans: The Gunnison's Prairie Dog Conservation Assessment (Seglund et al. 2005), The Gunnison's and White-tailed Conservation Strategy (WAWFA 2006), and the Interagency Management Plan for Black-tailed Prairie Dogs in Arizona (Van Pelt et al. 2001 Draft).

PROJECT FUNDING

Funding for this project was provided by: voluntary contributions to Arizona's Nongame Wildlife Checkoff; the Arizona Game and Fish Department's Heritage Fund; and Project W-95-M, under the Federal Aid in Wildlife Restoration Act (Pittman-Robertson Act). Additionally, many volunteers have actively participated in the Arizona Gunnison's Prairie Dog Working Group and have contributed significantly to this effort in terms of donated time and money.

INTRODUCTION

In 2004, Gunnison's prairie dog (GPD; *Cynomys gunnisoni*) long-term viability was questioned by a petition to list the species under the Endangered Species Act (ESA; Forest Guardians 2004). The petition cited habitat loss/conversion, shooting, disease, a history of eradication efforts, and inadequate federal and state regulatory mechanisms as threats to the long-term viability of the species. As a result, state wildlife agencies initiated the development of a multi-state Conservation Assessment to evaluate the range-wide status of the GPD.

After completing the Assessment in 2005 (Seglund et al. 2005), the states and federal cooperators developed a Conservation Strategy (Western Association of Fish and Wildlife Agencies, WAFWA, 2006) for both the GPD and the white-tailed prairie dog (WTPD; *C. leucurus*). The Conservation Strategy provided management and administrative guidelines to assist the development of state management plans for GPDs and their associated ecosystems. The objective of state and federal agencies involved in GPD management under the Strategy is to conserve and maintain viable prairie dog populations and the ecosystems they inhabit. This effort was described in the U.S. Fish and Wildlife Service's (USFWS) negative 90-day finding in 2006 for the GPD listing petition (USFWS 2006). However, this finding is currently being litigated.

This management plan describes specific activities to be taken in an effort to guide GPD conservation and management within the state of Arizona.

SPECIES INFORMATION

TAXONOMY

The family Sciuridae is a widespread family, comprised of 49 genera and 262 recent species. It includes tree and ground squirrels, chipmunks, marmots, and prairie dogs. Prairie dogs, like ground squirrels, have characteristic flattened heads, straight claws, short tails, and unspecialized ankles (Lawlor 1979). As a group, prairie dogs diverged from ground squirrels about 1.8 million years ago, during the late Pliocene or early Pleistocene (Clark et al. 1971).

Today, there are 5 extant species of prairie dogs, all of which inhabit western North America and belong to the genus *Cynomys*. The genus has been divided into 2 subgenera based on pelage color and tail length (Clark et al. 1971, Pizzimenti 1975). The WTPD, GPD, and Utah prairie dog (UPD; *C. parvidens*) comprise the subgenus *Leucocrossuromys*. This group is distinguished by relatively short, white-tipped tails, weaker social organization, and less specialized dentition and morphology than the black-tailed forms (Pizzimenti 1975). The black-tailed subgenus *Cynomys*, which includes the Black-tailed prairie dog (BTPD; *C. ludovicianus*) and Mexican prairie dog (MPD; *C. mexicanus*), has characteristic long, black-tipped tails and is more specialized morphologically, behaviorally, and ecologically (Pizzimenti 1975). The BTPD occupies short or mixed grass prairies across much of the Great Plains, whereas the MPD is restricted to a small area of grasslands in northeastern Mexico (Goodwin 1995). The *Cynomys* subgenus shows the greatest divergence from ancestral ground squirrel stock (Pizzimenti 1975).

Within the subgenus *Leucocrossuromys*, the GPD is genetically, morphologically, and behaviorally distinct from the other white-tailed species (Pizzimenti 1975). Genetic analysis of populations of WTPDs and GPDs in Ouray, Delta, and Montrose counties in Colorado confirmed that the genetic makeup of the 2 species was unique (Pizzimenti 1975).

Taxonomists divide the GPD into 2 subspecies: the Gunnison's (*C. g. gunnisoni*) and the Zuni (*C. g. zuniensis*; Hollister 1916; Hafner et al. 2005). *C. g. gunnisoni* is thought to be confined to the Rocky Mountain region of central and south-central Colorado and northern New Mexico. *C. g. zuniensis* ranges from extreme southeastern Utah, northwestern, and west-central New Mexico, and southwestern Colorado to the San Francisco Mountain Region and the Hualapai Indian Reservation in Arizona (Hollister 1916; Hafner et al. 2005).

DESCRIPTION

The GPD is the smallest species within the subgenus *Leucocrossuromys* (Pizzimenti 1975). Its weight varies seasonally ranging from 250 to 1350 g (0.6-3.0 lb; Fitzgerald et al. 1994). Body mass is sexually dimorphic, with males typically heavier than females (Hoogland 2003). Total body length ranges from 300 to 390 mm (11.8-15.4 in), and tail length measures 40 to 64 mm (1.6-2.5 in; Fitzgerald et al. 1994, Hoogland 1996). Its overall coloration is darker than *C. leucurus* and *C. parvidens* and although the top of the head, cheeks, and superciliary line are darker than the rest of the body, they do not exhibit the striking facial pattern found in the other 2 white-tailed species (Fitzgerald et al. 1994).

DISTRIBUTION

GPDs occur along the Colorado Plateau in southeastern Utah, southwestern Colorado, northern Arizona, and northwestern, west-central, north-central, and central New Mexico (Fitzgerald et al. 1994; Goodwin 1995; Knowles 2002; Figure 1). They inhabit shortgrass and mid-grass prairies, grass-shrub habitats in low valleys, and subalpine mountain meadows. They occur at elevations ranging from 1536 m (5039 ft) in the Chihuahua grasslands of New Mexico (Davidson et al. 1999) to 3660 m (12,008 ft) in the Rocky Mountain region of Colorado (Pizzimenti and Hoffman 1973; Fitzgerald et al. 1994).

Annual precipitation within the range of the GPD varies from 10 to 50 cm (3.9-19.7 in), with most precipitation falling as snow in the winter months and as monsoonal rains in the summer months (Lechleitner et al. 1962; Shalaway and Slobodchikoff 1988; Navajo Natural Heritage Program 1996; Cully 1997; Davidson et al. 1999; Bangert and Slobodchikoff 2000). Diurnal temperatures within habitats occupied by GPDs range from below 0° C (32º F) in winter to above 30º C (86º F) in summer (Longhurst 1944; Shalaway and Slobodchikoff 1988; Davidson et al. 1999; Bangert and Slobodchikoff 2000).

LIFE HISTORY

Habitat

GPDs generally inhabit areas that are flat, but sometimes occupy areas with steeper slopes if the slopes are also long (i.e. low variability; Wagner and Drickamer 2003). Fitzgerald and Lechleitner (1974) found that prairie dog burrows in central Colorado, did not occur on slopes greater than 15%. In New Mexico, slopes measured in occupied habitat ranged from 2% to 5% (Lorance et al. 2002). Selection of flat areas with less variable slopes may provide GPDs with a less obstructed view in all directions, increasing their ability to detect predators and warn conspecifics.

GPDs are semi-fossorial animals and for development of their burrows they require well drained, deep soils (Wagner and Drickamer 2003). Rocks on the surface of the ground may indicate rocky soils that make establishment of a burrow system difficult. Wagner and Drickamer (2003) documented an inverse relationship between the amount of rock covering the surface of the ground and presence of GPDs. Because prairie dogs hibernate and many colonies occur at high elevations, they rely on placement of hibernacula below the frost line.

Vegetative associations for the GPD have not been examined over a large number of colonies or across large geographic areas (Wagner and Drickamer 2003). Common plant species noted to occur in GPD colonies include shrubs (*Atriplex jonesii, A. canescens, Artemisia tridentata, A. frigida, Sarcobatus vermiculatus, Potentilla fruticosa, Chrysothamnus* spp.), grasses (*Bromus tectorum, Oryzopsis hymenoides, Aristida purpurea, Muhlenbergia spp., Sporobolus aeroides, Scleropogon brevifolius, Bouteloa gracilis, Hilaria jamesii, Agropyron smithii, A. trachycaulum, Koleria cristata, Festuca* spp.), and forbs (*Descurainia* spp.*, Cardaria draba, Lepidium virginicum, Cryptantha* spp.*, Senecio* spp.*, Sisymbrium altissimum, Penstemon* spp.*, Lappula redowski*; Longhurst 1944; Lechleitner et al. 1962, 1968; Fitzgerald and Lechleitner 1974; Rayor 1985; Shalaway and Slobodchikoff 1988; Davidson et al. 1999; Bangert and Slobodchikoff 2000; Lorance et al. 2002). Total vegetative cover measured on GPD colonies in Gunnison County, Colorado was 24% to 35% herbaceous, 9.5% to 25% shrub, and 39% to 66% bare ground (Rayor 1985). In Moreno Valley, New Mexico, cover by shrubs on colonies varied from 9% to 23% and grasses covered from 23% to 52% (Cully et al. 1997). In Northern Arizona, total ground cover measured on colonies ranged from 26% to 56% (Shalaway and Slobodchikoff 1988).

Dietary requirements

GPDs feed extensively on grasses, forbs, and sedges, but may also consume insects. Rayor (1985) found that the primary foods consumed by GPDs at 2 sites in Gunnison County, Colorado, were borages (Boraginaceae), mustards (Brassicaceae), grasses (Poaceae), and some shrubs. Shalaway and Slobodchikoff (1988) found that, although there were dramatic differences in both plant species availability and use in colonies located < 20 km (12.4 mi) apart, GPDs located near Flagstaff, AZ maintained a consistent pattern of dietary selection for general types of plants. They fed on grasses and forbs when available and switched to seeds as the grasses and forbs died out suggesting a seasonal shift in their diet as plant phenology progressed.

GPDs, like other white-tailed prairie dog species, have evolved in arid, nutrient-limiting environments with pronounced changes in moisture patterns and temperature extremes. To deal with these constraints, GPDs hibernate and aestivate when metabolically stressed. During the time they are above ground they must mate, give birth, and build fat stores, making the quality and quantity of vegetation an important component for survival and reproductive output (Beck 1994). During spring and fall there is little growing vegetation, therefore GPDs feed primarily on seeds and dead vegetation. Selection of a high energy food source such as seeds, allows GPDs to maintain their physical condition during emergence and the reproductive season and to increase body weight prior to winter hibernation. In summer as plants begin to grow, GPDs consume large amounts of live vegetation. Juvenile emergence in late May to July (dependent on elevation) allows young prairie dogs to take advantage of the abundant green vegetation. This is crucial because juvenile body mass appears to significantly influence survival rates and the ability to breed one year after birth. These demographic parameters may be the mechanism driving fluctuations in prairie dog populations (Rayor 1985; Menkens and Anderson 1989).

Prairie dogs obtain most of their needed water from the plants they eat (Vorhies 1945; Schmidt-Nielsen and Schmidt-Nielsen 1952). Collier (1975) found that higher moisture content in plants was correlated with higher population densities of UPDs. UPDs traveled up to 400 m (1312 ft) in the summer months to access vegetation growing in moist areas (Crocker-Bedford 1976; Crocker-Bedford and Spillett 1981). Similarly, Koford (1958) found that BTPDs congregate near moist vegetation and new colonies and colony expansion are more likely to occur in these areas. GPDs have also been described using areas near the edges of wet meadows (Longhurst 1944).

<u>Social structure</u>

The GPD has a complex social system, living in colonies of up to several hundred individuals with each colony subdivided into smaller territories occupied by social groups (coteries) or solitary individuals (Slobodchikoff 1984, 1988; Rayor 1988). Social groups vary from 2 to 19 individuals and may be composed of a single male/single female, single male/multiple females, or multiple male/multiple females (Slobodchikoff 2003). Structure of the social group appears to be correlated with distribution of food resources in a territory. Relatively uniform areas support single male/single female social groups whereas patchy resource areas support single male/multiple female or multiple male/multiple female groups. Territories are used and defended by social groups; agonistic behavioral interaction is common toward nonmembers. GPDs often feed in weakly defended peripheral sections of their territories that belong to other groups, but when members from different groups meet in these common feeding areas, conflicts can arise with one animal chasing the other back toward its territory (Fitzgerald and Lechleitner 1974; Rayor 1985, Travis et al. 1995, 1996).

GPDs are diurnal with the greatest activity in early morning and afternoon (Fitzgerald and Lechleitner 1974). Movements are reduced when vegetation is wet and heavy rain and snow will cause them to cease above-ground activities. On cloudy days, prairie dogs appear to be more cautious and stay closer to their burrow entrances. Winds below 37 km/hour (23 mi/hour) do not appear to alter GPD behavior (Fitzgerald and Lechleitner 1974).

Reproduction

Female GPDs are sexually receptive for a single day during the breeding season each year (Hoogland 1999) and will mate with up to 5 males (Hoogland 1998). The GPD mating strategy varies with regard to food availability and population density. When population densities are low and resources uniform, GPDs employ a monogamous mating system. As plant patchiness and population densities increase, monogamy gives way to polygyny with females mating with multiple males throughout the colony (Travis et al. 1995, 1996). Females copulate with multiple males to maximize reproductive success and promote genetic diversity among litter mates. The probability of pregnancy and parturition in GPDs was 92% for females that copulated with 1 or 2 males, as compared to 100% for females that copulated with at least 3 males (Hoogland 1998). In addition, litter size was found to vary directly with the number of female's sexual partners (Hoogland 1998). The frequency of multiple paternities is as high as 77% (Haynie et al. 2003).

Mating occurs from mid-March to mid-May, with gestation lasting 29 to 30 days and lactation lasting approximately 38 to 40 days (Hoogland 1997). Young emerge above ground at 4 weeks of age in late May to early July (Rayor 1985; Hoogland 1999). The age of first reproduction for females appears to depend on forage availability. Female GPDs are sexually mature at 1 year and copulate when food is abundant, but may not copulate until their second year if food is limited (Hoogland 1999). Age of first reproduction for males is also variable and appears to depend on the number of older, breeding males in the population (Rayor 1985, 1988; Hoogland 1996).

Hoogland (2001) studied reproduction in Arizona and found that GPDs reproduce slowly for 5 reasons: 1) survivorship was < 60% in the first year and remained low in subsequent years, 2) females produced only 1 litter per year, regardless of resource availability, 3) as few as 24% of the males copulated as yearlings, 4) the probability of weaning a litter each year was approximately 82%, and 5) mean litter size at the time of the first juvenile emergence was 3.77. Hoogland (2001) noted however, that other factors that can enhance reproductive output, with body mass being the most important. Heavy males are more likely to copulate and sire more offspring and for females, litter size correlates directly with maternal body mass and age (Hoogland 2001).

Hibernation

GPDs have evolved in arid, nutrient-limited environments with pronounced changes in moisture patterns and temperature extremes. To deal with these constraints, GPDs hibernate and aestivate when metabolically stressed (Harlow and Menkens 1986). Emergence from hibernation occurs from February to late April and immergence occurs from mid-September to November; both are dependent on elevation (Fitzgerald and Lechleitner 1974; Rayor 1988; Hoogland 1998).

Movements and home range

Dispersal in GPDs occurs in fall prior to hibernation and in spring prior to the mating season (Travis et al. 1996). Offspring usually remain in their natal territory into their yearling summer (Rayor 1988). Most females (95%) remain in their natal territory for life, whereas only 5% of males remain in their natal territory for more than 1 year (Hoogland 1999). Hoogland (1999) found that the majority of dispersing females dispersed to an adjacent clan, a distance ranging from 38 to 221 m (125-725 ft) and 56% percent of dispersing males went to an adjacent territory, a distance of 34 to 575 m (112-1886 ft).

Little work has been done to examine home range sizes in different habitats and for different sex and age classes with regard to GPDs. Rayor (1988) found that the area of individual home ranges in Colorado did not differ significantly between sites, sexes, or age groups, with median home range sizes of 0.07 to 0.08 ha (0.17 – 0.2ac). In comparison, WTPD home ranges range from 0.15 to 1.9 ha (0.37-4.7 ac; Clark 1977; Cooke 1993) and UPD home ranges range from 0.5 to 1.8 ha (1.2-4.4 ac). In UPDs, it is thought that the size of the home range is inversely related to density (Wright-Smith 1978 as interpreted by McDonald 1992).

Densities

GPDs can occur in extensive colonies with densely aggregated burrows as well as in areas with scattered, isolated burrows. Densities within colonies vary among habitats and are likely driven in part by vegetation quantity and quality, with hyper-productive environments correlating with higher densities of prairie dogs. For example, a comparison study examining UPD life history traits at 3 locations found densities ranging from 2.3 prairie dogs/ha (1/ac) at a high elevation site, 16 prairie dogs/ha (6/ac) at a low elevation site, and 36 prairie dogs/ha (15/ac) at a low elevation site associated with an alfalfa field (Crocker-Bedford 1976). The authors attributed the difference in densities to quantity and quality of available vegetation. On wildlands, GPD densities are thought to average 3 to 5/ha (1-2/ac). However, as brush is cleared to make fields densities can exceed 70/ha (28/ac; Longhurst 1944). Other researchers have found GPD densities to range from 4 to more than 57 prairie dogs/ha (2 to >23/ac) in favorable habitat (Fitzgerald and Lechleitner 1974; Rayor 1985; Van Pelt 1995).

Disease

Disease, especially the introduced pathogen *Yersinia pestis* (which causes sylvatic plague) may contribute to variation in year-to-year population densities. Turner (2001) found that after a plague epizootic severely reduced a population of UPDs in Bryce Canyon, survival of juveniles, juvenile mass, and the number of females successfully weaning young increased. Similarly, Cully (1997) found that in Moreno Valley, New Mexico, GPD populations tripled annually after a plague epizootic due to increased survivorship of juveniles and reproduction at an early age. These factors were thought to contribute to rapid recovery of the population. Rayor (1985) described a plague outbreak that eliminated a colony of GPDs in Colorado in 1981. When Cully (1989) revisited this colony in 1986, prairie dogs were again abundant despite several attempts to poison them. Repeated plague epizootics and subsequent recovery of local populations from these outbreaks, can result in a cycle of expansion and contraction in individual prairie dog colonies (Wagner and Drickamer 2003). Long-term consequences of continued plague infection on prairie dog populations can result in increased variance in local population densities.

ROLE OF PRAIRIE DOGS IN GRASSLAND ECOSYSTEMS

Prairie dogs are considered to be keystone species (Miller et al. 1994, Kotliar et al. 1999, USFWS 1999, Kotliar 2000). Keystone species are defined as having particularly strong, ramifying interaction, the strength of which are disproportionate to their population densities and are not wholly duplicated by other species (Soulé et al. 2003; 2005). When the density of a keystone species falls below some threshold, species diversity in the area may decrease, triggering ecological chain reactions ending with degraded or simplified ecosystems (Soulé et al 2003).

Another term proposed to refine the important role of keystone species in the ecosystem is "strongly interactive". The virtual or effective absence of a strongly interactive species leads to significant changes in some feature of its ecosystem (Soulé et al. 2003). Such changes include structural or compositional modifications, alterations in the import or export of nutrients, loss of resilience to disturbance, and decreases in native species diversity (Soulé et al. 2003). Species that are strongly interactive should be maintained at an ecologically effective population level. An ecologically effective population contains enough individuals with a wide enough geographic distribution to maintain the species' role in ecosystems (Soulé et al. 2003; 2005).

Studies on BTPD show that prairie dogs alter grasslands by modifying vegetation structure and composition, soil structure, nitrogen concentration in plant shoots, and landscape configuration. Prairie dog foraging activities and vegetation clipping behavior helps maintain short stature grass and facilitate the detection of predators (King 1955, Hoogland 1995). Prairie dog foraging also causes a shift in plant species composition, frequently increasing diversity and the proportion of short grasses and annual forbs compared to mid-height and tall grasses (Koford 1958, Agnew et al. 1986, Whicker and Detling 1988). Grazing by prairie dogs enhances the growing conditions of certain plants, increases the standing live-to-dead biomass ratio, and increases the nitrogen concentration and nutritional value in available plant shoots (Coppock et al. 1983a, 1983b, Whicker and Detling 1988). The digging actions of prairie dogs enhance soil structure, water filtration, and forbs growth.

Prairie dogs produce broader, landscape level effects as well. They create a mosaic of different patch structures within the grassland matrix, based on the distribution of colonies (Hoogland 1981, Whicker and Detling 1988). They also help maintain the grassland ecosystem by preventing the encroachment of woody vegetation. Weltzin et al. (1997) reported that historic populations of BTPD might have prevented mesquite from attaining dominance in desert grasslands of the southwest. Additionally, prairie dog colonies may serve as fire breaks in grassland communities (Kotliar et al. 1999). Variability in prairie dog densities can lead to different effects on plant communities.

A wide variety of wildlife uses some attribute of prairie dog colonies. Kotliar et al. (1999) reviewed the literature on prairie dog-associated species, and found that at least nine species showed some degree of dependence on prairie dogs (Appendix I). American bison (*Bison bison*) and pronghorn antelope (*Antilocapra americana*) preferentially forage on BTPD colonies (Coppock et al. 1983b, Krueger 1986), taking advantage of the highly nutritional vegetation (Foster and Hygnstrom 1990). A number of species use prairie dogs as prey. Among those of current conservation interest, golden eagle (*Aquila chrysaetos*) and ferruginous hawk (*Buteo regalis*) populations have been shown to decline when prairie dogs decline (Kotliar et al. 1999). In addition, the black-footed ferret (*Mustela nigripes*) diet consists almost exclusively of prairie dogs (Knowles and Knowles 1994, Kotliar et al. 1999). Furthermore, many species are known to use prairie dog burrows for shelter. Species that use prairie dog burrows include the burrowing owl (*Athene cunicularia*), swift fox (*Vulpes velox*), black-footed ferret, and many species of snakes, lizards, amphibians, and insects (Wuerthner 1997, Kotliar et al. 1999, Desmond et al. 2000). Incidental observations in northern Arizona have shown that burrowing owls in the area are almost entirely dependent of GPD burrows as a source for nesting cavities and all black-footed ferret reintroductions in Arizona have taken place in GPD colonies.

INTERACTION WITH HUMANS

Prairie dogs and their activities have historically been considered as incompatible with cattle grazing. This common misconception is largely based on a questionable study by Merriam (1902) in which he estimated that prairie dogs reduce range productivity by 50-75%, leading to the perception that prairie dogs compete with cattle for forage. However, current research indicates a 4-7% level of competition between livestock and prairie dogs; in other words, one cow with a calf eats as much as approximately 300 prairie dogs (Uresk and Paulson 1988, Miller et al. 1994). Competition between prairie dogs and cattle increases when forage is limited, such as in times of drought. Competition can be reduced at such times by providing alterative sources of feed for cattle. Although prairie dogs will reduce overall availability of forage for livestock, this effect is largely compensated for by the greater nutritional value of remaining forage (Whicker and Detling 1988). In fact, cattle often preferentially forage on prairie dog colonies (O'Meilia et al. 1982). Additionally, O'Meilia et al. (1982) reported no statistically significant difference between the market weight of steers that lived on and off prairie dog towns. Considering that large numbers of prairie dogs and bison lived sympatrically as recently as 150 years ago, one would expect that prairie dogs and cattle should also be able to coexist (Hoogland 1996).

In urban areas prairie dogs are sometimes considered a safety risk to children. People often cite concerns that children at play will accidentally hurt themselves by falling into burrows or that curious children approaching prairie dogs are at risk of getting bitten. While most wild animals will bite, little if any evidence exists for serious health problems caused due to prairie dog bites. Prairie dogs have also been implicated as causing damage to livestock (i.e., broken legs), agricultural crops, earthen dams, airports, and golf courses (Conover and Decker 1991, Hoogland 1996). The extent of such damage is unclear; however, leg fractures attributable to prairie dog burrows are rare (Carr 1973, Hoogland 1995).

Additionally, in some areas prairie dogs are considered a public health hazard. Prairie dogs are highly susceptible to sylvatic plague, although they are not a good reservoir for the disease. This high susceptibility can serve as an important warning system for the presence of plague in an area. Nationwide, very few cases of plague in humans occur and a small percentage of those that do are attributed to contact with prairie dogs. Since 1949, of the 257 cases of plague for which a source of infection was identified, 35 (13.6 %) were possibly attributed to contact with prairie dogs or their fleas (CDC per comm. 2007). In Arizona, 8 (20.5%) of the 39 reported plague cases for which environmental data exists have been potentially attributable to prairie dogs (CDC per comm. 2007).

However, prairie dogs have also been considered watchable wildlife, and many people enjoy viewing them. This interest has led to increased awareness and advocacy on the part of the GPD in Arizona and across its range. Several non-governmental organizations (e.g. Habitat Harmony, The Prairie Dog Coalition) currently conduct projects benefiting prairie dogs and provide education on these species.

THREATS

The 23 February 2004 petition to list the GPD under the ESA asserted that all 5 USFWS ESA listing criteria apply to the species (Forest Guardians 2004). In this section, current information regarding threats is summarized.

1) PRESENT OR THREATENED DESTRUCTION, MODIFICATION, OR CURTAILMENT OF HABITAT OR RANGE

Throughout the 19th and 20th centuries, lasting changes in GPD habitat have occurred. These changes resulted from conversion of rangelands to seeded pastures and croplands, urbanization, oil/gas exploration and extraction, intensive livestock grazing, alteration in fire regimes, and proliferation of non-native plant species. How these changes have affected GPD populations is difficult to quantify. Possible consequences of these impacts are presented below.

Agricultural land conversion

Range-wide, agricultural lands affect less than 3% of the GPD predicted range (Seglund et al. 2005). In Arizona, agricultural development currently impacts 12,725 ha (31,444 ac) or < 1% of the predicted range (Seglund et al. 2005). Conversion of land for agriculture in conjunction with eradication efforts caused historic population declines for the GPD (Knowles 2002). Prairie dogs were not tolerated on agricultural croplands and disturbance by them on cultivated lands brought about control or eradication of local populations. Agricultural lands however, have also benefited GPDs by providing highly-productive forage in place of their native arid landscape. GPD burrows can be found located adjacent to agricultural fields in previously unsuitable areas.

Urbanization

Range-wide, urbanization affects less than 1% of the GPD gross range and less than 2% of the predicted range (Seglund et al. 2005). In Arizona, urban development impacts < 1% of the gross (31,838 ha [78,673 ac]) and predicted range (17,147 ha [42,371 ac], Seglund et al. 2005). Although direct eradication of prairie dogs, habitat fragmentation, and colony isolation all can potentially occur in urban landscapes; as mentioned these actions affect a very small portion of the GPD range.

Oil/Gas/Uranium exploration and extraction

Within GPD range, many areas have been classified as valuable for oil, gas, and uranium development. Possible direct negative impacts associated with extraction include clearing and crushing of vegetation, reduction in available habitat due to pad construction, road development and well operation, displacement and killing of animals, alteration of surface water drainage, and increased compaction of soils (USFWS 1990). Vibroseis (seismic exploration) may also affect prairie dogs by collapsing tunnel systems, causing auditory impairment, and disrupting social systems (Clark 1986). Indirect effects include increased access into remote areas by shooters and OHV users. Gordon et al. (2003) found that shooting pressure was greatest on colonies with easy road access as compared to more remote colonies. Conversely, some developments associated with oil and gas extraction may aid the GPD by providing areas with a reduction in shrub cover. In Arizona, the amount of potential or actual habitat affected by this type of development is unknown but expected to be < 1% of the total potential range.

Livestock grazing

The effect of livestock grazing on the western landscape remains a controversial subject. Some assessments of livestock grazing in the West indicate it has had profound ecological consequences including alteration in species composition within plant communities, disruption of ecosystem function, and alteration of ecosystem structure (Fleischner 1994). However, other studies have shown that livestock grazing has had a minimal impact on these processes and have even shown that moderate grazing can lead to increased species diversity (Brown and Mcdonald 1995, Loeser et al. 2007). In Arizona the impact of grazing to the GPD is unknown. However, the areas that currently host some of the largest colonies in the state are actively grazed and have been actively grazed while GPDs in those areas have experienced a recent period of expansion.

Poor rangeland management has caused a decline in occupied habitat and population densities for the UPD (Collier and Spillett 1975). Conversely, well managed grazing has been found to benefit BTPD populations by creating increases in short grass species such as blue grama (*Bouteloua gracili*) and buffalograss (*Buchloe dactyloides*; Osborn 1942; Osborn and Allen 1949; Norris 1950; Smith 1958; Koford 1958). As a closely related species, the GPD would probably be affected in similar fashion by both positive or negative rangeland and grazing management practices.

Altered fire regimes

Beginning in the 1890s, fires decreased in frequency and intensity in the southwestern U.S. (Bahre 1991; Oakes 2000). Settlement resulted in active suppression of wildfires, and grazing reduced biomass on the ranges resulting in less intense fires (Oakes 2000). The reduction in fire frequencies and lower fire temperatures over the past century may have contributed to changes in vegetation. The end result of altered fire regimes are fluctuations in herbaceous cover from year-to-year, expansion of woody species, shortened seasonal availability of green plant material, a decrease in high quality perennial forbs, and absence of forage in the late summer (Crawford et al. 2004).

However, recent woody succession of grasslands and increased density of trees in historic woodland savannas are probably at least partially due to altered fire regimes. Anecdotal observations also suggest that this woody succession in northern Arizona has often occurred in the most productive, highest rainfall, areas of GPD habitat. Nonetheless, the true impact of altered fire regimes to GPDs in Arizona was not able to be determined.

Nonnative/Invasive/Noxious Plant Invasions

The invasion by nonnative, invasive, and noxious plants in GPD habitat has occurred across Arizona. The impact of these invasions on the landscape is varied. In some areas monocultures of an invader can completely exclude native species. However, in other areas, the invader is only a part of the general flora. The impact to GPDs in Arizona is unknown; however, GPDs appear to be able to use this altered habitat to some degree.

2) OVERUTILIZATION FOR COMMERCIAL, RECREATIONAL, SCIENTIFIC, OR EDUCATIONAL PURPOSES

Shooting

In Arizona, GPDs are classified by the Arizona Game and Fish Department as nongame mammals. They may be taken under auspices of a hunting license. In 2001, a hunting season was established for GPDs. They may only be hunted during the open season, which is June 16 to April 1 the following year. The level of take is monitored annually through the small game harvest surveys sent to those purchasing hunting licenses. Recent hunt data suggest that anywhere from 30,000 to 94,000 GPDs are taken each year (see Table 1).

Range-wide, peak shooting pressure on GPD colonies tends to occur in May and June when the weather is cooler and juveniles are emerging. This timing in shooting pressure makes lactating females and young of the year more vulnerable and causes loss of dependent young when females are killed. Significant take of these individuals reduces the yearly reproductive output of a population and may be additive to natural mortality. Arizona has instituted shooting closures during this time to help protect populations.

Limited research exists on the long-term effects of shooting on prairie dog populations, and research conducted thus far has focused on BTPDs. Extrapolation of the data to GPDs can only be inferred, but in general the data may be relevant. Below is a summary of studies that have been conducted:

- Stockrahm and Seabloom (1988) compared reproductive rates on 2 colonies that experienced intensive recreational shooting to 2 colonies that did not. They found that colonies experiencing heavy recreational shooting pressure had fewer males, smaller litter sizes, and very few females breeding as yearlings. These authors suggested that shooting disrupted the social system of the BTPD.
- Knowles (1988) conducted a controlled shooting experiment on 2 colonies subjected to shooting and 1 that was not. The results showed that shooting reduced prairie dog activity levels. By the second year of shooting, the smallest colony had been extirpated.
- Vosburgh and Irby (1998) compared 18 prairie dog colonies from 1994 to 1995 in areas protected from recreational shooting to those open to shooting. Colonies subjected to shooting declined more than colonies not subjected to shooting (15% versus 35%) and prairie dogs were more vigilant in shot colonies. The authors postulated that recreational shooting might, with additional research, be an effective management tool to limit populations but was not a viable technique to eliminate prairie dogs.
- Vosburgh (1999) compared 4 colonies subjected to shooting to 3 colonies without shooting on Fort Belknap Reservation, Montana. The number of prairie dogs declined by 20% on shot colonies and by 10% on colonies without shooting.
- A review conducted by the CDOW et al. (2002) described the effects of shooting closures on prairie dog populations at black-footed ferret reintroduction sites. The sources of information for this review included black-footed ferret allocation proposals and communication with individuals participating in reintroduction efforts. The non-quantified results of the review showed that shooting restrictions at some sites positively influenced abundance of BTPDs. There were no data to adequately address shooting closures and their effectiveness on WTPD populations. Though shooting closures have been established in some states, there currently are no data to

adequately measure their effectiveness at maintaining and/or expanding WTPD populations. In Utah, WTPD population estimates derived from black-footed ferret habitat surveys in Coyote Basin (closed to shooting) do not appear to differ significantly from similar surveys conducted in the Uintah Basin at sites that have not been closed to shooting (Seglund et al. 2005).

- Gordon et al. (2003) examined the effects of shooting on BTPDs at the Thunder Basin National Grassland, in northeastern Wyoming. They found that shooting did not appear to substantially affect BTPD behavior, short-term population levels, or physiology. High levels of shooting did result in mass emigration from the study plot.
- Pauli (2005) also examined the direct and indirect effects of shooting on 10 BTPD colonies on private lands surrounding the Thunder Basin National Grassland. The colonies were paired, one a treatment and one a control colony, with treatment colonies subjected to a pulse of shooting to reduce prairie dog abundance by 30%. On treatment colonies, survivors exhibited an 8-fold increase in alert behavior and reduced their above-ground activity by 66%, ultimately decreasing the amount of time spent foraging. This change in foraging behavior resulted in decreases in the body condition (by 35%) and increased flea loads (by 30%). Although lowered body condition did not affect overwinter survival, reproduction was reduced. Pregnancy rates declined by 50% and reproductive output fell by 76%. Thus, BTPDs did not exhibit compensatory natality in response to shooting which made them incapable of quickly recovering to pre-shooting densities.

3) DISEASE OR PREDATION

Disease

The primary factor limiting GPD populations from expanding appears to be sylvatic plague, a flea-transmitted disease caused by the bacterium Yersinia pestis (Heller 1991; Cully and Williams 2001). Plague is a non-native pathogen that originated in Asia, arriving in North America around 1899. It was first recorded in native mammals in California in 1908 (Barnes 1982). Since then, the disease has spread from the Pacific Coast east to the 100th meridian, infecting 76 species in 6 mammalian orders (Barnes 1993). The first confirmations of plague in GPDs were in northwestern Arizona in 1932 and in eastern Arizona in 1937. Today, plague has spread throughout the entire range of GPD (Barnes 1982).

Prairie dogs are highly susceptible to plague, and this susceptibility is thought to be a function of high population densities, abundant flea vectors, and uniformly low resistance (Biggins and Kosoy 2001a). BTPDs and GPDs can experience mortality rates of >99% during epizootics and eradication of populations can occur within 1 active season (Lechleitner et al. 1962, 1968; Rayor 1985; Cully 1989; Cully and Williams 2001). The specific factors that influence interspecific transmission of plague from reservoir populations into prairie dog populations is unknown, but outbreaks may be triggered by environmental conditions such as mild winters and moist springs (Parmenter et al. 1999). Girard et al. (2004) has postulated that when plague encounters a susceptible species that is plague naïve and is found at high densities, an epizootic occurs. The rapid dispersal of the pathogen through an area is followed by a slower transmission cycle that occurs in low-densities and resistant hosts which establishes the disease into stable reservoirs for future emergence. This dynamic balance between the amplification of the pathogen and its long-term persistence explains the emergence and subsequent success of plague at global, regional, and localized scales.

Research on plague during the past century has clarified certain aspects of its ecology, but many questions remain unanswered, particularly those related to how plague maintains itself in the ecosystem and under what conditions epizootics occur. Without answers to these questions it currently is impossible to predict the movement, impact, and/or timing of plague epizootics. In addition, information is needed to investigate the effects of changes in population demographics and recovery rates on colonies following a plague epizootic. Repeated plague epizootics, and subsequent recovery of local populations from these outbreaks, can result in a cycle of expansion and contraction in individual prairie dog colonies (Wagner and Drickamer 2003). Pauli (2005) found that plague survivors organized into functional coteries, and exhibited improved body condition after an epizootic. Colonies that were left supporting large healthy individuals grew significantly faster because healthier prairie dogs reached sexual maturity at an earlier age, produced larger litters, and had increased over-winter survival.

Cully (1997) found that after plague invaded an area, individual GPDs remained widely dispersed. In the following breeding season, however, remaining individuals aggregated into new colonies that expanded into suitable habitat. Seery (2004) found that during and after a plague epizootic, the number of BTPD colonies increased while the amount of occupied habitat declined. Research on BTPD also suggests that colonies repeatedly hit with plague exhibit a downward step-wise pattern in density with each successive plague epidemic, rarely reaching their previous density before getting hit with a new epidemic (Cully and Williams 2001).

The impacts of plague outbreaks, which can lead to the loss of prairie dog colonies of all sizes (Roach et al. 2001), are likely magnified by the isolation of colonies. It has been suggested that colony growth after an epizootic is the result of re-colonization by inter-colony dispersers (Antolin et al. 2002). Increased isolation thus decreases the likelihood that the colony can be re-colonized following a plague outbreak if the distance between the infected colony and the nearest neighbor colony are beyond the dispersal capabilities of the species. Lechleitner et al. (1962) documented a plague outbreak in a GPD colony in Colorado in 1959 that killed all of the individuals in the colony. Prior to the plague outbreak, this colony had been continuously occupied for 20 years despite several poisoning attempts. However, 2 years after the outbreak, the colony still had not been re-colonized, being isolated from other colonies by more than 12 km (7 mi). Recovery rates of GPD and UPD colonies 2 years post-epizootic found GPDs experienced 100% mortality and remained depopulated throughout the study due to lack of available immigrants (Turner 2001).

At present, no techniques are available for large-scale effective control or management because the ecology of plague differs between habitats, populations, and prairie dog species. Flea control methods are costly and labor intensive, but can be successfully used on a small scale (D. Biggins, USGS, pers. comm.). An integral part of managing plague and protecting GPD populations will be to understand the range-wide dynamics of plague.

There is evidence that some mammalian species are evolving a reduced susceptibility to plague (Williams et al. 1979). Resistance to plague may differ among populations of the same species, and it may change depending on amount of exposure (Biggins and Kosoy 2001b). Antibody titers have been found in UPDs, BTPDs, GPDs, and WTPDs indicating individual exposure to plague and subsequent recovery (Cully and Williams 2001; Biggins 2003b; Pauli 2005). Pauli (2005) found that approximately 5% of BTPDs can survive an epizootic with over 50% of the surviving prairie dogs developing antibodies to plague. Long-term, repeated exposure to plague may lead to selection of individuals that are genetically more resistant to the disease and are able to maintain plague in an enzootic form in the environment. However, populations of prairie dogs thus far have remained highly susceptible to plague even after being subjected to repeated exposure (Biggins and Kosoy 2001b).

In 2007, Wagner and Van Andel conducted a project to evaluate whether Gunnison's prairie dogs in the Aubrey Valley possess factors that may provide resistance to plague. Such factors would include unique antibodies or other proteins in the blood that allow the prairie dogs to effectively mount an immune response to the bacterium. Initial analyses indicated that 34 of the 69 tested antigens were significantly different ($P<0.05$) between the Aubrey Valley and Seligman populations. Of particular interest are 14 antigens found to be significantly higher in the Aubrey Valley population because each is known to be associated with a Th1 immune response, which is the type of immune response associated with successfully killing intracellular pathogens, such as *Y. pestis*. This is the same immune response that we would expect to see if these Gunnison's prairie dogs had been vaccinated for plague. However, the mechanism behind this increased immune response is unknown.

In Arizona, plague has been well documented throughout the geographic range of the GPD (Ecke and Johnson 1952; Lechleitner et al. 1968; Rayor 1985; Cully et al. 1997). However, the Aubrey Valley Complex has remained unaffected by the disease since at least 1974. Wagner and Drickamer (2003) found 57 of the 293 (19%) colonies of GPDs they surveyed in northern Arizona experienced die-offs during the summers of 2000 and 2001. Plague was confirmed as the causative agent for 15 of these 57 colonies and was suspected in the rest of these colonies. During surveys they also identified the approximate boundaries of 2 previous plague outbreaks. The Dilkon outbreak occurred over approximately 2900 km^2 (1120 mi^2) and was located west of the town of Dilkon, 120 km (75 mi) northeast of Flagstaff on the Navajo Indian Reservation. Previous surveys in the area identified 45 colonies on 3500 ha (8649 ac). Re-examination of these colonies in 2000 and 2001 found all but 2 of these colonies were inactive. At most of these inactive colonies, burrow entrances were completely closed and only mounds indicated where they used to occur.

The Seligman outbreak was located east of the town of Seligman, approximately 155 km (96 mi) northwest of Flagstaff. This outbreak occurred over approximately 1100 km^2 (425 mi^2). GPDs are becoming reestablished in some areas within the boundaries of the Seligman outbreak despite persistent plague activity. When AGFD conducted surveys in this area between 1990 and 1994, they identified 47 active colonies that covered approximately 3500 ha (8649 ac). In 1996, die-offs were observed in this area and the U.S. Centers for Disease Control and Prevention (CDC) confirmed plague as the cause. Surveys in 2001 found that only 11 of the 47 colonies were active. Thus, it is possible there was another, undocumented plague outbreak in this area in 1999 or 2000.

4) Inadequacy of Existing Regulatory Mechanisms

All states within the range of the GPD permit removal of the species for agricultural and for human health and safety purposes. Seasonal shooting closures have been implemented on all lands in Arizona except tribal, from 1 April to 15 June to protect pregnant and lactating females as well as their young.

5) Other Natural or Manmade Factors Affecting its Continued Existence

Poisoning

As early European settlement of the intermountain west occurred, control of mammalian species considered “vermin” became common practice. Prairie dogs became the focus of widespread eradication efforts largely as a result of their reputation as range and agricultural pests (Clark 1989). Private initiatives had significant effects on prairie dogs between 1870 to 1915 and may have reduced populations prior to government programs being instituted (Oakes 2000). The U.S. Bureau of Biological Survey (BBS) a division of the U.S. Department of Agriculture (USDA), implemented a “Westside Plan” that envisioned the elimination of prairie dogs, along with predators, across the western rangelands (Oakes 2000). The Agriculture Appropriations Act of 1915 gave statutory authorization for the BBS to conduct large scale eradication programs on National Forests and all other public lands (Oakes 2000).

In Arizona, control measures were extensive, thorough, and well organized, resulting in the extirpation of the BTPD from the state and causing a reduction in GPD populations. From 1916-1933, 1,766,694 ha (4,365,596 ac) of GPDs were poisoned (Oakes 2000). Another 2 million acres of prairie dogs were poisoned during the time period of 1934-1938 (Oakes 2000). Surveys conducted in 1921 and again in 1961 by BBS and PARC showed a 92% reduction in the amount of GPD occupied habitat of in the state (Oakes 2000).

Drought

Studies have found that GPDs on productive, wet sites have greater body mass, higher population densities, and faster expansion rates (Crocker-Bedford and Spillett 1981; Collier 1975; Rayor 1985). GPD colonies located on sites lacking sufficient quality and quantity of vegetation may have a difficult time obtaining adequate nutrition and water, resulting in animals spending less time foraging and longer periods in aestivation.

The effects of drought may have been amplified within the past century due to land use practices that resulted in the invasion by non-native plant species, alterations in plant species composition, and lowering of water tables. The proliferation of exotic annual weeds over native perennial grasses and forbs may impact the ability of GPDs to meet their dietary needs especially during drought years. Invasive species may not provide sufficient above or below ground forage or water stores which GPDs need to subsist. Invasive species also out-compete and eradicate native species with which GPDs have evolved.

Status of the Gunnison's Prairie Dog in Arizona

ARIZONA DISTRIBUTION

GPDs are found in the grasslands and to a lesser extent the shrublands north of the Mogollon Rim and south of the Colorado River. Historically, their range extended around the west end of the Mogollon Rim to the south nearly reaching Wilhoit and also extended south of the Mogollon Rim to the high prairies of Ash Creek, south of the Nantanes Mountains (Hoffmeister 1986).

Although prairie dogs are found throughout the area described, their presence in potential habitat is highly fragmented and widely scattered. The degree to which prairie dogs inhabit the landscape has probably changed over time and current patterns are most likely an artifact of historic control efforts and current plague outbreaks.

To better understand the distribution of prairie dogs across potential habitat, periodic surveys have been conducted. These efforts are described below.

Survey efforts

1. In the early 1900's, biologists from the BBS recommended that prairie dogs be eliminated due to the damage they caused to crops and rangeland forage (Merriam 1902; Bell 1921). This led to wide-scale poisoning of prairie dogs throughout the western United States (Roemer and Forrest 1996). In 1920, the BBS requested that prairie dog inventories be completed and maps produced to show the

distribution and extent of prairie dog occupation in order to plan and fund rodent eradication campaigns. When the results of these surveys and the results for poisoning efforts from 1916-1921 were combined, we get an estimate of pre-poisoning acreage for GPDs in Arizona. This estimate was 2,685,202 ha (6,635,280 ac) of occupied GPD habitat on public, private, and tribal lands in Apache, Coconino, Navajo, and Yavapai counties (Oakes 2000). Subsequently, the Predator and Rodent Control Agency (PARC) ordered a survey of prairie dog populations in the United States by state and county due to concerns over uncontrolled poisoning (Oakes 2000). States were given until October 1961 to submit their inventories. Results from the 1961 Arizona survey showed a 92% decline in occupied habitat since the 1921 surveys, with GPDs occupying only 180,235 ha (445,370 ac). Only 4029 ha (9956 ac; <3%) in the 1961 surveys were located on non-tribal lands. An additional 8 ha (20 ac) of occupied habitat was found in Mojave County in 1961. The 1961 surveys determined that BTPDs had been extirpated from Arizona.

2. In 1979, 88 GPD colonies were located on 5 National Forests in both Arizona and New Mexico (Ruffner 1980). Of these, 32 were visited and the sizes of 27 colonies mapped. In the Coconino National Forest, 9 colonies were located with a mean colony size of 34 ha (84 ac). On the Kaibab National Forest, 5 colonies were located with an average colony size of 59 ha (146 ac).

3. In east-central Arizona, the Arizona Game and Fish Department (AGFD) conducted a survey from May 1987 to April 1988, recording 46 colonies, 25 of which were on Bureau of Land Management (BLM) lands (Yarchin et al. 1988). The colonies on BLM land totaled 1297 ha (3205 ac). In 2006, consultants revisited 18 of the 25 sites found on BLM lands. Ten of these sites were considered active, however 2 of the sites held only one active burrow. The other 8 sites were in various states of inactivity from completely disappeared to well-formed burrows with no prairie dogs. Two additional colonies were discovered during the survey. The total active acreage mapped was 395 acres.

4. In 1990, AGFD initiated an effort to locate and map potential black-footed ferret habitat within the state (Van Pelt 1995). From this effort, 215 GPD colonies covering 13,846 ha (34,214 ac) were mapped in Yavapai, Coconino, and Navajo counties and 8 complexes identified: Aubrey Valley (7838 ha [19,368 ac]), Seligman (3060 ha [7561 ac]), Farm Dam (1284 ha [3173 ac]), Navajo Army Depot (308 ha [761 ac]), Government Prairie (155 ha [383 ac]), San Francisco Peak (205 ha [507 ac]), Wupatki (216 ha [534 ac]), and Homolovi (494 ha [1221 ac]). The Aubrey Valley Complex (AVC) was considered the best reintroduction site for black-footed ferrets because over half (51%) of Arizona's known carrying capacity for ferrets was identified here and it was the largest complex of GPDs in the state, with the next closest complex being one-third its size.

a. GPD colonies have been annually mapped in AVC since 1990, with estimates ranging from 6959 to 19,355 ha (17,196-47,827 ac) in 2007. In 1997, Global Positioning System (GPS) units were first used to map prairie dog colonies in AVC and at this time the AVC contained 16 separate GPD colonies encompassing 12,001 ha (29,655 ac). Apparent expansion of AVC from 1990 was likely due to a combination of more accurate mapping, actual expansion of colonies, and habitat conditions favoring expansion (Van Pelt and Winstead 2003).

b. The AVC has been continuously monitored for GPDs since 1996 by transect surveys (per Biggins et al. (1989, 1993). Field personnel survey 64 established transect-blocks between May and August. Results are compared to data from prior years to determine if notable density changes have occurred. When a notable change is observed, additional surveys are conducted to determine the extent of change. Point-counts from a vehicle may also occur throughout the year.

c. Estimates of GPD densities measured from 1996-2001 have shown fluctuations from year-to-year. During this 6-year period, average active burrow densities ranged from 21-33 per ha with percent of good habitat varying from 33%-61%. Higher prairie dog numbers tended to occur following mild winters and above average rainfall; lower numbers tended to occur during droughts. Since 1974, the Arizona Department of Health Services Vector and Zoonotic Diseases Division has monitored plague activity in Arizona by documenting human cases, testing carnivore blood samples for titers, and testing flea pools collected from prairie dog burrows. These tests documented the occurrence of plague in Coconino and Yavapai counties, but not within the AVC demonstrating that plague is not responsible for observed population fluctuations in AVC.

5. In 1994 and 1996, GPD colonies were located and mapped in the southwest corner of the Navajo Indian Reservation (Navajo Natural Heritage Program 1996). Ninety colonies were located in 1994 within 4 complexes. The Canyon Diablo complex contained 12 colonies, the Leupp complex contained 5 colonies, the Red Lake complex contained 3 colonies, and the Elephant Butte complex contained 70 colonies. Eighteen colonies covering 2423 ha (5987 ac) were transected to evaluate suitability of the area for black-footed ferrets. The survey determined this area was not suitable for black-footed ferret reintroduction due to a low density of GPDs. However, the total survey area represented only a small portion of what the Navajo Indian Reservation holds in terms of potential black-footed ferret habitat. The eastern section of the study area was not surveyed, but it was thought to contain more than 400 ha (988 ac) of active GPD colonies.

6. In 1998, mapping of GPD colonies was conducted on the Peaks and Mormon Lake Ranger Districts of the Coconino National Forest (Randazzo 1998). This project began by referencing Ruffner's (1980) work on the Peaks Ranger District. However, not all the colonies mapped by Ruffner were revisited. Ruffner mapped GPD colonies on both private and public lands, but the 1998 survey mapped colonies only on public lands. Twenty-one active colonies and 2 abandoned areas were located in 1998. Total hectares mapped were 1173 (2899 ac). Three of the colonies mapped in 1980 by Ruffner were active and one colony was inactive.

7. Wagner and Drickamer (2003) attempted to determine the current status of the GPD in Arizona by compiling information from previously conducted surveys (1987-1988 and 1990-1994) and revisiting those sites to evaluate the current status of colonies and map occupied habitat. The locations of more than 400 colonies of GPDs were documented from previous surveys, as well as boundary, size, and status (active or inactive) of the colonies at the time of the surveys. Of the 400 GPDs colonies identified, 293 were visited during the summers of 2000 and 2001. In the previous surveys, 270 (92%) of the 293 colonies were active. In 2000-2001 however, only 86 (29%) of the 293 colonies were active. In addition, Wagner and Drickamer (2003) documented a 66% reduction in the total area covered by active colonies. The 270 colonies that were identified as active in previous surveys covered approximately 13,559 ha (33,505 ac). The 86 colonies identified as active in the 2000/01 surveys covered approximately 4526 ha (11,184 ac).

8. During the surveys conducted by Wagner and Drickamer (2003), 57 of the 293 surveyed GPD colonies experienced die-offs during the summers of 2000 and 2001. Of these 57 colonies, 53 were identified as active during previous surveys. The other 4 colonies apparently became active at some point after the previous surveys and then experienced die-offs shortly before the 2000/01 surveys. Although plague was only confirmed as the causative agent in 15 of the die-offs, it was suspected in most, if not all, of the 57 die-offs.

9. In May and June 2002, AGFD conducted fixed-wing surveys of all grasslands and areas of low shrubs within Region 2, south of the Grand Canyon (S. MacVean, AGFD, pers. comm.). Aircraft flew 46 to 61 m (151-200 ft) above the ground along grid lines positioned 0.6 km (0.4 mi) apart in rough terrain and 0.8 km (0.5 mi) apart in smoother terrain. Grids and colony locations were recorded with a Trimble Geo Explorer GPS unit. The surveys recorded 353 colony locations along a transect >3000 km (1864 mi) in length. Wagner's field crew and volunteers from Grand Canyon Trust ground-truthed locations marked as colonies during aerial surveys. Identification of prairie dog colonies from the aircraft was 92% accurate. When corrected for this level of accuracy, a preliminary estimate of 325

points, with 3 GPS points recorded in each colony, resulted in an estimate of 108 prairie dog colonies detected in the survey area.

a. Comparing ground (Wagner and Drickamer 2003) to aerial techniques (S. MacVean, AGFD, pers. comm.), determined that approximately 42% of the colonies identified during ground surveys by Wagner and Drickamer (2003) were missed by aerial surveys and 58% of the colonies identified in the fixed-wing surveys were missed by Wagner and Drickamer (2003). The probability that some colonies were missed by both methods was 0.24 (0.42 equals the probability of being missed by aerial survey x 0.58 equals the probability of being missed by compiling known colonies) = 0.24. Thus, about 25% of the prairie dog colony locations most likely were missed by both surveys. The best estimate for the number of colonies in the survey area was calculated to be 168. However, this is an underestimate because AGFD was unable to fly all suitable habitat.

10. In 2005, AGFD mapped GPD colonies in Navajo and Apache counties (Beier and Bayless 2006). Known colonies within the study area were visited and remapped and colonies discovered opportunistically were also mapped. A total of 56 GPD colonies were identified with 50 being active. Permission was not obtained to map 10 of the colonies, and 7 additional colonies had less than 10 active burrows and were excluded, so 33 active colonies were mapped. These 33 colonies had a total area of 549 ha (1,356 ac). Burrow densities averaged 122.9 per hectare, with 48% of burrows being active.

11. In 2006-2007, AGFD completed the most comprehensive inventory effort to date. Known colonies across the state, outside of tribal lands, were revisited to assess status and if active were remapped. In addition, newly discovered colonies were mapped. A total of 203 historic colonies were visited. We found that 98 of the 203 colonies were active. In addition, 172 new colonies were identified as part of the survey. In total an estimated 43,849 ha (108,353 ac) of colonies were mapped. This represents greater than a 100% increase in occupied acres when compared to the approximately 20,000 ha (50,000 ac) of prairie dogs mapped during the years from 1987-1994. Mapping efforts in 2006-2007 were conducted on state, private, and federal lands. This number represents a minimum number of GPD acres as no systematic surveys were conducted and large areas of potential habitat (especially areas not near roads) have not been surveyed. In addition, this effort failed to revisit and map all historic colonies and over 100 new colony locations that were identified by Wagner and Drickamer (2003) during their work in 2000-2001.

Predicted range model

For the species, 25% percent of the gross range and 27% of the predicted range occurs in Arizona (Seglund et al. 2005). A predicted habitat model was created for the GPD in Arizona by modifying an existing model created by the SWreGAP (2006). This model was based on the concept of Wildlife Habitat Relationships (WHRs). WHRs are the resources and conditions present in areas where a species persists and reproduces or otherwise occurs (SWreGAP 2006). The resources or conditions used to create the Arizona GPD model included vegetative habitat type, elevation, and slope. This model allows us to identify areas of potential habitat for the GPD. We modified the original SWreGAP model by adjusting the input parameters to be Arizona specific. This model does not identify where GPDs are or were, only where they potentially could be (see model parameters Appendix II).

Within the state we estimate a total 4,798,891 ha (11,858,320 ac) of potential habitat, 56% percent of this is on tribal lands. Of the 2,115,311 ha (5,227,049 ac) not on tribal lands, 55.10% of the predicted habitat is located on private land, Bureau of Land Management (BLM) land comprises 3.78% of the predicted range, National Park Service (NPS) land comprises 2.02%, U.S. Forest Service (USFS) land comprises 6.61% of the predicted range, and state land comprises 31.96% of the predicted range (see map, Appendix II).

Summary

Historic poisoning campaigns and plague have caused declines in GPD occupied habitat in Arizona. In 1921, which was several years after poisoning began, 2,273,070 ha (5,616,878 ac) of GPD occupied habitat were estimated to occur within 4 counties (Apache, Navajo, Coconino, and Yavapai), by 1961 a 92% decline in occupied habitat was estimated. Both the 1921 and 1961 surveys included public, private, and tribal lands within 4 counties. By 1961, 97% (435,419 acres) of estimated GPD acreage was on tribal lands. No further mapping of this species took place until the 1980s and 1990s when surveys were conducted to locate potential black-footed ferret reintroduction sites.

Since the 1987-1994 mapping effort, two subsequent efforts have assessed the activity of the colonies mapped during that time period (Wagner and Drickamer 2000-2001 and AGFD 2006-2007). The results from these efforts can cautiously be used to understand more about recent population trends in the state. The 1987-1994 mapping efforts identified approximately 20,000 ha (50,000 ac) of active prairie dog colonies on non-tribal lands. This was up from an estimated 4000 ha (10,000 ac) on non-tribal lands in 1961. In 2006-2007 a subsequent revisiting of the same sites mapped in 1987-1994, and the mapping of new colonies, showed an increase to 43,849 ha (108,353 ac). Caution should be exercised when interpreting these results as no standardized inventory method was used. However, because the same roads were taken to arrive at historical colonies and because most new colonies were discovered while driving along these roads, it is probable that the new colonies mapped in 2006-2007 did not exist at the time of the 1987-1994 survey effort. Therefore, the increase from 20,000 ha (50,000 ac) to 43,849 ha (108,353 ac) probably does represent a real expansion in the last 15 years. However, according to Wagner and Drickamer (2003) plague outbreaks occur over relatively discrete areas in both space and time, thus, GPD populations may be expanding in some areas in Arizona while at the same time populations in other portions of its range may be contracting. In addition, due to errors inherent in mapping prairie dog colonies, the magnitude of the expansion suggested by the acreage estimates presented may be an over- or under-estimate.

In 2000-2001, Wagner and Drickamer (2003) performed a survey of the colonies mapped in 1987-1994 to determine persistence and activity. They found that only 30% of the colonies were still active (86 active colonies out of 293 sampled). While this would seem like a large reduction in the number of active colonies, they also identified 137 new colonies as part of the study. In 2006-2007, the AGFD repeated a visit to 233 of the 1987-1994 mapped colonies and found that a minimum of 50% were still active (116 of the colonies were confirmed active, 117 were not active). In addition, 172 new colonies were identified as part of the survey. Thus, while persistence in the exact same locations may only reach 50%, a large number of new colonies in both surveys suggests that prairie dogs shift across the landscape but persist in the same general geographic area.

A major cause of concern for the GPD is the incidence of plague. In our 2006-2007 effort we visited 203 of the same colonies that Wagner and Drickamer (2003) visited in 2000-2001. We found that 98 of the 203 colonies were active compared to Wagner and Drickamer (2003) who found only 86 of 293. This would imply that in the last 5 to 6 years some of the colonies that were not active in Wagner and Drickamer's survey were recolonized after plague die-offs in 2000-2002. In fact, when we look at colonies in the Flagstaff area known to have died off during the plague epizootic of 2000-2002, 21-28% were active again in 2007. While this evidence of recolonization after plague epizootics is of great importance, plague remains the greatest threat to GPDs in Arizona.

State Management and Regulations

The Arizona Game and Fish Department lists the GPD as a Species of Greatest Conservation Need under the Comprehensive Wildlife Conservation Strategy (CWCS; AGFD 2006). This document provides policy guidance to state and federal agencies, and the public, on AGFD priorities. The CWCS does recommend Priority Actions to address stressors to GPD populations (see Appendix III). However, it does not provide specific legal or regulatory protection for priority species.

In Arizona, the provisions of Arizona Revised Statutes Title 17 protect all native wildlife including federally listed species. The AGFD classifies all prairie dog species as nongame mammals. Recreational shooters are required to obtain a hunting license to take prairie dogs. In April 2001, the Arizona Game and Fish Commission changed the hunting season for GPD from year round to open July 1 – March 31 and June 16 – June 30. All hunters on state, federal, and private lands are required to follow the closure. Poisoning may occur on state, federal and private lands without a specific permit. However, the products registered for prairie dog control by the Environmental Protection Agency require a pesticide applicators before toxicants can be applied. Pesticide applicator licenses can only be obtained by going through a formal licensure process with the Arizona Department of Agriculture.

PURPOSE STATEMENT

The purpose of this management plan is to identify and implement management strategies in Arizona that will contribute to range-wide GPD conservation. Although this management plan focuses on GPDs, the risks identified for this species also affect other grassland species found in Arizona. When feasible and possible, the Department and the Working Group will evaluate management actions for the applicability to other sensitive grassland species and overall ecosystem management. The Working Group will develop and implement this plan using reliable, scientific data that will provide recommendations for the conservation of GPDs and their associated habitats while providing flexible, practical, and adaptive management strategies for landowners.

Potential GPD habitat in Arizona is a mosaic of federal, state, tribal, and private lands. Therefore, the effectiveness of this plan will depend on cooperation among those that manage these lands. The Arizona Gunnison's Prairie Dog Working Group (convened to help draft the state management plan; refer to Conservation Objectives and Actions) agreed to recommend managing GPDs across the state by maintaining current prairie dog acreage on private and state lands and maintaining or expanding populations on federal lands. Tribal lands were excluded as the group has no management authority over these lands. However, given the largest proportion of potential GPD habitat falls on private (55% of non-tribal potential habitat) and tribal lands (56% of all potential habitat) involvement by these landowners in the conservation management efforts is imperative and will be strongly encouraged. However, participation in the conservation effort will remain voluntary.

This management plan, and the actions outlined within, is part of an interstate effort to conserve GPDs and potentially restore them to areas from which they have been extirpated. The goal of this plan is to conserve the species in Arizona and the ecosystem of which it is a part. This plan is designed to be flexible enough to respond to changing conditions in the status of GPDs, their management needs, and the social and economic environment in which we live. Annual review of this plan will provide ample opportunities for adjustment to accommodate needs of the GPD, its associated species, and grassland habitat, as well as the changing needs, demands and expectations of the public and various agencies responsible for conservation of natural resources in Arizona (refer to Objective 13 of the conservation actions). The Department, in cooperation with the Working Group, will finalize this plan by **December 31, 2007**, as required by the interstate conservation agreement. To meet this deadline, some of the following management actions have already been initiated and/or completed.

COORDINATION WITH BLACK-FOOTED FERRET AND BURROWING OWL MANAGEMENT

As both the black-footed ferret and the burrowing owl depend on prairie dog burrows for their primary habitat, and because ferrets also depend on prairie dogs as food, the objectives of this plan will either directly or indirectly beneficially affect both black-footed ferrets and burrowing owls. Other than extreme management actions (i.e., transplants), maintaining and increasing prairie dogs can be the most effective management action designed to benefit black-footed ferrets and burrowing owls. One way to benefit all three species is to prioritize areas so that when the conservation actions outlined in this plan are implemented, they occur in locations where GPDs can or do coexist with burrowing owls and black-footed ferrets.

CONSERVATION OBJECTIVES AND ACTIONS

The *Interagency Management Plan for Gunnison's Prairie Dogs in Arizona* has 13 main objectives that are consistent with the range-wide management approach. These objectives will allow the Department and cooperators to manage GPDs in a manner that will contribute to the interstate conservation effort, CWCS, and the long-term viability of the species. The first four objectives are the highest priorities as identified by the Working Group and are presented in order of priority. The remaining objectives are of lower priority and are not presented in any particular order.

CONSERVATION OBJECTIVES AND ACTIONS

1. Address the listing factor, "Disease or Predation"

   A. **Disease**: Monitor the incidence of plague throughout GPD range. This will be accomplished using a plague protocol that will be developed. In theory, a network of volunteers, professional land managers, and State, Federal, County and Tribal, health departments will be used to monitor the occurrence of plague.

   B. **Disease**: Pursue research in plague prevention, dynamics, and mitigation (e.g. translocation, dusting) so that a strategy can be developed for response to plague outbreaks.

   C. **Disease**: When plague is detected, implement the following actions: 1) Increase monitoring effort to identify extent of outbreak. 2) Where and when appropriate and feasible, implement mitigation measures such as dusting burrows to kill fleas.

   D. **Disease**: Maintain a well dispersed population across appropriate range in the state to act as a buffer against plague and to allow for natural recolonization after outbreaks. Use translocation post plague as a mitigation effort to maintain distribution. Develop a plan based on best current knowledge of plague dynamics, GPD biology and metapopulation dynamics for how to conduct a transplant program in support of this objective. Consider using urban GPDs as source populations.

   E. **Disease**: Encourage the development of landscape scale immunizations for GPDs and maintain abreast of current research in this area.

2. Identify management areas and acreage goals for GPDs in order to maintain a viable population of GPDs that will contribute to the overall functioning of grassland and shrubland ecosystems in northern Arizona. Continue to monitor and assess the population.

   A. Maintain on non-tribal lands, at minimum, the number of active acres currently known in Arizona based on the 2007 survey; 43,849 ha (108,353 ac). The Working Group will evaluate this goal at least once every three years and adjust it as needed to address long-term population viability of the GPD and to maintain the species at an ecologically effective density that will contribute to the overall functioning of grassland and shrubland ecosystems in northern Arizona.

   B. Provide for expansion on federal lands in cooperation with federal land management agencies and on private and state lands with willing landowners/lessees.

   C. Mitigation measure to help in achieving management goals could include: the extension of closed season from June 15, hunting restrictions or limits in certain areas, restriction of control efforts, mechanisms to control the spread of disease, land conservation, re-establishment of extirpated colonies or establishment of new colonies, and habitat improvement.

   D. Monitor the GPD population every 3 years by revisiting and remapping known colonies and mapping any new colonies that have been discovered. If the number of active acres at any time declines by 40% or more, we will implement actions (see 2c) to halt further decline. Focus of the actions taken will be in areas where the problem is occurring, although some mitigation efforts may be carried out in other areas. This goal was developed based on the fact that a 40% decline would reduce the current minimum population estimate to a level slightly above what was estimated in the early 1990s. Since the 1990s the population has increased from an estimated 20,000 ha (50,000 ac) to its current level. This would suggest that if the current population was reduced to population similar in size to that of the early 1990s, the population could still recover. In addition, this level of decline is also being used as a trigger for actions on a range-wide basis (WAFWA 2007).

   E. Establish management agreements with cooperators (federal, public, State Trust, state, tribal, local government, and private landowners) to achieve and maintain acreage goals and expand acreage on federal land.

   F. Contribute to the range-wide monitoring effort. The Department and cooperators will use standardized protocols identified by the WTGWG and adopted by other states to monitor populations of GPDs. (see Appendix IV). The state will conduct monitoring every third year as outlined by the Gunnison's Prairie Dog Conservation Plan (WAWFA 2007).

G. Develop specific management objectives for each unit; these may include acreage and density goals. NRCS 8-digit Hydrologic Units (Figure 2) will be used as management units. Certain colonies within management units may also be identified as key colonies for which and special management objectives and stipulations may be developed.

H. Develop a protocol to monitor and evaluate the effectiveness of corrective measures (e.g. translocation, dusting, shooting closures).

3. Maintain GPDs across their historic range in Arizona.

A. The state will maintain GPDs across 75% of the historic range based on 1916 pre-poisoning range estimates. This goal will require the presence of at least one active prairie dog town in a minimum of 75% of the management units in which they historically occurred. NRCS 8-digit Hydrologic Units (Figure 2) will be used as management units. The status of this goal will be reassessed every three years as part of the monitoring program.

B. Identify corrective measures to be taken if number of occupied management units occupied falls below target numbers. These measures could include extension of closed season, hunting restrictions or limits in certain areas, restriction of control efforts, mechanisms to control the spread of disease, land conservation, re-establishment of extirpated colonies or establishment of new colonies, and habitat improvement.

4. Address the listing factor, "Present or Threatened Destruction, Modification or Curtailment of Habitat or Range" by specifically addressing the following: Agricultural land conversion, Urbanization, Oil/Gas exploration and extraction, and Livestock grazing.

A. **General habitat loss:** Monitor and identify new, continued, or diminishing threats to GPD habitat, such as urbanization, conversion to cropland, woody succession of grasslands, and livestock grazing. Work with town, city, county, and state government agencies to identify possible areas of future habitat fragmentation in association with planned development and roads, and work with municipalities to design open space programs that retain – and mitigate loss of – prairie dog colonies.

B. **General habitat loss:** To more fully address this listing factor we will identify current and potential habitat for GPDs and promote conservation of these areas. Using GIS, produce a state map depicting potential GPD and land ownership patterns. From this map determine the acres of potential GPD habitat in the state by landowner or land management agency (Appendix II). Potential habitat will initially be identified based on elevation, slope, and vegetation types known to be used by GPDs in Arizona (when a statewide NRCS soil layer that will allow for refinement of the model is made available, it will be added).

C. **General habitat loss:** Coordinate with federal, state, county, city, State Trust, tribal, and non-profit land-management agencies and private landowners to conduct on-the-ground surveys of sites identified as potential GPD habitat. This will help to further refine our understanding GPD habitat use. On-the-ground habitat inventories, ground-truthing, or other on-the-ground studies conducted on private or tribal lands pursuant to this management plan shall not occur without prior permission from the landowner or tribe.

D. **General habitat loss:** Develop habitat management guidelines for suitable/potential/excellent habitat. Through research efforts identify what habitat characteristics, vegetative components, grazing practices and restoration efforts benefit GPDs. Use this information to develop habitat recommendations for GPDs in Arizona. Encourage city, county, federal, public, State Trust, state, tribal, and private land managers to conserve or enhance suitable or potential habitat, including corridors that connect habitat blocks and allow for natural dispersal and population expansion.

E. **General habitat loss:** Pursue management agreements with federal, state, county, city, State Trust, tribal and non-profit land-management agencies and private landowners, where such agreements will address conservation objectives for the species. Examples of voluntary agreements that may be developed are: State Stewardship Agreements, USFWS Partners for Wildlife Agreements, and conservation easements among private organizations and government agencies.

F. **General habitat loss:** Increase the use of mechanical, chemical, and biological methods of weed control to manage noxious weeds in prairie dog management strategies, where appropriate.

G. **General habitat loss:** Monitor and research the effects of juniper encroachment and the natural succession of grasslands as a source of habitat loss affecting GPDs. Possible actions include: 1) the removal of woody succession from historic grasslands, especially near existing GPD towns or near sites with high potential for reintroduction; 2) restoring grasslands with moderate to high potential as GPD habitat.

H. **General habitat loss:** Ensure that projects that benefit GPD habitat are eligible for Game and Fish funds and grants.

I. **Oil/Gas exploration and extraction and Solar/Wind Power infrastructure:** This is not currently a major source of habitat loss for GPDS in Arizona. However, we will continue to monitor these sources of potential disturbance and in the event of increased surface disturbance; we will develop and distribute mitigation guidelines and pursue mitigation measures to protect active colonies.

J. **Livestock grazing:** Encourage recognized grazing management practices that maintain ecosystem health. This will be accomplished by working with all partners (Forest Service, State Land Department, BLM and private ranchers) to incorporate GPD management into range management plans. Emphasize maintenance of native plant species and natural revegetation. Actions that can be implemented include the reseeding of disturbed and burned areas using native, locally adapted plant species and restoring grasslands with moderate to high potential as GPD habitat.

K. **Livestock grazing:** Work with all partners (Forest Service, State Land Department, BLM and private ranchers) to incorporate GPD management into range management plans. For example, when appropriate, include GPDs management when developing Coordinated Resource Management Plans for grazing leases on State Lands.

L. **Urbanization**: Develop a mitigation program for urban prairie dogs. Such a program could incorporate municipal/county open space conservation programs that retain existing prairie dog colonies within comprehensive or regional plans. As a first step, review current comprehensive and regional plans and in the case that such plans do not retain existing prairie dog colonies, provide information to the appropriate governing bodies to facilitate the inclusion of provisions to protect urban colonies in such plans. Additionally, this program could be similar to mitigation programs for burrowing owls, where developers pay to translocate prairie dogs from lands to be developed. As a first step, initiate contact and discussions with developers in northern Arizona and work with municipal and county governing bodies to initiate a program where developers pay to translocate prairie dogs from lands to be developed. Determine how urban GPD can be best used to restock areas where GPD have been extirpated. Conduct population simulations to determine how to best use available animals. A key component of this effort will be to identify areas to which prairie dogs can be relocated and to develop a statewide protocol to address translocations (when, where to, how).

M. **Urbanization**: Pursue other mechanisms to mitigate effects of urbanization on GPD (Disclosure, CC&Rs, Ordinances (see Santa Fe 2001), and other planning tools). Possible actions include the relocation of displaced GPDs; working with cities and counties to develop prairie dog habitat management plans that focus on open space retention to maintain existing – or mitigate lost – prairie dog habitat. Another possible action is to educate urban landowners about prairie dogs so that more informed decisions about control can be made.

5. Address the listing factor, "Overutilization for Commercial, Recreational, Scientific or Educational Purposes" by specifically addressing the following: Shooting

A. **Shooting:** Monitor the number of GPDs taken by shooting. This will be achieved through small game surveys sent to hunters on a yearly basis. If our acreage objectives in a certain area are not being met, we will assess the impact of shooting in the area and if necessary recommend a hunting closure until population objectives are met.

B. **Shooting:** Identify areas were hunting may need to be regulated (e.g. recently translocated populations, vulnerable populations, populations considered to be key to the management strategy) and implement a hunting closure in those areas until population objectives are met.

C. **Shooting:** Identify and recommend changes that will improve how shooting data are collected so that better estimates of take can be created.

6. Address the listing factor: "Inadequacy of Existing Regulatory Mechanisms" by specifically addressing the following: Poisoning

A. **Poisoning:** Review and if necessary recommend changes to state statutes and regulations pertaining to prairie dog poisoning.

B. **Poisoning:** Develop or modify a Memorandum of Understanding (MOU) between the AGFD, the Arizona Department of Agriculture, and Wildlife Services a division of the Animal Plant and Health Inspection Service, in which agencies agree on policies regarding prairie dog control efforts, agree to monitor and report on the poisoning effort, and agree to curtail or suspend poisoning if occupied acreage falls below established objectives.

C. **Poisoning Prairie Dogs**: Pursue other mechanisms as alternatives to poisoning GPDs (translocations, alternative deterrence methods, etc…). Educate the public in GPD habitat about management alternatives. Develop literature and information handouts on alternatives to poisoning.

7. Address the listing factor, "Other Natural or Manmade Factors Affecting its Continued Existence" by specifically addressing the following: Drought

A. **Drought:** Monitor drought conditions and effect on GPD colonies. Identify specific effects due to drought, and if acreage objectives are not being met in a certain area as a result of drought, we will recommend that other stressors be reduced to mitigate impacts.

8. Solicit funding and assistance for GPD habitat inventories, potential re-establishment, research, grassland conservation, and landowner incentive programs.

A. Develop cooperative conservation efforts with land-management agencies in areas identified as focal areas for GPD conservation in Arizona.

B. Solicit funding for grassland acquisition, restoration, conservation easements, and prairie dog conservation in Arizona.

C. Utilize the existing landowner relations program and grant programs including, Landowner Incentive Program, State Wildlife Grants, Wildlife Conservation Fund and habitat partnership grants to encourage retention of existing prairie dogs and expansion in historic habitat.

D. Ensure that the GPD is on the AGFD's Sensitive Elements List, thus allowing Heritage Funding for projects that address specific research questions (refer to Objective 13) or projects focused on management and conservation of grasslands and prairie dog species in Arizona.

9. Educate the public, landowners and managers, and appropriate groups about prairie dogs and southwestern grassland ecosystems, and encourage support for GPD conservation.

A. Distribute educational brochures to the public. The brochure may include information on: 1) general ecology and natural history of the species; 2) plague; 3) the role of prairie dogs in maintaining healthy grasslands; 4) potential impacts and benefits of prairie dogs to private landowners; 5) management needs and challenges, including compatibility of prairie dogs with livestock grazing and non-lethal prairie dog control measures; 7) the species' status; and 8) the interstate conservation effort and how Arizona's management plan contributes to conservation of the species across its range.

B. Use Department publications and local media (i.e., newspaper, television) to educate the public about GPDs, their role in grassland ecosystems, associated conflicts, and national and state conservation efforts.

C. Develop a balanced curriculum for use in classrooms, including information on GPD ecology and management.

D. Distribute the *Interagency Management Plan for Gunnison's Prairie Dogs in Arizona* and hold public meetings to discuss the plan. Identify landowner and lessee concerns, and seek constructive solutions to meet conservation objectives.

E. Attend local group meetings (e.g., Arizona Cattlegrower's Association, Farm Bureau) to answer questions and address concerns regarding prairie dog management and Working Group activities.

F. Provide presentations to interested organizations.

G. Hold workshops to educate public on GPDs and alternative approaches to managing them.

10. Identify landowner incentives to encourage active participation by landowners in GPD management in Arizona.

A. Coordinate with the Gunnison's Prairie Dog Conservation Team to investigate the potential for a Landowner Incentive Program and other granting programs that will provide incentives for maintaining viable prairie dog populations and habitat on private and non-federal lands.

B. Explore other options for landowner incentives, such as direct payments from private funds, conservation easements, or stewardship agreements aimed at maintaining, enhancing, and expanding occupied GPD acres.

C. Develop and disseminate public informational materials and programs to inform landowners of available financial incentives for prairie dog habitat conversion.

D. Make personal contacts with owners of key habitat tracts (focus areas) and any landowner that expresses an interest in the program.

E. Develop cooperative agreement strategies to promote GPD conservation, such as Memorandums of Understanding (MOU) and Memorandums of Agreement (MOA). Encourage participation in land-use planning by federal, state, county, local, and tribal entities for the purpose of GPD conservation.

F. Work with landowners to develop conservation easements that will protect GPDs and their habitat.

11. Identify, prioritize, and implement research needs. These include the research needs identified by members of the interstate team as well as specific needs identified by the state working group.

Range-wide research needs

The USFWS (2006) determined that although none of the 5 listing factors were threats to the continued existence of the GPD, more information was needed on 3 of the 5 listing factors. More information is needed to allow better management regarding: land use practices affecting GPD habitat and distribution, the effects of plague, and effectiveness of current regulatory mechanisms. Additional information on these factors will aid in the design of management strategies to alleviate additive stresses during difficult environmental conditions and provide information on when, how, and to what extent control measures should be used.

A. Disease. The effect of plague on long-term viability of GPDs is unknown. The short-term effects are severe, and there are indications the long-term effects are detrimental. Existing research suggests that plague is the greatest threat currently affecting prairie dog populations.

1) Continue research on the use of pesticide dusting for flea control as a management tool. GPD colonies with plague have been found to have both a higher percentage of burrows infested with fleas and a greater number of fleas per infested burrow than plague free colonies, indicating that fleas may drive the cycle (Heller 1991).
2) Further examine conditions (e.g., weather) under which plague outbreaks are likely.
3) Evaluate ramifications of plague for long-term persistence of GPD populations at a landscape scale.
4) Examine recovery rates and population dynamics of infected colonies.
5) Examine the feasibility of using translocations to augment local prairie dog populations reduced by plague outbreaks.
6) Continue research to develop an oral plague vaccine that can be economically dispersed over large areas occupied by GPDs.
7) Determine what happens to plague between epizootics (maintenance mechanisms).
8) Determine the role of associated mammals in maintenance and transmission of plague.
9) Determine the mechanisms by which plague is spread between GPD colonies.
10) Determine the long term potential for plague to preclude attainment of GPD conservation objectives.
11) Model GPD metapopulation dynamics and viability in the presence of plague.
12) Determine the mechanisms by which GPD colonies in the Aubrey Valley Complex, Arizona remain free of plague.
13) Determine whether inbreeding depression occurs in recovering colonies.

B. Habitat loss. Studies should be conducted to identify habitat characteristics required to maintain viable GPD populations and to address the direct and indirect effects of land conversions on GPDs.

1) Determine the effects of timing and intensity of common grazing practices on GPD habitat use.
2) Determine the effects of fragmentation, and development of barriers due to urbanization, agricultural development, and woody succession on dispersal and maintenance of colonies.
3) Evaluate changes in distribution and population densities at sites prior to, during, and after oil/gas/wind/solar development.

4) Evaluate colonization rates after oil/gas wells are removed.
5) Evaluate the effects of vibroseis on GPDs.
6) Determine the effects of agricultural land conversions on population densities, reproductive output, and long-term viability.
7) Determine the spatial and temporal effects of fire and on GPD colonization rates and re-colonization rates.
8) Determine differences between non-native annual grasses and native plants in effects on population trends, reproductive output, and viability over the long-term.
9) Monitor impacts of rangeland restoration treatments, such as green-stripping with forage kochia, chaining, tree clearing, noxious weed control, and burning on GPD populations.
10) Examine the genetic structure of GPD metapopulations.
11) Pursue research to assess the effects of recognized, environmentally friendly, grazing management practices on GPDs and their habitat.

C. *Shooting*. Studies should be conducted to assess the impacts of shooting and the potential need for regulations to limit take.

1) Development of an appropriate monitoring technique to enable managers to make shooting sustainable over time and avoid extinctions of local populations.
2) Studies comparing exploited and non-exploited GPD populations will be conducted. Analysis will include effects on social interactions, foraging, distribution, emigration, population trends, and reproductive output. Studies will be conducted on a large scale over an extended time period to accurately evaluate the effects of recreational shooting.
3) Studies will be conducted that evaluate different levels of shooting pressure on GPD populations. This will provide information to help manage harvest levels and timing to protect populations.

D. *Chemical Control* Ultimately, poisoning must be managed by state wildlife agencies or state departments of agriculture if regulation of GPD take is necessary.

1) Evaluate the use of translocation as an alternative to poisoning. Specifically, evaluate different methods of capturing, survival of translocated individuals, and feasibility of large vs. small scale translocation efforts.
2) Examine the ability of GPD populations to rebound after use of poisons on colonies.
3) Develop non-lethal options for controlling GPDs.

E. *Drought.* Climate conditions cannot be managed directly, but other effects that might exacerbate potential drought impacts can be evaluated and managed, if necessary.

1) Monitor GPD populations during various environmental conditions over a significant part of the range.
2) Examine land use practices and their ability to influence GPD responses to environmental changes.
3) Research population dynamics under drought conditions.
4) Study the effects of grazing in areas occupied by GPD during drought years.

State specific research needs (not already mentioned above)

A. Urban Ecology

1) The role of urban colonies in metapopulation dynamics.
2) Determine if isolated urban colonies more plague resistant.
3) Determine the importance of urban colonies in maintaining the state population.
4) Develop effective translocation techniques.
5) Test and develop alternative methods to discourage prairie dog colonization (e.g., used kitty litter, vegetation barriers).

B. Plague

1) Determine if there is a correlation between colony density and incidence of plague.
2) Determine if some prairie dogs develop immunity to plague.
3) Determine the effects of plague on colonies with different densities.
4) Research potential plague resistance in Aubrey Valley.

C. Shooting

1) Determine if shooting can impact depressed populations; such as after a plague outbreak.

12. Establish the Arizona Gunnison's Prairie Dog Working Group, which will assist the Department with developing and implementing a state management plan for GPDs.

A. Organize the Working Group, which will include a balanced representation of state and federal agencies and programs, local and tribal governments, private landowners, and interested organizations and individuals. Work group participation will be voluntary. Participation by representatives should be maintained as much as possible to ensure group continuity.

B. Develop a working group charter that identifies the role and responsibility that each member will have in the working group. Also include guidelines pertaining to voting, participation, and other essential functions of the group.

C. Encourage interested parties to cooperate with the group by attending meetings and participating in voluntary, action-specific agreements to promote GPD conservation and education activities.

D. The Working Group will meet as often as needed to develop and implement the objectives of the state management plan. Working Group meetings will be open to the public, with agendas available to the public in advance.

E. Develop and implement conservation goals and objectives to ensure the state prairie dog management plan contributes to the conservation of the species.

F. Coordinate with the interstate Gunnison's prairie dog conservation team to meet range-wide goals and objectives.

14. Evaluate progress and accomplishments.

A. Submit an annual written report on Working Group activities to the WTGWG chair, and distribute the report to all interested parties. Within 60 calendar days of receipt of each report, the WTGWG will inform the Department, in writing, of any areas in which progress is not sufficient to contribute to the conservation agreement.

B. If the WTGWG identifies deficiencies, the Department, in cooperation with the Working Group, will determine whether implementation of recommended curative measures is mutually acceptable and feasible to Working Group members and affected public parties.

FIGURES AND TABLES

Figure 1. Gunnison's prairie dog gross range, predicted range, and location of colonies in Utah and Colorado (2002) as calculated by Seglund et al. (2005).

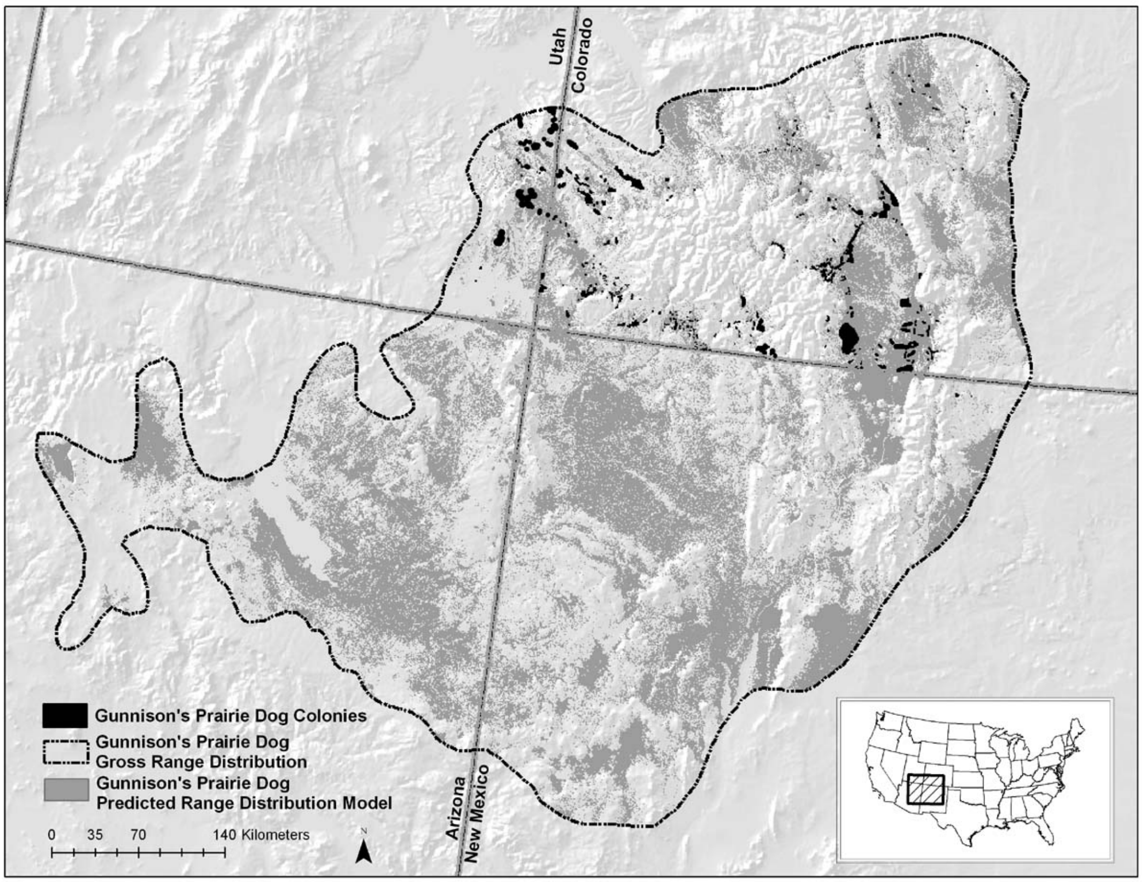

Figure 2. Natural Resources Conservation Service (NRCS) 8-digit Hydrologic Units within Gunnison's prairie predicted range for Arizona, used as management units.

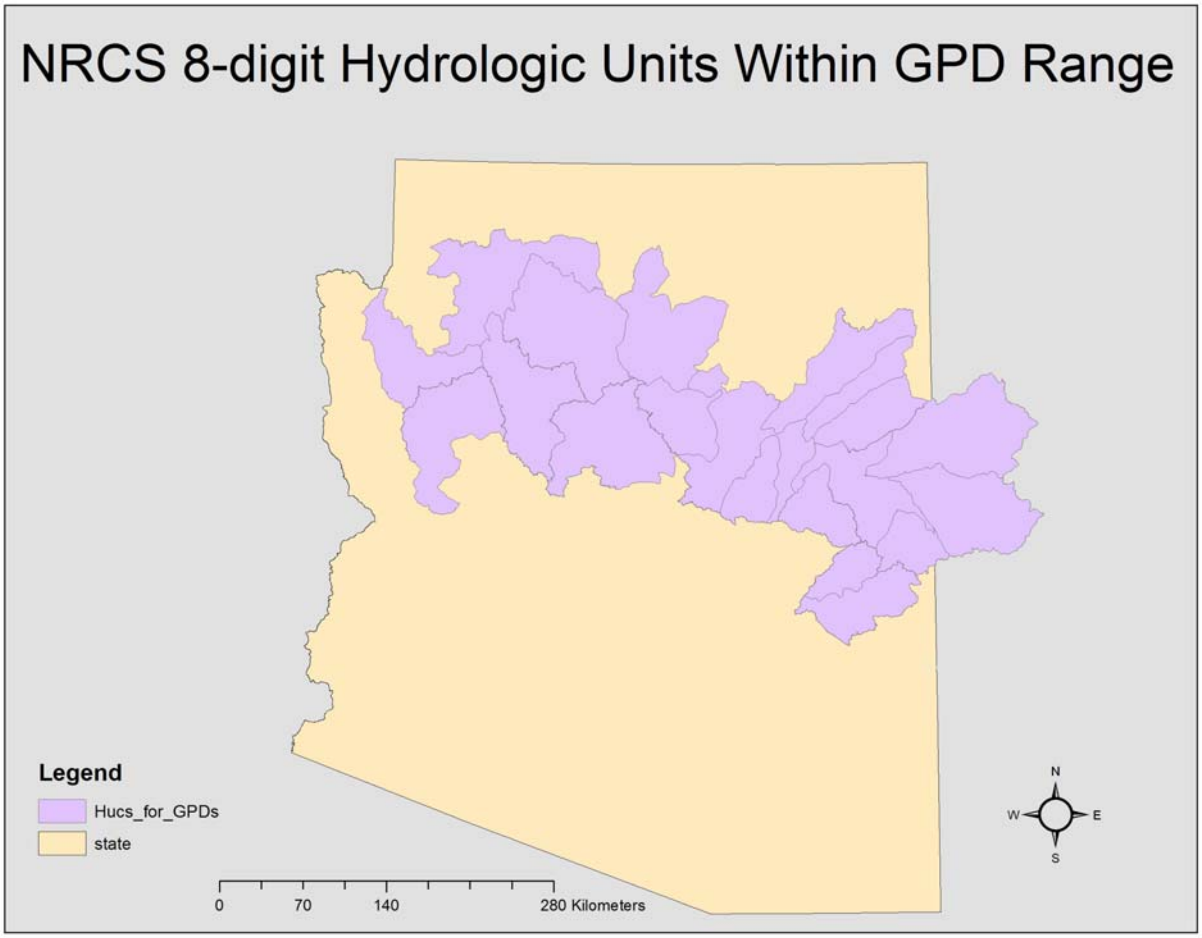

Table 1. Gunnison's prairie dog hunt data for Arizona, USA (2000-2006).

Year	Estimated number of GPDs killed	Estimated number of hunters	Estimated number of hunter days	Estimated number of GPDs per hunter day
2000	92593	3859	35208	3
2001	76691	2255	8463	9
2002	30814	2447	7380	4
2003	37659	2047	9509	4
2004	54117	2167	7409	7.3
2005	93229	2794	21378	4
2006	40477	1719	8454	4.8

LITERATURE CITED

Agnew, W., D.W. Uresk, and R.M. Hansen. 1986. Flora and fauna associated with prairie dog colonies and adjacent ungrazed mixed-grass prairie in western South Dakota. J. of Range Management 39:135-139.

Antolin, M.F., P. Gober, B. Luce, D.E. Biggins, W.E. Van Pelt, D.B. Seery, M. Lockhart, and M. Ball. 2002. The influence of sylvatic plague on North American wildlife at the landscape level, with special emphasis on black-footed ferret and prairie dog conservation. Transactions of the North American Wildlife and Natural Resource Conference 67: 104-127.

Arizona Department of Health Services (ADHS). 1993. Plague surveillance. Bacterial Zoonoses Branch, Division of Vector-Borne Infectious Diseases, National Center for Infectious Diseases, Centers for Disease Control and Prevention. 5(1):1-21.

Arizona Game and Fish Department. 2006. Arizona's Comprehensive Wildlife Conservation Strategy: 2005-2015. Arizona Game and Fish Department, Phoenix, Arizona.

Arizona Game and Fish Department. In prep. Wildlife of special concern in Arizona. Nongame and Endangered Wildlife Program, Arizona Game and Fish Department, Phoenix, Arizona. 40pp.

Bahre, C.J. 1991. Legacy of change historic human impact on vegetation in the Arizona borderlands. Tucson: The University of Arizona Press.

Bangert, R.K., and C.N. Slobodchikoff. 2000. The Gunnison's prairie dog structures high desert grassland as a keystone engineer. Journal of Arid Environments, 46: 357-369.

Barnes, A.M. 1982. Surveillance and control of bubonic plague in the United States. Symp. Zool. Soc. Lond. 50:237-270.

Barnes, A.M. 1993. A review of plague and its relevance to prairie dog populations and the black-footed ferret *in* J.L. Oldemeyer, D.E. Biggins, B.J. Miller, and R. Crete, editors. Proceedings of the symposium on the management of prairie dog complexes for the reintroduction of the black-footed ferret. Biological Report 13. July 1993. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Washington, D.C.

Beck, E.W. 1994. The effect of resource availability on the activity of white-tailed prairie dogs. M.S. thesis. Utah State University, Logan, Utah.

Beier P. and T. Bayless. 2006. Assessment of Gunnison's prairie dog colonies and their association with burrowing owls and mountain plovers in northeast Arizona plains grasslands. Unpublished report to Arizona Game and Fish. Northern Arizona University, Flagstaff, AZ.

Bell, W.B. 1921. Death to the rodents. Pages 421-438 *in* United States Department of Agriculture Yearbook 1920. Government Printing Office, Washington.

Biggins, D.E., B.J. Miller, L.R. Hanebury, B. Oakleaf, A.H. Farmer, R. Creete, and A. Dood. 1989. A system for evaluating black-footed ferret habitat. Report prepared for the Black-footed Ferret Interstate Coordinating Committee.

Biggins, D.E., B.J. Miller, L. Hanebury, R. Oakleaf, A. Farmer, R. Crete, and A. Dodd. 1993. A technique for evaluating black-footed ferret habitat. Pp. 73-88 *in* J.L. Oldemeyer, D.E. Biggins, and B.J. Miller, eds., Management of prairie dog complexes for the reintroduction of the black-footed ferret. USDI, U.S. Fish and Wildlife Service, Washington, D.C. 96pp.

Biggins, D.E. and M.Y. Kosoy. 2001a. Influences of introduced plague on North American mammals: implications from ecology of plague in Asia. Journal of Mammalogy 82(4):906-916.

Biggins, D.E. and M.Y. Kosoy. 2001b. Disruptions of ecosystems in western North America due to invasion by plague. Pages 21-23 *in* Conservation Biology of Ground Squirrels and the Shrub-steppe Ecosystem. Proceedings of the Symposium, Idaho Academy of Sciences, Caldwell, Idaho.

Brown, D.E., R.L. Todd, and S.H. Levy. 1974. Proposal for the reintroduction of the black-tailed prairie dog into Arizona. Unpublished Arizona Game and Fish Department Report, Phoenix, Arizona.

Carr, J.F. 1973. A rancher's view towards prairie dogs. Pp. 168-170 *in* R.L. Linder and C.N. Hillman, eds., Proceedings of the black-footed ferret and prairie dog workshop. South Dakota State University, Brookings, South Dakota. 208pp.

Clark, T.W., R.S. Hoffmann, and C.F. Nadler. 1971. *Cynomys leucurus*. Mammalian Species, 7:1-4.

Clark, T.W. 1977. Ecology and ethology of the white-tailed prairie dog. Milwaukee Public Museum Publications in Biology and Geology 3. Milwaukee Public Museum, Milwaukee, Wisconsin.

Clark, T.W. 1986. Some guidelines for management of the black-footed ferret. Great Basin Naturalist Memoirs, 8:160-168.

Clark, T.W. 1989. Conservation biology of the black-footed ferret, *Mustela nigripes*. Wildlife Preservation Trust Special Scientific Report No. 3. Wildlife Preservation Trust International, Philadelphia.

Coffeen, M.P. and Pederson, J.C. 1993. Techniques for the transplant of Utah prairie dogs. Pages 60-66 *in* J. L. Oldemeyer, D. E. Biggins, and B. J. Miller, editors. Proceedings of the symposium on the management of prairie dog complexes for the reintroduction of the black-footed ferret. U.S. Fish and Wildlife Service Biological Report 13. July 1993. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Washington, D.C.

Collier, G.D. 1975. The Utah prairie dog: abundance, distribution, and habitat requirements. Utah Division of Wildlife Resources Pub. No. 75-10., Salt Lake City, Utah.

Collier, G.D. and J.J. Spillett. 1975. Factors influencing the distribution of the Utah prairie dog. *Cynomys parvidens*. Southwest Nat. 20:151-158.

Colorado Division of Wildlife, Bureau of Land Management, U.S. Fish and Wildlife Service. 2002. Prairie dog recreational shooting and black-footed ferret recovery in northwest Colorado.

Conover, M.R. and D.J. Decker. 1991. Wildlife damage to crops: perceptions of agricultural and wildlife professionals in 1957 and 1987. Wildl. Soc. Bull. 19(1) 46-52.

Cooke, L. 1993. The role of life history traits in the evolution of sociality in the white-tailed prairie dog (*Cynomys leucurus*). Final Report to Arapaho National Wildlife Refuge, Walden, Colorado. Department of Biology, College of the Holy Cross, Worchester, Massachusetts.

Coppock, D.L., J.K. Detling, J.E. Ellis, and M.I. Dyer. 1983a. Plant-herbivore interactions in a North American mixed-grass prairie I. Effects of black-tailed prairie dogs on intraseasonal aboveground plant biomass and nutrient dynamics and plant species diversity. Oecologia 56:1-9.

Coppock, D.L., J.E. Ellis, J.K. Detling, and M.I. Dyer. 1983b. Plant-herbivore interactions in a North American mixed-grass prairie II. Responses of bison to modification of vegetation by prairie dogs. Oecologia 56:10-15.

Crawford J.A., Olson R.A., West N.E., Mosley J.C., Schroeder M.A., Whitson T.D., Miller R.F., Gregg M.A., and C.S. Boyd. 2004. Synthesis Paper - Ecology and management of sage-grouse and sage-grouse habitat. Journal of Range Management 57: 2-19

Crocker-Bedford, D.C. 1976. Food interaction between Utah prairie dogs and cattle. M.S. Thesis.

Utah State University, Logan, Utah.

Crocker-Bedford, D.C. and J.J. Spillett. 1981. Habitat relationships of the Utah prairie dog. Pub. No. 1981-0-677-202/4. U.S. Dept. of Agric., Forest Service, Intermountain Region, Ogden, Utah.

Cully, J.F., Jr. 1989. Plague in prairie dog ecosystems: importance for black-footed ferret management *in* The Prairie Dog Ecosystem: Managing for Biological Diversity. Eds. Tim W. Clark, Dan Hinckley, and Terrell Rich. Billings, MT: BLM.

Cully, J.F., A. M. Barnes, T.J. Quan, and G. Maupin. 1997. Dynamics of plague in a Gunnison's prairie dog colony complex from New Mexico. Journal of Wildlife Diseases, 33(4):706-719.

Cully, J.F. and E.S. Williams. 2001. Interspecific comparisons of sylvatic plague in prairie dogs. Journal of Mammalogy, 82(4): 894-905.

Davidson, A.D., R.R. Parmenter, and J.R. Gosz. 1999. Responses of small mammals and vegetation to a reintroduction of Gunnison's prairie dogs. Journal of Mammalogy, 80(4): 1311-1324.

Desmond, M.J., J.A. Savidge, and K.M. Eskridge. 2000. Correlations between burrowing owl and black-tailed prairie dog declines: a 7-year analysis. J. of Wildl. Manag. 64:1067-1075.

Ecke, D.H. and C.W. Johnson. 1952. Plague in Colorado and Texas. Public Health Monograph No. 6.

Fitzgerald, J.P., and R.R. Lechleitner. 1974. Observations on the biology of Gunnison's prairie dogs in central Colorado. American Midland Naturalist, 92:146-163.

Fitzgerald, J.P., C.A. Meaney, and D.M. Armstrong. 1994. Mammals of Colorado. Denver, CO: Denver Museum of Natural History and University Press of Colorado.

Fleischner, T.L. 1994. Ecological costs of livestock grazing in western North America. Conservation Biology, 8: 629-644.

Forest Guardians. 2004. Petition to the U.S. Fish and Wildlife Service to list the Gunnison's prairie dog as and endangered or threatened species under the Endangered Species Act, 16U.S.C. § 1531 et Seq. (1973 as amended), and to designate critical habitat. In the office of Endangered Species, USFWS, USDI.

Forrest, S.C. 2002. A summary of prairie dog poisoning in the Western United States, 1914-1964, based on Records at the U.S. National Archives, Washington, D.C. Draft report prepared for U.S. Fish and Wildlife Service.

Foster, N.S. and S.E. Hygnstrom. 1990. Prairie dogs and their ecosystem. University of Nebraska, Lincoln. Dept. of Forestry, Fisheries and Wildlife. 8pp.

Girard, J.M., D.M. Wagner, A.J. Vogler, C. Keys, C.J. Allender, L.C. Drickamer, and P. Keim. 2004. Differential plague-transmission dynamics determine *Yersinia pestis* population genetic structure on local, regional, and global scales. PNAS. 101(22):8408-8413.

Goodwin, T.H. 1995. Pliocene-Pleistocene biogeographic history of prairie dogs, genus Cynomys (Sciuridae). Journal of Mammalogy, 76(1):100-122.

Gordon, K.M., K.C. Keffer, and S.H. Anderson. 2003. Impacts of recreational shooting on black-tailed prairie dog behavior, population, and physiology. Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming, Laramie, Wyoming.

Grant, J.H. 1995. Dispersal, activity, and behavior of white-tailed prairie dogs. M.S. Thesis, Dept. of Zoology and Physiology, University of Wyoming, Laramie.

Hafner, D.J., B.R. Riddle, and T. Jeskova. 2005. Phylogeography of white-tailed prairie dogs *Cynomys gunnisoni*: Implications for subspecific recognition of *C. G. gunnisoni*. Unpublished report

Harlow, H.J. and G.E. Menkens Jr. 1986. A comparison of hibernation in the black tailed prairie dog, white-tailed prairie dog, and Wyoming ground squirrel. Canadian Journal of Zoology, 64: 793-796.

Haynie, M.L., R.A. Van Den Busche, J.L. Hoogland, and D.A. Gilbert. 2003. Parentage, multiple paternity, and breeding success in Gunnison's and Utah prairie dogs. Journal of Mammalogy, 84(4):1244-1253.

Heller, G.L. 1991. The dynamics of plague in a white-tailed prairie dog complex in Wyoming. M. S. thesis. University of Wyoming, Laramie, Wyoming.

Hoffmeister, D.F. 1986. Mammals of Arizona. Arizona Game and Fish Department and University of Arizona Press, Tucson. 276 pp.

Hollister, N. 1916. A systematic account of the prairie dogs. N. American Fauna 40:1-256.

Hoogland, J.L. 1981. The evolution of coloniality in white-tailed and black-tailed prairie dogs (Sciuridae: *Cynomys leucurus* and *C. ludovicianus*). Ecology 62:252-272.

Hoogland, J.L. 1995. The black-tailed prairie dog: social life of a burrowing mammal. University of

Chicago Press, Chicago, Illinois. 557pp.

Hoogland, J.L. 1996. Gunnison's prairie dog. Mammalian Species Account. American Society of Mammalogists.

Hoogland, J.L. 1997. Duration of gestation and lactation for Gunnison's prairie dogs. Journal of Mammalogy, 78(1):173-180.

Hoogland, J.L. 1998. Why do female Gunnison's prairie dogs copulate with more than one male? Animal Behavior. 55:351-359.

Hoogland, J.L. 1999. Philopatry, dispersal, and social organization of Gunnison's prairie dogs. Journal of Mammalogy, 80(1):243-251.

Hoogland, J.L. 2001. Black-tailed, Gunnison's, and Utah prairie dogs reproduce slowly. Journal of Mammalogy 82(4):917-927.

Hoogland, J.L. 2003. Sexual dimorphism of prairie dogs. Journal of Mammalogy, 84(4):1254-1266.

King, J.A. 1955. Social behavior, social organization, and population dynamics in a black-tailed prairie dog town in the Black Hills of South Dakota. Contributions from the Laboratory of Vertebrate Biology, University of Michigan 67:1-123.

Knowles, C.J. 1988. An evaluation of shooting and habitat alteration for control of black-tailed prairie dogs. Pages 53-56 *in* D.W. Uresk, G.L. Schenbeck, and R. Cefkin, eds. Eighth Great Plains wildlife damage control workshop proceedings. 28-30 April 1987, Rapid City, South Dakota. USDA Forest Service General Technical Report RM-154. 231 pp.

Knowles, C.J. and P.R. Knowles. 1994. A review of black-tailed prairie dog literature in relation to rangelands administered by the Custer National Forest. USDA Custer National Forest, Billings, MT.

Knowles, C.J. 2002. Status of white-tailed and Gunnison's prairie dogs. National Wildlife Federation, Missoula, MT and Environmental Defense, Washington, D.C. 30 pp.

Koford, C.B. 1958. Prairie dogs, whitefaces and blue gramma. Wildl. Monogr. 3. 78pp.

Kotliar, N.B., B.W. Baker, A.D. Whicker, and G. Plumb. 1999. A critical review of assumptions about the prairie dog as a keystone species. Environ. Management 24:177-192.

Kotliar, N.B. 2000. Application of the new keystone-species concept to prairie dogs: how well does it work? Conservation Biol. 14:1715-1721.

Krueger, K. 1986. Feeding relationships among bison, pronghorn, and prairie dogs: an experimental analysis. Ecol. 67:760-770.

Lawlor, T.E. 1979. Handbook to the orders and families of living mammals. Mad River Press, Eureka, California.

Lechleitner, R.R., J.V. Tileston, and L. Kartman. 1962. Die-off of a Gunnison's prairie dog colony in central Colorado. Ecological observations and description of the epizootic. Zoonoses Research, 1:185-199.

Lechleitner, R.R., L. Kartman, M.I. Goldenberg, and B.W. Hudson. 1968. An epizootic of plague in Gunnison's prairie dogs (*Cynomys gunnisoni*) in south-central Colorado. Ecology, 49(4):734-743.

Lincoln, R.J. and G.A. Boxshall. 1987. The Cambridge illustrated dictionary of Natural History. Cambridge University Press, Cambridge. 413pp.

Longhurst, W. 1944. Observations on the ecology of the Gunnison prairie dog in Colorado. Journal of Mammalogy, 25:24-36.

Lorance, A.E., M. Purkiss, and R. Diswood. 2002. Prairie dog habitat survey. Cooperative effort by San Juan College and the Bureau of Land Management.

Lowe, C.H., C.R. Schwalbe, and T.B. Johnson. 1986. The venomous reptiles of Arizona. Arizona Game and Fish Department, Phoenix. 115pp.

McDonald, K.P. 1992. Analysis of the Utah prairie dog recovery program, 1972-1992. Utah Division of Wildlife Resources, Cedar City, Utah.

Menkens, G.E., Jr. and S.H. Anderson. 1989. Temporal-spatial variation in white-tailed prairie dog demography and life histories in Wyoming. Canadian Journal of Zoology, 67:343-349.

Merriam, C.H. 1902. The prairie dog of the Great Plains. Pp. 257-270 in Yearbook of the U.S. Department of Agriculture 1901.

Miller, B., G. Ceballos, and R. Reading. 1994. The prairie dog and biotic diversity. Cons. Biol. 8:677-681.

Monson, G. and A.R. Phillips. 1981. Annotated checklist of the birds of Arizona. Second Edition. The University of Arizona Press, Tucson. 240pp.

Navajo Natural Heritage Program. 1996. Survey and evaluation of Gunnison's prairie dog. Arizona Game and Fish Department Report 31 December 1996.

Norris, J.J. 1950. Effects of rodents, rabbits, and cattle, on two vegetation types in semi-desert range. New Mexico Agric. Exp. Sta. Bull.

Oakes, C.L. 2000. History and consequence of keystone mammal eradication in the desert grasslands: the Arizona black-tailed prairie dog. Ph.D. Thesis. The University of Texas, Austin. 392pp.

Oldemeyer, J.L., D.E. Biggins, B.J. Miller, and R. Crete, editors. 1993. Proceedings of the symposium on the management of prairie dog complexes for the reintroduction of the black-footed ferret. Biological Report 13. July 1993. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Washington, D.C.

O'Meilia, M.E., F.L. Knopf, and J.C. Lewis. 1982. Some consequences of competition between prairie dogs and beef cattle. J. Range Manage. 35:580-585.

Osborn, B. 1942. Prairie dogs in shinnery (oak scrub) savannah. Ecology, 23:110-115.

Osborn, B., and P.F. Allen. 1949. Vegetation of an abandoned prairie dog town in tall grass prairie. Ecology, 30:322-332.

Parmenter, R.R., E.P. Yadav, C.A. Parmenter, P. Ettestad, and K.L. Gage. 1999. Incidence of plague associated with increased winter-spring precipitation in New Mexico. Amer. J. Trop. Med. Hyg. 61:814-821.

Pauli, J.N. 2005. Ecological studies of the black-tailed prairie dog (*Cynomys ludovicianus*): implications for biology and conservation. M.S., Department of Zoology and Physiology, University of Wyoming.

Pizzimenti, J.J. and R.S. Hoffman. 1973. *Cynomys gunnisoni*. Mammalian Species No. 25: 1-4.

Pizzimenti, J.J. 1975. Evolution of the prairie dog genus *Cynomys*. Occ. Papers, Mus. Nat. Hist. Univ. Kansas 39:1-73.

Power, M.E., D. Tilman, J.A. Estes, B.A. Menge, W.J. Bond, L.S. Mills, G. Daily, J.C. Castilla, J. Lubchenco, and R.T. Paine. 1996. Challenges in the quest for keystones. BioScience 466:9-20.

Randazzo, R. 1998. Prairie dog distribution on the Peaks and Mormon Lake Ranger Districts, Arizona 1998. NAU Environmental Science Department. 44 pp.

Rayor, L.S. 1985. Dynamics of a plague outbreak in Gunnison's prairie dog. Journal of Mammalogy, 66(1):194-196.

Rayor, L.S. 1988. Social organization and space-use in Gunnison's prairie dog. Behavioral Ecology and Sociobiology, 22:69-78.

Roach, J.L., P. Stapp, B. Van Horne, and M.F. Antolin. 2001. Genetic structure of a metapopulation of black-tailed prairie dogs. Journal of Mammalogy, 82:946-959.

Roemer, D.M. and S. Forrest. 1996. Prairie dog poisoning in Northern Great Plains: an analysis of programs and policies. Environmental Management, 20(3):349-359

Ruffner, G.A. 1980. A survey of black-footed ferret habitat on selected national forest lands in Arizona and New Mexico. Submitted to the U.S. Forest Service, 23 April 1980. 73 pp. + 1 map.

Santa Fe. 2001. City of Santa Fe, New Mexico Ordinance: 2001-35 Accessed May 2007 http://www.prairiedogcoalition.org/new-mexico-ordinance.php

Schmidt-Nielsen, K. and B. Schmidt-Nielsen. 1952. Water metabolism of desert mammals. Physiological Review, 32:135-166.

Seglund, A.E., A.E. Ernst, M. Grenier, B. Luce, A. Puchniak, and P. Schnurr. 2005. White-tailed prairie dog conservation assessment. Western Association of Fish and Wildlife Agencies, Laramie Wyoming. Unpublished Report. 138 pp.

Seglund, A.E., A.E. Ernst, and D.M. O'Neill. 2005. Gunnison's prairie dog conservation assessment. Western Association of Fish and Wildlife Agencies. Laramie, Wyoming. Unpublished Report. 87 pp.

Shalaway, S. and C.N. Slobodchikoff. 1988. Seasonal changes in the diet of Gunnison's prairie dog. Journal of Mammalogy, 69(4): 835-841.

Slobodchikoff, C.N. 1984. Resources and the evolution of social behavior. *in* A New Ecology: Novel Approaches to Interactive Systems. Editors. P. W. Price, C.N. Slobodchikoff, and W.S. Gaud. John Wiley & Sons, Inc.

Slobodchikoff, C.N., A. Robinson, and C. Schaack. 1988. Habitat use by Gunnison's prairie dogs. Paper presented at symposium, Management of Amphibians, Reptiles, and Small Mammals in North America. (Flagstaff, AZ, July 19-21, 1988).

Slobodchikoff, C.N. 2003. Communication and sociality in Gunnison's prairie dogs. Colorado Prairie Dog Technical Conference. February 25-27, 2003. Fort Collins, CO.

Smith, R.E. 1958. Natural history of the prairie dog in Kansas. Museum Natural History and State Biological Survey, University of Kansas Museum Natl. Hist. Misc. Publ. 16.

Soulé, M.E., J.A. Estes, J. Berger, and C. Martinez Del Rios. 2003. Ecological Effectiveness: Conservation Goals for Interactive Species. Conservation Biology 17(5):1238-1250.

Soulé, M.E., J.A. Estes, B. Miller, and D.L. Honnold. 2005. Strongly Interactive Species: Conservation, Policy, Management, and Ethics. BioScience 55(2):168-176.

Stockrahm, D.M. and R.W. Seabloom. 1988. Comparative reproductive performance of black-tailed prairie dog populations in North Dakota. Journal of Mammalogy, 69:160-164.

Travis, S.E., C.N. Slobodchikoff, and P. Keim. 1995. Ecological and demographic effects on intraspecific variation in the social system of prairie dogs. Ecology, 76(6):1794-1803.

Travis, S.E., C.N. Slobodchikoff, and P. Keim. 1996. Social assemblages and mating relationships in prairie dogs: a DNA fingerprint analysis. Behavioral Ecology, 7(1):95-100.

Turner, G.G. 2001. Recovery of Utah and Gunnison's prairie dog colonies following epizootics of sylvatic plague. M.S. Thesis, Frostburg State University, Frostburg, Maryland.

Uresk, D.W. and D.B. Paulson. 1988. Estimated carrying capacity for cattle competing with prairie dogs and forage utilization in western South Dakota. Pp. 387-390 in Symposium on management of amphibians, reptiles, and small mammals in North America, Flagstaff, Arizona, July 19-21, 1988. GTR RM-166. U.S. Forest Service, Washington, D.C.

U.S. Fish and Wildlife Service (USFWS). 1990. Guidelines for oil and gas activities in prairie dog ecosystems managed for black-footed ferret recovery. Draft Document. Denver Regional Office, Colorado.

U.S. Fish and Wildlife Service (USFWS). 2006. 90-day finding on a petition to list the Gunnison's prairie dog as threatened or endangered. Federal Register, February 7, 2006. Vol. 71, No. 25, Pages 6241-6248.

Van Pelt, W.E. 1995. Assessment of potential black-footed ferret habitat in northern Arizona. Nongame and Endangered Wildlife Program Technical Report 79. Arizona Game and Fish Department, Phoenix, Arizona.

Van Pelt, W.E. 1999. The black-tailed prairie dog conservation assessment and strategy. Arizona Game and Fish Department, Phoenix, Arizona. 55pp.

Van Pelt, W.E., A. Averill-Murray, and T.K. Snow. 2001. DRAFT Interagency Management Plan for Black-tailed Prairie Dogs in Arizona. Nongame and Endangered Wildlife Program. Arizona Game and Fish Department, Phoenix, Arizona.

Van Pelt, W.E. and R.A. Winstead. 2003. Review of black-footed ferret reintroduction in Arizona, 1996-2001. Nongame and Endangered Wildlife Program Technical Report 222. Arizona Game and Fish Department, Phoenix, Arizona.

Vorhies, C.T. 1945. Water requirements of desert animals in the southwest. University of Arizona Agricultural Experiment Station Technical Bulletin, 107:487-525.

Vosburgh, T.C. and L.R. Irby. 1998. Effects of recreational shooting on prairie dog colonies. Journal of Wildlife Management, 62(1):363-372.

Vosburgh, T.C. 1999. Impacts of recreational shooting of prairie dogs on Fort Belknap Reservation i*n* Vosburgh, T. and R. Stoneberg, 1999 Annual Report. Black-footed Ferret Recovery Activities on Fort Belknap Reservation. Unpublished Report.

Wagner, D.M. and L.C. Drickamer. 2003. Distribution, habitat use, and plague in Gunnison's prairie dogs in Arizona. Arizona Game and Fish Department, Heritage Grant I20009.

Weltzin, J.F., S. Archer, and R.K. Heitschmidt. 1997. Small-mammal regulation of vegetation structure in a temperate savanna. Ecology 78:751-763.

Western Association of Fish and Wildlife Agencies (WAFWA). 2006. White-tailed prairie dog and Gunnison's prairie dog conservation strategy. Western Association of Fish and Wildlife Agencies. Laramie, Wyoming. Unpublished Report. 23 pp.

Western Association of Fish and Wildlife Agencies (WAFWA). 2007. Gunnison's prairie dog conservation plan: addendum to the white-tailed and Gunnison's prairie dog conservation strategy. Western Association of Fish and Wildlife Agencies. Laramie, Wyoming. Unpublished Report. 39 pp

Whicker, A.D. and J.K. Detling. 1988. Ecological consequences of prairie dog disturbances. BioScience 38:778-785.

Williams, J.E., M.A. Moussa and D.C. Cavanaugh. 1979. Experimental plague in the California ground squirrel. Journal of Infectious Diseases 140:618-621.

Wuerthner, G. 1997. Viewpoint: the black-tailed prairie dog- headed for extinction? J. of Range Management 50: 459-466.

Western Association of Fish and Wildlife Agencies (WAFWA). 2006. White-tailed prairie dog and Gunnison's prairie dog conservation strategy. Western Association of Fish and Wildlife Agencies. Laramie, Wyoming. Unpublished Report. 23 pp.

Western Association of Fish and Wildlife Agencies (WAFWA). 2007. Gunnison's prairie dog conservation plan: addendum to the white-tailed and Gunnison's prairie dog conservation strategy. Western Association of Fish and Wildlife Agencies. Laramie, Wyoming. Unpublished Report. 39 pp.

Wright-Smith, M.A. 1978. The ecology and social organization of *Cynomys parvidens* (Utah prairie dog) in south central Utah. M.A. Thesis. Indiana University, Bloomington, Indiana.

Yarchin, J.C., G.C. Dickens, R.L. Glinski, and R.B. Spicer. 1988. An investigation of prairie dog populations and associated sensitive predators in the Little Colorado River Basin. Report for the U.S. Bureau of Land Management, May 15, 1988.

APPENDIX I. VERTEBRATE SPECIES DEPENDENT ON PRAIRIE DOGS

(Adapted from Kotliar et al. (1999)).

Species	Status and Distribution in Arizona
Prairie Dog-Associated Species*:	
Black-footed Ferret (*Mustela nigripes*)	Endangered; extirpated from state and re-established into Aubrey Valley near Seligman, AZ. Historic range probably from western Coconino County eastward, north of Mogollon Rim, potentially south of the Rim in Graham and Cochise counties[1]
Mountain Plover (*Charadrius montanus*)	Candidate species; very local breeder in small numbers near Springerville, AZ[2]
Burrowing Owl (*Athene cunicularia*)	Numbers may be decreasing; found sparingly throughout AZ[3]
Golden Eagle (*Aquila chrysaetos*)	Fairly common in mountainous areas throughout state[3]
Ferruginous Hawk (*Buteo regalis*)	Species of Special Concern[4], breeding population only; uncommon and widely distributed summer resident of northern AZ and irregular summer resident in southeastern AZ, fairly common in winter in southern part of state[3]
Horned Lark (*Eremophila alpestris*)	Common in open grassland and farmland throughout state[3]
Deer Mouse (*Peromyscus maniculatus*)	Common and widely distributed throughout AZ except arid desert and some southern oak woodlands[1]
N. Grasshopper Mouse (*Onychomys leucogaster*)	Common and distributed across Northern AZ & south of Mogollon Plateau from near Gila River south through Cochise County[1]
Swift Fox (*Vulpes velox*)	Former Candidate Sp., not found in Arizona[1]

*These species are dependent on prairie dogs to varying degrees.
[1] Hoffmeister 1986
[2] Arizona Breeding Bird Atlas 2005.
[3] Monson and Phillips 1981
[4] The Arizona Game and Fish Department maintains a list of Wildlife of Special Concern in Arizona, which includes species whose occurrence in Arizona is, or may be, in jeopardy due to population declines and habitat loss/destruction. Inclusion on this list affords no special legal status for the species (AGFD, in prep).
[5] Lowe et al. 1986

APPENDIX II. GUNNISON'S PRAIRIE DOG POTENTIAL HABITAT

From: http://fws-mcfwru.nmsu.edu/swregap/habitatreview/TextModels/180184.pdf

*Modifications to the "Relationships" made for the Arizona model are italicized.

Southwest Regional Gap Analysis Wildlife Habitat Relationship

ID 433 **Model Name** SWReGAP 180184

Taxa code (ITIS) 180184

Common Name Gunnison's prairie dog

Scientific Name *Cynomys gunnisoni*

Created By spropeck **Date** 11/24/2002 8:59:34 P

Model Description

Final SWReGAP Model: GUNNISON'S PRAIRIE DOG (*Cynomys gunnisoni*), includes previous data from Colorado GAP, New Mexico GAP, Utah GAP, and NatureServe.

Background -C. gunnisoni lives in shortgrass and midgrass prairies and grass-shrub habitats with an herbaceous understory (Thompson et al. 1996, New Mexico Department of Game and Fish 2000). It also inhabits open meadows and brushlands of high mountain valleys and plateaus, Great Basin sagebrush, Great Basin rabbitbrush and winterfat, montane grassland, (Thompson et al. 1996, New Mexico Department of Game and Fish 2000). PNV-The species prefers sloping grounds over the edges of meadows and scattered juniper and pines, and it does not occur where black-tailed prairie dogs occur (Thompson et al. 1996). The species is found in grama "short-grass" and mixed "short-grass (Stinnett 1981). It is also found in the mixed shrub habitat dominated by broom snakeweed, which also includes rubber rabbitbrush and fourwing saltbush interspersed with sparse stands of big sagebrush (New Mexico Department of Game and Fish 2000). The species occasionally occurs in spruce-fir, Douglas-fir - white fir, ponderosa pine, bristle-cone - limber pine, mountain scrub, big bluestem, sand bluestem, tobosa, sacaton, Apache plume, mesquite, and agriculture (New Mexico Department of Game and Fish 2000). It occurs in pinyon, one-seed juniper, big sagebrush, and rubber rabbitbrush, sideoats, wheatgrass, galleta -

ricegrass, alkali sacaton, and black grama (Thompson et al. 1996, New Mexico Department of Game and Fish 2000).

C. gunnisoni's diet consists mostly of grasses and sedges (Fitzgerald et al. 1994). Food items include grama grass (Bouteloua oligostachya), false buffalograss (Munroa squarrosa), wild sunflowers (Verbesina encelioides), borages, goosefoot, pigweed, lupine, dandelions, mustards, fescues, June-grass, muhly, rushes, paintbrush, senecio, chiming bells, prairies sage, big sage, and rabbitbrush (Fitzgerald et al. 1994, Bailey 1971). Free water is not required (Fitzgerald et al. 1994). The elevation is from 305 to 3659m (Thompson et al. 1996). The maximum slope this species occurs on is 20% (Earnst 2004), or 18 degrees. Gunnison's prairie dog occurs south of the Colorado River across northern Arizona (Hoffmeister 1986, Wagner and Drickamer 2004). It occurs in western and southern Colorado (Fitzgerald et al. 1994). The species is found in northwest New Mexico (Findley et al. 1975). In Utah it ocurs in the southeast (Durrant 1952).

In Arizona, the species stays below ground during the coldest parts of winter but it is not known if they hibernate (New Mexico Department of Game and Fish2000). If the temperature is warm early in the year it emerges; if the temperature is cold through late spring it emerges late (New Mexico Department of Game and Fish 2000). The presence of colonies is inversely related to the amount of rock cover (Wagner and Drickamer 2004). The average surface rock cover in Arizona at colonies is 6.33%, and the average soil depth is 1.05m (Wagner and Drickamer 2004). Can be found in the following mountain ranges: Lukachukai Mountains; Cochetopa Hills; Sangre de Christo Mountains; San Juan Mountains; Jemez Mountains; Gallinas Mountains; Mogollon Mountains; Sandia Mountains; Zuni Mountains; Datil Mountains; Chuska Mountains; Mogollon -In Arizona, the species stays below ground during the coldest parts of winter but it is not known if they hibernate (New Mexico Department of Game and Fish 2000). If the temperature is warm early in the year it emerges; if the temperature is cold through late spring it emerges late (New Mexico Department of Game and Fish 2000). The presence of colonies is inversely related to the amount of rock cover (Wagner and Drickamer 2004). The average surface rock cover in Arizona at colonies is 6.33%, and the average soil depth is 1.05m (Wagner and Drickamer 2004). Can be found in the following mountain ranges: Lukachukai Mountains; Cochetopa Hills; Sangre de Christo Mountains; San Juan Mountains; Jemez Mountains; Gallinas Mountains; Mogollon Mountains; Sandia Mountains; Zuni Mountains; Datil Mountains; Chuska Mountains; Mogollon Mountains

Description Changes Removal of landcover class "Inter-Mountain Basins Greasewood Flat"; Land Cover- Added: 96, 14, 47, 56, 59, 75, 86, 231, 311- Removed: 12 based on review from the New Mexico Department of Game and Fish review 2004; Removal of all aspects and landcover classes "Southern Rocky Mountain Pinyon- Juniper Woodland," "Colorado Plateau Pinyon-Juniper Woodland," "Madrean Pinyon-Juniper Woodland." Removal of several watersheds in Arizona (Wagner and Drickamer 2004). Added land cover classes 38 and 39 (NM CWCS Review 2005).

Relationships

Slope Min *0-10 degrees*

Elevation *1200-4000 m*

Precipitation n/a

Temperature n/a

Landform n/a

Aspect n/a

Distance to Water n/a

Soil associations n/a

Soil Depth n/a

Ecological System
S013 Inter-Mountain Basins Volcanic Rock and Cinder Land
S014 Inter-Mountain Basins Wash
S038 Southern Rocky Mountain Pinyon-Juniper Woodland
S039 Colorado Plateau Pinyon-Juniper Woodland
S047 Rocky Mountain Lower Montane-Foothill Shrubland
S054 Inter-Mountain Basins Big Sagebrush Shrubland
S055 Great Basin Xeric Mixed Sagebrush Shrubland
S056 Colorado Plateau Mixed Low Sagebrush Shrubland
S058 Apacherian-Chihuahuan Mesquite Upland Scrub
S059 Colorado Plateau Blackbrush-Mormon Tea Shrubland
S060 Mojave Mid-Elevation Mixed Desert Scrub
S065 Inter-Mountain Basins Mixed Salt Desert Scrub
S070 Sonora-Mojave Desert Mixed Salt Desert Scrub
S071 Inter-Mountain Basins Montane Sagebrush Steppe
S074 Southern Rocky Mountain Juniper Woodland and Savanna
S075 Inter-Mountain Basins Juniper Savanna
S078 Inter-Mountain Basins Big Sagebrush Steppe
S079 Inter-Mountain Basins Semi-Desert Shrub Steppe
S086 Western Great Plains Foothill and Piedmont Grassland
S087 Central Mixedgrass Prairie
S096 Inter-Mountain Basins Greasewood Flat

S116 Chihuahuan Mixed Salt Desert Scrub
S120 Western Great Plains Floodplain Herbaceous Wetland
S138 Western Great Plains Mesquite Woodland and Shrubland
N31 Barren Lands
D11 Recently Chained Pinyon-Juniper Areas

Ecological Systems used for Arizona
Inter-Mountain Basins Big Sagebrush Shrubland
Great Basin Xeric Mixed Sagebrush Shrubland
Colorado Plateau Mixed Low Sagebrush Shrubland
Inter-Mountain Basins Mixed Salt Desert Scrub
Inter-Mountain Basins Montane Sagebrush Steppe
Southern Rocky Mountain Juniper Woodland and Savanna
Inter-Mountain Basins Juniper Savanna
Apacherian-Chihuahuan Piedmont Semi-Desert Grassland and Steppe
Inter-Mountain Basins Big Sagebrush Steppe
Inter-Mountain Basins Semi-Desert Shrub Steppe
Southern Rocky Mountain Montane-Subalpine Grassland
Inter-Mountain Basins Semi-Desert Grassland
Southern Colorado Plateau Sand Shrubland
Developed, Open Space - Low Intensity
Developed, Medium - High Intensity
Barren Lands, Non-specific
Invasive Perennial Grassland
Invasive Perennial Forbland
Invasive Annual and Biennial Forbland
Recently Chained Pinyon-Juniper Areas

Citations

Thompson, B. C., P. J. Crist, J. S. Prior-Magee, R. A. Deitner, D. L. Garber, and M. A. Hughes 1996 Gap analysis of biological diversity conservation in New Mexico using geographic information systems Research Completion Report, New Mexico Cooperative Fish and Wildlife Research Unit, Las Cruces

New Mexico Department of Game and Fish 2002 Biota Information System of New Mexico. New Mexico Department of Game and Fish electronic database, BISON, Version January 2002, Santa Fe, New Mexico http://nmnhp.unm.edu/bisonm/bisonquery.php. Accessed on 25 August 2003

Fitzgerald, J.P., C. A. Meaney, and D. M. Armstrong 1994 Mammals of Colorado Denver

Museum of Natural History and University Press of Colorado, Niwot, Colorado. 467 pages

Cockrum, E. L 1960 The recent mammals of Arizona: Their taxonomy and distribution. The University of Arizona Press, Tucson, Arizona. 276 Pages

Stinnett, S. S 1981 Food habits and effects of Gunnison's, Zuni, and black-tailed prairie dogs on plant communities in New Mexico New Mexico State University, Las Cruces. 138 pages

Bailey, Vernon 1971 Mammals of the southwestern United States Dover Publications, Inc., New York, New York. 412 pages

Zeveloff, Samuel I 1988 Mammals of the intermountain west University of Utah Press, Salt Lake City, Utah. 365 pages

Pizzimenti, J. J., and R. S. Hoffman 1973 Cynomys gunnisoni Mammalian Species 25:1-4

Frey, J. K. and T. L. Yates 1996 Mammalian Diversity in New Mexico New Mexico Journal of Science36:4-37 Wednesday, August 10, 2005 Page 3 of 4

Hoffmeister, D.F 1986 Mammals of Arizona The University of Arizona Press and the Arizona Game and Fish Department, Tucson, Arizona. 602 pages

Findley, J. S., A. H. Harris, D. E. Wilson, and C. Jones 1975 Mammals of New Mexico University of New Mexico, Albuquerque, New Mexico. 360 pages

Earnst, Andrea 2004 Personal communication

Wagner, D. M., and L. C. Drickamer 2004 Abiotic habitat correlates of Gunnison's prairie dog in Arizona Journal of Wildlife Management 68 (1): 188-197

Durrant, S.D. 1952 Mammals of Utah: taxonomy and distribution. University of Kansas, Museum of Natural History 6: 1-549.

New Mexico Department of Game and Fish 2005 NM CWCS Review

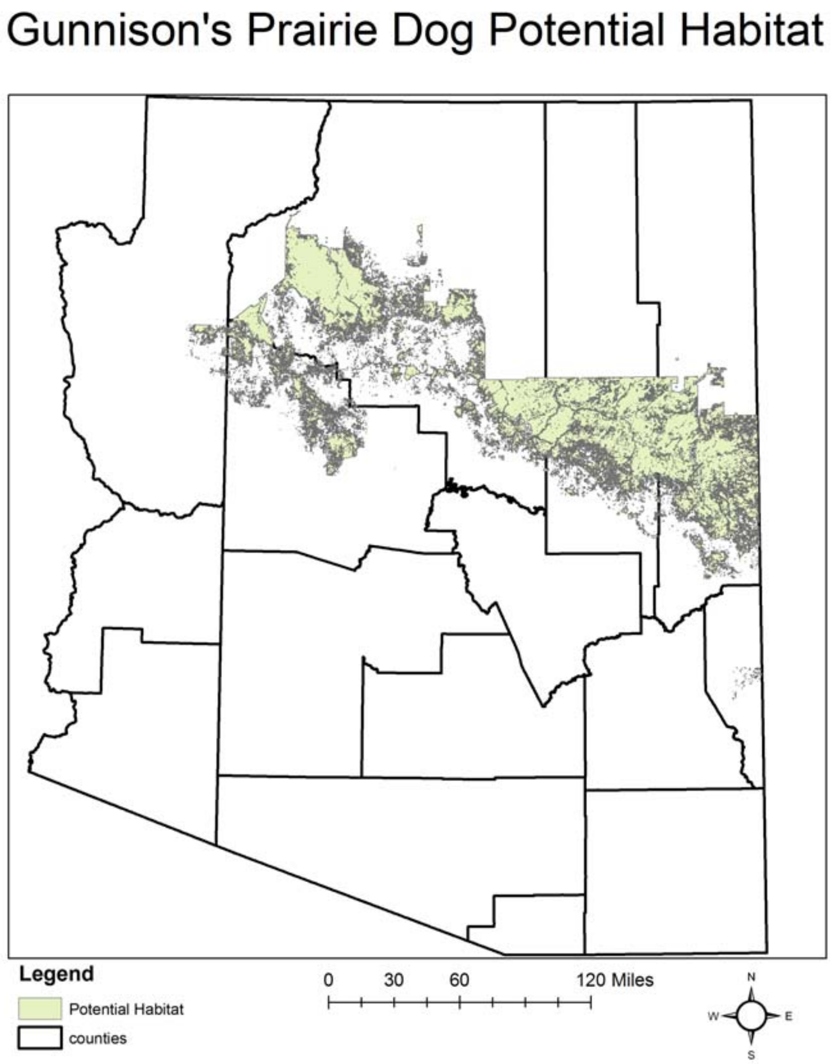

Figure 1: Map of potential Gunnison's prairie dog habitat, excluding tribal lands, for the state of Arizona, USA.

Table 1: Ownership of Gunnison's prairie dog potential habitat, excluding tribal lands, in Arizona, USA.

	BLM	FS	Other	National Parks	Private	State	Total
Potential Acres	197,590	345,411	27,880	105,658	2,879,904	1,670,606	5,227,049
% of Potential	3.78%	6.61%	0.53%	2.02%	55.10%	31.96%	100.00%

APPENDIX III. GUNNISON'S PRAIRIE DOG PRIORITY ACTIONS FROM CWCS

Gunnison's Prairie Dog (*Cynomys gunnisoni*)

Category: Abiotic resource use — ***Priority***
Stressor: Drilling for fuels — Medium
- Encourage design of extractive operations that minimizes disturbance to wildlife.

Category: Changes in Ecological Processes — ***Priority***
Stressor: Habitat degradation/shrub invasions — Medium
- Use integrated management activities in concert to address nuisance plants.
- Restore natural fire regimes (frequency, intensity, and mosaic distribution) to improve wildlife habitat.

Stressor: Habitat fragmentation/barriers — Medium
- Acquire land to protect important habitat and wildlife corridors.
- Acquire land or conservation easements on portions of rangeland critical to wildlife.
- Acquire land or conservation easements to protect key conservation areas.

Category: Climate Change — ***Priority***
Stressor: Drought — High
- Promote adjustment of livestock management practices during droughts to ensure sufficient forage for wildlife.

Category: Consumptive use of biological resources — ***Priority***
Stressor: Grazing by ungulates — Medium
- Disseminate information to partners on effects of grazing on resources.
- Protect sensitive habitats from excessive grazing.
- Acquire land or conservation easements on portions of rangeland critical to wildlife.
- Develop and implement livestock and big game management guidelines that minimize habitat degradation while maintaining stock ponds where appropriate.
- Work cooperatively with landowners/permittees by providing financial and technical assistance (thru incentive programs) to conservation projects.

Stressor: Harvesting/collecting animals — Medium
- Increase enforcement of existing laws pertaining to the illegal harvest of wildlife.
- Develop harvest guidelines for sensitive species to minimize impacts to important life stages (breeding, raising young, etc.).

Category: Habitat conversion — ***Priority***
Stressor: Agricultural conversion — Medium
- Acquire land or conservation easements to protect key conservation areas.
- Mitigate habitat loss from agricultural conversion and/or urban/rural development.

Stressor: Livestock management — High
- Protect sensitive habitats from excessive grazing.
- Develop and implement livestock and big game management guidelines that minimize habitat degradation while maintaining stock ponds where appropriate.

- Work cooperatively with landowners/permittees by providing financial and technical assistance (thru incentive programs) to conservation projects.

Stressor: Rural development High

- Acquire land or conservation easements to protect key conservation areas.
- Work with city and county planners to promote in-fill development and limit urban/rural sprawl.
- Identify key conservation areas to protect from development.

Stressor: Urban growth High

- Acquire land or conservation easements to protect key conservation areas.
- Identify key conservation areas to protect from development.

Category: Invasive species ***Priority***

Stressor: Disease/pathogens/parasites High

- Pursue projects to limit spread of disease to sensitive wildlife populations.
- Collaborate with partners on disease/pathogen/parasite issues to protect wildlife.

Stressor: Nuisance plants Medium

- Adopt national standards and efforts to reduce and control nuisance species.
- Revegetate disturbed areas with native plants.

Category: Non-consumptive resource use ***Priority***

Stressor: Off-range recreational shooting Medium

- Develop harvest guidelines for sensitive species to minimize impacts to important life stages (breeding, raising young, etc.).

APPENDIX IV. GUNNISON'S PRAIRIE DOG MONITORING PROTOCOL

Prepared by

Dr. William F. Andelt
Department of Fish, Wildlife, and Conservation Biology
Colorado State University
Fort Collins, CO 80523
Ph: 970-491-7093
email: billan@warnercnr.colostate.edu

and

Amy E. Seglund
Colorado Division of Wildlife
Wildlife Conservation Section
Southwest Region Service Center
2300 South Townsend
Montrose, CO 81401
Ph: 970-252-6014
email: amy.seglund@state.co.us

Prepared for

WTPD and GUPD Working Group

February 2007

Introduction

The White-tailed (*Cynomys leucurus*; WTPD) and Gunnison's Prairie Dog (*C. gunnisoni*; GUPD) Conservation Plan (WAFWA 2007) required the development and use of an objective, repeatable estimation technique to measure the response of WTPD and GUPD populations to factors affecting their viability. Techniques used to evaluate prairie dog populations have relied on delineating colony boundaries based on burrow distribution. However, WTPD and GUPD colony boundaries can be difficult to map with distribution and activity levels within boundaries extremely variable. The end result of mapping is therefore a subjective effort by investigators who rely on their best estimate by using topographic features or breaks in habitats to delineate boundaries. In addition, individual burrow activity is not assessed, resulting in both active and inactive areas included in estimates of occupied habitat. The consequence of mapping both active and inactive areas is an inaccurate estimation of occupied habitat.

In 2002, Colorado embarked on an effort to develop an objective technique to monitor WTPD and GUPD populations. Aerial surveys using the line intercept methodology had been developed for estimating occupied area by black-tailed prairie dogs (*C. ludovicianus*). Thus this was the first method investigated to determine if it could be successfully used for WTPD and GUPD. After conducting a pilot study, it was determined that the line intercept methodology significantly overestimated the lengths of GUPD and WTPD colonies compared to lengths measured on the ground. In addition, the proportions of lengths of prairie dog colonies detected by aerial crews were only weakly correlated; the crews did not consistently report finding prairie dogs in the same areas along transects. Due to the lack of correlation between aerial and ground crews, the line intercept methodology was abandoned as a viable technique to monitor WTPD and GUPD populations.

After abandoning the use of the line intercept methodology, Colorado investigated using Occupancy Modeling (MacKenzie et al. 2002) as an objective technique to monitor WTPD and GUPD. Unlike acreage estimates, measures of statistical precision and confidence intervals could be calculated for occupancy estimates. Currently Colorado is implementing Occupancy Modeling for both WTPD and GUPD within in the state. Colorado has completed one year of surveys in 2004 for WTPD and in 2005 for GUPD. Results from the surveys found WTPD occupying 24.1% (SE = 12.8) of 47,710 0.25-km^2 plots and GUPD occupying 7.5% (SE = 1.3) of 158,225 0.25-km^2 plots (Andelt et al. 2005).

Occupancy surveys have the potential to be a successful tool for establishing baseline occupancy rates for WTPD and GUPD in order to monitor changes in occupancy through time (Andelt et al. 2005, 2006a, 2006b). This manuscript was prepared to standardize occupancy surveys throughout the range of both the GUPD and WTPD. All states within the range of these species have agreed, in the Multi-state Conservation Plans, to implement an occupancy approach to monitor range-wide WTPD and GUPD population trends.

Range-wide Methodology for Occupancy Sampling for WTPD and GUPD

Defining Sampling Areas: Occupancy will be estimated by sampling 0.25 km^2 (0.5 km per side) quadrats. Quadrats will be randomly selected within each state boundary in areas designated as suitable WTPD and GUPD habitat. This defined area of inference within states will remain constant throughout the duration of the monitoring effort. In addition, the quadrats randomly selected to be sampled will not change unless all quadrats are disposed of and a new set of quadrats are randomly selected from the area of inference.

Suitable habitat does not necessarily mean that the habitat is occupied, rather it is defined as suitable or potentially suitable based on variables designated by a state as necessary for prairie dog colonization. States need not define their areas of inference in the same manner in order to conduct a range-wide occupancy survey. It is only necessary that the states develop the most accurate area of inference from the best available data. The area of inference may include tribal lands if the state is given permission to sample these lands, however they should be placed in a different strata since the permission to sample these lands may be removed at any time.

States may wish to include the use of stratification. Stratification is useful for:

- Interest in occupancy at subdivisions smaller than the whole state or range
- Logistical convenience (ability to sample an entire stratum quickly and with similar methods)
- Need for different methods in different areas (some strata may be more easily sampled from the ground versus the air, some strata may have very good information on prairie dog locations)
- Variance reduction (individual strata with uniform occupancy rates will increase precision)

States however do not need to stratify and in addition, stratification does not need to be the same within each state boundary in order to conduct a range-wide occupancy approach.

Below is a description of how Colorado developed their area of inference and selected quadrats to sample for both WTPD and GUPD.

Colorado - Protocol for Developing Base Maps to Overlay Quadrats

Methods

WTPD: Development of Maps and Sampling Areas: Field personnel from the Colorado Division of Wildlife, Forest Service, and the Bureau of Land Management mapped colonies of active (prairie dogs present during the last ± 3 years), inactive (prairie dogs occurred in the area in the past but were not recently present) and unknown (prairie dogs had been active but current status was unknown) WTPD colonies on 1:50,000 US Geological Survey County maps in the summer of 2002 (Colorado Division of Wildlife 2002). These data, in addition to data on the overall range of WTPD areas were input into a GIS database by Colorado Division of Wildlife personnel. The final product included active, inactive, and unknown colonies, and the overall range of white-tailed prairie dogs in each county on 11 x 17-inch (28 x 43-cm) colored topographic maps which contained an overlay of township, range, and sections. County extension agents, weed and pest supervisors, and Natural Resources Conservation Service, USDA Forest Service, Bureau of Land Management, and CDOW personnel reviewed and updated the sampling frame (Figure 1).

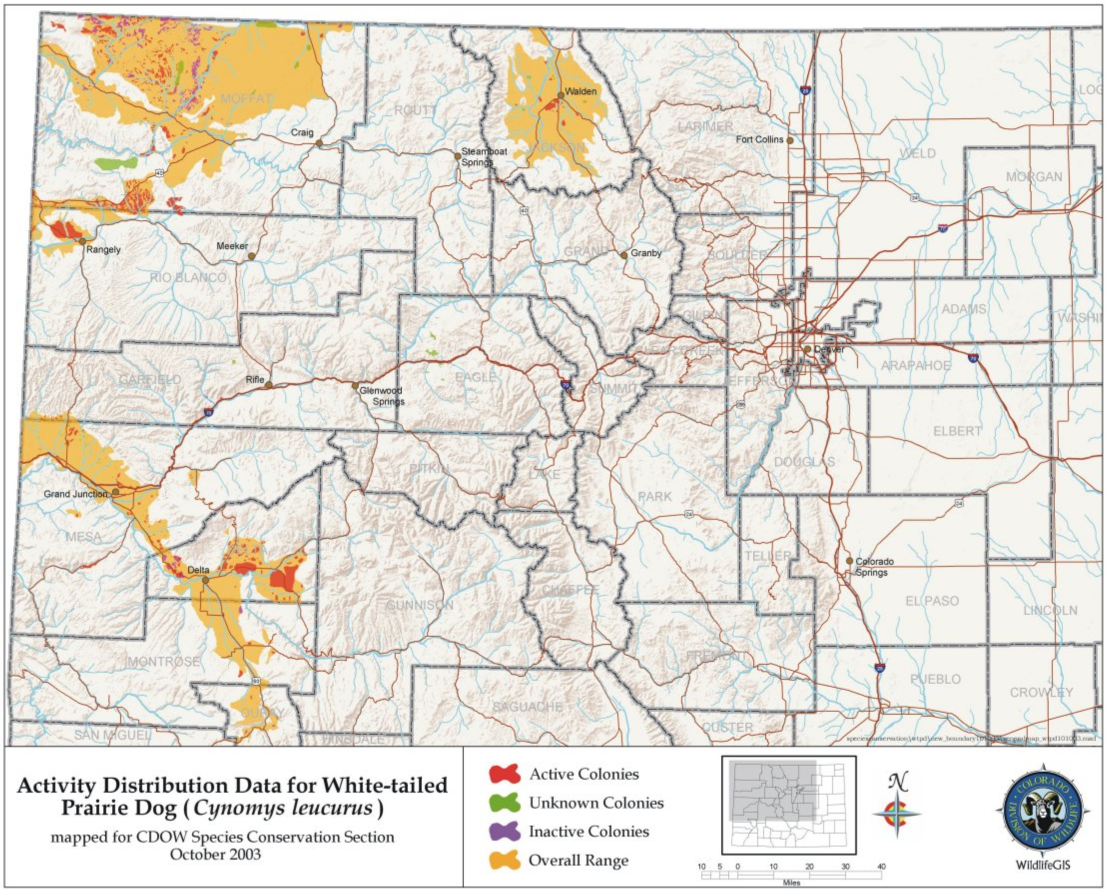

Figure 1. Range of white-tailed prairie dogs in Colorado. Three primary sampling strata consisted of Moffat and Rio Blanco counties, Eagle, Grand, Jackson, Larimer, and Routt counties, and Delta, Garfield, Mesa, Montrose, and Ouray counties.

WTPD: Selection of Quadrats: The range of WTPD in Colorado was overlaid with 1,640 x 1,640 feet (500 x 500 m) quadrats in ArcInfo using the NAD27 datum and the Zone 13 projection. Quadrats were eliminated if they occurred above 10,000 feet (3,048 m) elevation (using the 30 m digital elevation model), were on slopes >30°, or were in vegetation where WTPD do not occur. A sampling frame of 47,710 quadrats was established from which a stratified random sample of 318 quadrats was selected from 10 strata (Table 1). Three general areas were sampled: Grand Junction (GJ), North Park (NP), and Northwest (NW). Quadrats in GJ and NW were classified a priori based on Colorado Division of Wildlife GIS layers as active, inactive, unknown, or other. Quadrats in NP were classified as either unknown (active, inactive, unknown) or other. The number of quadrats in each stratum was optimized based upon our a priori estimates of the probability (active = 0.9, unknown = 0.5, inactive = 0.1, and other = 0.05) of WTPDs being present within quadrats.

Table 1. Stratification for the sample of 318 quadrats from 10 strata of the WTPD occupancy survey in northwestern Colorado.

Strata	Stratum Population	Stratum Sample
GJ Active	1,963	20
GJ Inactive	170	12
GJ Other	11,654	55
GJ Unknown	523	9
NP Other	7,442	35
NP Unknown	462	7
NW Active	4,237	53
NW Inactive	1,278	23
NW Other	19,289	96
NW Unknown	692	8
Total	47,710	318

GUPD: Sampling Areas and Selection of Quadrats: A sampling area for GUPD was established preliminary from range maps in Armstrong (1972) and Fitzgerald et al. (1994). However, the sampling area was expanded by including areas in north-central Archuleta County, north-west El Paso County, and extreme north-east San Miguel County where colonies of GUPD were reported or where they were believed to possibly occur (Colorado Division of Wildlife 2002). Delta County, the northeastern portion of Montrose County, and the northern half of Ouray County were eliminated from the sampling area because prairie dogs in these areas are WTPD (P. M. Schnurr, Colorado Division of Wildlife, personal communication). This modified range was input in a GIS database by personnel from the Colorado Division of Wildlife. Seven strata (Figure 1) were developed based upon the overall ranges (Armstrong 1972, Fitzgerald et al. 1994) of the *zuniensis* subspecies (Ute Mountain Ute Indian Reservation, Southern Ute Indian Reservation, and remaining areas [South-West]), and the *gunnisoni* subspecies (Gunnison Valley, San Luis Valley, South Park, and South-East), and geography of Colorado. The Continental divide and other mountain ridges usually separated strata.

Longhurst (1944) reported that GUPD are probably limited to 10,000 feet (3,048 m) in elevation however, in areas with warm air currents they may be found at slightly higher elevations. Pizzimenti and Hoffman (1973) and Fitzgerald et al. (1994) reported that GUPD range in elevation from 6,000–12,000 feet (1,830 to 3,660 m) across their range. Several professionals (J. Ferguson, Bureau of Land Management; M. Threlkeld, Colorado Department of Agriculture; J. A. Capodice, Bureau of Land Management [retired]; and J. F. Cully, Kansas State University; personal communications), familiar with Gunnison's prairie dogs in Colorado, indicated that they generally are not found above 10,000 feet (3,048 m) elevation.

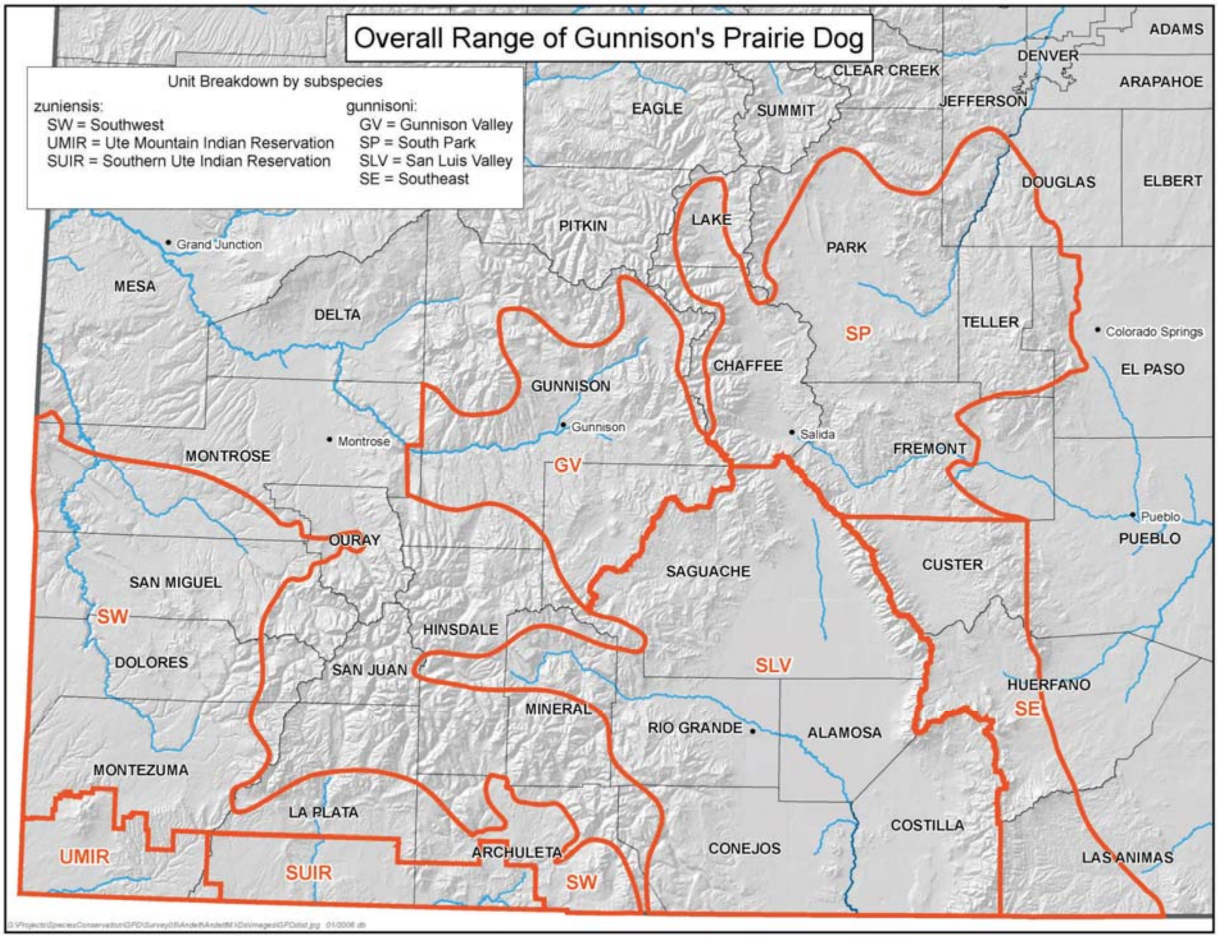

Figure 1. Strata used for sampling Gunnison's prairie dogs in Colorado during 2005.

GUPD have been described as inhabiting grasslands (Travis and Slobodchikoff 1993, Travis et al. 1997, Bangert and Slobodchikoff 2000, Perla and Slobodchikoff 2002, Girard et al. 2004), grasslands and shrub-grasslands (Cully 1997), grasslands to montane meadows (Findley et al. 1975), mountain grasslands (Lechleitner et al. 1962), valley floors to higher meadows (Longhurst 1944), and alpine meadows (Perla and Slobodchikoff 2002). The above articles and the expertise of 3 professionals (J. Ferguson, Bureau of Land Management; J. A. Capodice, Bureau of Land Management [retired]; and A. E. Seglund, Utah Division of Wildlife Resources; personal communications), familiar with GUPD, was used to further refine vegetation cover types contained in the Basin Wide Geographic Information System (GIS) as potentially occupied or unoccupied by GUPD in Colorado (Appendix 1). In addition, since GUPD are generally not found on slopes >15% (Fitzgerald and Lechleitner 1974; Lorance et al. 2002 [cited by Seglund et al. 2005]; Yazzie and Sanders 2003 [cited by Seglund et al. 2005]; J. Ferguson, Bureau of Land Management; M. Threlkeld, Colorado Department of Agriculture; J. A. Capodice, Bureau of Land Management [retired]; and J. F. Cully, Kansas State University; personal communications) a slope layer was added to better depict the suitable habitat. The overall range of GUPD in Colorado (Figure 1) was overlaid with 1,640 x 1,640 feet (500 x 500 m) square quadrats and the Basin Wide vegetation cover types in ArcInfo (ESRI, Redlands, California) using the NAD27 datum and the Zone 13 projection. Quadrats were eliminated if all areas within quadrats were above 10,000 feet (3,048 m) elevation (30 m digital elevation model), were on slopes <15%, or were in vegetation types where GUPD are not known to occur.

Three hundred and eighty-one quadrats were randomly selected from within 7 strata where occurrence of GUPD likely varied. The number of quadrats in each stratum were optimized (Table 2) based upon a priori estimates of the probability of GUPD occurrence within quadrats (W. F. Andelt, unpublished data) using the methods described in Thompson et al. (1998). Permission to visit quadrats on the Ute Mountain Ute Indian Reservation early in the sampling process was denied. Thus, this stratum was dropped from the survey, and the original sample size was reduced to 361 quadrats.

Table 2. A priori estimates of probability of occurrence of GUPD in quadrats, number of quadrats available for sampling, optimal allocation of the sampling effort, and actual numbers of quadrats sampled for each of 7 strata in Colorado during 2005.

Strata (*h*)	Estimated Probability of occurrence	Quadrats Available (U_h)	Optimal Allocation of Quadrats to Sample	Quadrats Sampled (u_h)
Gunnison Valley	0.03	14,178	20	20
South-East	0.03	15,543	21	21
San Luis Valley	0.05	47,143	83	83
South Park	0.05	27,297	48	47
Southern Ute Indian Reservation	0.25	9,823	34	34
Ute Mountain Ute Indian Reservation	0.10	7,600	20	0
South-West	0.25	44,241	155	153
Totals		165,826	381	358

Sampling of Quadrats
To locate quadrats on the ground, UTM locations of the 4-corners of a quadrat will be downloaded from ArcInfo shape files into GPS units. In addition, topographic maps (11 x 17 inch (28 x 43-cm) and land management maps (1:100,000) showing the location of quadrats will be provided to observers to assist in locating quadrats.

Quadrats will be visited 2 times during periods when prairie dogs are most active. For Colorado, these activity periods run from late March through mid-July for WTPD and late March through mid to late August for GUPD. Other states seasonal duration of sampling may differ due to elevation and latitudinal differences. Two visits to quadrats will be attempted to determine the detection probability however, limitations due to personnel, funding, and weather may result in areas being surveyed a single time. States will prioritize non-detection sites for revisit and those sites with a positive detection on the first visit as a lower priority for a second visit.

Two visits to a quadrat must be completed within 7 days so as to minimize violating the assumption of a closed population. To avoid observer bias and minimize possible independence violations (more likely to redetect a species once it has been detected due to prior knowledge), different observers should visit the quadrat on each of the two occasions. However, if only one technician is hired to conduct surveys, it is recommended that a supervisor or second observer visit a subset of the plots. Quadrats should be sampled unless winds are greater than 23 mi/hour or there is moderate to heavy rainfall.

Visual observations of a prairie dog are the only acceptable method that counts as a positive detection. Because auditory detections are hard to pinpoint with regards to exact location of the calling animal, this type of detection cannot be used since detections need to be confirmed within a quadrat. Scat samples are also not acceptable as the age of the scat is too difficult to pinpoint without an in depth analysis.

After arriving at a quadrat corner, if an observer detects a prairie dog they do not need to visit all four corners of the plot. If the observer arrives and no prairie dogs are detected in the quadrat, they must conduct 5 minute observations at each of the four corners of the plot until they detect a prairie dog or until all four corners have been visited. If as walking between corners a prairie dog is detected you can discontinue the survey of that plot.

Data recorded for each study quadrat will include the name of the individual conducting the sampling, date, quadrat number, time spent at quadrat, and UTM coordinates of the southwest corner of the quadrat (Appendix 2). At each plot, the observer will record air temperature and wind speed averaged over 10 seconds.

During sampling of quadrats, observations of other important species such as ferruginous hawks (*Buteo regalis*), burrowing owls (*Athene cunicularia*), Mountain plovers (*Charadrius montanus*) and kit fox (*Vulpes macrotis*) can be recorded. Note that private landowners in Colorado were not informed that information on the occurrence of these species were to be collected beforehand. Some landowners later expressed concern about this oversight. We recommend that data collection be limited only to those species that landowners have specifically approved.

Estimating Occupancy of WTPD or GUPD Quadrats from Aircraft

To locate quadrats from the air, a GPS unit will be attached to a laptop computer that contains an appropriate mapping program. The coordinates for the 4 corners of each grid quadrat are entered in the program and overlaid on a topographic map. The track function can be used to show the position of the airplane relative to each quadrat and saved for later reference. The airplane is flown at an elevation of about 100 m above ground and 3 passes spaced across each quadrat are completed. The pilot and observer both watch for prairie dogs.

Statistical Analyses

Data will be input into an access database and the analysis will be conducted by Colorado. Occupancy models (MacKenzie et al. 2002) will be fit to the observed encounter histories for WTPD and GUPD with program MARK (White and Burnham 1999) with model selection by information-theoretic methods (Burnham and Anderson 2002). MacKenzie et al.'s model estimates the probability of detection (*p*) during a single visit and the probability of occupancy (Ψ) based on multiple visits to quadrats. Thus, this model corrects for "false negatives", i.e., quadrats where no prairie dogs are observed, but where prairie dogs actually exist. The logit link will be used in all models to relate covariates to detection and occupancy probabilities.

Quadrat-specific covariates that will be collected to improve the estimate of occupancy probability for each quadrat include: average temperature, wind speed, starting time, and Julian date. Elevation of the quadrat and elevation squared have been incorporated as covariates to improve prediction of occupancy rates for WTPD and GUPD in Colorado and will be included in the range-wide sampling effort. If states wish to include additional covariates that they think may improve the estimate of occupancy probability they can include them in their data collection efforts.

Occupancy estimation for entire sampling frame in Colorado: Model selection results placed almost all weight on one model for both WTPD and GUPD, so model averaging was not required. However, quadrat-specific covariates greatly improved prediction of occupancy rates for both species, so a complex procedure was required to estimate occupancy rates for all quadrats in the sampling frame. For the minimum AICc model with *r* quadrat-specific covariates, the fitted model was

$$\hat{\psi}_i = \frac{\exp\left(\sum_{k=0}^{r} \hat{\beta}_k x_{ki}\right)}{1 + \exp\left(\sum_{k=0}^{r} \hat{\beta}_k x_{ki}\right)} ,$$

where the *r* covariate values for observation i are x_{1i}, x_{2i}, …, x_{ri}, and $x_{0i} = 1$. The estimates from Program MARK are the intercept ($\hat{\beta}_0$) and *r* slope parameters ($\hat{\beta}_1$, $\hat{\beta}_2$, …, $\hat{\beta}_r$). The number of quadrats estimated to be occupied in stratum $h = 1,\ldots,H$ (H = 6 for GUPD, 10 for WTPD) with the minimum AICc model that included *r* covariates was computed as the sum of the estimated probability of occupancy of each quadrat, $\hat{N}_h = \sum_{i=1}^{U_h} \hat{\psi}_i$, where U_h is the number of quadrats in the population of stratum *h*. The total number of occupied quadrats for all strata was estimated as $\hat{N} = \sum_{h=1}^{H} \hat{N}_h$. The variance of $\hat{N}_h$ was estimated as the sum of the estimated variance-covariance matrix of the $\hat{\psi}_i$, $i = 1,\ldots,U_h$, where

$$\hat{\text{Var}}(\hat{\psi}_i) = \left[\hat{\psi}_i(1-\hat{\psi}_i)\right]^2 \left[\sum_{k=0}^{r} x_{ki}{}^2 \hat{\text{Var}}(\hat{\beta}_k) + \sum_{k'=0,k'<k}^{k-1} 2x_{ki}x_{k'i}\hat{\text{Cov}}(\hat{\beta}_k, \hat{\beta}_{k'}) \right] ,$$

and

$$\hat{\text{Cov}}(\hat{\psi}_i, \hat{\psi}_j) = \hat{\psi}_i(1-\hat{\psi}_i)\hat{\psi}_j(1-\hat{\psi}_j) \left[\sum_{k=0}^{r} x_{ki}x_{kj} \hat{\text{Var}}(\hat{\beta}_k) + \sum_{k'=0,k'<k}^{k-1} (x_{ki}x_{k'j} + x_{kj}x_{k'i})\hat{\text{Cov}}(\hat{\beta}_k, \hat{\beta}_{k'}) \right]$$

where Var(.) indicates the variance of the enclosed estimator, and Cov(.,.) indicates the covariance of the 2 enclosed estimators. Thus,

$$\hat{\text{Var}}(\hat{N}_h) = \sum_{i=1}^{U_h} \hat{\text{Var}}(\hat{\psi}_i) + 2 \sum_{j=1, j<i}^{i-1} \hat{\text{Cov}}(\hat{\psi}_i, \hat{\psi}_j) .$$

The covariance of pairs of $\hat{\psi}_i$ estimates, when they occur in strata h and h' ($h \neq h'$), was also computed with the above covariance estimator formula, but indicator variables were used to adjust for different intercepts between the 2 strata. The covariance between pairs of $\hat{\psi}_i$ estimates, when they occur in strata h and h' ($h \neq h'$), was needed to compute the covariance of the $\hat{N}_h = \sum_{i=1}^{U_h} \hat{\psi}_i$ between the 6 or 10 strata. For GUPD strata where the Division of Wildlife Range covariate was not available, the x_{1i} or x_{1j} covariate value was taken as zero, and the formula reduces properly to the correct covariance. These formulae are different than those presented in Bowden et al. (2003) because they used a covariate to predict an estimated population size using a ratio estimator with correlated estimates, whereas our covariates are used to estimate directly the correlated estimates of occupancy rate.

Miscellaneous

Equipment: Equipment needed to conduct surveys may include all of the following: clipboards, waterproof pens, topographic maps, compasses, GPS units, battery chargers and rechargeable batteries, 10-power binoculars, backpacks, high lift jacks, tow chains, shovels, jumper cables, quadrat corner stakes, fluorescent red paint for corner stakes, hammers, thermometers, appropriate windspeed and temperature meters (i.e., Speedtech Instruments, Great Falls, Virginia), phone cards, and first aid kits.

Establishing Ownership of Quadrats: Plot ownership can be established by contacting County Assessor web sites and offices, reviewing plat books, and by contacting adjacent landowners. Contact information for lessees of State Land Board lands can be obtained from the State Land Board. Data sheets need to contain the plot number, owners name, address, and telephone number. The observer should record each phone call made to the landowner and special instructions such as need to notify a lessee shortly before visiting the land, access thru locked gates, and if the owner desires a copy of the final report. If information on species other than prairie dogs is desired, landowners should be asked for permission to collect that data.

Informing Cooperators: Inform anyone who may be affected by surveys including Extension Agents, County Sheriffs, Bureau of Land Management, U.S. Forest Service, Division of Wildlife, Division of Parks and Outdoor Recreation, National Park Service, National Wildlife Refuges, State Land Board, The Nature Conservancy, Native American tribes, Natural Resources Conservation Service, and USDA/APHIS Wildlife Services.

Liability Issues: Some private landowners may be concerned about their liability for observers while they are on the landowner's property. In Colorado, our legal advisors believe that a landowner's liability to persons on their land would be covered under provisions of Section 13-21-115 of the Colorado Revised Statutes. Observers should be considered a "licensee" on private property. A landowner can only be found liable to a licensee if he/she fails in his/her duty owed to that other person as that duty is described in the statute. The statute limits the landowner's risk of liability, and should provide adequate protection to a landowner under normal circumstances.

GUNNISON PRAIRIE DOG OCCUPANCY SURVEY DATA FORM

OBSERVER ____________________ **DATE** _____________ **PLOT NUMBER** __________
STATE ____Arizona________ **STRATUM** ______Region________________________

UTM LOCATION OF THE SOUTHWEST CORNER OF PLOT **NAD** ___27__ **Zone** _12___

Easting:_____________________ **Northing:**________________________

ELEVATION OF PLOT USING GPS UNIT:_______________________
VISIT: First _______ **Second** ________
TIME START OBSERVATION _____________ **TOTAL TIME ON PLOT** _____________
TIME END OBSERVATION _____________

PRAIRIE DOGS VISUALLY OBSERVED: **YES** **NO**

PRAIRIE DOG BURROWS PRESENT: **YES** **NO**

PRAIRIE DOG SCAT OBSERVED: **YES** **NO**

MID –SURVEY:
TEMP: _____ **% CLOUD COVER:** _______ **PRECIP:**_______ **WIND SPEED:** _______

HABITAT TYPE (CIRCLE ALL IN PLOT) **GRASSLAND** **SHRUBLAND** **WOODLAND**

BURROWING OWLS ON PLOT: **YES** **NO**
NUMBER OBSERVED: ADULT _____________ **JUVENILE** _____________
NEST LOCATED **YES** **NO**

FERRUGINOUS HAWKS ON PLOT: **YES** **NO**
NUMBER OBSERVED: ADULT _____________ **JUVENILE** _____________
NEST LOCATED **YES** **NO**

GOLDEN EAGLES OBSERVED: **YES** **NO**
NUMBER OBSERVED: ADULT _____________ **JUVENILE** _____________
NEST LOCATED **YES** **NO**

OTHER OBSERVATIONS: Please note whether the scat looks fresh or old, whether burrows appear to be abandoned or in use, any observations of prairie dogs or their sign off the plot and percentage of plot occupied by prairie dogs. Also note any other species observed (birds, mammals, reptiles).

Literature cited

Andelt, W. F., G. C. White, and K. Navo. 2006a. Occupancy of random quadrats by Gunnison's prairie dogs in Colorado. Final Report, Colorado Division of Wildlife, Denver, Colorado, USA.

Andelt, W. F., G. C. White, P. M. Schnurr, and T. C. Kinsell. 2005. Occupancy of random quadrats by white-tailed prairie dogs in Colorado. Final report. Colorado Division of Wildlife. Denver, Colorado. 16pp.

Andelt, W. F., G. C. White, P. M. Schnurr, and K. W. Navo. 2006b. Occupancy of random quadrats by white-tailed and Gunnison's prairie dogs. (Manuscript will be submitted to Journal of Wildlife Management).

Armstrong, D. M. 1972. Distribution of mammals in Colorado. Museum of Natural History, University of Kansas Monograph 3, Lawrence, Kansas, USA.

Bangert, R. K., and C. N. Slobodchikoff. 2000. The Gunnison's prairie dog structures a high desert grassland as a keystone engineer. Journal of Arid Environments 46:357–369.

Burnham, K. P., and D. R. Anderson. 2002. Model selection and multimodel inference: a practical information-theoretic approach. Second edition. Springer-Verlag, New York, New York, USA.

Bowden, D. C., G. C. White, A. B. Franklin, and J. L. Ganey. 2003. Estimating population size with correlated sampling unit estimates. Journal of Wildlife Management 67:1–10.

Colorado Agricultural Statistics Service. 1990. Vertebrate rodent infestation survey. Colorado Department of Agriculture, Lakewood, Colorado, USA.

Colorado Division of Wildlife. 2002 (September). Report of acreages of active colonies for Gunnison's prairie dogs (*Cynomys gunnisoni*) and white-tailed prairie dogs (*Cynomys leucurus*). Unpublished report, Colorado Division of Wildlife, Denver, Colorado, USA.

Findley, J. S. A. H. Harris, D. E. Wilson, and C. Jones. 1975. Mammals of New Mexico. University of New Mexico Press, Albuquerque, New Mexico.

Cully, J. F., Jr. 1997. Dynamics of plague in a Gunnison's prairie dog colony complex from New Mexico. Journal of Wildlife Diseases, 33(4): 706–719.

Fitzgerald, J. P., and R. R. Lechleitner. 1974. Observations on the biology of Gunnison's prairie dogs in central Colorado. American Midland Naturalist 92:146–163.

Fitzgerald, J. P., C. A. Meaney, and D. M. Armstrong. 1994. Mammals of Colorado. University Press of Colorado, Niwot, Colorado, USA.

Girard, J. M., D. M. Wagner, A. J. Vogler, C. Keys, C. J. Allender, L. C. Drickamer, and P. Keim. 2004. Differential plague-transmission dynamics determine *Yersinia pestis* population genetic structure on local, regional, and global scales. Proceedings of the National Academy of Sciences of the United States of America 101:8408–8413.

Lechleitner, R. R., J. V. Tileston, and L. Kartman. 1962. Die-off of a Gunnison's prairie dog colony in central Colorado, I. Ecological observations and description of the epizootic. Zoonoses Research 1:185–199.

Longhurst, W. 1944. Observations on the ecology of the Gunnison prairie dog in Colorado. Journal of Mammalogy 25:24–36.

MacKenzie, D. I., J. D. Nichols, G. B. Lachman, S. Droege, J. A. Royle, and C. A. Langtimm. 2002. Estimating site occupancy rates when detection probabilities are less than one. Ecology 83:2248–2255.

Perla, B. S., and C. N. Slobodchikoff. 2002. Habitat structure and alarm call dialects in Gunnison's prairie dog (*Cynomys gunnisoni*). Behavioral Ecology 13:844–850.

Pizzimenti, J. J., and R. S. Hoffman. 1973. *Cynomys gunnisoni*. Mammalian Species 25:1–4.

Seglund, A. E., A. E. Ernst, and D. M. O'Neill. 2005. Gunnison's prairie dog conservation assessment. Western Association of Fish and Wildlife Agencies. Laramie, Wyoming, USA.

Thompson, W. L., G. C. White, and C. Gowan. 1998. Monitoring vertebrate populations. Academic Press, New York, New York, USA.

Travis, S. E., and C. N. Slobodchikoff. 1993. Effects of food resource distribution on the social system of Gunnison's prairie dog (*Cynomys gunnisoni*). Canadian Journal of Zoology 71:1186–1192.

Travis, S. E., C. N. Slobodchikoff, and P. Keim. 1997. DNA fingerprinting reveals low genetic diversity in Gunnison's prairie dog (*Cynomys gunnisoni*). Journal of Mammalogy 78:725–732.

White, G. C., and K. P. Burnham. 1999. Program MARK: survival estimation from populations of marked animals. Bird Study 46 Supplement: 120–139.

APPENDIX V. GLOSSARY OF TERMS USED IN THE MANAGEMENT PLAN

Adaptive management- The process of monitoring results of implemented conservation efforts, then adjusting those efforts according to what was learned (*Announcement of Draft Policy for Evaluation of Conservation Efforts When Making Listing Decisions Under the ESA, December 22, 1999*).

Associated Species- Species that benefit from Gunnison's prairie dogs, either directly or indirectly, but are not dependent on prairie dogs for survival.

Candidate Conservation Agreement with Assurances (CCAA)- Voluntary agreements between landowners and the US Fish and Wildlife Service that identify actions that landowners commit to take to conserve declining (proposed or candidate) species. In exchange, the Service provides the landowner assurances that no additional conservation measures or land-use restrictions will be required above that indicated in the CCAA should the species be listed as threatened or endangered in the future. To receive assurances, the Service must determine that the benefits of the conservation measures to be implemented, when combined with those benefits that would be achieved if it is assumed that the conservation measures were also to be implemented on other necessary properties, would preclude or remove the need to list the covered species. Assurances only apply to non-federal entities and do not apply to federal lands.

Candidate Species- Species that the US Fish and Wildlife Service, through review of available information, has determined should be proposed for addition to the federal endangered and threatened species list.

Colony- A concentration of prairie dogs with an average density of at least ten prairie dogs/acre.

Complex- A group of prairie dog colonies distributed such that individual prairie dogs can physically disperse from one colony to another. For management purposes, this is defined as 7 km (4.3 mi), which is the longest nightly movement recorded for the black-footed ferret, an obligate predator on prairie dogs. Inter-colony movements of Gunnison's prairie dogs are typically confined to approximately 8 km (5 mi).

Conservation- (a) From section 3(3) of the federal Endangered Species Act: "… 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 under {the} Act are no longer necessary;" (b) The retention of natural balance, diversity, and evolutionary change in the environment.

Conservation Easement- A voluntary land-protection tool that places restrictions (e.g., development) on a piece of property to protect associated natural or man-made resources. A landowner can either sell or donate an easement and it is a legally binding agreement.

Control Measures- Actions taken to reduce the numbers and/or occupied acreage of prairie dogs, primarily through lethal means.

Corrective Measures- Actions taken to increase the numbers and/or occupied acreage of prairie dogs, perhaps following a plague outbreak or some other event which may have caused occupied acreage to fall below target levels.

Ecologically Effective- An ecologically effective population contains enough individuals with a wide enough geographic distribution to maintain the species' role in ecosystems

Ecosystem- A dynamic and interrelated complex of plant and animal communities and their associated nonliving (e.g., physical and chemical) environment.

Endangered Species- A species in danger of extinction within the near future throughout all or a significant portion of its range.

Extirpated Species- A species no longer surviving in regions that were once part of their range.

Habitat- The local environment occupied by an organism and those components required to complete its life cycles, including air, food, cover, water, and spatial requirements.

Historic Range- Those geographic areas the species was known or believed to occupy in the past.

Incentive- Assistance, financial payment or other action which encourages individuals or organizations to participate in an effort or activity, or which offsets any sacrifices an individual or organization may make to participate in an effort or activity.

Keystone Species- A species that (1) has a large overall effect on ecosystem structure or function, (2) has a disproportionately large effect relative to its abundance, and (3) has a unique function in the ecosystem not provided by other species (Power et al. 1996, Kotliar 2000, Kotliar et al. 1999).

Listing- The formal process through which the US Fish and Wildlife Service adds species to the Federal List of Endangered and Threatened Wildlife and Plants.

Management Areas- Specific areas may be identified around the state as unique management areas. Each area can have different management objectives and goals.

Petition (for Listing)- A formal request, with the support of adequate biological data, suggesting that a species be listed, reclassified, or delisted, or that critical habitat be revised for a listed species.

Occupied Acreage- Land (acreage) that has animals in residence.

Population- All individuals of one species occupying a defined area and usually isolated to some degree from other similar groups.

Range- The geographic area a species is known or believed to occupy.

Re-establish- To restore a species to an area that it historically inhabited.

Species- A group of individuals that can actually or potentially breed with each other and produce fertile offspring under natural conditions, but cannot with other such groups.

Species of Concern- An informal term, conferring no special legal status, given to species that are of management concern due to declining numbers and/or loss of habitat. The Arizona Game and Fish Department maintains a list of species of special concern that identifies species whose occurrence in Arizona may be in jeopardy (AGFD, in prep).

State Trust lands- Lands entrusted to the state by the Federal government and managed by the State Land Department for revenue for Trust beneficiaries (e.g., public schools, colleges, hospitals, charitable institutions).

Subspecies- A group of interbreeding natural populations differing morphologically and genetically, and often isolated geographically from other such groups within a biological species but interbreeding successfully with them where their ranges overlap.

Sylvatic Plague- An acute, infectious disease caused by the bacteria *Yersinia pestis* that primarily affects rodents, rabbits, and associated carnivore and scavenger species. The agent is transmitted through the bite of an infected flea or through direct contact with an infected carcass. It is known as bubonic plague in humans and sylvatic plague in the wild. This disease causes almost 100% mortality in infected Gunnison's prairie dogs.

Threatened Species- A species that is likely to become endangered within the near future throughout all or a significant portion of its range.