RECOVERY OF THE UTAH PRAIRIE DOG: PUBLIC PERCEPTION AND CATTLE GRAZING AS A MANAGEMENT TOOL

by

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ABSTRACT

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Utah State University, 2006

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The Utah prairie dog (*Cynomys parvidens*), a threatened species, has experienced minimal recovery since implementation of a 1991 recovery plan. Over 70% of the population is found on private lands yet only those prairie dogs found on public lands have been counted toward recovery. Reevaluation of the recovery plan is ongoing, and the new plan will likely incorporate private lands into the recovery process. I surveyed Utah residents to identify stakeholder perceptions regarding the species and its management. Rural and agriculture respondents tended to be more knowledgeable and also more opinionated than urban stakeholders. Most agriculture respondents (79%) reported high levels of damage and low interest in working with government agencies to manage the species. They did, however, express some interest in working with the Utah State University Extension Service and Utah Farm Bureau Federation. While there was not strong support for landowner damage compensation, those that did support compensation overwhelmingly felt that private conservation groups should provide the funds. These findings suggest that if private lands are to be included in Utah prairie dog population recovery goals, efforts conducted to engage and educate stakeholders should be made by non-regulatory personnel. Additionally, alleviation of damage issues would likely increase landowner acceptance of conservation.

Previous research has suggested that reductions in shrub canopy cover that resulted in increased grass and forb cover may benefit Utah prairie dogs. From 2002-2005, I evaluated the effects of 3 forage utilization rates (20-30%, 50-60%, and 80-90%) achieved by using domestic cattle under a high-intensity/short-duration grazing regime on Utah prairie dog habitat use and foraging behavior on the Awapa Plateau. I found no evidence that high-intensity/short-duration cattle grazing affected Utah prairie dog densities or burrow density. However, Utah prairie dogs spent more time foraging and were less vigilant as forage utilization by cattle increased. No change in plant composition over time was detected for any treatment levels. My results suggest that high (80%) forage utilization rates may negatively affect Utah prairie dogs. To enhance Utah prairie dog habitat I recommend using mechanical means to treat areas that exhibit $> 2\%$ shrub canopy cover.

(168 pages)

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CHAPTER 1

INTRODUCTION

Description

The Utah prairie dog (*Cynomys parvidens*) is in the white-tail prairie dog subgenera (Leucocrossuromys). Genetic data reveal a close relation with the white-tailed prairie dog (*C. leucurus*) (Pizzimenti and Nadler 1972). The species is found in arid grasslands and sagebrush steppes in southwestern and south-central Utah (Figure 1-1). It was historically known to inhabit Beaver, Garfield, Iron, Kane, Piute, Sevier, and Wayne counties. Utah prairie dogs are colonial ground-dwelling squirrels. They are territorial and exhibit harem-polygynous family groups called clans (Fitzgerald and Lechleitner 1974). Adults are cinnamon to clay in color, have dark markings both above and below the eye, and have white-tipped tails (Durrant 1952). Weights generally range from 250-1100 g. Adults of the species range from 305-360 mm in length (U.S. Fish and Wildlife Service 1991). Utah prairie dogs alter the vegetation community, alter soil structure, and provide niches for numerous other species. For these reasons it is considered a keystone species (Mills et al. 1993).

Kelson (1949) hypothesized that an ancestral species of the Utah prairie dog invaded the state sometime in the early Pleistocene when the climate was cooler and wetter. This ancestor is thought to be *C. meandensis* (Clark et al. 1971). Under the selective pressures of a changing climate speciation likely occurred. This view of a "relic" species is further supported by the widely scattered populations (Collier and

Spillett 1975). McDonald (1993) estimated that as many as 95,000 Utah prairie dogs inhabited Utah prior to control efforts that were initiated in the 1920's. Collier and Spillett (1975) estimated that they occupied 37,000 ha in 1920. Major eradication efforts using toxicants (poison baits) took place around 1933, 1950, and 1960 (Collier and Spillett 1973). By 1973, Collier and Spillett (1973) estimated that only 3,300 animals remained. They predicted that by 2000 if the population trajectory remained unchanged the species would be extinct. Roberts et al. (2000) assessed population viability of the species and found that under current catastrophe (such as disease and habitat destruction) rates, the species will disappear within 200 years. The Awapa Plateau population was found to be most vulnerable to extinction.

Food Habits and Habitat

Because Utah prairie dogs meet all of their water requirements from vegetation, there exists a strong correlation with available plant moisture and Utah prairie dog densities (U.S. Fish and Wildlife Service 1991). Colonies are generally found in swale formations with deeper soils and succulent vegetation. Soil depth is also important relative to burrowing. Deep, well-drained soils are preferred as burrow sites. Colonies are typically found in Mollisols, and animals rarely occupy steep slopes (Collier and Spillett 1975). Burrows typically are 1-m deep and may extend for several meters underground. There are normally several openings to the burrow system. Height of vegetation can affect colony location, since prairie dogs' main defense against predation is the ability to see potential predators. Therefore, the species prefers areas where the height of vegetation is low enough to facilitate this observation.

Plant species vary greatly within the range of the Utah prairie dog since it is known to occupy sites from 1,500 m to over 2,700 m elevation. Little research has been conducted to document the food habits of the Utah prairie dog. A variety of grass species are consumed depending on availability (U.S. Fish and Wildlife Service 1991). Forbs are also an important food item particularly during drought periods (Crocker-Bedford and Spillett 1981). Utah prairie dogs appear to be selective in their foraging. Young leaves, flowers, and seeds are the preferred parts of plants eaten (U.S. Fish and Wildlife Service 1991).

Crocker-Bedford (1976) found that cool season grasses accounted for 44%, while perennial forbs comprised 52% of the adult Utah prairie dog's diet. Specific forbs consumed included phlox (*Phlox sp*.), cryptantha (*Cryptantha abata*), and fendler spurge (*Euphorbia fendleri*). Cicadas (*Magicicada sp*.) comprised nearly 50% of their diet for a period in 1974 (Crocker-Bedford 1976). Litter and cattle feces were also consumed by juvenile prairie dogs (< 10%). This study site was located at approximately 2,230 m. At another study site (approximately 2,070 m) nearly 80% of the diet was cool season grasses. European glorybind (*Convolvulus arvensis*) was the only major forb consumed. On another site that had been reseeded with crested wheatgrass (*Agropyron cristatum*), this grass was the preferred forage (Crocker-Bedford 1976). Alfalfa (*Medicago sativa*) is also heavily used at lower elevations when available (U.S. Fish and Wildlife Service 1991). Crocker-Bedford and Spillett (1981) examined habitat requirements at higher elevations. It was recommended that for sites above 2,100 m elevation the total percent canopy cover should be 42%. Furthermore, they recommended that coverage of cool season grasses should be 30%, with 5% warm season grasses. The recommended forb and shrub cover was 5% and 2%, respectively (Crocker-Bedford and Spillett 1981).

Life History

The sex ratio for the Utah prairie dog is skewed 1:2 toward females (Mackey 1988). This may be due to higher juvenile male mortality (dispersal) and higher adult male mortality due to territorial conflicts (U.S. Fish and Wildlife Service 1991). Normally, Utah prairie dogs produce 1 litter/year and average litter size is from 3-5 (Pizzimenti and Collier 1975, Wright-Smith 1978). Most Utah prairie dogs are born in April. Normally the young emerge from the burrows at 5-7 weeks of age sometime in late May or early June (depending on elevation). By early fall they are indistinguishable from adults. Juveniles reach sexual maturity at 1 year (U.S. Fish and Wildlife Service 1991). The species' energy requirements are highest during the period when most prairie dogs are active and before juvenile dispersal (U.S. Fish and Wildlife Service 1991).

Utah prairie dogs have a low reproductive rate. Hoogland (2001) proposed 5 reasons for this. They include: 1) low first year survival (< 50%), 2) 1 litter/year, 3) low copulation rate of yearling males (49%), 4) low probability of weaning a litter (67%), and 5) low mean litter size at emergence (3.88).

Utah prairie dogs begin to hibernate sometime between September and December. The actual time is dependent on site elevation, sex of the animal, and food availability. In general adult males are the first to hibernate, followed by adult females several weeks later. Juveniles remain active longer. Emergence varies again depending on the elevation, but generally by February and April most are active (U.S. Fish and Wildlife Service 1991).

Mackey (1988) reported that 12% of Utah prairie dogs dispersed annually. Juveniles made up 86% of this annual dispersal. Average distance of dispersal was 0.27 km for males and 0.68 km for females. Crocker-Bedford and Spillett (1977) found the home range of male Utah prairie dogs to be 4.7 ha and 2.3 ha for females. In both sexes the home range was somewhat elongated. Foraging activity generally was within 60 m of the central area of the home ranges until mid-June, after which distances increased up to 300 m in some instances (Crocker-Bedford and Spillett 1977).

Disease and Predation

Plague reached central Utah around 1935 (Hansen 1954). This period also was marked by massive control efforts, therefore initial effects of the disease on the population are difficult to ascertain. The overall effect of diseases on the Utah prairie dog is poorly understood (D. Biggens, U. S. Geological Service, personal communication).

Major predators of the Utah prairie dog include badger (*Taxidea taxus*), coyote (*Canis latrans*), various raptors, and man (U.S. Fish and Wildlife Service 1991). Predation is thought to have little effect on established colonies (Collier and Spillett 1972), but may decrease colonization success (Jacquart et al. 1986).

Interactions with Livestock Grazing

There have been few studies examining cattle and prairie dog interactions. The first and most comprehensive study was conducted by Crocker-Bedford (1976). Three study sites were chosen near Panguitch, Utah at elevations from 2,000-2,300 m. He reported there was more forage available to prairie dogs than to cattle. The principal foods of both species were alfalfa (*Medicago sativa*), western wheatgrass (*Agropyron smithii*), and crested wheatgrass (*Agropyron cristatum*). He also determined that prairie dogs foraged more selectively than cattle were capable of. He established the animal unit (AU) equivalent of a prairie dog between 410 and 500 animals. Jaynes (1982) reported that 300-400 prairie dogs were equivalent to one AU. Prairie dog densities ranged from 2.3/ha to 35/ha in the Crocker-Bedford study. The percentage of primary production consumed by prairie dogs varied greatly but he concluded that prairie dogs may reduce availability of forage for cattle in some areas. He further stated that cattle might increase populations in areas where vegetation biomass is high. However, it has been suggested that heavy long-term cattle grazing may have eliminated prairie dog habitat in swale locations (Crocker-Bedford and Spillett 1981).

These findings suggest that cattle grazing can be compatible with Utah prairie dog conservation. Ritchie (1998) evaluated prairie dog foraging rates and weight gain relative to the timing of grazing. He also compared population dynamics to vegetational characteristics. He reported that frequency of population crashes was correlated negatively with plant species richness. Spring grazing by cattle appeared to increase juvenile weight gain in Utah prairie dogs but decreased adult foraging rates. No studies of Utah prairie dogs have evaluated the relationship of forage utilization by domestic livestock to prairie dog habitat use.

Listing History

The species was listed as endangered in 1973 pursuant to the Endangered Species Act (ESA) of 1969, but was down-listed to threatened in 1984 after substantial numbers were found on private lands (U.S. Fish and Wildlife Service 1991). Factors contributing to declines in Utah prairie dog numbers include: large-scale habitat changes, drought, disease [most notable plague (*Yersinia pestis*)] long-term climatic changes, eradication efforts, and improper grazing by domestic livestock (U.S. Fish and Wildlife Service 1991). Additionally, physiographic barriers and competition from Uinta ground squirrels (*Spermophilus armatus*) may have limited the species distribution (Collier and Spillett 1973).

The Utah Division of Wildlife Resources (UDWR) began an annual census of the species in 1975 (Figures 1-2 and 1-3). Ritchie (1998) evaluated the reliability of the annual counts by the UDWR and reported them to be highly repeatable. A long-term recovery plan was completed by the U.S. Fish and Wildlife Service (USFWS) in 1991 in an effort to recover populations on public lands in 3 target areas (USFWS 1991). The concentration areas identified included the West Desert, the Paunsaugunt Plateau, and the Awapa Plateau (Figure 1-4). The goal of the plan is the eventual delisting of the species. The criteria which must be met for this goal to be achieved include: 1) Three populations on public lands are established and maintained, with one population in each of the following areas: a) West Desert, b) Paunsaugunt Area, and c) Awapa Plateau,

2) a minimum population of 813 animals, counted on public land in the spring, is maintained in each population for 5 consecutive years, and 3) a formal Memorandum of Understanding would need to be signed among the U.S. Fish and Wildlife Service and the Bureau of Land Management, the National Park Service, the Forest Service, and the Utah Division of Wildlife Resources for long-term management of each population following delisting, including the transfer of animals for genetic purposes (USFWS 1991). Seal (1987) recommended the minimum population size of 813 animals to sustain genetic diversity in the 3 populations.

The current management plan includes strategies to allow prairie dog transplants and take permits. A transplant program was initiated by the UDWR in 1972 to remove problem animals from agricultural areas and to supplement and expand prairie dog populations (Bonzo and Day 2002). Although initial results were marginal at best, these efforts did reveal insight into future transplants. Jacquart et al. (1986) and Coffeen and Pederson (1993) helped to develop current translocation methods and protocol. It was determined that only adult males should be moved early in the summer (females and juveniles later), and enclosures and brush removal may aid in colony establishment. The UDWR currently constructs artificial burrows prior to release and provides initial supplemental food to aid in establishment. Additionally, landowners can be issued take permits to remove damage causing Utah prairie dogs between June 1 and December 31 (USFWS 1991). These dates were set to target juvenile prairie dogs. This program was implemented to mitigate landowner conflict with haying operations (USFWS 1991).

Despite the fact that the Utah prairie dog has been a listed species for over 30 years, it does not appear that it is recovering. This has prompted the USFWS to reevaluate the recovery plan. Private lands will likely be a major component of the new plan (E. Boeke, USFWS, personal communication). Additionally, habitat management and disease impacts need to better understood if this species is to increase in numbers on public lands that are currently protected.

Social Context

Kellert (1985) suggested a need to articulate and specify the values that society derives from endangered wildlife, and further to define the tradeoffs involved for different segments of the human population. There is a concern that listing under the ESA can actually hinder species conservation, particularly with species which the general public does not deem "necessary." Brook et al. (2003) reported this to be the case with the Preble's meadow jumping mouse (*Zapus hudsonius preblei*). They concluded that endangered species would benefit from: increased communication of information through social networks, alleviating landowner economic concerns, increased collaborative processes, and assurances that landowners will not suffer hardship when managing their land to benefit endangered species. Species considered as "lower forms of life" such as rodents and invertebrates are often viewed with less concern (Kellert 1993). However, there is evidence that large charismatic species are viewed positively by large segments of the population (Kellert et al. 1996). While the Utah prairie dog is certainly not large, some may consider it charismatic. Therefore, it may be difficult to predict the value that the general public would place on it. Kellert (1985) noted similar difficulty in assessing societal factors for endangered invertebrates in developing countries.

Human dimensions research on prairie dogs has mostly focused on black-tailed prairie dogs (*Cynomys ludovicianus*) (Reading and Kellert 1993, Beckoff and Ickes 1999, Reading et al. 1999, Zinn and Andelt 1999). Reading et al. (1999) found increasing levels of antagonism toward prairie dogs from conservation groups, urban residents, rural residents, and ranchers respectively. This could be similar with the Utah prairie dog. However, the general population may be more inclined to view the Utah prairie dog positively because it is an endangered species. Furthermore, this may lead agricultural producers to view it less positively (Brook et al. 2003). Fort Collins residents that were directly affected by prairie dogs also held more negative opinions than those residents not affected (Zinn and Andelt 1999). Those affected were more knowledgeable about the species. Therefore knowledge did not seem to increase positive feelings. This finding regarding knowledge was echoed in a Montana study (Reading et al. 1999). Most agricultural producers in Wyoming (who had black-tailed prairie dogs on their properties) felt that the species negatively impacted their operation. The desired management practice was complete removal. However there was strong interest in programs that could assist in managing damage to agricultural crops (Wyoming Game and Fish Department, unpublished document 2001).

Purpose and Need

Public Perception Study

It has been estimated that Utah prairie dogs cost Utah $1.5 million annually (Ivan Matheson, former Utah state senator, personal communication). Knowledge of public perception and acceptance of Utah prairie dog conservation efforts is lacking. Specifics on amounts and types of damage caused by the Utah prairie dog are unknown. Information obtained from a survey of the public could assist land management agencies to identify and implement conservation actions that will embrace public concerns and benefit the Utah prairie dog. The negligible increases in Utah prairie dog numbers on public land have prompted the U.S. Fish and Wildlife Service to revaluate the Utah prairie dog recovery plan (E. Boeke, USFWS, personal communication). The new plan may incorporate private lands into the decision making process. This is logical since over 70% of Utah prairie dogs occur on private lands (U.S. Fish and Wildlife Service 1991). The information provided from this survey could identify the incentives to conserve Utah prairie dogs on private land. Additionally, perceptions from the general population are important to ascertain since the public must accept conservation actions before success can be expected.

My specific objectives were: 1) to determine perceptions among different stakeholder groups (urban Utah residents, residents of rural counties within Utah prairie dog range, and agricultural producers within Utah prairie dog range) regarding the Utah prairie dog and the conservation of the species, 2) to determine levels of knowledge concerning the Utah prairie dog, and 3) to determine agriculture producer willingness to participate in conservation measures for the Utah prairie dog. The null hypothesis for objective 1 is that there will be no differences in perceptions of stakeholder groups regarding the Utah prairie dog. My alternate hypothesis is that agriculture producers will have more negative opinions regarding Utah prairie dogs than either urban or rural populations due to issue salience and prairie dog damage. My null hypothesis for objective 2 is that there will be no differences in knowledge of stakeholder groups regarding the Utah prairie dog and the alternate hypothesis is that agriculture producers and rural residents will have more knowledge of Utah prairie dogs than the urban population due to issue salience. The null hypothesis for objective 3 is that agriculture producers will have little interest in participating in conservation measures for the Utah prairie dog, and the alternate hypothesis is that agriculture producers will have interest in participating in conservation measures for the Utah prairie dog.

Grazing Study

Grazing by domestic livestock continues to be the dominant land use across most of the range of the Utah prairie dog. Therefore, it is necessary to fully understand the potential impacts that grazing might have on the plant community and consequently on Utah prairie dog populations. A key to Utah prairie dog conservation is identifying grazing practices which allow it to not only survive, but to maintain distinct and viable populations across a wide range of environmental conditions. Few studies have addressed this issue.

Crocker-Bedford (1976) evaluated cattle-prairie dog interactions; however his study areas were below 2,300 m elevation. Many Utah prairie dog colonies located in my study area are between 2,500 and 2,800 m elevation. Ritchie (1998) did include comparable colonies in his study of habitat and grazing. However, he only examined the timing of grazing. The effects of grazing intensity (forage utilization) over time have not been evaluated at any elevation for the Utah prairie dog. Additionally, there are 2 proposed Utah prairie dog mitigation banks on Parker Mountain. One has already been treated and will be ready to receive prairie dogs in a few years. Management of these 2 sites is contingent on recommendations derived from my grazing study. Additionally, it appears that for some areas on the Awapa Plateau, plant composition does not meet recommended guidelines (Crocker-Bedford 1976). Previous research has shown that high shrub densities may be detrimental to Utah prairie dogs (Allan and Osborn 1949, Collier and Spillett 1973).

My specific objectives were: 1) to determine if cattle grazing can be used to improve Utah prairie dog habitat in areas higher than 2,300 m and 2) to determine if cattle grazing intensities affect Utah prairie dog behavior and distribution. The null hypothesis for objective 1 is that there will be no difference in plant composition between treatment levels. Alternate hypotheses include: pastures grazed by domestic livestock to achieve 20-30% forage utilization will exhibit a decrease in composition of grass and forbs, and an increase in shrub composition over time due to increased competitive pressure from shrub species; pastures grazed by domestic livestock to achieve 50-60% forage utilization will exhibit no change in shrub, grass, or forb composition over time; pastures grazed by domestic livestock to achieve 80-90% forage utilization will exhibit an increase in the grass and forb composition and a decrease in shrub composition over time due to reduced competition from grazed shrubs.

The null hypothesis for objective 2 is that different grazing intensities will have no effect on Utah prairie dog counts, borrow establishment, and foraging rates. Alternate hypotheses include: pastures grazed to achieve 20-30% forage utilization will exhibit increasing prairie dog counts, higher burrow establishment, and lower foraging rates over time due to higher forage availability; pastures grazed to achieve 50-60% forage utilization will exhibit no change in prairie dog counts, lower burrow establishment, and higher foraging rates over time; and pastures grazed to achieve 80-90% forage utilization will exhibit lower prairie dog counts, lower burrow establishment, and higher foraging rates due to decreased forage availability. These hypotheses assume that high cattle forage consumption will reduce shrub cover through direct consumption (as preferred forage becomes limiting within the grazing period) and by trampling. By releasing more resources (i.e. water and nutrients), grass cover is expected to increase over time which would be beneficial to the Utah prairie dog.

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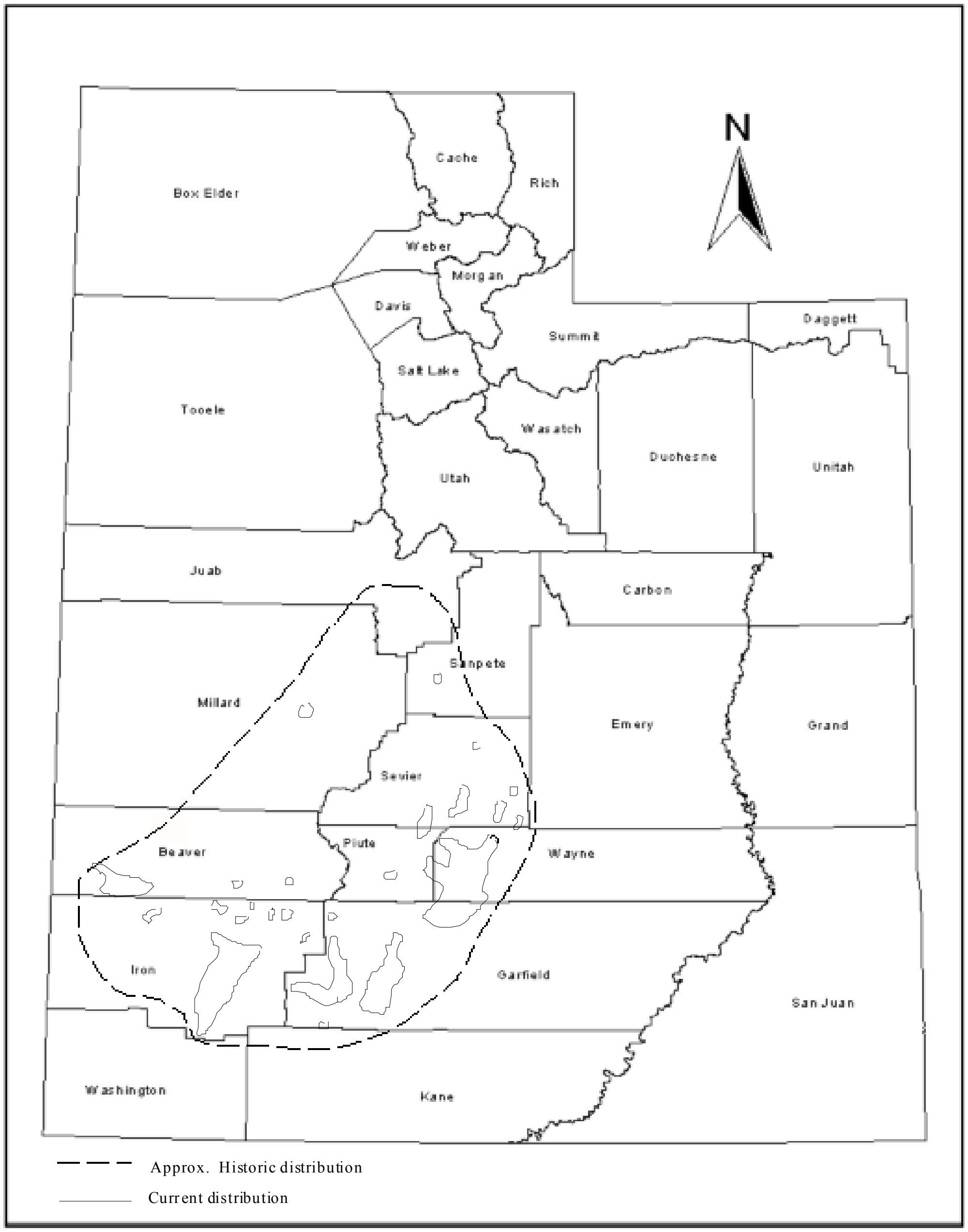

Figure 1-1. Past and present distributions of the Utah prairie dog (Bonzo and Day 2002).

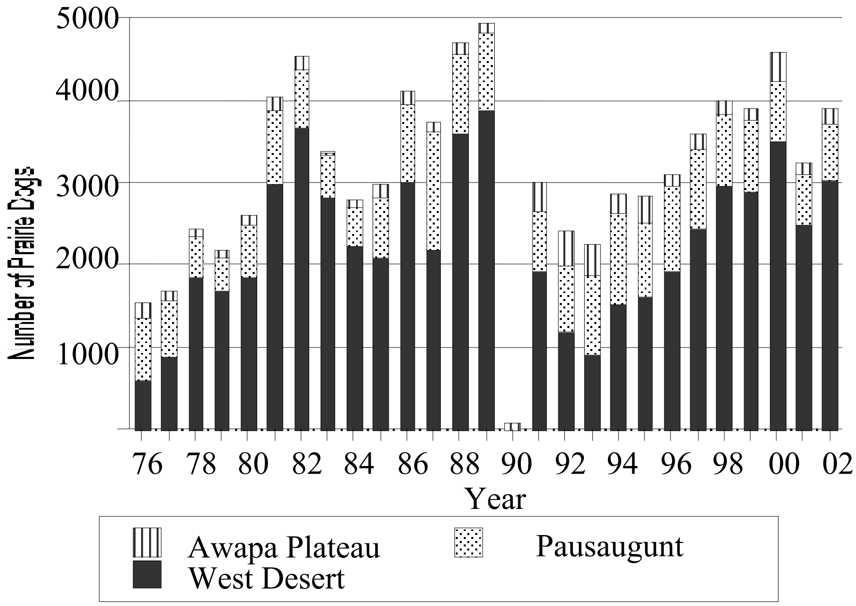

Figure 1-2. Annual counts of Utah prairie dogs on private lands (Bonzo and Day 2002).

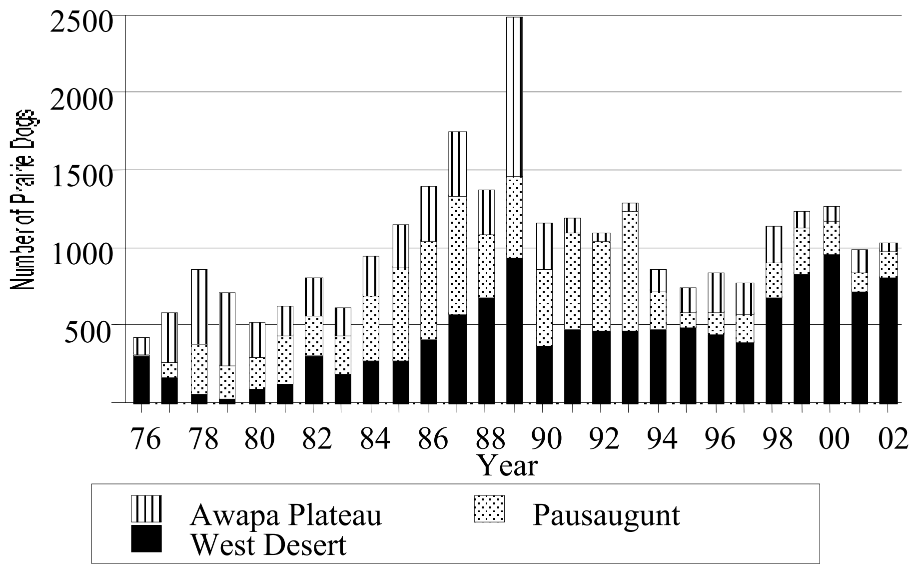

Figure 1-3. Annual counts of Utah prairie dogs on public lands (Bonzo and Day 2002).

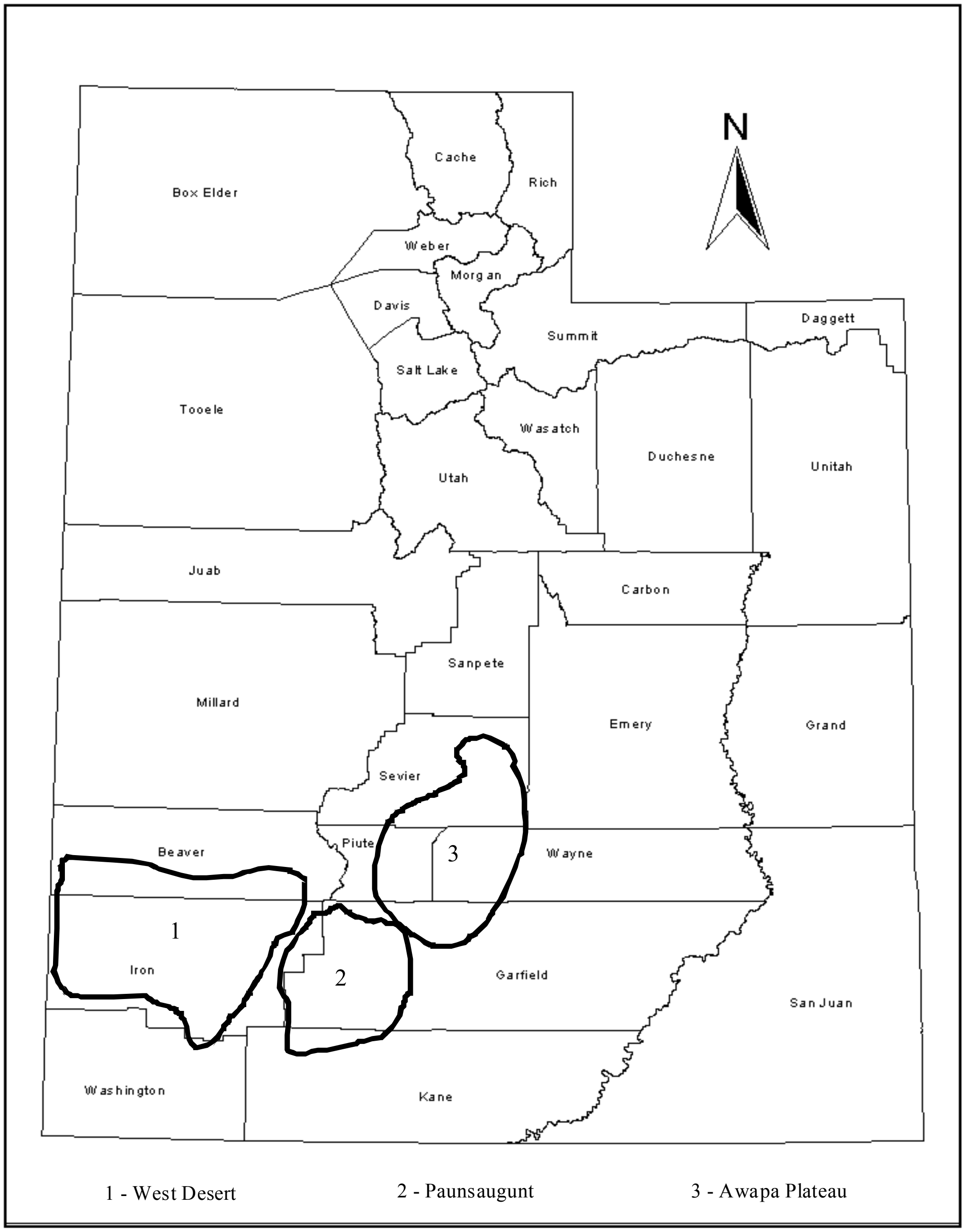

Figure 1- 4. Locations of the 3 Utah prairie dog recovery areas (Bonzo and Day 2002).

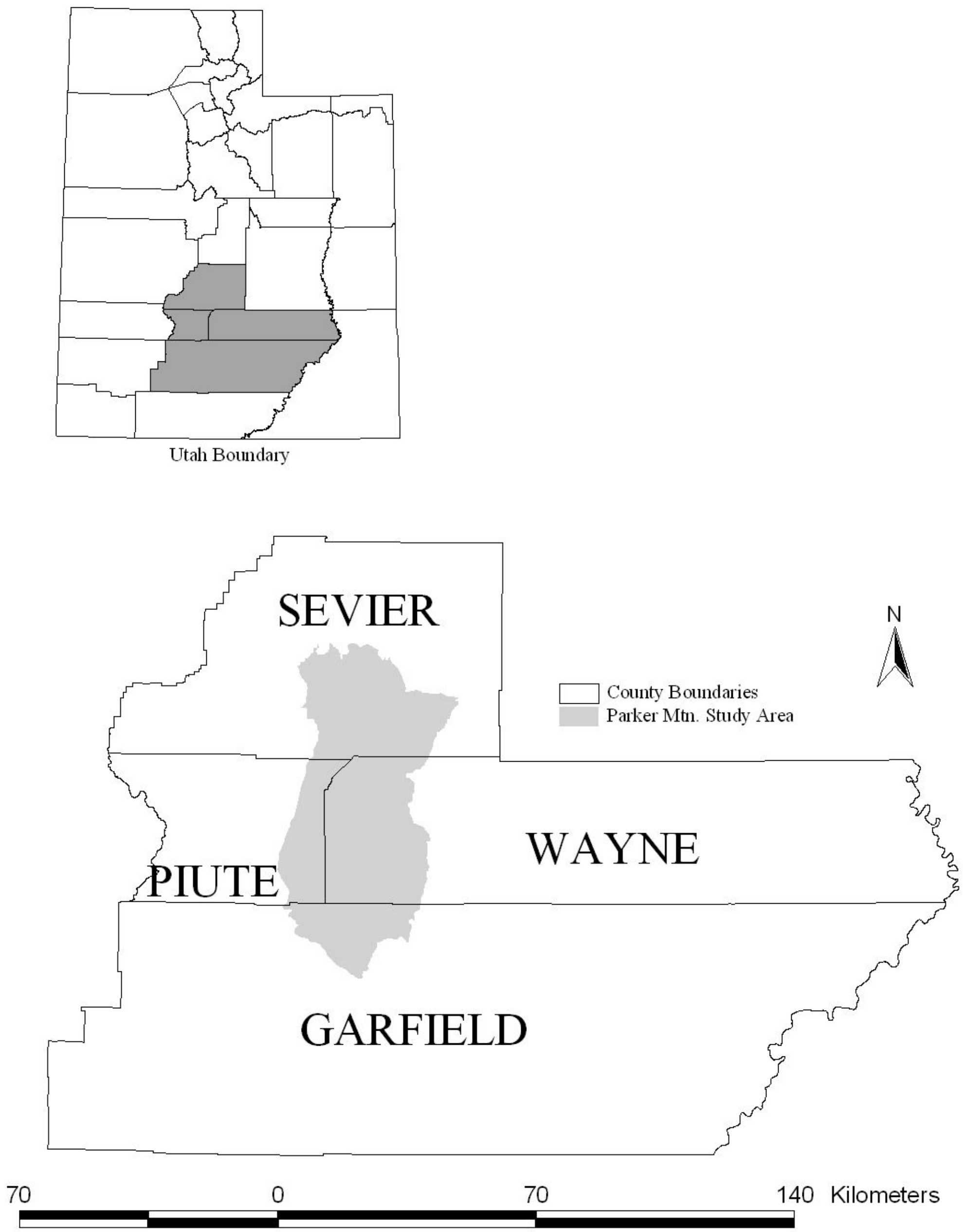

Figure 1-5. Location of experimental grazing pastures on Parker Mountain, Utah.

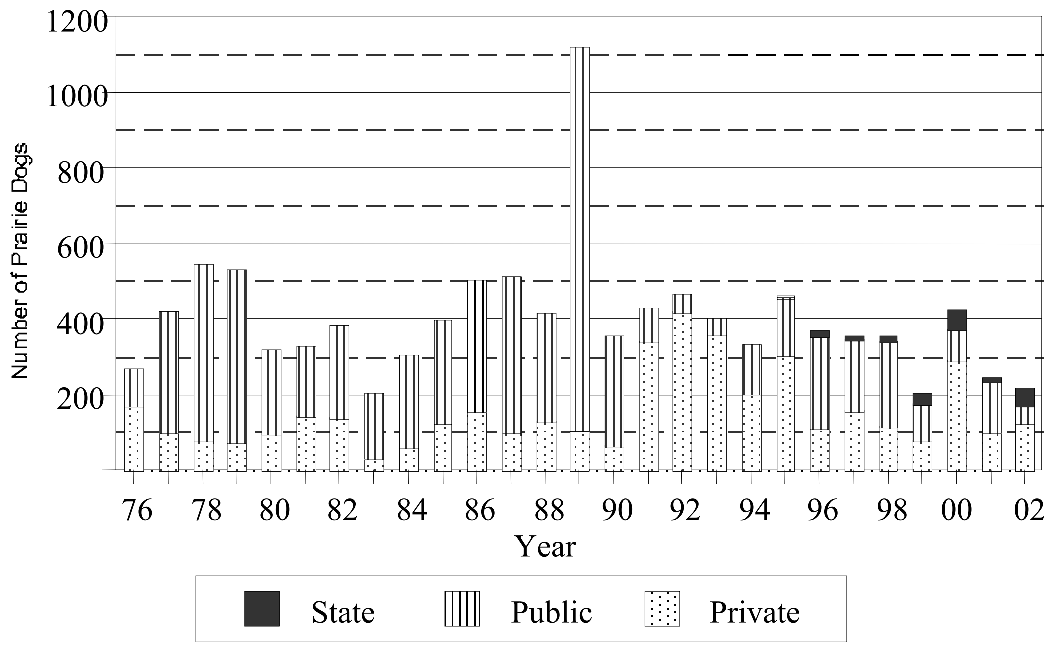

Figure 1-6. Annual counts of Utah prairie dogs on the Awapa Plateau Recovery Area for 1976-2002 (Bonzo and Day 2002).

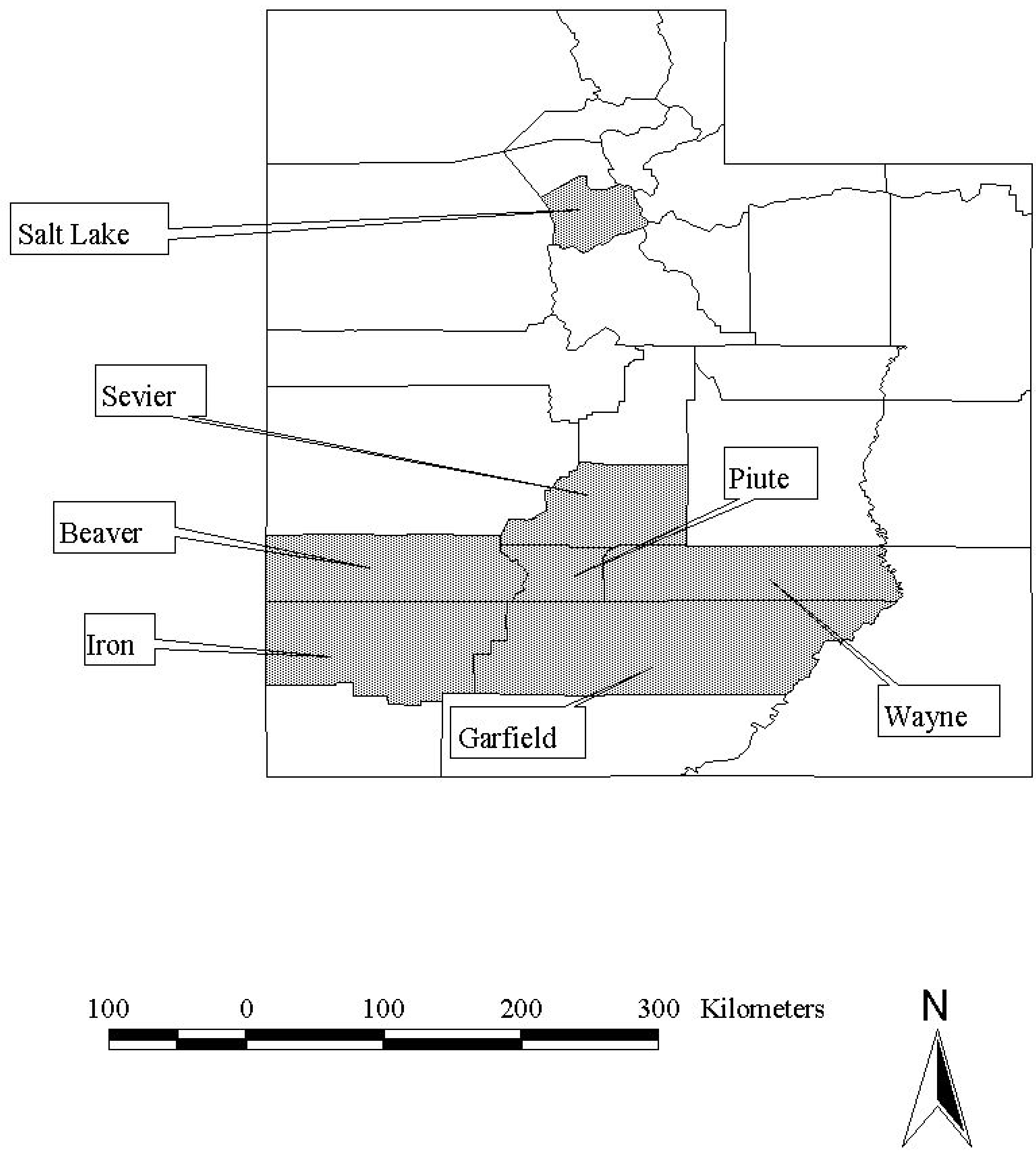

Figure 1-7. Locations of Utah counties that were surveyed during 2005 to assess perceptions and levels of damage surrounding the Utah prairie dog.

CHAPTER 2

STAKEHOLDER PERCEPTIONS REGARDING THE UTAH PRAIRIE DOG AND ITS MANAGEMENT

Abstract: The Utah prairie dog (*Cynomys parvidens*), federally listed as a threatened species, has experienced minimal recovery since implementation of a 1991 recovery plan. This may be because prairie dogs on private land cannot be counted towards recovery goals. It is estimated that 70% of the population inhabits private land. The plan is currently being reevaluated and prairie dogs on private lands may be considered toward recovery. Specifics regarding stakeholder perceptions and agriculture producer interest in various conservation measures for the Utah prairie dog are unknown. I surveyed Utah residents to identify stakeholder attitudes and knowledge regarding the species and its management with particular emphasis on options for conservation on private lands. My survey population included 600 agricultural producers and 600 residents of largely rural counties within the range of the Utah prairie dog; and 600 residents of a metropolitan area. Rural and agricultural respondents tended to be more knowledgeable and also more opinionated about Utah prairie dogs than urban stakeholders. Most agriculture respondents (79%) reported high levels of wildlife damage and low interest in working with state and federal agencies to manage the species. They did, however, express some interest in working with non-regulatory organizations like the Utah State University Extension Service and Utah Farm Bureau Federation. While there was not strong support for landowner damage compensation, those that did support compensation overwhelmingly felt that private

conservation groups should provide the funds. These findings suggest that if private lands are to be included in Utah prairie dog population recovery goals, the efforts conducted to engage and educate stakeholders should be made by non-regulatory personnel. Additionally, alleviation of damage issues would likely increase landowner acceptance of conservation measures.

Introduction

The Utah prairie dog currently inhabits 8 counties in southwestern Utah (Figure 2-1). The species was listed as an endangered species in 1973 pursuant to the Endangered Species Act (ESA) of 1969, but was down-listed to threatened in 1984 after substantial numbers were found inhabiting private lands (USFWS 1991). The decline in Utah prairie dog numbers are commonly attributed to large-scale habitat changes, drought, disease [most notably plague (*Yersinia pestis*)] long-term climatic changes, eradication efforts, and overgrazing by domestic livestock (USFWS 1991). Physiographic barriers and competition from Uinta ground squirrels (*Spermophilus armatus*) may have limited the species' overall distribution (Collier and Spillett 1973).

The Utah Division of Wildlife Resources (DWR) began an annual census of the species in 1975 (Bonzo and Day 2002). A long-term Utah prairie dog recovery plan was approved by the USFWS in 1991 (USFWS 1991). The plan included population recovery goals for 3 areas in Utah; the West Desert, the Paunsaugunt Plateau, and the Awapa Plateau (Figure 2-2) (USFWS 1991). The plan also stipulated that only those populations that inhabit federal land could be counted toward recovery. This stipulation was put in place because of the objections of communities and landowners.

To further address local concerns regarding damage caused by prairie dogs, the recovery plan included provisions for prairie dog transplants and take permits. The DWR initiated a transplant program in 1972 to remove problem animals from agricultural areas and supplement/expand prairie dog populations on federal land. Although initial results were not successful, these efforts did provide information to guide future transplants.

Additionally, landowners can be issued “take permits” to remove Utah prairie dogs that are causing damage between June 1 and December 31 (USFWS 1991). These dates were set to target juvenile prairie dogs. This program was implemented to mitigate landowner damage to hay and haying equipment (USFWS 1991).

The Utah prairie dog recovery plan has resulted in negligible gains in Utah prairie dog numbers which has prompted the USFWS to reevaluate the conservation actions identified in the plan (Elise Boeke, USFWS, personal communication). Because over 70% of Utah prairie dogs occur on private lands, the new plan may incorporate private lands into the decision-making process (USFWS 1991).

Kellert (1985) suggested there is a need to articulate and specify the values that society derives from endangered wildlife, and further to define the tradeoffs involved for different segments of the human population. There is a concern that listing under the ESA can actually hinder species conservation, particularly with species which the general public does not deem “necessary.” Brook et al. (2003) reported this to be the case with the Preble’s meadow jumping mouse (*Zapus hudsonius preblei*). They concluded that endangered species would benefit from: increased communication of information through social networks, alleviating landowner economic concerns, increased collaborative processes, and assurances that landowners will not suffer hardship for management of their land to benefit endangered species. Species considered as "lower forms of life," such as rodents and invertebrates, are often viewed with low concern (Kellert 1993). However, there is evidence that large charismatic species are viewed positively by greater segments of the population (Kellert et al. 1996). While the Utah prairie dog is certainly not large, some may consider it a charismatic species. Therefore, it may be difficult to predict the value that the general public would place on it. Kellert (1985) noted similar difficulty in assessing societal factors for endangered invertebrates in developing countries.

Human dimensions research on prairie dogs have largely focused on black-tailed prairie dogs (*Cynomys ludovicianus*) (Reading and Kellert 1993, Beckoff and Ickes 1999, Reading et al. 1999, Zinn and Andelt 1999). Reading et al. (1999) found increasing levels of antagonism toward prairie dogs from conservation groups, urban residents, rural residents, and ranchers, respectively. It may be anticipated that this would be similar with the Utah prairie dog. However, the general population may be more inclined to view the Utah prairie dog positively because it is an endangered species and there is widespread support for the ESA (Czech and Krausman 1999). Yet, this may lead agricultural producers to view it less positively (Brook et al. 2003). Fort Collins residents that were directly affected by prairie dogs also held more negative opinions than those residents not affected (Zinn and Andelt 1999). Those affected were more knowledgeable about the species than other people. Therefore, knowledge did not seem to increase positive feelings. This finding regarding knowledge was echoed in a Montana study (Reading et al. 1999). Most agricultural producers in Wyoming that had black-tailed prairie dogs on their property felt that the species negatively impacted their operation

(Wyoming Game and Fish Department, unpublished document 2001). The management practice most desired was complete removal. However there was strong interest in programs that could assist in managing damage to agriculture operations.

Specifics on amounts and types of damage caused by the Utah prairie dog are unknown. Because of its foraging and burrowing activity and its status as threatened, the species is in constant conflict with ranching, farming, and development concerns. It has been estimated that Utah prairie dogs cost Utah farms and communities $1.5 million annually (Ivan Matheson, former Utah State Senator, personal communication). Information obtained from a survey of stakeholders could assist managers to identify and implement conservation actions that will embrace public concerns and benefit the Utah prairie dog. This information could identify the incentives needed to conserve Utah prairie dogs on private land.

My specific objectives were to determine: 1) perceptions among different stakeholder groups (urban Utah residents, residents of rural counties within Utah prairie dog range, and agricultural producers within Utah prairie dog range) regarding the Utah prairie dog and the conservation of the species, 2) levels of knowledge concerning the Utah prairie dog, and 3) agriculture producer willingness to participate in conservation measures for the Utah prairie dog. The null hypothesis for objective 1 is that there will be no differences in perceptions among stakeholder groups regarding the Utah prairie dog. My alternate hypothesis is that agriculture producers will have more negative opinions regarding Utah prairie dogs than either urban or rural populations due to issue salience and prairie dog damage. My null hypothesis for objective 2 is that there will be no differences in knowledge among stakeholder groups regarding the Utah prairie dog and the alternate hypothesis is that agriculture producers and rural residents will have more knowledge of Utah prairie dogs than the urban population due to issue salience. The null hypothesis for objective 3 is that agriculture producers will have little interest in participating in conservation measures for the Utah prairie dog, and the alternate hypothesis is that agriculture producers will have interest in participating in conservation measures for the Utah prairie dog.

Study Area

Utah prairie dogs are found in 8 counties in southwestern Utah (Figure 2-1). Those counties include: Beaver, Garfield, Iron, Kane, Millard, Piute, Sanpete, Sevier, and Wayne. Because of the limited distribution in Sanpete and Millard counties, I only selected Beaver, Garfield, Iron, Kane, Piute, Sevier, and Wayne counties for survey inclusion (Figure 2-3). Additionally, urban residents outside of the range of the Utah prairie dog were surveyed to determine how their perceptions and values may differ from people in the 6 southwestern counties. Salt Lake County was chosen because it represents the largest metropolitan area most removed from agricultural concerns (Figure 2-3).

Methods

Survey Development and Administration

I developed 2 mailback surveys to conduct this study (Appendix A and B). These surveys and the study methodology were approved by the Institutional Review Board at Utah State University (IRB # 1167). I mailed surveys to a stratified random sample of

600 individuals each; strata included agricultural producers who live within the historic range of the Utah prairie dog, rural residents within the historic range of the Utah prairie dog, and urban residents in Salt Lake County. I chose 600 for each population to ensure adequate sample size for analysis, given recent concerns regarding low return rates for mail surveys (Connelly et al. 2003).

Names, addresses, and telephone numbers for the urban and rural residents were obtained from a survey sampling firm (Survey Sampling Inc., Fairfield, Connecticut). The study population was therefore limited to households that are listed in telephone directories. The names for the rural and urban component were randomly drawn from a pool of all names for the counties of interest. The names for the agriculture survey were drawn based proportionally from each county so that counties with higher populations of agriculture producers were adequately represented. I contacted the Farm Service Agency (FSA) to acquire names and addresses for agriculture producers within the range of the Utah prairie dog. Their list includes all agriculture producers that have utilized any Farm Bill program. Consultation with FSA revealed that this list was the most complete list available of agricultural producers for this area. However, it was anticipated that some producers on the FSA list have retired yet still remain on FSA records.

The rural and urban populations both received identical surveys. This survey consisted of 23 questions, with multiple subquestions (Appendix A). These questions were designed to examine respondents; knowledge and feelings about the management of the species, feelings about the ESA, views of nature, wildlife damage assessment, and general demographics. The agriculture population received a more detailed survey consisting of 36 questions with multiple subquestions (Appendix B). In addition to the general questions detailed above, this survey contained questions regarding farm operations and details, levels of farm damage caused by the Utah prairie dog, and interest in conservation options for the management of the Utah prairie dog.

An initial introductory letter was mailed during February to all survey recipients (Dillman 2000). This date was chosen because February in Utah is normally a month with low levels of outdoor agricultural activity and greater attention to paperwork (Mark Brunson, Utah State University, personal communication). Additionally, research has shown that surveys mailed in the late winter period generally have higher response rates than surveys mailed during other periods of the year (Connelly et al 2003). The letter informed them that a mailback questionnaire would follow, the reasons for the survey, and contact information. A survey, a self-addressed postage-paid envelope, and a cover letter were mailed 1 week later. The cover letter again described the survey's purpose. One week later a reminder postcard was sent to all survey recipients. A second survey was sent to all nonrespondents 3 weeks after the original mailing date (Dillman 2000).

Data Analysis

I used descriptive statistics and cross tabulations to examine responses. For nominal data, chi-square tests were conducted (Conover 1999). Ordinal responses were examined using measures of association so that both the strength and the direction of relationships could be determined. Somers' *d* measure of association was used for data with 1 ordinal variable and 1 nominal variable (Somers 1962). When both variables had ordinal responses, the gamma measure of association was used because it is a symmetric test and does not assume that 1 variable is independent (Goodman and Kruskal 1979).

For all measures of association the asymptotic standard error (ASE) is reported. In instances with 1 ordinal variable and 1 nominal variable that contained more than 2 levels, ridit analysis was used (Agresti 1984). This test generates the Cochran Mantel-Haenszel test statistic and an associated *P*-value. Tests among the 3 survey groups were conducted using the Kruskal-Wallis test. The Statistical Analysis System (SAS) was used to generate all statistics (SAS 1999). Responses of "Not Sure" and "No Opinion" were excluded from calculations of means or inferential tests involving means. I considered all inferential tests with $P < 0.05$ to be significant.

Results

Response Rate

Urban residents returned 196 surveys (82 undeliverable and 10 unusable), resulting in an adjusted response rate of 46%. Rural residents returned 276 surveys (89 undeliverable and 9 unusable) resulting in an adjusted response rate of 61%. Agriculturists returned 296 surveys (59 undeliverable and 12 unusable), resulting in an adjusted response rate of 59%.

Demographics

Urban respondents tended to be better educated and older than the Salt Lake county general population (U. S. Bureau of the Census 2004). While Salt Lake County is the most urbanized county in Utah, only few of the respondents reported growing up in an urban community (Table 2-1). Rural respondents were also slightly better educated and older than the 6 county sample region (U. S. Bureau of the Census 2004). Most rural respondents indicated they grew up in small towns or rural areas. Agriculture respondents also were slightly better educated than and twice as old as the 6 county region as a whole (U. S. Bureau of the Census 2004). However, agriculture respondents' age was comparable (60 versus 55.2) to the mean age reported for Utah agricultural producers (U.S. Department of Agriculture, 2002). Most agriculture respondents indicated they grew up in small towns and rural areas. Most respondents were males in urban, rural, and the agriculture sample groups.

Only 3% of urban and 14% of rural respondents reported being engaged in agriculture enterprises compared to 80% of the agriculture respondents. About 24% of urban and 62% of rural respondents indicated they had family members involved in agriculture enterprises. Forty-five percent of the urban and 33% of the rural respondents reported that they did not have any family involvement in agriculture within the past 2 generations.

Species Knowledge

Few (13%) urban respondents knew the Utah prairie dog was a separate species of prairie dog, and most (65%) were unsure if it *should* be considered a unique species. In comparison, 46% of rural respondents and 48% of agriculturists knew it was a separate species. However, many rural (47%) and agriculture (57%) respondents thought that it should not be considered a unique species. Most rural (74%) and agriculture (74%) respondents knew it was a listed species under the ESA compared to 23% of urban respondents. Only 30% of urban respondents and 12% of rural residents thought the species should be listed. Few agriculturists (4%) thought it should be listed.

Most agriculture respondents agreed with the statement that prairie dogs compete with cattle for forage. Most urban and rural respondents did not know (Table 2-2). Most agriculture and rural respondents disagreed that prairie dogs are beneficial to the soil. Urban residents were mostly unsure. Both the urban and rural groups were largely unsure whether the species spreads disease or changes the plant community, while most agriculturists did agree with both statements. Most agriculture and rural respondents believed prairie dogs cause livestock injury, while most urban respondents did not know. When asked if the species was necessary for other wildlife, a plurality of agriculture respondents disagreed while most urban respondents agreed. The rural respondents were equivocal (Table 2-2).

Urban respondents believed that poisoning (̃ = 2.54, SE = 0.05) and habitat loss/development (̃ = 2.5, SE = 0.06) were important factors contributing to Utah prairie dog declines (Table 2-3). Climatic change was not considered an important factor (̃ = 1.58, SE = 0.07). Rural respondents thought that climatic change (̃ = 1.49, SE = 0.05) and overgrazing (̃ = 1.61, SE = 0.05) were not important. Agriculture respondents felt that diseases (̃ = 2.48, SE = 0.05) and predation (̃ = 2.11, SE = 0.06) were important reasons for Utah prairie dog declines (Table 2-3).

Attitudes and Opinions

When asked if they believed that the Utah prairie dog counts conducted by the DWR were accurate, most (70%) of the urban respondents were not sure. Only 8% of the rural and 7% of the agriculture respondents thought the counts were accurate. Most (66%) agriculture respondents believed that agriculture producers who had prairie dogs on their land should be compensated for damages, while rural respondents were equally split between agreement and disagreement. Most (68%) urban respondents were opposed to compensating agriculture producers. Most agriculture (74%) and rural (50%) respondents, and 33% of urban respondents felt that conservation/environmental groups should fund this compensation if it was provided (Table 2-4).

I also examined whether respondent involvement in agriculture operations influenced their support for compensation programs. Family members' involvement in agriculture did not affect urban respondent's beliefs regarding compensation ($\chi^2_1 = 0$, $P = 1.0$). Agriculture ($\chi^2_1 = 5.9$, $P = 0.015$) and rural ($\chi^2_1 = 7.6$, $P = 0.006$) respondents' views on compensation were related to whether or not they currently were active in agriculture. Additionally, rural respondents' views on compensation were related to whether or not they had family members active in agriculture ($\chi^2_1 = 4.2$, $P = 0.04$).

Most (61%) agriculture respondents thought that the Utah prairie dog had a right to exist only on public land, while 23% thought it did not have a right to exist at all. Most rural (64%) respondents likewise believed it should be only on public land, and 23% thought it should be on both private and public lands. Most (58%) urban respondents believed it should be on both private and public land, and another 39% thought only public land should have Utah prairie dogs. For urban and rural respondents, family member involvement in agriculture had no effect on this belief ($\chi^2_1 = 0.42$, $P = 0.52$ and $\chi^2_2 = 2.42$, $P = 0.52$). Likewise, for the rural and agriculture respondents, personal agriculture activity did not affect their belief regarding existence of Utah prairie dogs ($\chi^2_2 = 2.03$, $P = 0.36$ and $\chi^2_2 = 1.3$, $P = 0.52$, respectively).

Respondents differed regarding Utah prairie dog protection. Rural and agriculture respondents were more likely to support protection if prairie dogs did not interfere with their livelihood. Urban residents were more likely to believe prairie dogs should receive at least some protection (Table 2-5). The rural respondents differed from both the agriculture ($\chi^2_1 = 15.70$, $P < 0.0001$) and the urban respondents ($\chi^2_1 = 54.94$, $P < 0.0001$) on how they viewed the Utah prairie dog. Urban and agriculture respondents also differed from each other ($\chi^2_1 = 112.10$, $P < 0.0001$). The agriculture respondents held the most negative views; urban respondents held the most positive.

I found that for urban respondents, whether or not family members were active in agriculture was not correlated with how they felt about the Utah prairie dog (Somers' d = 0.017, ASE = 0.09). Furthermore, there was little correlation for the rural respondents for either family agriculture activity (Somers' d = -0.144, ASE = 0.097) or personal agriculture activity (Somers' d = -0.079, ASE = 0.073). For agriculture respondents there was little correlation between whether or not they were currently engaged in agriculture and how they felt about the Utah prairie dog (Somers' d = -0.177, ASE = 0.084).

The agriculture respondents strongly agreed that although the original intent of the ESA was good, it is being misused, and threatens property rights (Table 2-6). About half thought it should be revoked. Most (64%) disagreed that it had been a success or that it should be maintained without change (76%). Rural respondents had similar opinions (Table 2-6). The urban respondents also believed that the original intent was good, however most were not sure if it is being misused (54%). Although many were uncertain, they generally did not believe the act should be revoked (Table 2-6).

Agriculture respondents did not believe that the DWR, USFWS, BLM, or private conservation groups had been effective in dealing with Utah prairie dog issues (Table 2-7). Utah State University Extension was ranked as being more effective. Rural and urban respondents were more likely to have no opinion regarding this topic (Table 2-7).

I asked how people ranked themselves regarding the proper relationship between wild animals and human society (wildlife/human scale). The scale went from 1 to 6, with 6 being that human needs always come first and 1 that wildlife needs always come first. The agriculture respondents were more likely to believe that human needs were more important (̃ = 2.58, SE = 0.09). Rural residents were very similar in attitude (̃ = 2.8, SE = 0.08). The urban respondents were nearly neutral in their attitude (̃ = 3.3, SE = 0.1).

I tested whether this ranking affected the respondents' beliefs regarding the Utah prairie dog's right to exist in southern Utah, and how the respondent felt in general about the Utah prairie dog. Rural respondents' wildlife/human relationship ranking did significantly affect whether or not they thought that the Utah prairie dog had a right to exist in southern Utah (Cochran-Mantel Haenszel = 13.50, $P = 0.0002$). As the scale moved toward the human end, the respondent was more likely to feel the Utah prairie dog did not have a right to exist in southern Utah. This scale was also somewhat positively correlated with how they felt about the Utah prairie dog ($\gamma = 0.33$, ASE = 0.079). As the scale moved toward the human end, the respondent was more likely to have more negative feelings. The agriculture respondents were similar in that there was a positive correlation between their opinion of the Utah prairie dog and their scale score ($\gamma = 0.236$, ASE = 0.084). The relationship between the scale score and whether they thought the Utah prairie dog had a right to exist in southern Utah was not significant (Cochran-

Mantel Haenszel = 3.67, *P* = 0.055). The urban respondents likewise showed correlations between scale score and whether they thought the Utah prairie dog had right to exist in southern Utah (Somers' *d* = -0.25, ASE = 0.079) and their feelings about the species (γ = 0.59, ASE = 0.082). The direction of the relationship was always the same. As the scale moved toward the human end, the respondent was more likely to have more negative feelings toward the species.

Wildlife Damage

Approximately 20% of urban, 45% of rural, and 79% of agriculture respondents indicated they had experienced damage caused by wildlife within the past 5 years. Urban and rural respondents indicated property damage, vehicle collision, and damage to plants as the most common damage (Table 2-1). Damage to plants and property were cited most frequently by agriculture respondents (Table 2-1)

I tested to see if damage history affected how a respondent viewed themselves on the wildlife/human scale, and how they felt about the Utah prairie dog. For the urban respondents there was no correlation for either question (Somers' *d* = -0.01, ASE = 0.099 and Somers'*d* = 0.45, ASE = 0.1, respectively). Likewise for the rural respondents there was no correlation for either question (Somers' *d* = -0.09, ASE = 0.07 and Somers'*d* = 0.0024, ASE = 0.07, respectively). For the agriculture respondents there was no correlation between the human versus wildlife scale and damage history (Somers' d = 0.048, ASE = 0.087). However, there was a slight correlation between damage history and how they felt about prairie dogs (Somers' *d* = -0.21, ASE = 0.084). Those that had not experienced wildlife damage were more inclined to view the Utah prairie dog positively.

Summary Agriculture Statistics

I asked agricultural respondents a series of questions to determine agricultural operations. I also wanted to know the levels of damage that Utah prairie dogs were causing. More respondents were involved in cattle (66%) than sheep (19%) or dairy (9%) operations. Small grain (27%) and row crop (14%) were also well represented. Nearly all respondents (91%) raised alfalfa or some other hay crop. Only 5% indicated fee hunting as a type of operation.

Most respondents reported that the majority of their land was deeded, with 71% indicating over 75% of their operation fell into that class. Leased land was indicated, but most utilized it at less than 50% of the total acreage (Table 2-8). The USFS, BLM, and State Lands were similar in acreage. Nearly half of the respondents indicated no use of government lands (Table 2-8). Moderate (between 50 and 300 acres) sized farms were indicated most often (40%). Most of the respondents had farmed >25 years (71%).

Most indicated that Utah prairie dogs were active on land that they ranched or farmed (62%), and half of those (34%) indicated that the prairie dogs affected their operation. After deleting outliers, the mean number of hectares occupied by Utah prairie dogs was 176/operation. I then asked what types of damage Utah prairie dogs caused. Forage loss (29%), equipment damage (20%), horse injury (20%), and livestock injury (19%) were all indicated. Also, 11% reported loss of economic opportunity and 8% reported a loss of public AUM’s (animal unit months).

I tested whether the presence of Utah prairie dogs on farm-land influenced opinions regarding the Utah prairie dog. There was a negative correlation between the presence of Utah prairie dogs and the respondents opinion regarding the species (Somers' d = -0.3168, ASE = 0.0716). I also tested whether presence was related to beliefs on compensation and beliefs regarding whether the species has a right to exist in southern Utah. While the species' presence on a respondent's land was related to whether or not they thought the species had a right to exist in southern Utah (χ^2_2 = 8.43, P = 0.015), there was no relationship between presence and agreement with landowner compensation (χ^2_1 = 1.6, P = 0.28). Landowners who had Utah prairie dogs on their land were more likely to feel that the species did not have a place in southern Utah.

There was a negative correlation between Utah prairie dogs effect on an operation and the respondent's opinion regarding the species (Somers' d = -0.3093, ASE = 0.0764). Additionally, beliefs on compensation (χ^2_1 = 7.45, P = 0.006) and beliefs regarding whether the species has a place in southern Utah (χ^2_2 = 13.76, P = 0.001) were related to affect on operation. The human versus wildlife scale score was not related to effect on operation (Somers' d = -0.04, ASE = 0.078). Landowners that were affected by the Utah prairie dog were more likely to hold negative views on the species, believe the species should not be on private lands, and believe that landowners should be compensated for losses.

I asked respondents to estimate the annual loss caused by Utah prairie dog damage for several categories. Unfortunately, many respondents did not understand the question. Because of the high degree of variability in responses, I was not able to draw any conclusions from this question.

Conservation Options

The last series of questions for the agriculture population dealt with conservation and management options regarding the Utah prairie dog. Only 8% of the respondents had received DWR assistance in managing Utah prairie dog conflicts. Of those one received technical advice, four had prairie dogs removed, and seventeen received prairie dog take permits. No habitat modification projects were identified. While only 8% had received help in the past, 27% were interested in assistance to compensate losses caused by prairie dogs (either financial or technical). Another 23% were not sure. I tested to see if respondents interest in receiving assistance was related to presence of the species, affect on operation by the species, past assistance history, and the number of years the respondent had been involved in agriculture production. Interest in assistance was related to presence ($\chi^2_1 = 12.09$, $P = 0.0005$), effect on operation ($\chi^2_1 = 17.61$, $P < 0.0001$), and past assistance history ($\chi^2_1 = 7.47$, $P = 0.006$). Those respondents who had Utah prairie dogs on their land, were affected by the species, and who had received assistance in the past were more likely to be interested in assistance to compensate for losses. There was no relationship detected between willingness to receive assistance and number of years the respondent had been involved in agriculture production (Somers' $d = 0.172$, ASE = 0.075).

The DWR, USFWS, BLM, U.S. Forest Service (USFS), Natural Resources and Conservation Service (NRCS), and USDA Wildlife Services all scored very similarly in regard to whether landowners were willing to work with the groups (Table 2-9). The 2 conservation groups scored worse. Nearly 74% and 68% had no interest in working with these groups (respectively). Utah Farm Bureau Federation and Utah State University

Extension Service had nearly identical ratings with 48% and 47% very willing to work with them, respectively (Table 2-9).

I asked what types of assistance would be most beneficial to the agriculture respondents. They could choose more than 1 option. Killing some prairie dogs was selected by 40% of respondents, with another 33% preferring to kill all prairie dogs. Approximately 24% wanted some prairie dogs relocated, and 26% wanted all prairie dogs relocated. Compensation of forage/crop loss, equipment damage, and livestock injury was selected by 38%, 28% and 30% respectively. About 19% wanted technical advice and another 8% wanted fencing of colonies. Nearly 24% were interested in range improvements in areas occupied by prairie dogs. Forty percent of respondents wanted relief from regulations and another 11% were interested in conservation easements or other tax relief measures.

When asked if they were interested in entering some of their land into a conservation easement, 89% said no, 6% were somewhat willing, 1% very willing, and 4% not sure. I asked those that were interested how much the easement should be. Three respondents indicated $10-$25/acre/year, one indicated $26-$50/acre/year, eleven chose $51-$100/acre/year, and twenty chose >$100/acre/year. Of these 21 respondents, 10 thought that 5-10 years was ideal, 3 chose 11-25 years, 3 chose 26-50 years, and 5 chose perpetuity. I then asked how many acres they would enroll. Seventeen respondents indicated 10-40 acres, 4 indicated 11-160 acres, 4 indicated 161-640 acres, and 3 indicated >640 acres. Unfortunately, there were too few respondents interested in conservation easements to allow more detailed analysis.

When asked if they would be willing to allow Utah prairie dogs to be relocated on their land in exchange for financial compensation, only 4% said yes and another 10% were not sure. Of these, when asked how much compensation it would require, 7 respondents indicated >$100/acre/year, 2 thought $51-$100/acre/year was sufficient, and 1 thought $26-$50/acre/year was adequate. Unfortunately, there were too few respondents interested in relocations to allow more detailed analysis.

The final questions addressed the ESA. I asked whether the fear of restrictions under the act hindered their willingness to receive aid or assistance. Approximately 70% indicated it did. Another 34% admitted that they had in some way attempted to discourage Utah prairie dogs on their land to avoid regulatory problems.

Discussion

Reading et al. (1999) found that levels of antagonism toward prairie dogs increased on a gradient from conservation groups, urban residents, rural residents, and ranchers, respectively. I anticipated this to be similar with the Utah prairie dog. However, the general population might be more inclined to view the Utah prairie dog positively because it is an endangered species. Furthermore, this may lead agricultural producers to view it less positively than if it were not a listed species (Brook et al. 2003). Kellert (1985) suggested that species recovery efforts would be more successful if managers were better able to articulate the values society derives from endangered wildlife and define the human tradeoffs involved when a species is listed. Brook et al. (2003) reported that listing may hinder recovery of the Preble's meadow jumping mouse (*Zapus hudsonius preblei*), a rodent species not widely viewed as having value.

Although the Utah prairie dog is a rodent, some stakeholders may consider it a charismatic species. As expected, agricultural producers had more negative attitudes than did urban respondents regarding the species.

Zinn and Andelt (1999) reported that Fort Collins residents that were directly affected by prairie dogs also held more negative opinions than those residents not affected. Those affected also were more knowledgeable about the species, but this did not increase positive feelings. These findings were echoed in a Montana study (Reading et al. 1999). Most agricultural producers in Wyoming that had black-tailed prairie dogs on their property felt that the species negatively impacted their operation (Wyoming Game and Fish Department, unpublished document 2001). The desired management practice was complete removal. However there was strong interest in programs that could assist in managing damage to agriculture operations.

The results of my study show similar patterns as previous research in that those more affected by Utah prairie dogs (rural and agriculture respondents) were more knowledgeable about the species and aspects of its management. The rural and agriculture respondents were also more opinionated. This was expected, because issue salience causes individuals to have stronger opinions and feelings and be less neutral (Manfredo et al. 1992).

While most rural and agriculture respondents were aware that the Utah prairie dog was a listed species, many did not realize that it is a unique species. This brings into question public understanding or acceptance of the species concept. This was further reflected in many of the comments attached to the surveys where respondents expressed confusion about what a prairie dog was. It seems that many other rodent species were confused with prairie dogs. Many associated Utah prairie dogs with other rodents and made no distinction between the species.

Most urban respondents had little opinion regarding agency effectiveness in managing Utah prairie dogs. However, rural and agriculture respondents expressed strong sentiments. Agriculture respondents in particular were very negative in views of agency effectiveness. The only exception to this was the Extension Service. This is not surprising since many landowners are familiar with the Extension Service and receive useful information for many aspects of agriculture operations from their local county Extension agent. Also, having a local agent in their community likely increases their acceptance. Furthermore, both the Extension Service and Farm Bureau are non-regulatory and thus not as likely to be seen as threatening.

While detailed historic information is lacking regarding the decline of the Utah prairie dog, it is known that major eradication efforts (primarily poison) took place up until the 1960s (USFWS 1991). The urban respondents seemed to be somewhat knowledgeable of this fact. Surprisingly though, the agriculture respondents ranked shooting and poisoning much lower than disease and predation as causes for decline. The rural respondents had similar responses, but the degree of difference was not as pronounced. There seems to be a widespread belief in southern Utah that disease is a major population control to Utah prairie dogs. This may not actually represent true opinions however. From personal experience, most ranchers in southern Utah seem very knowledgeable about the eradication effort's effectiveness. They do seem to feel that at present, disease is the major limiting factor. It is possible that the agriculture respondents did not want to acknowledge eradication effects publicly. Another alternative is that respondents did not understand that we were asking about historic population reductions, not recent population changes.

Agriculture respondents did not view the Utah prairie dog as a keystone species. Urban residents did accept this concept. Further evaluation of the Utah prairie dog knowledge statements shows that the agriculture respondents generally do not accept positive aspects of the Utah prairie dog. Urban residents would be expected to see more of the positive aspects, since they do not personally deal with the negative implications. Those who do not have direct exposure to a problem would be expected to have less awareness of damage issues (McIvor and Conover 1994). Other reasons that might cause urban residents to view the Utah prairie dog more favorably are the charismatic appeal of the species. Kellert (1979) showed that emotions (affective) may be more related to positive feelings about wildlife than is knowledge (cognitive). Dahlgren et al. (1977) recommended that education programs aimed to increase knowledge of wildlife should include direct contacts with wildlife in a natural setting. For the urban respondents, this would likely result in the neutral opinions found in the rural respondents of this survey. It may be beneficial to educate the public as to why the Utah prairie dog is a separate species and why maintaining its genetic uniqueness is important. However, further educational programs will likely not change the opinions of those who are already familiar with it. In their minds, the negative aspects of the species will likely take precedence in decision making. Finding ways to alleviate damage issues would be more productive than attempting to change longstanding views regarding the species. Urban residents might be more inclined to sympathize with landowners dealing with Utah prairie dog damage if they were made aware of the extent and impact of the damage.

Decker et al. (2005) concluded that not only does the direct impact of wildlife influence attitude, but the perceived impact upon other people (indirect) may also be important in shaping attitudes toward wildlife. Thus we would expect that the low knowledge levels for urban respondents found in my study would lead those respondents to derive attitudes primarily from wildlife values and not from direct or indirect impacts.

I found that wildlife damage rates varied greatly between respondent groups. The urban respondents had similar rates (20% versus 24%) as a similar previous study (Reiter et al 1999). Agriculture respondents reported very high rates of damage, and rural respondents were in between the 2 groups.

This again substantiates the theory that those who do not have direct exposure to a problem would be expected to have less awareness of damage issues (McIvor and Conover 1994), and highlights the need to find ways to alleviate landowner damage issues to increase acceptance of Utah prairie dog recovery and management. McIvor and Conover (1994) noted that people with more direct contact with an issue were likely more aware of wildlife damage issues surrounding it. Manfredo et al. (1992) found that at higher levels of experience and discussion of an issue, it became easier to predict behavior from attitude and that attitude became more extreme. From these studies, I would expect agriculture respondents to be more opinionated and hold deep entrenched ideas regarding the species.

Compensation for wildlife damage on private lands does not appear to have broad acceptance from those outside of the agriculture community (Kellert 1979, McIvor and Conover 1994, Reiter et al. 1999). I found similar results. While the majority of agriculture respondents agreed with the concept, only half of the rural respondents did, and less than one-third of the urban residents did. Further tests showed that there was a strong association with participation in agriculture and acceptance of compensation programs. Therefore, those individuals not directly affected, do not favor this strategy. My results are similar to those of Messmer and Schroeder (1996), who found that Utah alfalfa farmers were most interested in compensation and incentive programs rather than assistance and information programs. A study by Czech and Krausman (1999) found that the public did support compensation of landowners who were negatively affected by ESA implications. Our survey question did not mention ESA burdens, but rather damage caused by prairie dogs. Therefore, it is possible that Utah residents not involved with agriculture would be more supportive of compensation to address regulatory burdens on landowners. It has been suggested that compensation programs may lead to more damage issues and reliance on payments (Bulte and Rondeau 2005). Targeting payments toward conservation outcomes rather than compensating losses directly would therefore be more beneficial to species recovery. These conservation payments should have strong landowner incentives to gain acceptance within the agricultural community.

An interesting note is that in all 3 respondent groups, the most populace response was that conservation /environmental groups should be responsible for any compensation if it occurs. Private insurance was the least acceptable for all 3 groups. This is contrary to previous research that found 41% of respondents supportive of private insurance paying for compensation and only 18% of respondents supportive of conservation/environmental groups funding compensation. I hypothesize this is a result of the view that endangered species management is driven by outside special interest groups. This sentiment has been noted from numerous personal contacts in southern Utah (D. Elmore, personal observation).

Environmental attitude scales have been successfully utilized in previous studies (Catton and Dunlap 1980). Ajzen and Fishbein (1980) proposed that a person's beliefs and attitudes is a good indicator of intention to behave. Therefore, I constructed a much simplified version of these scales in an attempt to test whether it could be a useful predictor of intent to behave. I found that the urban respondents were neutral in attitude. Both the rural and agriculture respondents were inclined toward the human end of the scale. Brunson and Steel (1994) found that most Americans see themselves as environmentalists. Our somewhat contrary findings are likely due to the fact that 2 of the populations I sampled were very rural. Even the urban respondents indicated close cultural ties to agriculture production, and were not far removed from a rural background. Our results also show that a generalized summary of an environmental attitude scale does seem to be related to how respondents viewed the Utah prairie dog and its place in southern Utah. Caution should be exercised in utility of this finding. Attitude and intent to behave are not necessarily indicative of realized behavior (Bright et al. 1993). Targeting individuals for inclusion in Utah prairie dog management options based solely on this scale is not recommended.

Another interesting finding from this study is that there is widespread belief that the original intent of the ESA was good. Even most agriculture respondents held this belief. However, both the rural and agriculture groups believe it has been misused and threatens property rights. Urban residents did not believe the act should be revoked, but beyond that they seemed unsure of how successful it had been and if it needed reform.

Both the rural and agriculture groups believed that reform was needed. Other research has found that the general public is not in favor of weakening or eliminating the ESA (Czech and Krausman 1999). From evaluating responses from ESA statements, agency effectiveness, and Utah prairie dogs place in southern Utah, it would appear that most antagonism from southern Utah respondents is directed at the bureaucracy surrounding the Utah prairie dogs' listing, and not necessarily at the species itself. While damage issues are apparent from our results, a majority of landowners believe that the species has a place in the ecosystem (albeit on public land).

The ESA listing of the Utah prairie dog possibly prevented further losses and possible extinction of the species. It is not the intent of this paper to evaluate this. However, it appears that at present the ESA listing may be more of a hindrance to recovery for both the West Desert and Paunsaugunt recovery areas. As there are large populations of Utah prairie dogs on public land in the Awapa recovery area, and private land damage issues are not as widespread in that area, I will exclude it from discussion here. The other 2 recovery areas have great numbers of Utah prairie dogs on private lands and have generated great conflict. One-third of our agriculture respondents admitted that they had taken action to discourage Utah prairie dogs on their land to avoid regulatory problems (i.e. ESA). From personal experience, I suspect this number is actually higher. Additionally, 70% indicated that fear of restrictions under the ESA prevents them from receiving aid or assistance. It could be argued that the ESA has prevented much higher prairie dog control on private land. However, from examining the comments and personal communication with ranchers, this is doubtful. Most landowners could likely eliminate the species without implications if they so chose. I have found that most landowners are willing to tolerate prairie dogs within some reasonable limit. Exceptions to this may be in urban housing, golf courses, and cemeteries where no level of damage is viewed as acceptable. I speculate that landowners adjacent to land already occupied by the Utah prairie dog are more likely to limit its spread due to fears regarding the ESA. This same mentality surrounding the red-cockaded woodpecker (*Picoides borealis*) was largely responsible for creation of the U.S. Fish and Wildlife Services' Safe Harbor Program.

I do not wish to imply that the species should be delisted without adequate recovery, nor that the ESA does not contribute to species recovery. What is needed is a better application of the act in regards to the Utah prairie dog. I conclude, as did Brook et al. (2003), that as presently implemented, the ESA listing is not aiding in recovery efforts on private lands and may in fact be detrimental.

Because of the low number of respondents that expressed interest in conservation easements and translocations, it is difficult to determine landowner characteristics to implement conservation strategy guidelines. It appears that most landowners are interested in control measures. However, a few successful case studies and the resultant peer communication likely could sway many landowners to consider conservation measures as long as the benefits outweighed the costs. Information from peers would be more influential than any other outside source (Conover 2002). Additionally, increasing the effectiveness of damage resolution would likely make landowners more willing to discuss management options to benefit the species.

As stated in the results, the respondents for all 3 groups tended to be more educated and older than the populations from which they were sampled from. These biases are likely due to more available free time for older persons and greater familiarity with surveys about complex topics among more educated persons. Also, responses were highly skewed toward male for all groups. This is likely a consequence of males predominately listed as head of household and as land ownership contacts. Similar bias has been reported in other studies (Reiter et al. 1999). Thus, our results may not be completely indicative of the true populations from which they were derived.

One potential management consideration concerns the fact that the average age of agriculture producers is nearly twice the county average. While this group was not very open to conservation measures for prairie dogs, they will be turning over farm operations to their children or the land ownership will change within the next 10-20 years. Thus, a new generation of operators will soon be in control of vast acreages of agricultural land. How this new generation's views regarding Utah prairie dogs will differ is difficult to predict. It would be beneficial to repeat this survey for the agricultural subgroup in another decade to evaluate potentially changing views.

Additionally, response rates for this type of natural resource survey were within the range of other recently reported studies (Connelly et al. 2003). Response rates approximately 50% are typical for multiple-page surveys (Neuman 1994). Both the rural and agriculture population response rates were near the 65% level recommended by Dolsen and Machlis (1991). The higher response rate for these groups is likely due to higher issue salience (Connelly et al. 2003).

Management Implications

The results of this study show that the rural and urban respondents in Utah differ in how they view the Utah prairie dog. Those outside of agricultural operations tend to have positive feelings toward the species. Thus, there is public support for its management. Yet, those most affected by management actions have different attitudes and perceptions. Specifically, there exists a fear regarding the ESA and low trust levels for government organizations and conservation groups. Both constituent groups should be considered by the USFWS so that a plan is formulated which conserves the species but does so in a way acceptable and compatible with agricultural and rural community needs.

Based on the results of this study, I recommend that personal direct contact, rather than large-scale information programs, be initiated. The contact should be a made by a trusted source such as Utah Farm Bureau or Utah State University Extension Service. I do not recommend that local extension agents be that contact since close interpersonal relationships may hinder project success. However, local extension agents would be beneficial as a liaison between landowners and an extension specialist. An effort should be made to alleviate damage as much as possible under ESA restrictions. I recommend that actions taken on private lands should have some measurable contribution to species recovery within the plan. If damage compensation is necessary, outside sources of revenue (non-government) should be sought so that landowners will be more responsive. It has become obvious that private lands are necessary in the recovery of this species. I encourage the Utah prairie dog recovery team to carefully consider landowners in the recovery process. Steps should be taken so that incentives are in place that are adequate to outweigh damage incurred.

If several successful case studies are carried out in each recovery area, I anticipate increased landowner interest. Initial contacts should be targeted to those landowners that have received assistance from the DWR in the past, since they are more likely to be responsive. Many Farm Bill programs exist that could be used to benefit Utah prairie dogs and landowners simultaneously. These programs need to be brought to the attention of landowners in affected areas. Additionally, the Safe Harbor program should be further explored for application in this area.

Lastly, I believe that much antagonism could be alleviated if certain high-conflict areas could be managed more intensively. Areas such as cemeteries, golf-courses, hospitals, and existing homes have been identified as areas where tolerance of damage is low. Tight restrictions under the ESA continue to aggravate residents of affected communities. Every effort should be made in these areas to reduce damage issues.

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Table 2-1. Selected demographics for urban, rural, and agriculture respondents in Utah, 2005.

	Urban	Rural	Agriculture
Statistics[a]	%	%	%
Education			
No High School	2 (10)[b]	< 1 (11)	2 (11)
High School	16 (24)	20 (32)	30 (32)
Some College	29 (28)	43 (29)	35 (29)
College	53 (35)	36 (25)	33 (25)
Background			
Urban	21	8	3
Suburban	38	9	2
Small Town	25	56	60
Rural	15	28	35
Male	70 (50)	78 (50)	83 (50)
Age	47 (29)	43 (32)	60 (32)
Damage[c]			
Property	15	20	54
Vehicle Collision	11	21	30
Plant/Crop	10	24	68

Table 2-1. Continued

Statistics[a]	Urban %	Rural %	Agriculturist %
Damage			
Livestock/Pet Injury	3	5	21
Personal Injury	1	2	6
Quality of Life	0	2	10

[a]All numbers reported as percentages except for age which is median age.

[b]U. S. Census Bureau statistics are shown for comparison in parenthesis where applicable.

[c]Damage occurring within previous 5-years.

Table 2-2. Urban, rural, and agriculture respondents that agreed, did not know, or disagreed with statements regarding the Utah prairie dog, 2005.

	Urban			Rural			Agriculture		
Statement	A	NS	D[a]	A	NS	D	A	NS	D
		%			%			%	
Forage[b]	14	54	32	27	42	31	51	29	19
Soil	28	61	11	5	40	45	10	26	63
Disease	17	67	16	38	52	10	51	44	5
Plant	25	59	16	40	47	14	57	39	4
Injury	27	50	23	61	24	16	73	16	11
Keystone	55	39	6	35	36	29	21	32	47

[a]Choices were: agree (A), not sure (NS), or disagree (D).

[b]Statements were, prairie dogs: compete with cattle for forage (forage), are beneficial to the soil (soil), spread disease (disease), change the plant community (plant), cause livestock injury (injury), and are necessary for other wildlife (keystone).

Table 2-3. Mean level of importance of various reasons for Utah prairie dog population declines for urban, rural, and agriculturist respondents, 2005.

	Urban		Rural		Agriculturist	
Reason	*x*[a]	SE	*x*	SE	*x*	SE
Shooting	2.27	0.06	1.96	0.05	1.56	0.05
Poisoning	2.54	0.05	2.16	0.05	1.82	0.05
Habitat Loss	2.5	0.06	2.18	0.05	1.86	0.06
Overgrazing	2.14	0.07	1.61	0.05	1.31	0.04
Climatic Change	1.58	0.07	1.49	0.05	1.61	0.06
Disease	2.11	0.07	2.26	0.06	2.48	0.05
Predation	2.16	0.07	1.92	0.05	2.11	0.06

[a]Choices were: 1 = not important, 2 = somewhat important, 3 = very important

Table 2-4. Urban, rural, and agriculture respondents that felt various groups should pay for damage caused by Utah prairie dog damage, 2005.

Groups	Urban %	Rural %	Agriculture %
Private Insurance	11	3	4
State Government	23	17	24
Federal Government	22	23	36
Conservation/Environmental	33	50	74

Table 2-5. Urban, rural, and agriculture respondents beliefs regarding the Utah prairie dog, 2005.

Category	Urban %	Rural %	Agriculture %
Dead[a]	1	17	28
OK	10	29	31
Unconcerned	30	19	18
Some Protected	50	31	23
All Protected	9	4	0

[a]Choices were: the only good prairie dog is a dead prairie dog (Dead), they are OK as long as they do not interfere with my life (OK), live and let live (Unconcerned), they should be protected to some degree (Some Protected), and they should be protected at all costs (All Protected).

Table 2-6. Urban, rural, and agriculture respondents that agreed, did not know, or disagreed with statements regarding the Endangered Species Act, 2005.

	Urban			Rural			Agriculture		
Statement	A	NS	D[a]	A	NS	D	A	NS	D
Good Intent[b]	77	20	3	74	15	11	62	19	19
Misused	29	54	17	66	25	9	83	11	6
Threatening	31	40	28	72	19	9	86	9	5
Revoked	8	38	54	29	38	33	53	31	16
Maintained	19	58	23	13	32	55	4	21	76
Success	25	59	16	10	47	42	7	30	64

[a]Choices were: agree (A), not sure (NS), or disagree (D).

[b]Statements were: the original intent was good (Good Intent), it is being misused (Misused), it threatens private property rights (Threatening), it should be revoked (Revoked), it should be maintained as is (Maintained), and the act has been a success (Success).

Table 2-7. Urban, rural, and agriculture respondent perceived effectiveness of various organizations in managing the Utah prairie dog, 2005.

	Urban		Rural		Agriculture	
Group	x^a	SE	x^a	SE	x^a	SE
Utah Division of Wildlife Resources	2.27	0.06	1.96	0.05	1.56	0.05
U.S. Fish and Wildlife Service	2.54	0.05	2.16	0.05	1.82	0.05
Bureau of Land Management	2.5	0.06	2.18	0.05	1.86	0.06
Private Conservation Groups	2.14	0.07	1.61	0.05	1.31	0.04
Utah State University Extension	1.58	0.07	1.49	0.05	1.61	0.06

[a] Choices were: 1 = not effective, 2 = somewhat effective, 3 = very effective

Table 2-8. Agriculture operations for agriculture respondents under various land ownerships, 2005.

Category	None[a]	1-20%	21-50%	51-75%	76-100%
Deeded Land	2	7	10	10	71
Leased Private	20	12	8	5	6
U.S. Forest Service	24	8	9	3	2
Bureau of Land Management	22	9	12	2	10
State Land	23	14	2	<1	<1
Other	25	1	0	0	0

[a]Not all respondents correctly classified their land. Therefore, percentages under "None" should be ignored.

Table 2-9. Agriculture respondent willingness to work with various organizations to manage conflict caused by Utah prairie dogs, 2005.

Groups	Very Willing %	Somewhat %	Not Willing %
UDWR[a]	28	38	36
USFWS	19	31	50
BLM	22	37	42
USFS	19	35	46
NRCS	22	40	38
Wildlife Services	20	38	42
Environmental Defense	10	16	74
Nature Conservancy	10	22	68
Farm Bureau	48	34	19
Extension	47	37	16

[a]Groups are: Utah Division of Wildlife Resources (UDWR), U.S. Fish and Wildlife Service (USFWS), Bureau of Land Management (BLM), U.S. Forest Service (USFS), Natural Resources and Conservation Service (NRCS), Wildlife Services, Environmental Defense, Nature Conservancy, Farm Bureau, and Utah State University Extension Service (Extension).

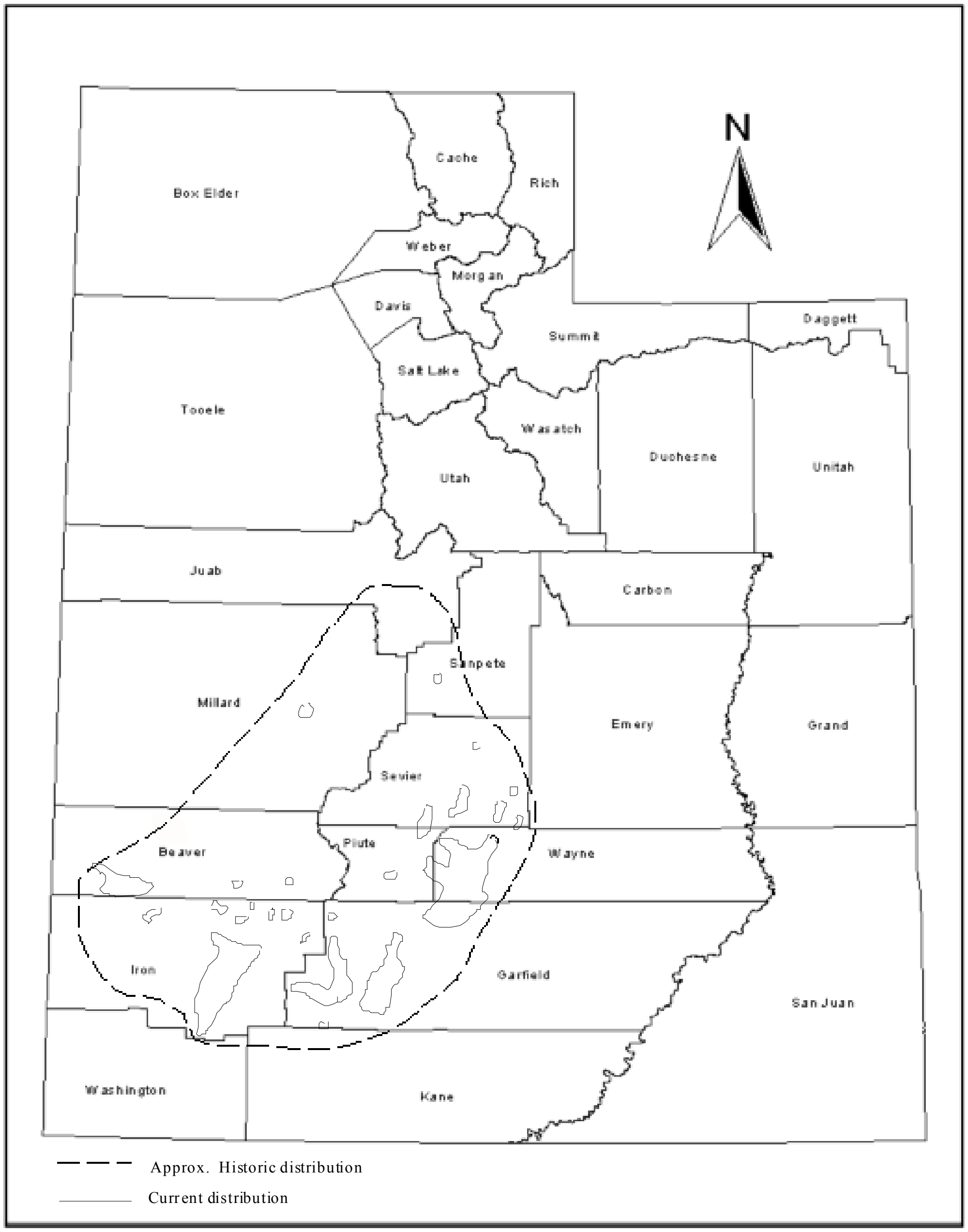

Figure 2-1. Past and present distributions of the Utah prairie dog (Bonzo and Day 2002).

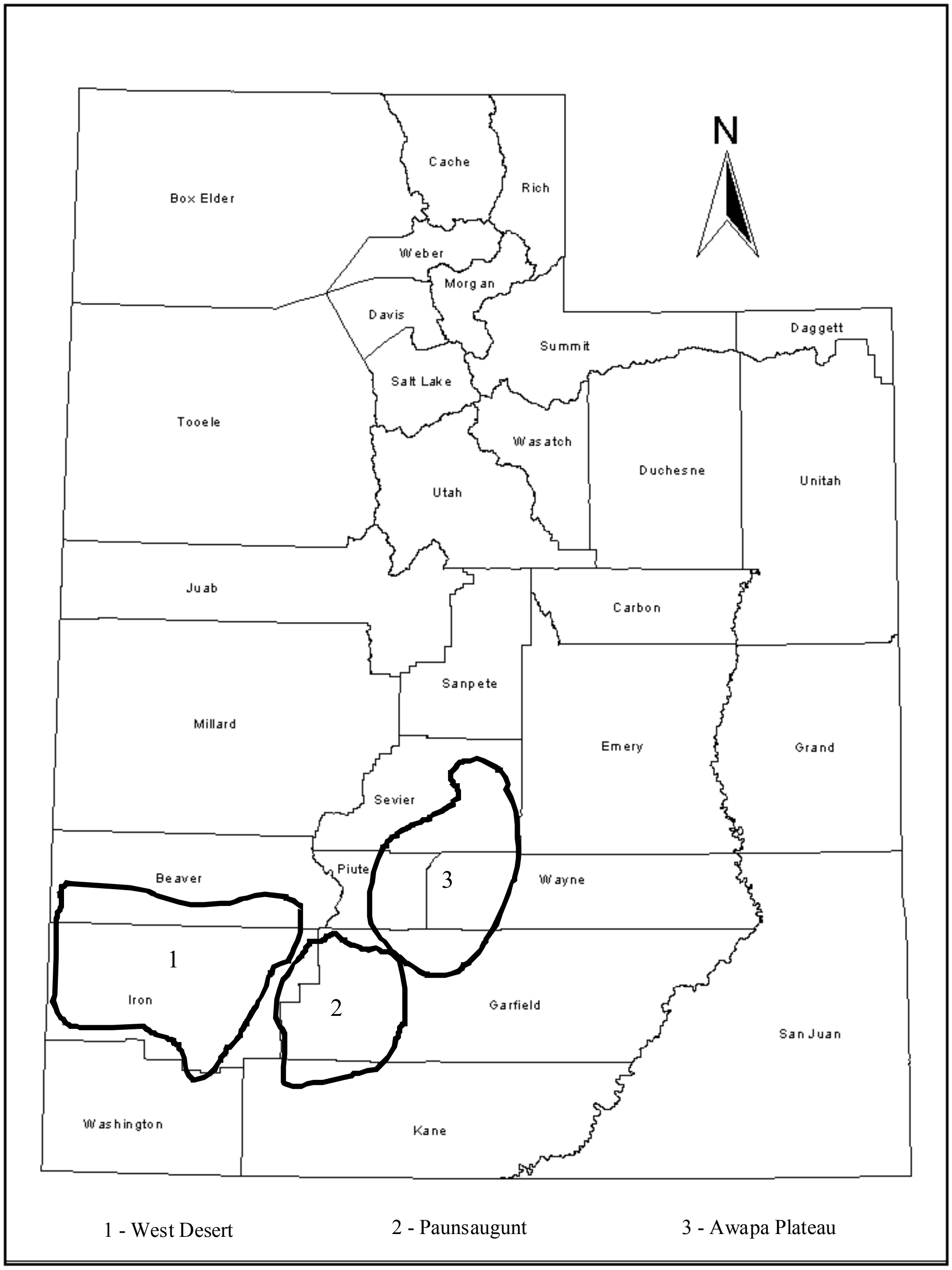

Figure 2-2. Location of the 3 Utah prairie dog recovery areas (Bonzo and Day 2002).

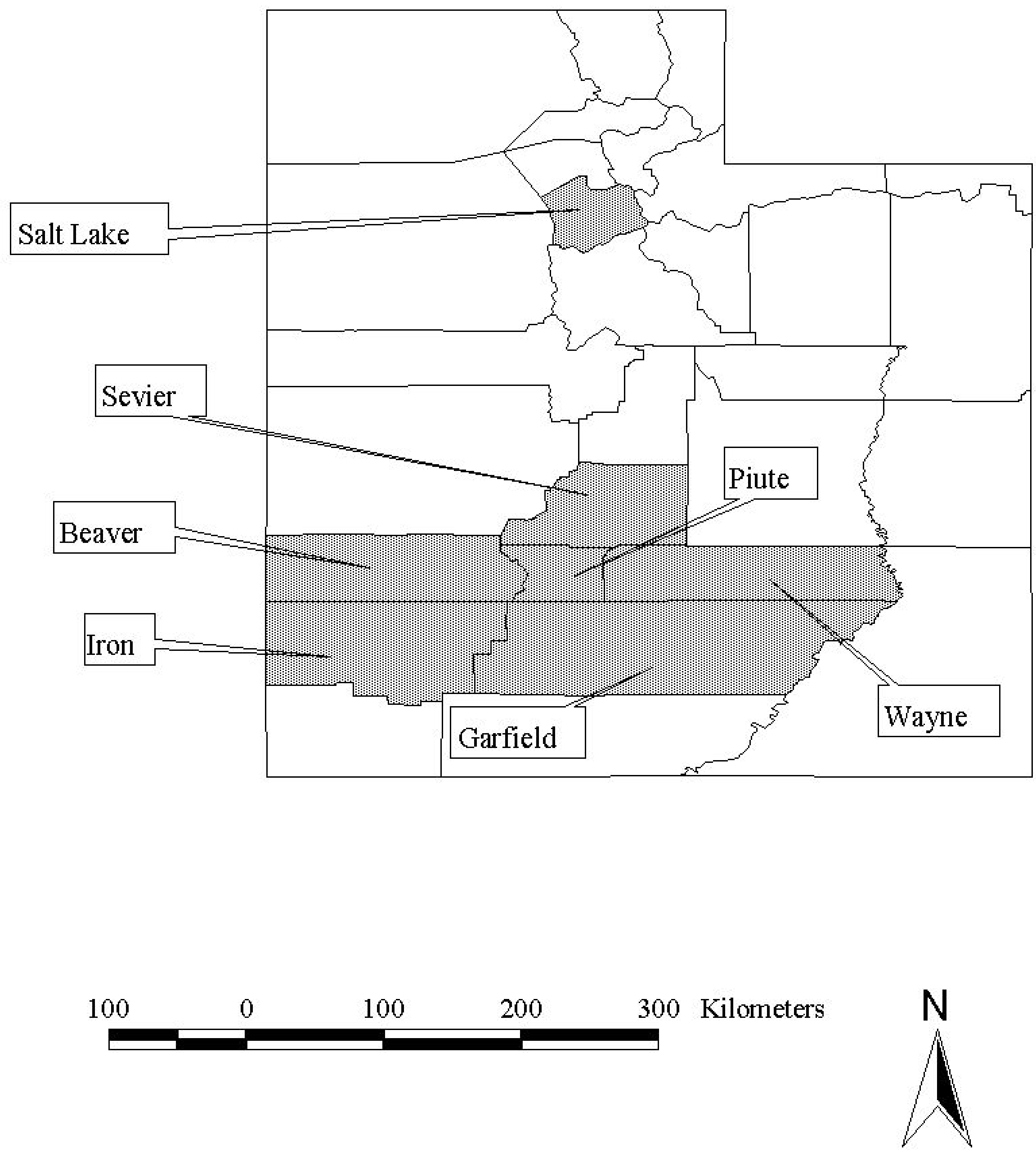

Figure 2-3. Locations of Utah counties that were surveyed during 2005 to assess perceptions and levels of damage surrounding the Utah prairie dog.

CHAPTER 3

THE EFFECT OF DIFFERENT CATTLE GRAZING INTENSITIES ON UTAH PRAIRIE DOGS AND THEIR HABITAT

***Abstract*:** The Utah prairie dog (*Cynomys parvidens*) is a federally listed species that occurs only in southwestern Utah. The Awapa Plateau in south central Utah is one of 3 Utah prairie dog recovery areas. The prairie dog population in this area has not achieved recovery goals established in 1991 by the U.S. Fish and Wildlife Service (USFWS). In 2002 the USFWS approved 3 Utah prairie dog mitigation banks on the Awapa. Little information exists regarding how these mitigation banks should be managed to optimize benefits for the species. Past research has suggested that reductions in shrub canopy cover that resulted in increased grass and forb cover may enhance Utah prairie dog recovery. From 2002-2005, I evaluated the effects of 20-30%, 50-60%, and 80-90% forage (grass) utilization rates, using domestic cattle to achieve a high-intensity/short duration grazing regime (growing season graze), on Utah prairie dog habitat use and foraging behavior. This was in attempt to reduce shrub cover by utilizing high stocking rates of cattle, for short periods, to improve Utah prairie dog habitat in shrub dominated landscapes. I found no evidence that high-intensity/short-duration cattle grazing affected Utah prairie dog densities or burrow density. However, Utah prairie dogs spent more time foraging and were less vigilant as forage utilization by cattle increased. Higher foraging rates coincided with reduced grass cover in the high utilization pastures. No change in plant composition over time was detected for any treatment levels. Growing-season high-intensity/short duration grazing was not found to shift vegetation

composition to favor Utah prairie dogs within 3 years. My results suggest that implementation of high forage utilization by cattle (80-90%) may negatively effect Utah prairie dogs if it results in increasing predation risks and reduced energy intake. To enhance Utah prairie dog habitat I recommend using mechanical means to treat areas that exhibit > 2 % shrub canopy cover. This treatment could then be maintained by fall grazing to control undesirable shrub encroachment.

Introduction

The Utah prairie dog was listed as an endangered species in 1973 pursuant to the Endangered Species Act (ESA) of 1969. The species was down-listed to threatened in 1984 after substantial numbers were found to be doing well on private lands in parts of Utah. The U.S. Fish and Wildlife Service (USFWS) completed a species recovery plan in 1991. The focus of the plan was to recover populations on federal lands in 3 areas (USFWS 1991). The areas identified included the West Desert of Utah, the Paunsaugunt Plateau, and the Awapa Plateau (which includes Parker Mountain).

Because Utah prairie dogs obtain nearly all of their moisture requirements from vegetation, there exists a strong correlation with available plant moisture and Utah prairie dog densities (USFWS 1991). Colonies are generally found in swale formations with deeper soils and succulent vegetation. Soil depth is also important for burrowing. Deep well drained soils are preferred as burrow sites. Colonies are typically found in Mollisols, and animals rarely occupy steep slopes (Collier and Spillett 1975). Burrows typically are 1 m deep and may extend for several meters underground. There are normally several openings to the burrow system. Height of vegetation can affect colony location. Prairie dogs defense against predation is the ability to spot potential predators. Therefore, the species prefers areas where the height of vegetation is low enough to facilitate this observation. Plant height of less than 31 cm seems to be preferred (Collier 1975). Plant height is important due to visual obstructions which aid in predation on prairie dogs. It can deter prairie dog utilization of habitat (Crocker-Bedford 1975).

Limited research has been conducted to document the food habits of the Utah prairie dog. Plant species varies greatly within the range of the species since it is known to occupy sites from 1,500 m to over 2,700 m. A variety of grass species are consumed depending on availability and are the predominant plant group consumed (USFWS 1991). Forbs are also an important food item particularly during drought periods (Crocker-Bedford and Spillett 1981). Utah prairie dogs appear to be selective in their foraging. Young leaves, flowers, and seeds are preferred parts of plants eaten (USFWS 1991).

There have been few studies examining cattle and Utah prairie dog interactions. Crocker-Bedford (1976) studied 3 areas that were inhabited by prairie dogs and grazed by cattle. His study area was located near Panguitch, Utah at elevations ranging from 2,000-2,300 m. He reported there was more forage available to prairie dogs than to cattle. The principal foods of both species were alfalfa (*Medicago sativa*), western wheatgrass (*Agropyron smithii*), and crested wheatgrass (*Agropyron cristatum*) all of which are introduced forage. Neither cattle nor prairie dogs showed a general dietary trend. He concluded that prairie dogs were more selective foragers than cattle. He established equivalent Utah prairie dog AUM's between 410 and 500 animals.

Crocker-Bedford (1976) reported that cool season grasses accounted for 44%, while perennial forbs comprised 52% of the adult Utah prairie dog diet. Specific forbs consumed included phlox (*Phlox sp*.), cryptantha (*Cryptantha abata*), and fendler spurge (*Euphorbia fendleri*). Cicadas (*Magicicada sp*.) comprised nearly 50% of their diet for a period in 1974 (Crocker-Bedford 1976). Litter and cattle feces were also consumed by juvenile prairie dogs (< 10%). This study site was located at approximately 2,230 m. At another study site (approximately 2,070 m.) nearly 80% of the diet was cool season grasses. European glorybind (*Convolvulus arvensis*) was the only major forb consumed. On another site that had been reseeded with crested wheatgrass (*Agropyron cristatum*), this grass was the preferred forage (Crocker-Bedford 1976). He recommended that for sites above 2,100 m the total percent canopy cover of all plants should be 42%; 30% cool season grasses, 5 % warm season grasses, 5% forbs, and 2% shrubs.

Prairie dog densities ranged from 2.3/ha to 35/ha in the Crocker-Bedford study. Additionally, the percentage of primary production consumed by prairie dogs varied greatly by site. He stated that cattle probably do not reduce populations of Utah prairie dogs within the year, but rather might increase populations in areas where vegetation production is high. However, he suggested that heavy long-term cattle grazing may have eliminated prairie dog habitat in swale locations by favoring shrubs. Collier and Spillett (1973) speculated that loss of Utah prairie dogs in the Escalante Desert in was caused in part by shrub encroachment. However, Allan and Osborn (1949) reported the disappearance of a colony of Utah prairie dogs because vegetation encroached on the site after cattle grazing was removed.

Ritchie (1998) evaluated prairie dog foraging rates and weight gain relative to the timing of grazing. He also compared population dynamics to vegetation characteristics. He reported that frequency of population crashes was negatively correlated with plant species richness. Spring grazing appeared to increase juvenile weight gain but decreased adult foraging rates. Ritchie recommended a deferred rotation grazing scheme so that pastures were not grazed every year at the same season. Other research has indicated that simulated grazing (mechanical clipping) increased the quality but decreased the quantity of forage available for Utah prairie dogs (Cheng and Ritchie 2005). They noted subsequent reductions in prairie dog growth rates once forage reduction exceeded 50%. Furthermore, they reported that juvenile foraging rates increased and vigilance rates decreased as percent forage removal increased. This study was conducted below 2,500 m elevation where crested wheatgrass was the predominant forage. In fact, most studies examining relationships between cattle grazing and Utah prairie dogs have occurred below 2,500 m elevation. Therefore, results of these studies may not be applicable to the Awapa recovery area.

Grazing by domestic livestock continues to be the dominant land use activity across most of the range of the Utah prairie dog. Previous studies suggest that grazing may not only be compatible with the Utah prairie dog, but can be used as a management tool. Prior to implementing this management strategy, more information is needed to understand the potential impacts that high intensity/short duration grazing might have on the plant community and consequently on Utah prairie dog populations.

Player and Urness (1982) speculated that many sites previously inhabited by Utah prairie dogs are no longer suitable because of changes in plant composition and structure. Elmore and Workman (1976) determined that sagebrush height and density was the restricting factor on most historic colony sites. Other research has found that reduction of shrub height and density increased success rates of Utah prairie dog reintroductions

(Player and Urness 1982). Licht and Sanchez (1993) concluded that cattle point attractants (such as water tanks and supplemental feed sites) may encourage colonization by black-tailed prairie dogs (*Cynomys ludovicianus*). This could be attributed to decrease in shrub component and increased production of annual grasses and forbs. Other research has found that reduction of shrub height and density increased success rates of Utah prairie dog reintroductions (Player and Urness 1982). Elimination of the black-tailed prairie dog (*Cynomys ludovicianus*) has been attributed to increased woody cover in areas once occupied by that species (Weltzin et al. 1997). These results suggest that reduced shrub canopy cover and height may benefit prairie dogs. If Utah prairie dogs behave similarly, periodic brush management to reduce canopy cover in areas inhabited by the species may facilitate recovery. The current recovery methods rely largely on reintroductions which are both costly and have low success rates (Bonzo and Day 2002).

While shrub reductions and increased grass and forb composition achieved by grazing may be beneficial to Utah prairie dogs in the long-term, existing colonies may be negatively affected in the short-term by reduced forage during the treatment. Prairie dogs begin to hibernate sometime between September and December. The actual time is dependent on elevation of site, sex of the animal, and food availability. In general adult males are the first to hibernate, followed by adult females several weeks later. Juveniles remain active longer. Emergence varies again depending on the elevation, but generally by February and April most are active (USFWS 1991). At high elevation sites with short growing-seasons, any reduction in weight of Utah prairie dogs may have survival costs in terms of over-winter survival.

In 2002, the USFWS approved 3 Utah prairie dog mitigation banks on the Awapa recovery area. The banks are operated by School and Institutional Trust Lands Administration (SITLA) to provide mitigation credits to assist local communities affected by the ESA regulation regarding take permits. Little information is available regarding how the banks should be managed to optimize benefits to the species in the banks. One of the 3 mitigation banks was mechanically treated to reduce shrub canopy cover and reseeded with a grass and forb mixture in 2002. There is evidence that Utah prairie dogs are attempting recolonization of this treated site after years of absence (Dwayne Elmore, personal observation). However, mechanical treatments are costly to implement large-scale. Livestock grazing would be more cost effective if it achieved a similar vegetation response. More information is needed prior to wide scale application.

Many areas of the Awapa have grass cover less than and shrub cover in excess of what is recommended for Utah prairie dogs (Dwayne Elmore, personal observation). I tested whether high intensity (up to 90% forage utilization) cattle grazing could reduce shrub canopy cover within a reasonable timeframe (3 years). Although, the 80-90% forage utilization has limited wide-scale applicability to rangeland management, it may have potential in site-specific situations to manage vegetation for Utah prairie dogs.

My objectives were to 1) determine the effect of 3 grazing intensities on Utah prairie dog behavior and habitat use in high elevation (> 2,300 m. elevation) a shrub-steppe community, and 2) determine if cattle grazing can be used to improve Utah prairie dog habitat in a high elevation shrub-steppe community. The null hypothesis for objective 1 is that different grazing intensities will have no effect on Utah prairie dog counts, borrowing activity, and foraging rates. Alternate hypotheses include: pastures grazed to achieve 20-30% forage utilization will exhibit increasing prairie dog counts, high burrow establishment, and low foraging rates due to increased forage availability; pastures grazed to achieve 50-60% forage utilization will exhibit no change in prairie dog counts, low burrow establishment, and high foraging rates; and pastures grazed to achieve 80-90% forage utilization will exhibit lower prairie dog counts, low burrow establishment, and higher foraging rates due to decreased forage availability.

The null hypothesis for objective 2 is that there will be no difference in plant composition between treatment levels. Alternate hypotheses include: pastures grazed by domestic livestock to achieve 20-30% forage utilization will exhibit a decrease in composition of grass and forbs, and an increase in shrub composition over time due to increased competitive pressure from shrub species; pastures grazed by domestic livestock to achieve 50-60% forage utilization will exhibit no change in shrub, grass, or forb composition over time; pastures grazed by domestic livestock to achieve 80-90% forage utilization will exhibit an increase in the grass and forb composition and a decrease in shrub composition over time due to reduced composition from grazed shrubs. These hypotheses assume that high cattle forage consumption will reduce shrub cover through direct consumption (as preferred forage becomes limiting within the grazing period) and by trampling. By releasing more resources (i.e. water and nutrients), grass cover is expected to increase over time which would be beneficial to the Utah prairie dog.

Study Area

The Parker Mountain Resource Area consists of 153,655 ha and is located in Garfield, Piute, and Wayne counties in south central Utah on the Awapa Plateau (Figure 3-1). It is bounded to the north by Fish Lake Mountain, to the west by Grass Valley, to the east by Boulder Mountain, and to the south by the Aquarius Plateau. The area is largely managed by Bureau of Land Management (33%), U.S. Forest Service (31%), SITLA (31%), private landowners (5%), and the UDWR (< 1%).

The area is composed of rolling topography dominated by sagebrush with scattered patches of aspen (*Populus tremuloides*). Mountain big sagebrush (*Artemisia tridentate* ssp. *vaseyana*) and black sagebrush (*Artemisia nova*) are present with limited amounts of silver sagebrush (*Artemisia cana*). Key forage species include needle-and-thread grass (*Stipa comata*), letterman needlegrass (*Stipa lettermani*), bluebunch wheatgrass (*Agropyron inerme* and *Agropyron spicatum*), mountain brome (*Bromus carinatus*), western wheatgrass (*Agropyron smithii*), blue grama (*Bouteloua gracilis*), sheep fescue (*Festuca ovina*), slender wheatgrass (*Agrypyron pauciflorum*), and prairie junegrass (*Koeleria cristata*).

Parent material for Parker Mountain is composed mostly of volcanic deposits. Soils in this area are generally loamy, rocky, and well-drained. Elevation varies from 2,200-3,000 m. The frost free season is less than 80 days. Parker Mountain receives 40-50 cm of precipitation annually, with most occurring during the dormant season as snow (60%) and in late summer (monsoon pattern) (Jaynes 1982).

This experiment was conducted on SITLA property near the junction of Garfield, Piute, and Wayne counties, and us commonly known as the "tanks" area (Figure 3-2). It is located in the "South" pasture of the SITLA land block and will be referred to as the South Butte mitigation bank. This area is dominated by black sagebrush. Some mountain big sagebrush exists on the site on north and east facing slopes. Also, there is a considerable degree of sagebrush hybridization at the site. Soils on the ridges are Forsey series and the swales are composed of Parkay series (Jaynes 1982). The geology of the study site is characterized by undifferentiated latite and basaltic andesite flows (20-25 million years before present) and andesite breccias (25-30 million years before present) (Jaynes 1982).

The dominant land use activity on Parker Mountain is grazing by domestic livestock. Historically both sheep and cattle were heavily grazed on Parker, which may have resulted in large areas composed almost entirely of sagebrush with few grass and forb species (Jaynes 1982). An abundant population of pronghorn antelope (*Antilocapra americana*) is present on this site during much of the year. Other important grazers on Parker Mountain are mule deer (*Odocoileus hemionus*) and elk (*Cervus canadensis*). These 2 species are occasionally on the study site during the winter but rarely during the growing-season. Utah prairie dogs inhabit several colony sites across Parker Mountain, although the numbers have declined in recent years, partially due to drought conditions (unpublished UDWR data). Annual counts of Utah prairie dogs show that the Awapa recovery area has made minimal recovery at best (Figure 3-3)

Due to market conditions resulting in declining profitability of sheep production, there continues to be a trend towards increasing cattle grazing and decreasing sheep grazing on Parker Mountain. There is currently only 1 sheep producer grazing on the SITLA land block (approximately 365 AUM's) (Ron Torgerson, SITLA, personal communication). This trend is expected to continue into the foreseeable future, and therefore I evaluated only cattle grazing and not sheep in this experiment. Currently, there are 1,000 AUM's allocated to the "South" pasture. Cattle typically are placed on the pasture around June 1 and are moved off in early fall. Forage production is estimated to be 170 kg/ha. The forage utilization goal is 60% for this pasture (Ron Torgerson, SITLA, personal communication).

There are several Utah prairie dog colonies in the vicinity of the south butte mitigation bank (within several kilometers). A large colony is located to the south of the treatment site. Additionally, prairie dogs inhabit the entire study site at much lower densities, although densities increased substantially during the study period. Historic mounds are found throughout the site.

Mackey (1988) reported that 12% of Utah prairie dogs dispersed annually. Juveniles made up 86% of this annual dispersal. Average distance of dispersal was 0.27 km for males and 0.68 km for females. Therefore, I assumed that prairie dogs can disperse throughout the entire study area (Mackey 1988). Additionally, to control for as much environmental variation as possible, the study site was chosen so that all experimental pastures would have similar soil type and vegetation composition. By locating all experimental pastures together I eliminated the effect of microclimate (specifically precipitation) differences in this monsoon prone area.

Methods

Grazing Treatments

Nine pastures, 8.1 ha each, were constructed in a drainage located in the South Butte mitigation bank of Parker Mountain (Figure 3-2). Fence construction was completed by a local contractor through Utah State University. Two 9,475-liter water tanks were placed on the highest elevations of the pastures and a network of water pipe was installed. Each pasture had a smaller water tank (approximately 380 liters) which was supplied by the larger tanks by gravity flow. Three treatment levels were used to evaluate the effect of grazing intensity on the plant community and Utah prairie dogs. The 3 treatment levels were low (20-30%), moderate (50-60%), and high forage utilization (80-90%).

Each of the experimental pastures had a treatment level randomly assigned but stratified by elevation. Because of the undulating topography, it was not possible to locate the study site in a completely level area. Therefore some pastures were on a slightly higher elevation. I expected slight differences in vegetation due to differences in soil and water levels along the elevation gradient. The pastures were therefore stratified into ridge and swale sites. Pastures 1, 3, 5, and 6 were classified as ridge sites. Pastures 2, 4, 7, 8, and 9 were classified as swale sites (Figure 3-2). The randomization specified that each treatment must be represented in both site types. This was an attempt to control for slope position.

Stocking rate was determined based on SITLA forage measurements for that area (170 kg/ha). I wanted to apply a short-duration grazing regime over a period of approximately 3 weeks. Therefore, based on the knowledge that cattle typically consume 2% of their body weight daily (Holecheck 1988) and that the cattle used would weigh approximately 363 kg each, stocking rate was set at 4 cows/pasture (low forage utilization), 8 cows/pasture (moderate forage utilization), and 11 cows/pasture (high forage utilization). This was adjusted by increasing cattle numbers by 1 animal for each pasture 2004 and 2005 to reach forage utilization objectives within the allotted time. Cattle were placed on the pastures simultaneously in early June (varied with year, based on site readiness) and removed when the assigned forage utilization levels are met for each pasture. Forage utilization of grasses was determined by ocular estimation after training had occurred (BLM 1984), because of the sparse grass cover and the lack of 1 predominant forage. Cattle (heifers) were borrowed from a member of the local grazing association.

Prairie Dog Monitoring

Burrows. At the beginning of the study, the locations of any historic prairie dog mounds and burrows within the experimental pastures were recorded with global positioning system (GPS) technology. During the study, any new burrow construction or occupation of historic mounds was noted and the locations recorded. A historic mound was defined as a prairie dog mound which currently had no visible burrow entrances. An active burrow was defined as a burrow with obvious recent prairie dog activity. This activity included fresh disturbed soil or prairie dog droppings around burrow entrance. An inactive burrow lacked recent signs of activity. Due to the close proximity of all experimental pastures, all pastures were within the range of dispersal of prairie dogs from surrounding colonies or from mounds currently occupied within the experimental pastures (Mackey 1988).

Prairie Dog Censuses. Weekly census of Utah prairie dogs were conducted throughout the summers during 2002-2005. Each pasture was surveyed individually, using UDWR protocol (USFWS 1991). Protocol states that the wind speed should be < 16 km/hour, weather must be sunny, and the time must be between 0900 and 1600 hrs. Also, pastures were surveyed from approximately 100 m. initially, and then I moved within the area to perform a more thorough search. An attempt was made to survey pastures in the same pattern throughout the study. Additionally, a control colony located to the south of the experimental pastures was surveyed weekly. This was done to control for normal fluctuations in prairie dog numbers corresponding to juvenile emergence and subadult dispersal. Crocker-Bedford (1975) estimated that only 40-60% of Utah prairie dogs are above ground at any time. Therefore, Utah prairie dog censuses only serve as an index to the relative population and not an actual population count.

Foraging. I used similar techniques as described by Ritchie (1998) and Cheng and Ritchie (2005) to conduct forage observations of Utah prairie dogs for 1 pasture in each treatment level. Observation blinds were constructed in pastures with the highest, and approximately equal, prairie dog numbers such that each treatment level was sampled. Ritchie recorded biting rates and biting size of Utah prairie dogs (Ritchie 1998). The likelihood of obtaining an accurate and adequate sample using this method on the proposed study site is questionable due to high shrub density. Therefore I recorded only foraging activity as a measure of total foraging at 15 minute intervals between 0900-1200 hrs. Each pasture was sampled once every week on a common day from early June until early late July. Every 15 minutes, all visible prairie dogs within the pasture under observation were counted, an activity noted, and adults were distinguished from juveniles. Although only foraging and alert activities were included in final analysis, activities recorded included: alert, foraging, moving, conflict, playing, and resting,

Vegetation

Each pasture was divided into 4 equal quadrants. Within each quadrant 3 transects 25 m in length were randomly placed for each vegetation sampling period. Therefore for each pasture there were 12 transects for each sampling period. This subdivision was to ensure that all portions of a pasture were sampled. The beginning point and the direction of transects were randomly determined. Vegetation measurements were taken at 5-m intervals along transects. At each interval a Daubenmire frame was used to evaluate species present, percentage of ground occupied by each species, and average species height (Daubenmire 1959). Additionally, a modified 10-m line intercept transect was utilized to evaluate shrub abundance and height along the transects (Canfield 1941). However, during preliminary analysis, I determined that due to the low stature and small canopy cover of individual shrub plants, Daubenmire results more precisely represented shrub composition on the landscape. Therefore, line intercept data were not used in the final analysis. Vegetation measurements were taken immediately before treatment, immediately after treatment, and in late summer for 3 field seasons.

Two exclosures (each 2.5 x 2.5 m) were constructed in each pasture so that forage utilization could be monitored. The exclosures also allow for comparison of grazing regimes to an ungrazed plot across time. Each exclosure had a paired unexclosed plot. A complete list of plant species detected within the experimental pastures can be found in Appendix C.

Data Analysis

Utah prairie dog censuses and burrow data were analyzed using the Proc Mixed procedure due to the repeated nature of data collection (SAS 1999). Plots of residuals were examined to ensure that ANOVA (analysis of variance) assumptions of normality and equality of variance were met for both data sets. Transformations were applied if assumptions were not met. Pasture was nested within treatment in the mixed ANOVA models. Fixed effects included treatment level, year (or time), and treatment/year interactions. Only active burrows were considered for analysis between years because inactive burrows quickly collapsed and were not easily located and therefore not an acceptable indicator. For prairie dog count data, year and survey week were combined to form a single time variable. I considered all inferential tests with $P < 0.05$ to be significant.

Descriptive statistics and plots were used to categorize forage observation data. I computed the proportion of prairie dogs foraging by dividing the number of prairie dogs observed foraging by the total prairie dogs observed for each treatment level during each period. This proportion foraging was used as an indicator of foraging effort by treatment level across time. Adults and juveniles were examined separately. Additionally, the proportion of alert (those standing erect) prairie dogs (adults and juveniles combined) was computed and compared across time between treatments.

The experimental unit for the vegetation data was the pasture with treatment being the level of forage utilization. This is a mixed design where Daubenmire frame was nested within transect, that was nested within quadrant, that was nested within pasture. Thus the sampling unit is the Daubenmire frame. Due to the power of this type of nested design and the high precision expected (due to low variation and high sampling intensity) I expected any effect due to treatment to be evident. All data were tested for normality and equality of variance assumptions of ANOVA by examination of the residuals and by comparison of variance between treatments. Transformations of the raw data were applied if assumptions were not met. Due to the repeated measurements design, Proc Mixed was used to analyze all vegetation data. Test of effect slices in Proc Mixed were used when appropriate to examine interactions (SAS 1999). The canopy cover and height data for grasses, forbs, and shrubs were obtained from Daubenmire frames. Since the dominant shrub (in terms of cover and height) on the landscape was *Artemisia* spp., and due to drastic palatability differences between it and other shrubs present, only this genus was analyzed. In other words, several genera of shrubs such as *Chrysothamnus* and *Erigonum* were consumed heavily by cattle and the reductions in these shrubs masked treatment effect on *Artemisia* which was the desired shrub to reduce. Fixed effects included treatment level, period, year, and treatment/period/year interactions. I considered all inferential tests with $P < 0.05$ to be significant.

Results

Burrows

Utah prairie dog burrow distribution and density varied by year (Figures 3-4, 3-5, and 3-6). With only 1 exception, the number of active burrows increased within each pasture over the 3 years (Table 3-1). In one instance there was no change in active burrows between years. The range of increase in active burrows was between 17% and 245% from 2003-2005. There was no treatment/year interaction ($F_4 = 0.57$, $P = 0.69$). Analysis revealed that level of forage utilization did not influence the change in active burrows over time ($F_2 = 0.98$, $P = 0.43$). Year was related to change in active burrows over time ($F_2 = 14.56$, $P = 0.0006$).

Prairie Dog Censuses

The number of Utah prairie dogs surveyed was characterized by low initial numbers before juvenile emergence (Figures 3-7, 3-8, and 3-9). Numbers then quickly peaked in early June, and began a slow decline by late summer as subadults dispersed. The control colony experienced a plague outbreak in 2005. For that reason, the control was not considered in inferential tests. There was no treatment/time interaction ($F_{68} = 0.69$, $P = 0.96$). Forage utilization level was not related to prairie dog counts ($F_2 = 2.21$, $P = 0.19$). Time was related to Utah prairie dog survey data ($F_{34} = 8.08$, $P < 0.0001$) as would be expected due to juvenile emergence and annual fluctuations.

Foraging

Foraging time varied among treatments across time (Table 3-2). Examination of plots comparing proportion of adult Utah prairie dogs foraging revealed a general trend toward increased foraging time in the high forage utilization pasture in both 2004 and 2005 (Figures 3-10 and 3-11). There were occasional abrupt changes in forage time. Some of these can be explained [such as the presence of a weasel (*Mustela frenata* on 7/8/05)], and others are of unknown cause. The low forage utilization pasture showed the same increasing trend as did the high forage utilization pasture in 2005.

Juvenile prairie dogs increased foraging effort over time in all treatment levels. This observation would be expected as they wean and begin foraging above ground. However, juvenile foraging time was highest in the high forage utilization pasture in both 2004 and 2005 (Figures 3-12 and 3-13). The low forage utilization pasture had the lowest forage time for juveniles in both years. Utah prairie dog alert time (vigilance) was lower in the high forage utilization pasture than in the moderate treatment level (Figures 3-14 and 3-15). Utah prairie dogs in the low treatment level pasture had the highest alert time for 2004 and the lowest time in 2005 (Figures 3-14 and 3-15).

Grass

The average percent canopy cover of grass for the experimental pastures was 11.23%. Cool season grasses comprised <1% of the total canopy cover (Table 3-3). There was no treatment effect ($F_2 = 0.31$, $P = 0.74$) for grass cover. However, there was a year effect ($F_2 = 7.62$, $P = 0.0013$) and a period effect ($F_2 = 8.08$, $P = 0.0009$) as would be expected due to annual precipitation and seasonal plant phenology differences.

For grass height there was both a treatment/period (F_4 = 7.04, P = 0.0002) and a year/period interaction (F_4 = 6.72, P = 0.0002). Both the high and moderate treatment levels differed between periods (F_2 = 30.42, P < 0.0001 and F_2 = 3.39, P = 0.042, respectively), while the low treatment level did not differ between treatments (F_2 = 0.86, P = 0.43). This is due to the increased rates of forage utilization in those treatments. Additionally, the post-period and last-period differed between treatment levels (F_2 = 18.54, P < 0.0001 and F_2 = 3.57, P = 0.036, respectively), while the pre-period did not differ between treatments (F_2 = 2.44, P = 0.098). Pre-period, post-period, and last-period also differed between years (F_2 = 8.47, P = 0.0007, F_2 = 13.11, P < 0.0001, and F_2 = 11.2, P = 0.0001, respectively). Periods within years differed for 2003 (F_2 = 26.67, P <0.0001) and for 2004 (F_2 = 5.62, P = 0.006), but not for 2005 (F_2 = 1.74, P = 0.19).

Forb

Forb canopy cover for the experimental pastures was 7.5% (Table 3-3). There was no treatment effect (F_2 = 1.3, P = 0.34) or period effect (F_2 = 3.03, P = 0.057) for forb cover. There was a year effect (F_2 = 10.56, P = 0.0002) likely explained by precipitation differences.

Neither treatment nor period effects were significant for forb height (F_2 = 4.35, P = 0.068 and F_2 = 3.01, P = 0.058, respectively). Year/period interaction was significant (F_4 = 6.17, P = 0.0004). Once again the post-period and last-period differed between years (F_2 = 4.85, P = 0.012 and F_2 = 21.81, P < 0.0001, respectively), while the pre-period did not differ between years (F_2 = 1.81, P = 0.32). Periods within years did not differ for 2003 (F_2 = 2.39, P = .10) and for 2004 (F_2 = 1.56, P = 0.22), but did differ for 2005 (F_2 = 11.4, P < 0.0001).

Shrub

Shrub canopy cover for the experimental pastures was 25.8% (Table 3-3). There was no treatment effect for shrub percent canopy cover (F_2 = 1.51, P = 0.3). Both year and period effects were significant (F_2 = 16.59, P < 0.0001 and F_2 = 4.43, P = 0.02, respectively) reflecting precipitation and plant phenology.

Average shrub height for the experimental pastures was 10.85 cm. There was no treatment effect for average shrub height (F_2 = 4.69, P = 0.059). There was a year/period interaction (F_2 = 4.10, P = 0.006). The post-period differed between years (F_2 = 7.21, P = 0.002), while the pre-period and last-period did not differ between years (F_2 = 2.22, P = 0.12 and F_2 = 0.57, P = 0.57, respectively). Periods differed during 2003 (F_2 = 9.57, P = 0.0003), but not during 2004 or 2005 (F_2 = 2.36, P = 0.11 and F_2 = 1.89, P = 0.16, respectively).

Discussion

My observations support previous findings that reduction in amount of available forage increases forage time and decreases vigilance time of Utah prairie dogs (Ritchie 1998, Cheng and Ritchie 2005). While I was not able to examine survivorship of individual prairie dogs over time, other research has found that at higher forage utilization levels by cattle, not only did Utah prairie dog foraging time increase but survivorship decreased (Ritchie 1998, Cheng and Ritchie 2005). My census data and burrow distribution data do not support this hypothesis. There are several plausible explanations to explain this difference.

First, I believe dispersal of sub-adults from surrounding areas may have masked any losses of prairie dogs in the high utilization pastures that may have occurred because of low survival rates. Secondly, while foraging time did increase under high forage utilization, prairie dogs in these areas, through selective grazing, may still have been able to obtain enough energy reserves to survive hibernation without loss of fitness. Both of these explanations would be more likely during a wet cycle where food availability was higher. In 2004, precipitation was 126% above normal at a nearby weather station. In 2005, precipitation was 205% above normal by July for that same station (Table 3-4). Cheng and Ritchie (2005) noted that their study coincided with a drought which likely exacerbated negative effects.

Another consideration is the density of the prairie dogs in the experimental pastures. Pastures with similar (but not equal) prairie dog numbers were chosen to examine forage time. However, the moderate treatment level pasture had the highest initial counts and peak counts in both 2004 and 2005. Therefore, the difference in foraging time cannot be explained by prairie dog density. Density of prairie dogs may have affected prairie dog response to high forage utilization by cattle, however. Examination of prairie dog surveys by individual pastures revealed that one of the 3 high utilization pastures had declining prairie dog counts across time. Initially, this pasture had some of the highest prairie dogs densities of any of the pastures. The remaining 2 high utilization pastures had increasing prairie dog numbers across time. Both of these pastures had few if any prairie dogs at the beginning of the study. Thus, differences in initial prairie dog density may have masked any treatment effects. All of these concerns should provide caution in using survey data or burrow numbers as indicators of colony health. While foraging time may be more indicative of treatment effects, these data still do not provide essential survivorship data.

A major concern for the Awapa Plateau recovery area is the short growing-season. With elevations above 2,500 m, snow cover frequently persists until mid-May on many sites. Because prairie dogs enter hibernation early in the fall, the time to acquire sufficient energy reserves is less than at the other Utah prairie dog recovery areas. Therefore, even slight reductions in forage availability may cause serious long-term population reductions particularly in drought periods (Cheng and Ritchie 2005).

I noted that juvenile prairie dog foraging time in particular increased under high utilization grazing. Because the Awapa Plateau recovery area receives much of its annual rainfall in late summer as monsoon rain, this may have helped mitigate any juvenile over-winter mortality. As juveniles enter hibernation later in the year, the increased availability of warm-season grasses after cattle were removed may partially explain the lack of difference in prairie dog counts or burrow establishment among grazing intensity levels. This warm-season grass response was noted by an approximately 1% grass cover increase and a 1.5 cm grass height increase between the end of the grazing period and late summer for the high forage utilization pastures.

Previous studies have focused on facilitation versus competition among different species of herbivores of dissimilar size and diet (McNaughton 1983, Bakker et al. 2004). Additionally, many studies have addressed effects of prairie dog herbivory and competition on large herbivore grazing patterns (Coppock et al. 1983, Knowles 1986, Krueger 1986, Fahnestock and Detling 2002). However, this topic is beyond the scope of my study, as I was only interested in the effects on the Utah prairie dog (particularly its habitat). In general, the literature suggests that competition can be expected when plant productivity is low or animal density is high (Heske and Campbell 1991, Keesing 1998). With forage production estimated at 170 kg/ha and a frost free season of less than 80 days, my study site can be considered to have low productivity. Additionally, cattle densities were high on the high utilization pastures, albeit for a short period of time. By placing cattle at such density, diet selectivity would be expected to decrease (Savory 1999). Therefore, I would expect that conditions were in place to create competition. My Utah prairie dog forage observation data supports this argument.

However, an important question yet to be answered is whether this actually affected survival of Utah prairie dogs. Although, I did not collect data to directly test this, results from previous studies suggests this is likely, particularly during drought (Ritchie 1998, Cheng and Ritchie 2005). Ritchie (1998) and Cheng and Ritchie (2005) found profound survival differences based on forage utilization level. However, the systems examined for these studies were much simpler than those found on the Awapa. Specifically, in the areas they studied the monsoon rain pattern is less pronounced, and the area is dominated by a low diversity of cool-season grasses. Additionally, these studies took place during a major drought period.

During the 3-year study period, I was not able to detect any reduction in shrub canopy cover or change plant class composition. One purpose of this study was to evaluate if high intensity/short duration grazing (utilizing cattle during the growing-season) would result in a reduction in shrub canopy cover and an increase in palatable grass and forb cover. The vegetation cover differences detected reflected seasonal and annual variation, but not treatment effects. Height did differ between treatments but for grass only, reflecting higher levels of forage utilization by cattle.

Shrub height did not appear to be above Utah prairie dog guidelines for the South Butte mitigation bank. However, other areas on the Awapa may have shrub cover above the recommended 31 cm (e.g. Tanks mitigation bank). Grass cover was < 50% recommended and warm season grass cover was < 20% recommended. If the current recommendations for vegetation for Utah prairie dog are to be followed, then further methods of vegetation treatments should be evaluated on the Awapa Plateau. Based on the fact that I did not detect the hypothesized shrub reductions and subsequent increase in grass cover, and the potential negative effects that may exist for Utah prairie dogs, it seems unnecessary to further test the effects of growing-season high-intensity grazing by domestic cattle as a shrub reduction method for the Utah prairie dog. Rather, I would suggest alternative methods of shrub reduction be evaluated on the Awapa recovery area. Future research examining habitat alterations of any kind should address individual survival of Utah prairie dogs in the treatment areas. These data will provide stronger evidence of treatment effects than any observational data. While there was initial concern in my research as to whether there were sufficient Utah prairie dogs within the treatment area to obtain adequate sample sizes and to risk trapping mortalities, I believe the necessity of the data warrants its inclusion in future research.

Mechanical means of shrub reduction may be more appropriate on the Awapa Plateau. Previous research has shown that forage production typically doubles or triples within the initial 5 years of big sagebrush (*Artemisia tridentata*) treatments (Bartolome and Heady 1988, McDaniel et al. 1992). Areas around the Awapa mitigation banks are dominated by black sagebrush (*Artemisia nova*). However, growth forms on the Awapa Plateau are not typical of black sagebrush with plant stature and cover approaching that of big sagebrush in the deeper soil areas that Utah prairie dogs prefer. Additionally, there exists great hybridization of big sagebrush and black sagebrush on these sites (Jaynes 1982). Therefore, the black sagebrush found on the Awapa may approximate big sagebrush in terms of response.

Another potential shrub reduction technique is fall grazing with domestic sheep. Shrub intake by domestic sheep typically increases in the fall (Seefeldt 2005). Fall grazing by domestic sheep over many years has been shown to reduce three-tipped sagebrush (*A. tripartitea*) canopy cover (Bork et al. 1998). Seefeldt (2005) found no reductions in canopy cover of *A. tridentate* after only 3 years of fall sheep grazing. Fall sheep grazing with energy and protein supplementation has shown some promise of reducing big sagebrush cover, but more data are needed (T. Staggs, Utah State University, unpublished data). Based on the literature, it appears that even during the fall when shrub intake is greatest in domestic sheep, reductions in sagebrush cover may be difficult to achieve within a short time frame (3 years).

It is likely that some type of biological control (such as domestic grazing) will be necessary to reduce undesirable shrub response (*Chrysothamnus* spp.) and to reduce *A. nova* reestablishment following mechanical treatments. Bartolome and Heady (1988) found that after 10 years the effects of *A. tridentata* control diminished on most sites. Therefore, a combination of mechanical and biological control may be most appropriate. These need further investigation on the Awapa. While combining treatments would increase total cost of shrub reduction, the desired effect would be achieved in a shorter time period. Based on the fact that the Utah prairie dog is a listed species and has experienced minimal recovery on the Awapa, time may be more valuable than other resources.

Management Implications

Grazing by domestic livestock has been speculated to be a cost-effective management tool compared to mechanical methods such as harrowing or disking, which can reach costs of $20/ha (R. Torgerson, SITLA, personal communication). However, consideration must be given to the continued cost of administration of the ESA for the Utah prairie dog, private landowner implications of the ESA, and time and logistical considerations of implementing a landscape level high-intensity/short duration grazing regime. With all of these factors taken into account, $20/ha for mechanical control begins to appear more acceptable as a shrub reduction method, particularly if Utah prairie dog numbers reach levels where maintenance of shrub levels are possible so that continued treatments are not necessary.

Additionally, based on previous mechanical treatments (harrow and aerators) on the Awapa for greater sage-grouse (*Centrocercus urophasianus*), and on plant species composition in and around the Utah prairie dog mitigation banks, seeding of grasses and forbs is likely unnecessary following treatment (D. Dahlgren unpublished data). This would greatly reduce the cost of mechanical treatments.

I recommend that high-intensity/short duration grazing of cattle during the growing-season not be implemented in areas currently occupied by Utah prairie dogs as a method of shrub canopy reduction. Instead, mechanical treatments (such as harrowing of brush hogging) should be evaluated on the Awapa recovery area to examine the hypothesis that Utah prairie dog numbers will increase as shrub levels are reduced and that Utah prairie dogs will increase dispersal rates into newly treated areas. The Tanks mitigation bank and the South Butte mitigation banks both have shrub cover above and grass cover below the recommendations for Utah prairie dogs. Evaluation of mechanical and/or fall grazing treatments could be evaluated on either site. Regardless of the method of shrub reduction, quantified data on Utah prairie dog survival should be collected with regard to treatment response. Large-scale shrub reductions should not be applied for Utah prairie dog management on the Awapa Plateau until definitive evidence is obtained regarding its efficacy.

In areas where mechanical treatment is not feasible (such as rocky areas or areas with significant archaeological significance) then fall grazing alone (preferably by sheep) should be utilized to reduce shrub cover. While this method may be cheaper, it will likely take longer to achieve the desired results and in some years early snowfall may prohibit its use at these high elevation sites. Additionally, supplements may be necessary to increase shrub consumption by livestock. Biological maintenance in the form of sheep and cattle will likely be necessary to control unwanted shrubs post treatment. Specifically, rabbitbrush (*Chrysothamnus viscidiflorus*) encroachment may be a significant problem on the Awapa (R. Torgerson, SITLA, personal communication). It has been noted that (*Chrysothamnus viscidiflorus*) in this area are highly palatable to livestock, and thus could be controlled with livestock grazing.

Herbicide treatments are not recommended except in very low-statured stands of black sagebrush where residual brush will not obstruct prairie dog vision (< 31cm). Herbicide treatment is generally an economical method to increase forage production in sagebrush steppe (Holecheck and Hess 1994). Unfortunately, the woody debris left from an herbicide treatment would need to be mechanically removed if the height exceeded that recommended for Utah prairie dogs, thereby increasing cost. This would preclude its use on many areas on the Awapa. Additionally, specific herbicides should be approved for use on rodents if occupied Utah prairie dog colonies are to be treated.

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Table 3-1. Active burrows counted for each pasture during 2003-2005, Parker Mountain, Utah.

Pasture	Treatment Level	Active Burrows			% Change
		2003	2004	2005	
1	moderate	89	177	198	122
2	high	40	76	138	245
3	high	0	26	91	250 [a]
4	low	126	147	147	17
5	moderate	190	222	288	52
6	low	23	25	37	61
7	high	182	188	235	29
8	moderate	107	117	175	64
9	low	72	110	235	226

[a]Pasture 3 percent change calculated from 2004 to 2005 since 2003 had no burrows detected.

Table 3-2. Proportion of total adult and juvenile Utah prairie dogs counted that were observed foraging 2004 and 2005 in selected pastures for each treatment level.

Year and Time[a]	Adult Foraging			Juvenile Foraging		
	High[b]	Mod	Low	High	Mod	Low
2004						
1[c]	0.18[d]	0.47	0.87	NA[e]	NA	NA
2	0.25	0.53	0.39	NA	NA	NA
3	0.25	0.56	0.62	0.06	0	0.02
4	0.23	0.44	0.40	0.36	0	0.20
5	0.31	0.45	0.27	0.13	0.02	0.12
6	0.17	0.31	0.54	0.18	0.37	0
7	0.23	0.20	0.23	0.22	0.35	0
8	0.33	0.42	0.38	0.24	0	0.50
9	0.40	0.29	0.53	0.13	0.41	0.25
10	0.67	0.32	0.35	0.45	0.33	NA
2005						
1	0.40	0.55	0.30	NA	NA	NA
2	0.33	0.48	0.13	NA	NA	NA
3	0.72	0.45	0.20	NA	0	NA
4	0.54	0.75	0.43	0.41	0.25	0

Table 3-2 continued.

Year and Time	Adult Foraging			Juvenile Foraging		
	High	Mod	Low	High	Mod	Low
2005						
5	0.69	0.39	0.25	0.33	0.17	0.35
6	0.11	0.63	0.44	0.07	0.20	0.20
7	0.63	0.42	0.50	0.18	0.33	0.13
8	0.77	0.50	0.77	0.80	0.44	0.24

[a]Forage observation for 2004 was 5/20/2004 – 7/28/2004. Forage observation for 2005 was 5/28/2005 – 7/26/2005.

[b]Time periods representing week of survey for each year.

[c]Levels of treatment were 80-90% forage utilization (High), 40-50% forage utilization (Mod), and 15-25% forage utilization (Low).

[d]Proportion foraging were calculated by dividing the number of Utah prairie dogs observed foraging by the total Utah prairie dogs observed for that period in that treatment.

[e]No juvenile prairie dogs detected for this time period.

Table 3-3. Plants measured in experimental pastures in 2003-2005, Parker Mountain, Utah

Scientific Name	% of Class	% of Landscape
Grasses		
Agropyron spp.	8.23[a]	< 1[b]
Bouteloua gracilis	3.12	< 1
Carex spp.	26.36	2.96
Koeleria cristata	1.08	< 1
Muhlenbergia richardsonsis	0.04	< 1
Poa spp.	40.46	4.54
Sitanion hystrix	3.10	< 1
Stipa spp.	17.58	1.97
Unknown	0.03	< 1
Forbs		
Agoseris sp.	0.05	< 1
Antennaria dimorpha	4.00	< 1
Arabis spp.	5.36	< 1
Arenaria sp.	0.13	< 1
Aster spp.	0.03	< 1
Astragalus spp.	6.17	< 1
Cactus	0.03	< 1

Table 3-3 continued.

Scientific Name	% of Class	% of Landscape
Forbs continued.		
Caestilleja spp.	0.05	< 1
Centrostegia thurberi	2.68	< 1
Chenopodium album	0.10	< 1
Erigeron spp.	13.05	1.00
Erigonum spp.	5.20	< 1
Gayophytum sp.	9.91	< 1
Gilia aggregate	0.12	< 1
Heuchera parvifolia	0.27	< 1
Lappula redowski	0.27	< 1
Linum lewisi	0.23	< 1
Lomatium sp.	0.17	< 1
Lupinus spp.	1.12	< 1
Orobanche fasciculata	0.08	< 1
Penstemon spp.	5.52	< 1
Phlox spp.	24.84	1.80
Polygonum aviculare	3.55	< 1
Potentilla spp.	15.55	1.20
Senecio spp.	0.45	< 1

Table 3-3 continued.

Scientific Name	% of Class	% of Landscape
Forbs continued.		
Tarazacum officinale	0.70	< 1
Trifolium sp.	0.23	< 1
Unknown	0.05	< 1
Shrubs		
Artemisia nova	48.75	12.60
Artemisia tridentata vaseyana	0.17	< 1
A. nova x *A. tridentata vaseyana*	4.85	1.29
Chrysothamnus viscidiflorus	28.94	7.50
Erigonum microthecum	7.75	2.01
Gutierrezia sarothrae	0.03	< 1
Leptodactylon pungens	9.08	2.32
Mahonia repens	0.03	< 1
Tetradymia sp.	0.04	< 1

[a]Percentages calculated as percentage of plant class composition (either grass, forb, or shrub).

[b]Percentages calculated as percentage of total canopy cover.

Table 3-4. Precipitation records from 2002-2005 for Koosharem and Angle, Utah.

	Koosharem				Angle			
	2002	2003	2004	2005	2002	2003	2004	2005
January	0.03[a]	1.35	1.78	3.1	0	0.18	0.20	NA[b]
February	0.31	1.37	1.94	2.06	0.51	1.22	0.91	1.12
March	0.38	3.66	0.03	2.21	0.10	1.22	0.25	2.01
April	2.72	0.76	4.93	2.08	0.99	0.86	3.40	2.62
May	0	1.60	1.83	2.21	0	1.12	1.55	2.29
June	1.09	0.15	0.38	7.52	0	0.03	1.22	8.51
July	2.11	2.97	2.9	NA	1.04	2.13	1.63	NA
August	0.69	2.79	4.93	NA	1.22	7.21	3.05	NA
September	6.07	0.94	NA	NA	7.98	0.36	0.89	NA
October	3.43	1.45	8.81	NA	4.34	1.37	7.49	NA
November	1.65	1.52	2.08	NA	1.58	0.97	1.22	NA
December	1.65	3.20	1.14	NA	NA	1.17	0	NA
Yearly Totals	20.17	21.77	30[c]	NA	17.76[b]	17.83	21.82	NA

[a]All data in centimeters.

[b]Precipitation data not available.

[c]Incomplete data for that year.

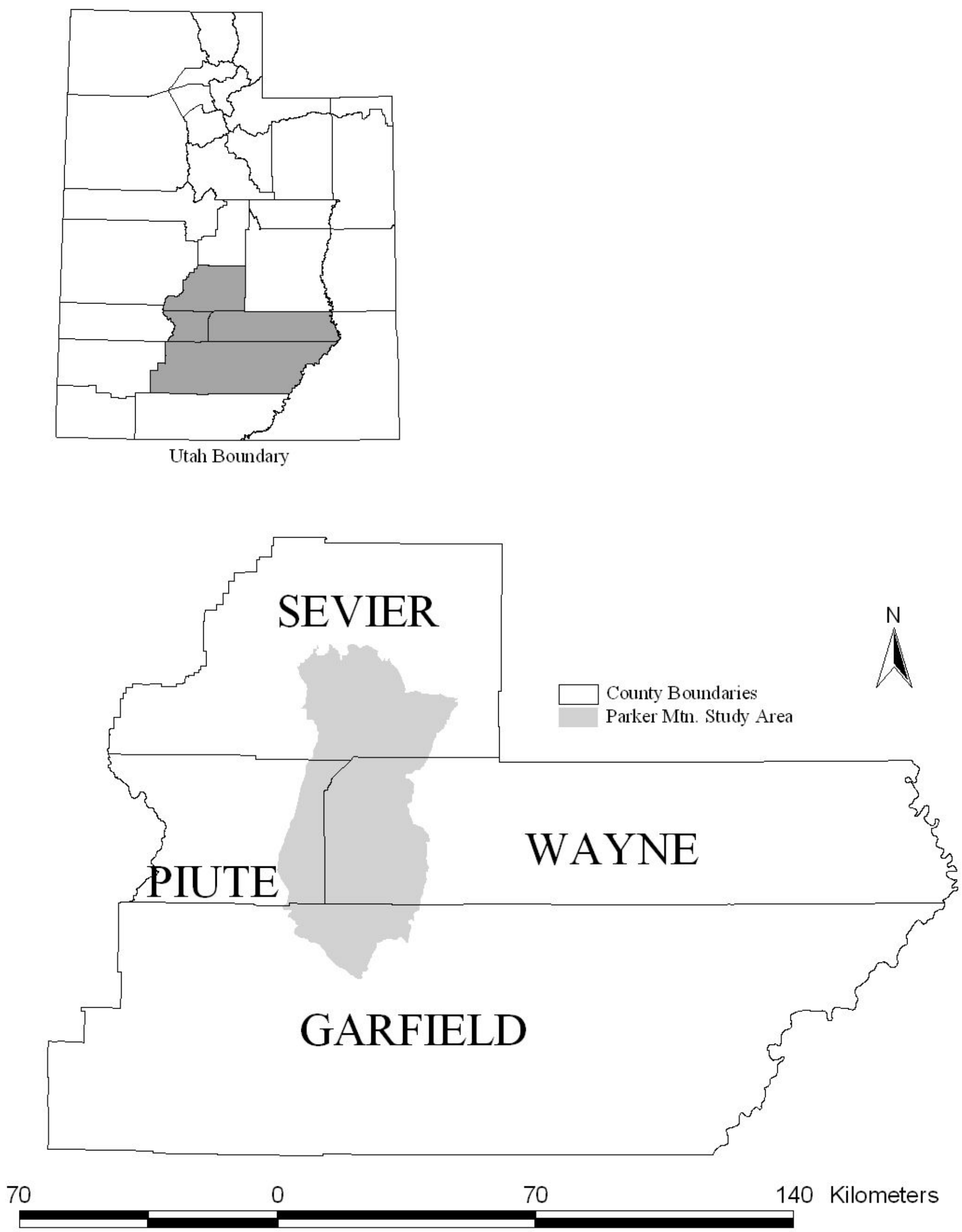

Figure 3-1. Location of study area, Parker Mountain, Utah.

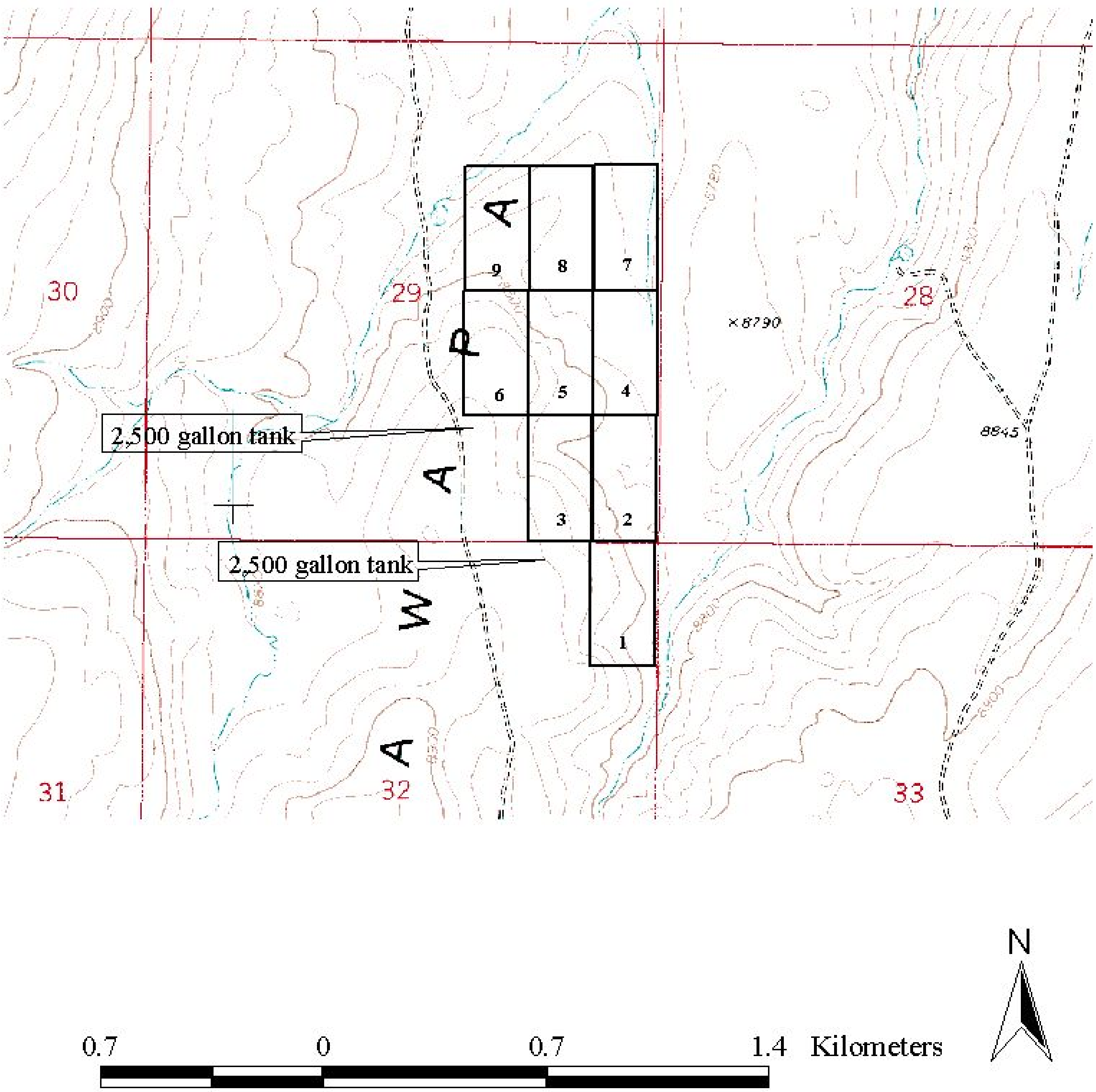

Figure 3-2. Experimental pasture locations and water tank location on Parker Mountain, Utah.

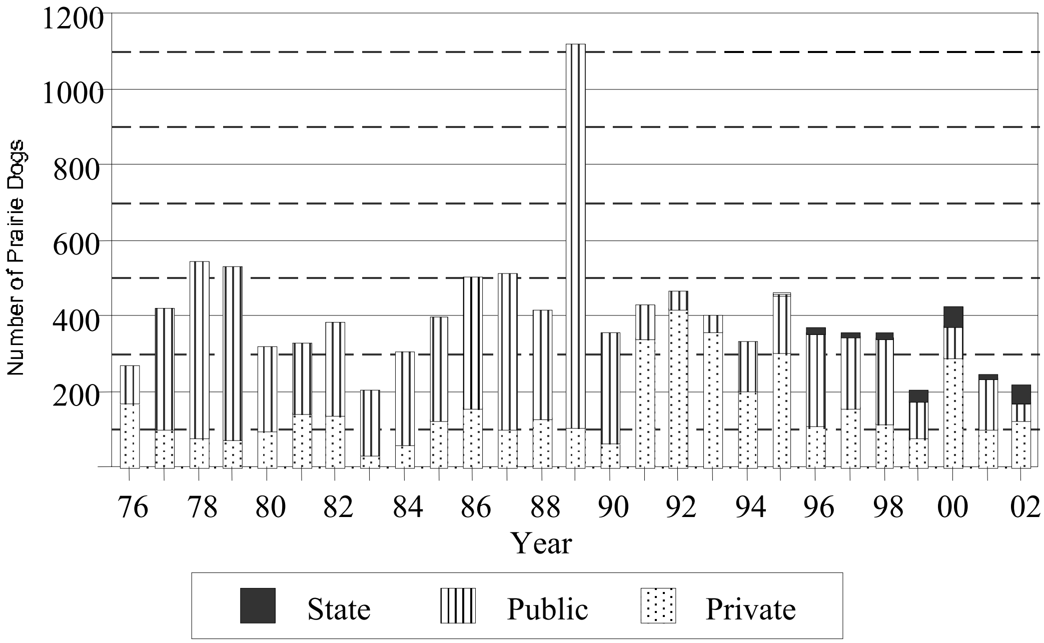

Figure 3-3. Annual counts of Utah prairie dogs on the Awapa Plateau Recovery Area for 1976-2002 (UDWR Annual Report 2002).

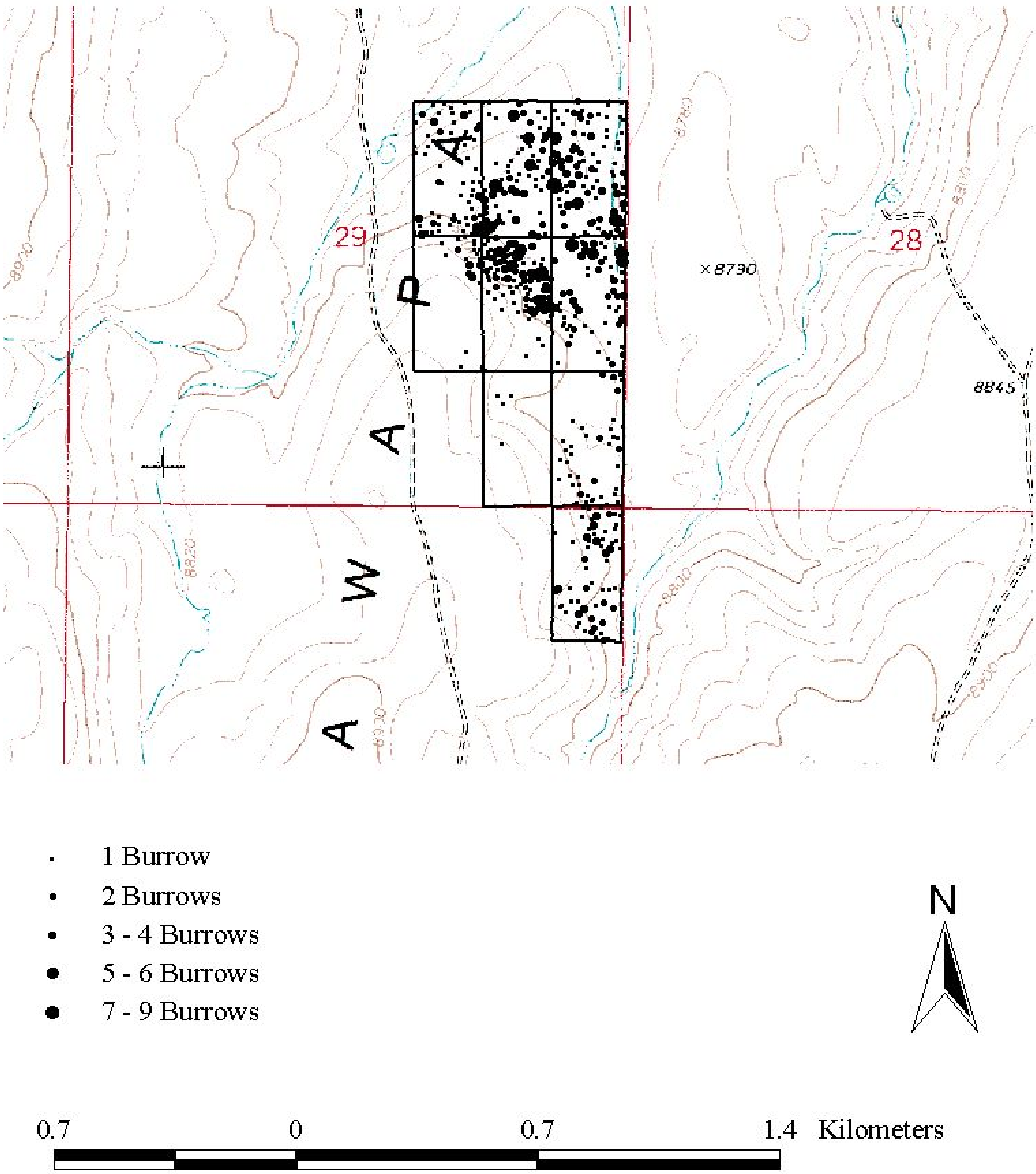

Figure 3-4. Distribution of prairie dog burrows in experimental treatment pastures on Parker Mountain Utah, 2003.

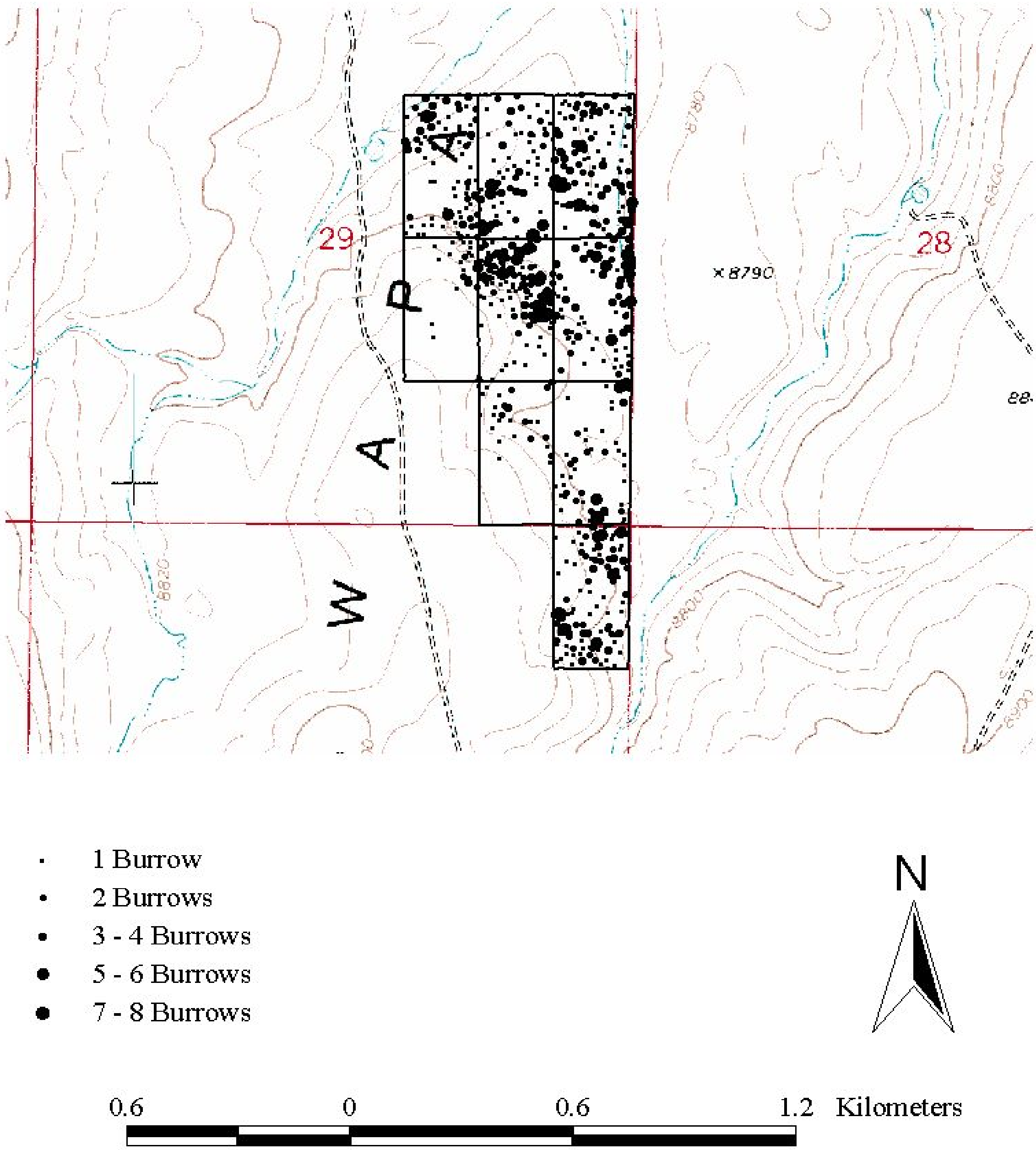

Figure 3-5. Distribution of prairie dog burrows in experimental treatment pastures on Parker Mountain Utah, 2004.

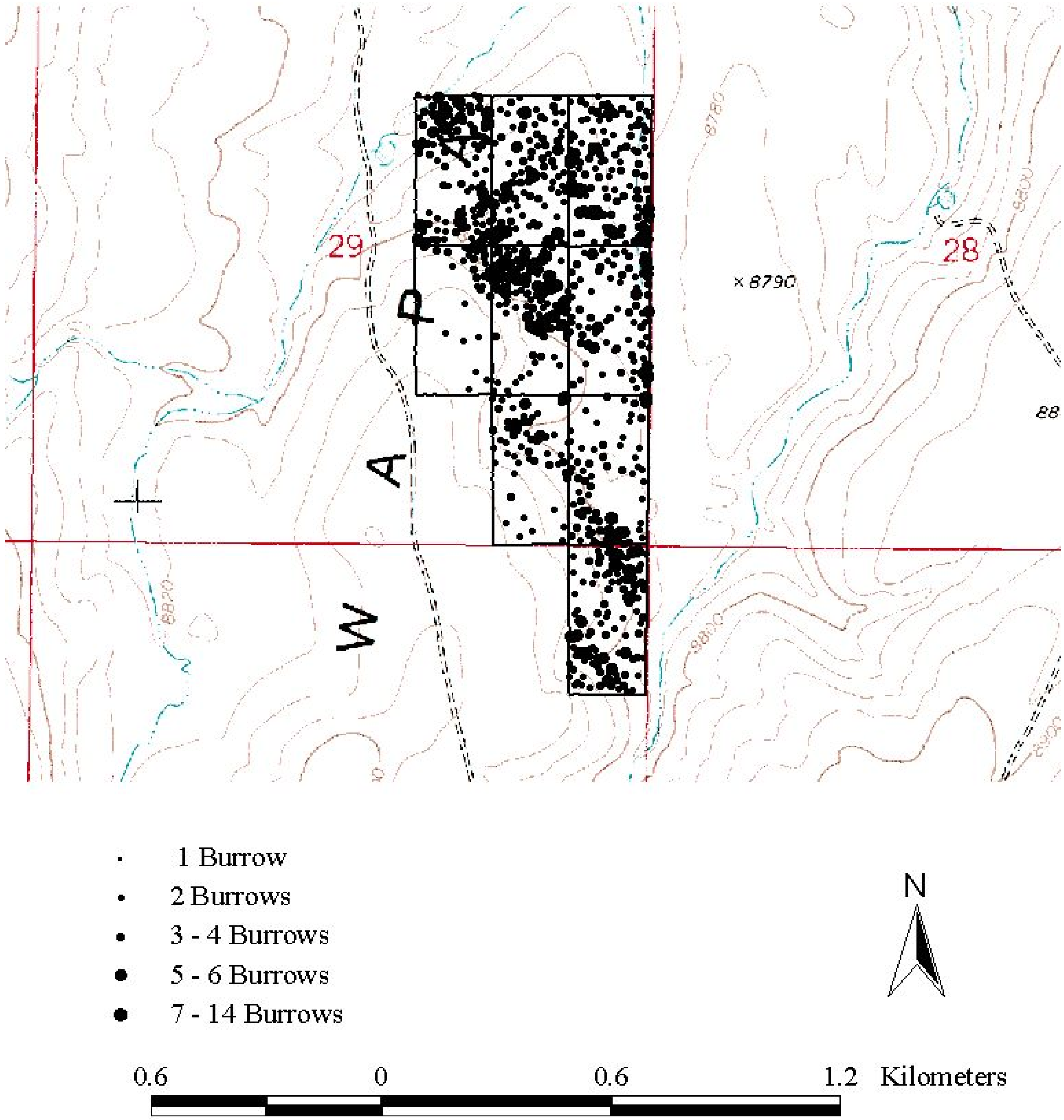

Figure 3-6. Distribution of prairie dog burrows in experimental treatment pastures on Parker Mountain Utah, 2005.

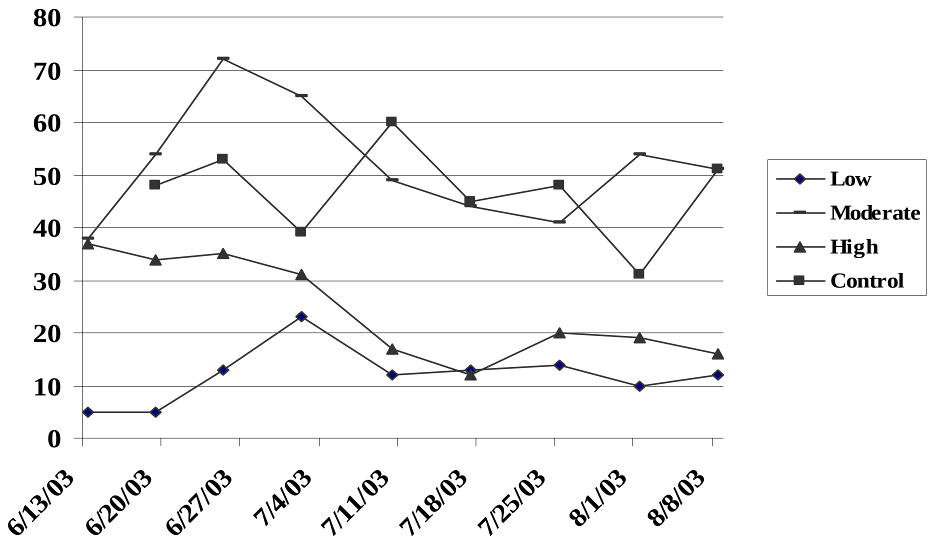

Figure 3-7. Numbers of Utah prairie dogs in experimental pastures under low, moderate, and high forage utilization levels compared to control area, Parker Mountain, 2003. (Note: Data is not continuous, but is shown as such for interpretive purposes.)

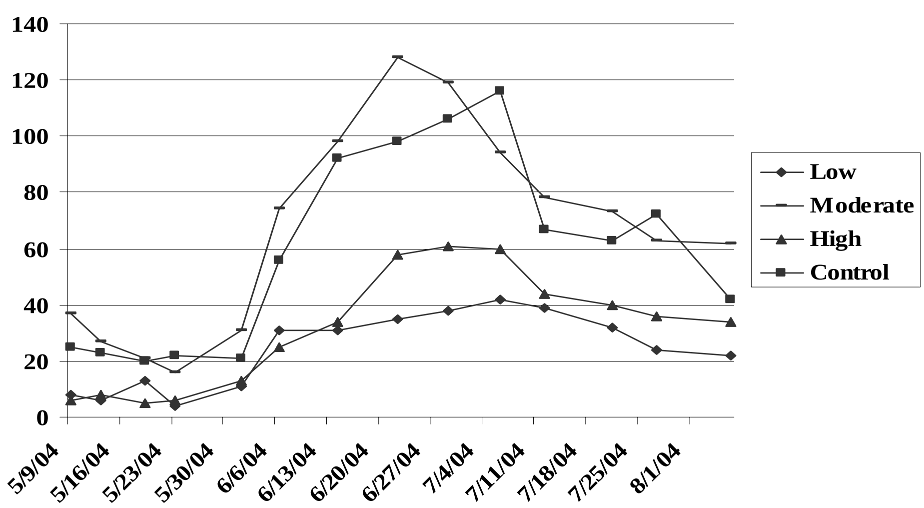

Figure 3-8. Numbers of Utah prairie dogs in experimental pastures under low, moderate, and high forage utilization levels compared to control area, Parker Mountain, 2004. (Note: Data is not continuous, but is shown as such for interpretive purposes.)

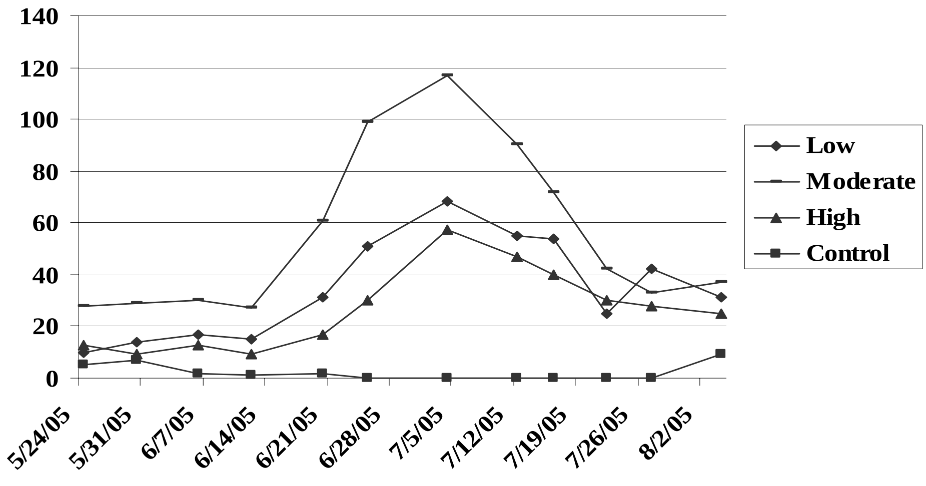

Figure 3-9. Numbers of Utah prairie dogs in experimental pastures under low, moderate, and high forage utilization levels compared to control area, Parker Mountain, 2005. (Note: The control area experienced a plague outbreak during 2005. Data is not continuous, but is shown as such for interpretive purposes.)

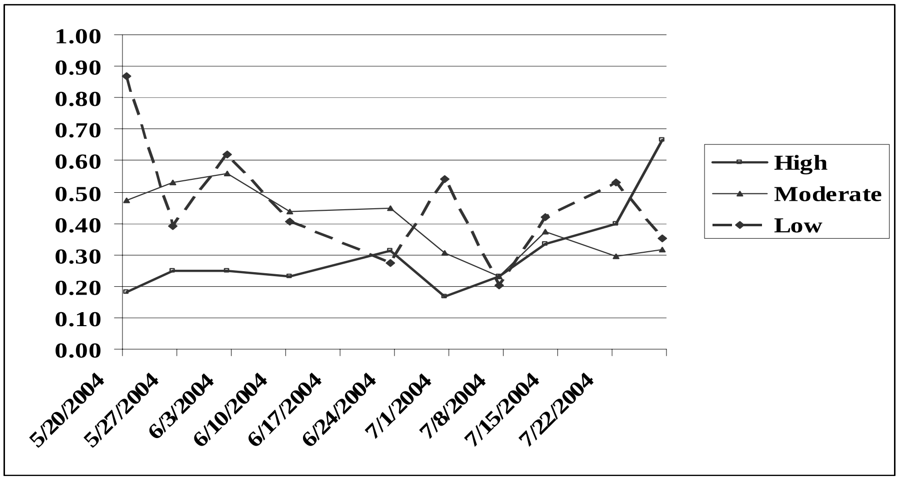

Figure 3-10. Proportion of total adult Utah prairie dogs observed by treatment level in selected pastures that were observed foraging, Parker Mountain, 2004. (Note: Grazing period was 5/27/2004 until 6/15/2004. Data is not continuous, but is shown as such for interpretive purposes.)

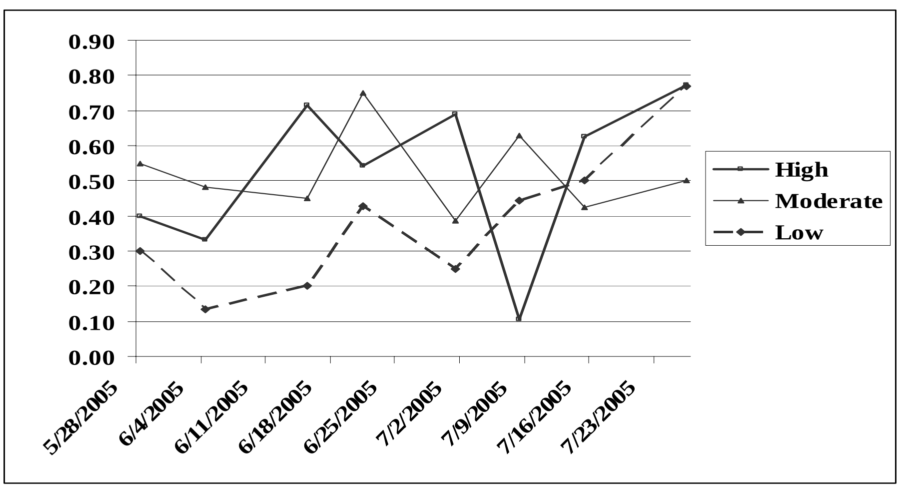

Figure 3-11. Proportion of total adult Utah prairie dogs observed by treatment level in selected pastures that were observed foraging, Parker Mountain, 2005. (Note: Grazing period was 6/7/2005 until 6/27/2005. Data is not continuous, but is shown as such for interpretive purposes.)

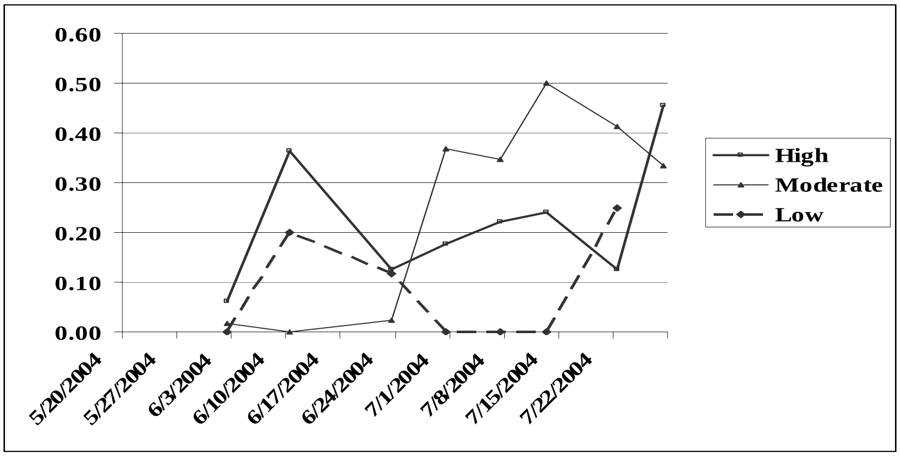

Figure 3-12. Proportion of total juvenile Utah prairie dogs observed by treatment level in selected pastures that were observed foraging, Parker Mountain, 2004. (Note: Grazing period was 5/27/2004 until 6/15/2004. Data is not continuous, but is shown as such for interpretive purposes.)

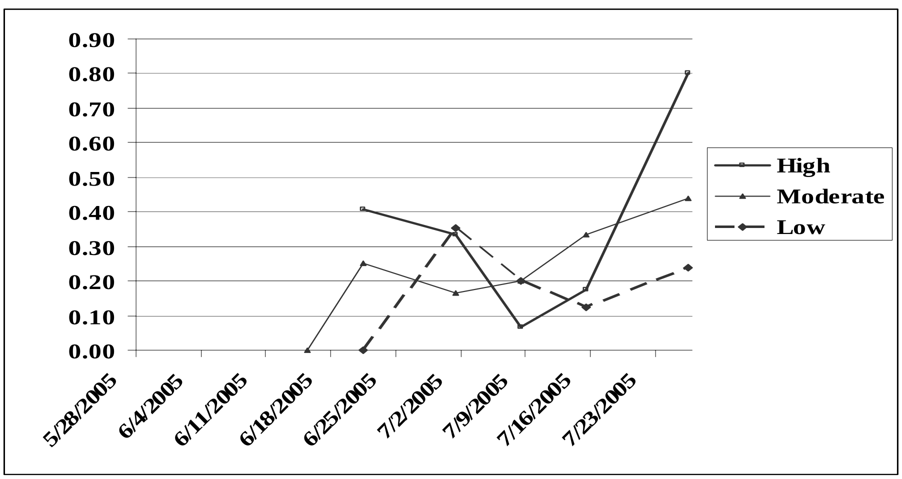

Figure 3-13. Proportion of total juvenile Utah prairie dogs observed by treatment level in selected pastures that were observed foraging, Parker Mountain, 2005. (Note: Grazing period was 6/7/2005 until 6/27/2005. Data is not continuous, but is shown as such for interpretive purposes.)

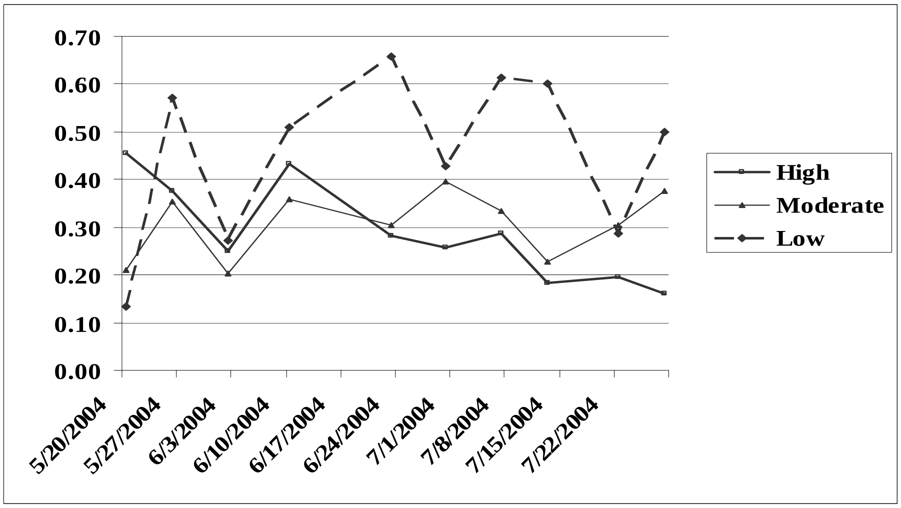

Figure 3-14. Proportion of total Utah prairie dogs observed by treatment level in selected pastures that were observed alert, Parker Mountain, 2004. (Note: Grazing period was 5/27/2004 until 6/15/2004. Data is not continuous, but is shown as such for interpretive purposes.)

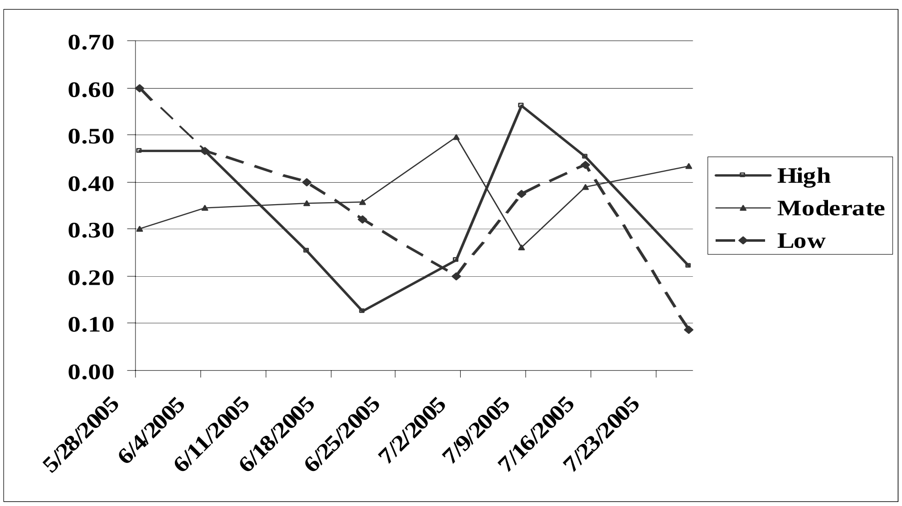

Figure 3-15. Proportion of total Utah prairie dogs observed by treatment level in selected pastures that were observed alert, Parker Mountain, 2005. (Note: Grazing period was 6/7/2005 until 6/27/2005. Data is not continuous, but is shown as such for interpretive purposes.)

CHAPTER 4

SUMMARY AND CONCLUSIONS

Discussion of recovery of the Utah prairie dog (*Cynomys parvidens*) must consider the 3 separate recovery areas as identified by the U.S. Fish and Wildlife Service (1991). The Awapa Plateau, Paunsaugunt Plateau, and West Desert recovery areas are dramatically different in terms of soils, elevation, precipitation, and vegetation. To accommodate these differences, I recommend that habitat management and population studies be conducted at the scale of the recovery area. Additionally from a land-ownership standpoint, the Paunsaugunt Plateau and West Desert differ from the Awapa Plateau. A large proportion of Utah prairie dogs for these 2 recovery areas exist on private lands (Bonzo and Day 2002). The Awapa Plateau has a significant proportion of Utah prairie dogs on public lands (both state and federal), and recovery of the Awapa Plateau population will largely take place on these public lands. Management efforts on federal lands have not been sufficient to meet recovery goals.

The U.S. Fish and Wildlife Service (USFWS) is coordinating an effort to reevaluate the 1991 recovery plan so that private lands are considered. Thus, my survey data on stakeholder perceptions and attitudes will provide timely data, particularly for recovery efforts on the Paunsaugunt Plateau and West Desert areas. My results support previous studies that show increasing levels of antagonism toward prairie dogs as the personal attitudes moved toward utilitarian values (Reading et al. 1999) and as levels of human/wildlife interaction increased (Zinn and Andelt 1999). Also, I found that knowledge did not necessarily translate into positive attitudes (Reading et al. 1999) and issue salience did appear to increase extreme attitudes (Manfredo et al. 1992). Brook et al. (2003) concluded that the Endangered Species Act (ESA) may hinder some species' recovery. My respondents also expressed concern over the ESA and 34% of agriculture respondents indicated they had taken action against Utah prairie dogs because of potential ESA implications. There exist high levels of uncertainty regarding the effectiveness of the ESA and high levels of distrust of the ESA among the agricultural respondents. This study echoed Brook et al. (2003) in questioning effectiveness of ESA application for some species.

Reported wildlife damage rates were twice as high for the agriculture respondents as compared to the other respondent groups. I found that direct impact of wildlife did affect attitude (Decker et al. 2005), and that groups not affected tend to have less awareness (McIvor and Conover 1994). Those respondents not engaged in agricultural production did not generally support compensation of wildlife damage (Kellert 1979, McIvor and Conover 1994, Reiter et al. 1999). I believe that if the general public were made more aware of the situation surrounding the species, damage compensation would be viewed more favorably (Czech and Krausman 1999). However, public acceptance of private insurance or government provided compensation is much lower than for private conservation/environmental groups providing that compensation. This highlights the need for advocacy groups to be more proactive in solutions and provide funding to solve wildlife damage issues. However, results of my survey show that agriculturists have much higher trust in Utah State University Extension and Utah Farm Bureau than in conservation groups. In general, I found low support for most conservation actions that would benefit Utah prairie dogs. There was interest in damage assistance, as other studies have similarly reported (Wyoming Game and Fish Department, unpublished document 2001). Therefore, based on these findings, programs to aid in Utah prairie dog recovery on private lands should consider the alleviation of wildlife damage on these lands and should be directed by Extension and/or Utah Farm Bureau with cooperation by other groups but limited direct negotiation with rural landowners.

As previously mentioned, the Awapa recovery area has substantial Utah prairie dog habitat in state ownership. Thus, management to increase the carrying capacity of these lands and to expand current colonies must be a primary recovery objective for this area. Player and Urness (1982) speculated that many historical Utah prairie dog colony sites no longer contain suitable habitat due to high shrub canopy cover.

My grazing research examined the hypothesis that reductions of shrub cover would increase grass canopy cover (Bartolome and Heady 1988, McDaniel et al. 1992) and over time increase carrying capacity of the Utah prairie dogs on that site (Elmore and Workman 1976). I implemented a high-intensity/short duration grazing system to test this (Savory 1999). I believe the results of my research will be useful in the management of grazing on the Awapa, but it can also direct habitat management for the 3 Utah prairie dog mitigation banks that are currently in place on this recovery area.

The shrub canopy cover on my research site was much higher and grass cover was lower than that recommended for high elevation sites (Crocker-Bedford and Spillet 1981). Although my results indicate that grazing did not reduce shrub canopy cover over a 3-year period, it did sustain grass and forb cover. In addition, prairie dog densities and burrow activities did not differ among treatments. However, the higher grazing intensities did affect Utah prairie dog behavior. I detected a trend towards increasing prairie dog foraging rates under higher livestock grazing intensities. This was particularly evident in juvenile prairie dogs.

My observations support previous research in other recovery areas (Ritchie 1998, Cheng and Ritchie 2005). I believe my results could be explained by several factors which include: dispersal of sub-adults into treatment areas, selective grazing of Utah prairie dogs, density dependent effects of Utah prairie dogs, and warm-season grass response as a compensating factor.

While continuation of high intensity/short duration growing-season grazing by domestic cattle might lead to the desired habitat conditions in the long-term, the possible negative implications (such as decreased body weight and subsequent differential mortality) of increased foraging rates of Utah prairie dogs should be considered particularly in drought periods (Cheng and Ritchie 2005).

Based on my research I recommend alternative methods of shrub reduction that would take less time or remove forage at less critical periods (such as during the dormant season) be evaluated. Regardless of the treatment method employed, future research should address individual survival of Utah prairie dogs in the treatment areas. Mechanical treatments, while costly, may be a better option for reducing shrub cover in areas currently occupied by Utah prairie dogs. Fall grazing by domestic sheep has shown positive results of sagebrush reductions (Bork et al. 1998). It is likely that some type of biological control (such as domestic grazing) will be necessary to reduce undesirable shrub response (*Chrysothamnus viscidiflorus*) and to reduce *Artemisia nova* reestablishment even if mechanical treatments are utilized (Bartolome and Heady 1988). Therefore, a combination of mechanical and biological control may be most appropriate.

In areas where mechanical treatment is not feasible then fall grazing alone or herbicide treatments may be useful in reducing shrub cover. Herbicide treatments are not recommended except in very low-statured stands of *A. nova* where residual brush will not obstruct prairie dog vision (< 31cm). The results of this study do indicate that moderate grazing is likely a compatible use in areas occupied by the Utah prairie dog on the Awapa Plateau. Therefore, the current Utah prairie dog mitigation banks need not be excluded from livestock grazing.

Since the Utah prairie dog was declared a listed species under the ESA in 1974, managers have seen only marginal results toward recovery. Those involved with the recovery of this species must become more aggressive and adaptive in recovery efforts if there is to be change. Private lands must be an integral part of the recovery of this species. It is hoped that the information provided in this research proves helpful in facilitating this landowner involvement. There are some pieces of information that are difficult to summarize with a *P* value or some descriptive statistic. However, I feel compelled to express them in some form. It would appear that most antagonism that landowners feel regarding this issue is directed not at the species but at the bureaucracy surrounding ESA application. This should both encourage managers that recovery is possible on private lands, but also caution that years of distrust will not disappear quickly. Trust is a major issue that cannot be overemphasized. Direct personal contact must take place to engage landowners. However, “who will make this contact” is a critical consideration, both in terms of affiliation and individual personality.

Examination of treatment methods for the Awapa recovery area should be continued. Historic mounds throughout the Awapa attest that vast areas were once occupied by this species. The fact that the species has not recolonized more of these historic sites is perplexing. It may be due to habitat unsuitability alone. The climate has obviously changed since Utah prairie dogs colonized this area during the Pleistocene (Kelson 1949). Grazing methods in more recent times may have shifted the shrub composition into a state that will require considerable disturbance to change (Westoby et al. 1989). Utah prairie dogs themselves may have once maintained the Awapa as a grass-dominated system in some areas. Other research has proposed this idea of vegetation regulation for other small mammals (Weltzin et al. 1997, Ryerson and Parmenter 2001). Regardless of the cause, management should be directed to shift vegetation toward what is optimal for Utah prairie dogs. More research is needed to determine this optimal vegetation component for the Awapa and how Utah prairie dogs respond to treatments. Regardless of the methods, management on the Awapa should be adaptive so that new information is quickly added to the decision-making process and so that all stakeholders are involved.

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APPENDICES

Appendix A.

Utah Prairie Dog Public Opinion Survey for Agriculture Producers

November 18, 2004

Dear Survey Recipient,

Recently, we sent you a letter informing you of a public opinion survey that is being conducted by researchers at Utah State University on the Utah Prairie Dog. The goal of the survey is to gain a better understanding of public opinions regarding the Utah prairie dog, the impacts they may cause, and how they might be better managed. Your feelings are important to wildlife and agricultural managers as part of an overall effort to help local communities better manage prairie dog conflicts.

The information collected from this survey will be of interest to numerous groups that aid agricultural producers and deal with conservation issues. This is your opportunity to make your ideas heard regarding the Utah prairie dog.

We respect and value your opinions. This survey is entirely voluntary. Your participation in this survey does not commit you to any action and you may withdraw at any time. There are no anticipated risks in participating in this study. Any information you provide will be kept completely confidential. The identification number identifies you as a participant but only for mailing purposes. This information will be kept in a locked cabinet and the identification number destroyed at the conclusion of the study.

We ask you to complete the enclosed survey at your earliest convenience. We have enclosed a self-addressed, postage paid envelope. If you have any questions regarding this study, please contact Dwayne Elmore at (435) 770-0739 or by email at updsurvey@hotmail.com. Thank you for your time and participation. The future of Utah prairie dog management and resolution of private land conflicts is in your hands.

Respectfully,

____________________	____________________
Terry Messmer	Dwayne Elmore
Extension Wildlife Specialist	Graduate Research Associate
Utah State University	Utah State University

Utah Prairie Dog Public Opinion Survey

SECTION A

1. Prior to this survey were you aware that the Utah prairie dog is considered a separate species of prairie dog?
   ___ Yes
   ___ No

2. Do you believe that the Utah prairie dog should be considered a separate species of prairie dog?
   ___ Yes
   ___ No
   ___ Not Sure

3. Prior to this survey were you aware that the Utah prairie dog is listed as a threatened species under the Endangered Species Act?
   ___ Yes
   ___ No

4. Do you believe that the Utah prairie dog should be listed as a threatened species?
   ___ Yes
   ___ No
   ___ Not Sure

5. What is your overall opinion of Utah prairie dogs?
   ___ The only good prairie dog is a dead prairie dog.
   ___ They are OK as long as they do not interfere with my life.
   ___ Live and let live.
   ___ They should be protected to some degree.
   ___ They should be protected at all costs.

6. What is your opinion of the Endangered Species Act? Please circle a number between 1 (disagree) and 3 (agree) to indicate how you feel about each statement.

	Disagree	Do Not Know	Agree
The original intent was good.	1	2	3
It is being misused.	1	2	3
It threatens private property rights.	1	2	3
It should be revoked.	1	2	3
It should be maintained as is.	1	2	3
The act has been a success.	1	2	3

ID# ________
(for mailing purposes only)

7. Do you believe that the Utah prairie dog has a place in southern Utah?
    ___ Yes, on private and public lands
    ___ Yes, on public lands only
    ___ No

8. For the following statements about prairie dogs, please circle a number between 1 (disagree) and 3 (agree) to indicate how you feel about each statement.

	Disagree	Do Not Know	Agree
Prairie dogs compete with cattle for forage.	1	2	3
Prairie dogs are beneficial to the soil.	1	2	3
Prairie dogs spread disease.	1	2	3
Prairie dogs change the plant community.	1	2	3
Prairie dogs cause livestock injury.	1	2	3
Prairie dogs are necessary for other wildlife.	1	2	3

9. The Utah prairie dog was listed because the populations had significantly declined? What do you believe contributed to this decline? Please circle a number between 1 (not important) and 4 (not sure) to indicate how you feel about each possible cause of decline.

	Not Important	Somewhat Important	Very Important	Not Sure
Shooting	1	2	3	4
Poisoning	1	2	3	4
Habitat Loss/Development	1	2	3	4
Overgrazing	1	2	3	4
Climatic Change	1	2	3	4
Disease	1	2	3	4
Predation	1	2	3	4

10. How effective do you feel the following agencies have been in dealing with prairie dog conflicts? Please circle a number between 1 (not effective) and 4 (no opinion) for each agency.

	Not Effective	Somewhat Effective	Very Effective	No Opinion
Utah Division of Wildlife Resources	1	2	3	4
U.S. Fish and Wildlife Services	1	2	3	4
Bureau of Land Management	1	2	3	4
Private Conservation Groups	1	2	3	4
Utah State University Extension Service	1	2	3	4

11. Do you believe the Utah Division of Wildlife Resources Utah prairie dog counts are accurate?
___ Yes
___ No
___ Not Sure

12. Do you believe ranchers or farmers who allow Utah prairie dogs to live on their private lands should be compensated?
___ Yes
___ No
___ Not Sure

13. Who do you think should pay for the cost of compensation? Please check all that apply.
___ Private Insurance
___ State Government
___ Federal Government
___ Conservation/Environmental Groups
___ Other (please specify) ___________
___ No compensation should be provided

14. Different people have different ideas about the proper relationship between wild animals and human society. Using the scale below how would you describe your ideas on this topic? Please circle a number that best represents your views.

1-------2-------3-------4-------5-------6

Human needs should always be first.	Wildlife preservation should always be considered first.

15. Within the past 5 years have you personally experienced damage caused by wildlife?
___ Yes
___ No

If yes, in what forms?
___ Vehicle Collision
___ Damage to Plants or Crops
___ Livestock or Pet Injury
___ Personal Injury
___ Property Damage
___ Loss of Personal Security or Quality of Life
___ Other (please specify) ________

16. Are you currently engaged in agricultural production?
    ___ Yes
    ___ No

If you answered yes, please complete section B and C, if you answered no please complete section C only. Thank you.

SECTION B

1. Which of the following describes your operation? Please check all that apply.
    ___ Cattle Ranching
    ___ Sheep Ranching
    ___ Dairy
    ___ Small Grain
    ___ Row Crop
    ___ Alfalfa or Hay
    ___ Fee Hunting
    ___ Other (Please specify) _____________

2. What percentage of the land in your agricultural operation falls under the following categories? Please circle a number between 0 (None) and 4 (76-100%) for each category that you have agricultural land in.

	None	1-20%	21-50%	51-75%	76-100%
Deeded Land	0	1	2	3	4
Leased Private	0	1	2	3	4
Forest Service	0	1	2	3	4
BLM	0	1	2	3	4
State	0	1	2	3	4
Other	0	1	2	3	4

3. About how many acres of land do you ranch and/or farm on (including land you lease)?
    ___ 1-50
    ___ 51-300
    ___ 301-1000
    ___ > 1000

4. How long have you been involved in agricultural production?
    ___ 1-5 years
    ___ 6-15 years
    ___ 16-25 years
    ___ > 25 years

5. Do you have Utah prairie dogs on land that you ranch or farm?
   ___ Yes
   ___ No

If so, Please check the land category(s) that Utah prairie dogs occupy.
   ___ Deeded Land
   ___ Leased Private
   ___ Forest Service
   ___ BLM
   ___ State
   ___ Other

   Approximately how many acres do they occupy?

   ___

6. Do Utah prairie dogs affect your operation?
   ___ Yes
   ___ No

   If you answered yes to the above question, in what forms of loss?
   Please check all that apply.
   ___ Equipment Damage
   ___ Forage Loss
   ___ Livestock Injury
   ___ Horse Injury
   ___ Loss of Public AUMs
   ___ Loss of Economic Opportunity
   ___ Other (Please specify) ______________

7. For the past 5 years, what is your estimated **annual** loss due to Utah prairie dogs for the following categories (if applicable)?
   ___ Equipment Damage (in dollars)
   ___ Forage Loss (percentage)
   ___ Livestock Injury (number of events)
   ___ Horse Injury (number of events)
   ___ Loss of Public AUMs (in AUMs)
   ___ Loss of Economic Opportunity (in dollars)
   ___ Other (Please specify) ______________

8. Have you received assistance from the Utah Division of Wildlife Resources in dealing with Utah prairie dog conflict?
   ___ Yes
   ___ No

If so, what types of assistance? Please check all that apply.

___ Technical Advice
___ Prairie Dog Removal
___ Prairie Dog Take Permits
___ Habitat Modification

9. Would you be interested in financial or technical assistance provided to compensate losses caused by Utah prairie dogs?

___ Yes
___ No
___ Not Sure

10. Which of the following organizations would you be most willing to work with to reduce Utah prairie dog impacts to your operation? Please circle a number between 1 (not at all) and 3 (very willing) for each of the following organizations.

	Not At All	Somewhat Willing	Very Willing
Utah Division of Wildlife Resources	1	2	3
U.S. Fish and Wildlife Services	1	2	3
Bureau of Land Management	1	2	3
U.S. Forest Service	1	2	3
Environmental Defense	1	2	3
Nature Conservancy	1	2	3
Farm Bureau	1	2	3
Utah State University Extension	1	2	3
Natural Resource and Conservation Service	1	2	3
USDA Wildlife Services	1	2	3

11. What types of aid or assistance would be most beneficial to you in dealing with Utah prairie dogs? Please check all that apply.

___ Kill some prairie dogs
___ Kill all prairie dogs
___ Relocation of some prairie dogs
___ Relocation of all prairie dogs
___ Compensation for forage/crop loss
___ Compensation for equipment damage
___ Compensation for livestock injury
___ Technical advice on minimizing conflict with prairie dogs
___ Fencing prairie dog colonies
___ Range improvement in areas occupied by prairie dogs
___ Conservation easement or other type of tax relief.
___ Relief from negative consequences of regulations.

12. How willing would you be to enter some of your land into a conservation easement for Utah prairie dog management?

___ Not at all
___ Somewhat Willing
___ Very Willing
___ Not Sure

How much would you need to be paid to encourage you to enter into a conservation easement?

___ $10-25/acre/year
___ $26-50/acre/year
___ $51-100/acre/year
___ >$100/acre/year
___ Not Applicable

Ideally, how long would the easement be?

___ 5-10 years
___ 11-25 years
___ 26-50 years
___ Perpetuity
___ Not Applicable

How many acres of your land would you be willing to enroll?

___ 10-40
___ 41-160
___ 161-640
___ >640
___ Not Applicable

13. Would you be willing to allow Utah prairie dogs to be relocated onto your land in exchange for financial compensation?

___ Yes
___ No
___ Not Sure

If you answered yes to the above question, how much compensation would you require?

___ $10-25/acre/year
___ $26-50/acre/year
___ $51-100/acre/year
___ >$100/acre/year
___ Not Applicable

14. Does the fear of restrictions under the Endangered Species Act hinder your willingness to receive aid or assistance?
    ___ Yes
    ___ No

15. Have you attempted in some way to discourage Utah prairie dogs on your land to avoid regulatory problems?
    ___ Yes
    ___ No

SECTION C

Questions in this final section help us more fully understand peoples' views and opinions. All responses are strictly confidential.

1. Which of the following best describes the community in which you grew up?
    ___ Urban Area
    ___ Small Town
    ___ Suburban Area
    ___ Rural Area

2. Which of the following best describes your education?
    ___ Some High School
    ___ High School Completed
    ___ Some College
    ___ College Completed

3. Are you?
    ___ Male
    ___ Female

4. What is your age?

    ___

5. Is there anything else you would like to tell us about how you feel about the Utah prairie dog?

Thank you for you time.

Appendix B.

Utah Prairie Dog Public Opinion Survey for the Urban and Rural Populations

March 14, 2004

Dear Survey Recipient,

A few weeks ago we sent you a survey that is being conducted by researchers at Utah State University about Utah prairie dogs. As of today we have not received your completed survey.

The purpose of the survey is to gain a better understanding of public opinions about Utah prairie dogs and their management. In order to make appropriate decisions regarding the Utah prairie dog, managers need to know what you think about this issue. Even if you are unsure whether or not you have enough information about the subject to complete the survey, your opinions matter.

This survey is entirely voluntary. Your participation in this survey does not commit you to any action and you may withdraw at any time. There are no anticipated risks in participating in this study. Any information you provide will be kept completely confidential. The identification number identifies you as a participant but only for mailing purposes. This information will be kept in a locked cabinet and the identification number destroyed at the conclusion of the study.

In the case that your survey has been misplaced, a replacement is enclosed. We have also enclosed a self-addressed, postage paid envelope. If you have any questions regarding this study, please contact Dwayne Elmore at (435) 770-0739 or by email at updsurvey@hotmail.com. Again, thank you for your time and participation.

Sincerely,

Terry Messmer
Extension Wildlife Specialist
Utah State University

Dwayne Elmore
Graduate Research Associate
Utah State University

Utah Prairie Dog Public Opinion Survey

1. Prior to this survey were you aware that the Utah prairie dog is considered a separate species of prairie dog?
   ___ Yes
   ___ No

2. Do you believe that the Utah prairie dog should be considered a separate species of prairie dog?
   ___ Yes
   ___ No
   ___ Not Sure

3. Prior to this survey were you aware that the Utah prairie dog is listed as a threatened species under the Endangered Species Act?
   ___ Yes
   ___ No

4. Do you believe that the Utah prairie dog should be listed a threatened species?
   ___ Yes
   ___ No
   ___ Not Sure

5. What is your overall opinion of Utah prairie dogs?
   ___ The only good prairie dog is a dead prairie dog.
   ___ They are OK as long as they do not interfere with my life.
   ___ Live and let live.
   ___ They should be protected to some degree.
   ___ They should be protected at all costs.

6. What do you feel about the Endangered Species Act? Please circle a number between 1 (disagree) and 3 (agree) to indicate how you feel about each statement.

	Disagree	Do Not Know	Agree
The original intent was good.	1	2	3
It is being misused.	1	2	3
It threatens private property rights.	1	2	3
It should be revoked.	1	2	3
It should be maintained as is.	1	2	3
The act has been a success.	1	2	3

7. Do you believe that the Utah prairie dog has a place in southern Utah?
   ___ Yes, on private and public lands
   ___ Yes, on public lands only
   ___ No

ID# _______
(for mailing purposes only)

8. For the following statements about prairie dogs, please circle a number between 1 (disagree) and 3 (agree) to indicate how you feel about each statement.

	Disagree	Do Not Know	Agree
Prairie dogs compete with cattle for forage.	1	2	3
Prairie dogs are beneficial to the soil.	1	2	3
Prairie dogs spread disease.	1	2	3
Prairie dogs change the plant community.	1	2	3
Prairie dogs cause livestock injury.	1	2	3
Prairie dogs are necessary for other wildlife.	1	2	3

9. The Utah prairie dog was listed as a threatened species because of a dramatic decrease in the population. What do you think contributed to this decline? Please circle a number between 1 (not important) and 4 (not sure) to indicate how you feel about each possible cause of decline.

	Not Important	Somewhat Important	Very Important	Not Sure
Shooting	1	2	3	4
Poisoning	1	2	3	4
Habitat Loss/Development	1	2	3	4
Overgrazing	1	2	3	4
Climatic Change	1	2	3	4
Disease	1	2	3	4
Predation	1	2	3	4

10. How effective do you feel the following agencies have been in dealing with prairie dog conflict? Please circle a number between 1 (not effective) and 4 (no opinion) for each agency.

	Not Effective	Somewhat Effective	Very Effective	No Opinion
Utah Division of Wildlife Resources	1	2	3	4
U.S. Fish and Wildlife Services	1	2	3	4
Bureau of Land Management	1	2	3	4
Private Conservation Groups	1	2	3	4
Utah State University Extension	1	2	3	4

11. Do you believe the Utah Division of Wildlife Resources Utah prairie dog counts are accurate?
___ Yes
___ No
___ Not Sure

12. Do you believe ranchers or farmers who allow Utah prairie dogs to live on their private lands should be compensated?
___ Yes
___ No

13. Who do you think should pay for the cost of compensation? Please check all that apply.
    ___ Private Insurance
    ___ State Government
    ___ Federal Government
    ___ Conservation/Environmental Groups
    ___ Other (please specify) ___________
    ___ No compensation should be provided

14. Different people have different ideas about the proper relationship between wild animals and human society. Using the scale below how would you describe your ideas on this topic? Please circle a number that best represents your views.

1-------2-------3-------4-------5-------6

Human needs should always be first.	Wildlife preservation should always be considered first.

15. Within the past 5 years have you personally experienced damage caused by wildlife?
    ___ Yes
    ___ No

    If yes, in what forms?
    ___ Vehicle Collision
    ___ Damage to Plants or Crops
    ___ Livestock or Pet Injury
    ___ Personal Injury
    ___ Property Damage
    ___ Loss of Personal Security or Quality of Life
    ___ Other (please specify) ________

Questions in this final section help us more fully understand peoples' views and opinions. All responses are strictly confidential.

1. Are you currently actively engaged in farming or ranching?
   ___ Yes
   ___ No

2. Do you have family members who are actively engaged in farming or ranching?
   ___ Yes
   ___ No

3. Has your family been actively engaged in farming or ranching within?
   ___ Current Generation
   ___ 1 Generation
   ___ 2 Generations
   ___ Not Applicable

4. Which of the following best describes the community in which you grew up?
   ___ Urban Area
   ___ Small Town
   ___ Suburban Area
   ___ Rural Area

5. Which of the following best describes your education?
   ___ Some High School
   ___ High School Completed
   ___ Some College
   ___ College Completed

6. Are you?
   ___ Male
   ___ Female

7. What is your age?

   ___

8. Is there anything else you would like to tell us about how you feel about the Utah prairie dog?

Thank you for you time.

Appendix C.

Plants Detected During Vegetation Sampling on Parker Mountain Utah

Common Name	Scientific Name
Grasses	
blue grama	*Bouteloua gracilis*
Letterman needlegrass	*Stipa lettermani*
needlleandthread	*Stipa comata*
poa	*Poa* spp
prairie junegrass	*Koeleria cristata*
Richardson's muley	*Muhlenbergia richardsonsis*
sedge	*Carex* spp
squirreltail	*Sitanion hystrix*
wheatgrass	*Agropyron smithii*, *A. pauciflorum*, *A*. spp
Forbs	
alumroot	*Heuchera parvifolia*
aster	*Aster* spp.
astragalus	*Astragalus* spp
broom rape	*Orobanche fasciculata*
buckwheat	*Erigonum microthecum* and *E*. spp
cactus	Multiple genera
cinquefoil	*Potentilla* spp
clover	*Trifolium* sp

Common Name	Scientific Name
Forbs continued.	
daisy	*Erigeron aphanactis* and *E*. spp.
dandelion	*Tarazacum officinale*
false dandelion	*Agoseris* sp
flax	*Linum lewisi*
granite gilia	*Leptodactylon pungens*
ground smoke	*Gayophytum* sp
groundsel	*Senecio spartiodes* and *S*. sp
indian paintbrush	*Caestilleja* spp
Lampsquarter	*Chenopodium album*
lomatium	*Lomatium* sp
lupine	*Lupinus* spp
mustard	*Arabis* spp
penstemon	*Penstemon caespitosa* and *P*. spp
phlox	*Phlox longifolia* and *P*. spp
prostrate knotweed	*Polygonum aviculare*
pussytoes	*Antennaria dimorpha*
red triangles	*Centrostegia thurberi*
sandwort	*Arenaria* sp

Common Name	Scientific Name
Forbs continued.	
scarlet gilia	*Gilia aggregata*
stickseed	*Lappula redowski*
Shrubs	
black sagebrush	*Artemisia nova*
horsebrush	*Tetradymia* sp
mountain big sagebrush	*Artemisia tridentata vaseyana*
oregon grape	*Mahonia repens*
rabbitbrush	*Chrysothamnus* spp
snakeweed	*Gutierrezia sarothrae*

CURRICULUM VITAE

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Education:

-Currently working on a Ph.D. project in Wildlife Biology at Utah State University (anticipated degree May 2006), cumulative GPA of 3.92. Advisor: Dr. Terry A. Messmer.

-Completed a M.S. in Wildlife and Fisheries Science with a minor in Statistics in May of 2002 (Mississippi State University), cumulative GPA of 3.60. Advisor: Dr. Francisco J. Vilella.

-Completion of thesis entitled "Landscape Correlates and Variability in Mourning Dove Abundance along Call-Count Routes in Mississippi."

-Completed a B.S. in Wildlife Biology in May of 1997 (University of Tennessee at Martin) with a cumulative GPA of 3.73.

-International study in Brazil, 1997.

Experience:

-Graduate Research Assistantship at Utah State University, 2001-present. Conducted grazing and sage grouse telemetry research, implemented social surveys, and heavily involved with nationally recognized community based conservation planning.

-Co-organizer of Utah Prairie Dog Focus Group Meetings to involve landowners in ESA recovery actions, 2005.

-Mississippi Gap Analysis Program (GAP), 2001-2002.
Assisted with data delivery and completion of Mississippi GAP final report.

-Graduate Research Assistantship at Mississippi State University, 1998-2001. Conducted call-counts for mourning doves, created GIS data sets, and spatially analyzed GIS data.

-Ducks Unlimited, Great Plains Regional Office, 1997. Banded waterfowl, ground-truthed GIS data, prepared presentations for donors, located project sites on digital quads, and updated databases.

-Worked at Tennessee National Wildlife Refuge (1996) and Reelfoot National Wildlife Refuge (1997). Collected data from wood duck boxes, coordinated wood duck banding program, conducted beaver control, collected goose collar numbers, controlled invasive aquatic plants, and assisted with MAPS neotropical bird banding.

Special Skills:

-Designed and implemented 3 social science surveys.

-Supervised numerous technicians on multiple projects.

-Designed 2 Utah prairie dog research proposals that successfully secured extramural funds.

-Assisted on a Habitat Conservation Plan and 3 Mitigation Banks for the Threatened Utah prairie dog.

-Lectured on dove ecology for multiple labs at Mississippi State University and for the Mississippi Department of Wildlife, Fisheries, and Parks.

-Proficient with the use of GIS and GPS technology.

-Computer use with numerous computer software including: Word Perfect, Excel, Power Point, Word, ArcView, ArcInfo, ERDAS Imagine, Pathfinder Office, and SAS using both Windows and Unix operating systems.

-Teaching assistant for Soil Science labs at the University of Tennessee at Martin, 1996.

-Experience with numerous wildlife forensic techniques, control burning, telemetry, and wildlife damage control.

Professional Memberships and Involvement:

-Member of the Jack H. Berryman Institute for Wildlife Damage Management, 2001-present. Graduate President, 2004.

-Member of the Society for Range Management, 2002-present.

-Member of The Wildlife Society, 1995-present. Treasurer of student chapter and chairman of Tennessee Valley Authority contract committee, 1996-97.

-Collegiate FFA, 1995-97.

-Alpha Gamma Rho, Served on Scholarship Committee, House Manager Committee, and Chairman of Standards Committee.

-Student Ambassador to the School of Agriculture and Human Environmental Science, 1996-97.

-Student Government Association, Congress Representative (1996-97) and Constitutional Revision Committee, 1997.

-Student representative on Brehm Hall Renovation Committee, 1996.

Awards and Honors:

-Initiated into Psi Sigma Pi, 2002.

-Associate Wildlife Biologist (TWS), 1998.

-Glen C. Elkins Conservation Award, 1997.

-Outstanding Natural Resource Management Student, 1997.

-Initiated into Order of Omega, 1997.

-Initiated into Phi Kappa Phi, 1996.

-National Dean's List, 1995-97.

-National Collegiate Natural Science Award, 1995-97.

-All American Scholar, 1995-1997.

-Who's Who Among College Students, 1994-97

Presentations and Posters:

-Coauthor of poster entitled "Utah prairie dogs: creative strategies to de-list a problematic endangered species" at the 2006 Vertebrate Pest Conference in Berkeley, California.

-Paper entitled "Stakeholder Attitudes Regarding Utah Prairie Dog Recovery" at the 2006 Annual Meeting of the Utah Chapter of The Wildlife Society in Moab, Utah.

-Coauthor of paper entitled "Landowner perceptions of ranchland conservation: a matter of trust" at the 2006 Annual Meeting of The Society for Range Management in Vancouver, BC.

-Paper entitled "Stakeholder Attitudes Regarding Utah Prairie Dog Recovery" at the 2005 Jack H. Berryman Institute Symposium in Logan, UT.

-Paper entitled "Landscape and Habitat Analysis along Dove Call-Count Routes in Mississippi" at the 2000 Annual Meeting of The Wildlife Society in Nashville, TN.

-Paper entitled "Landscape and Habitat Analysis along Dove Call-Count Routes in Mississippi" at the 2000 Annual Meeting of the Mississippi Chapter of The Wildlife Society in Jackson, MS.

-Poster entitled "Eurasian Collared Dove Expansion in Mississippi" at the 1999 Annual Meeting of The American Ornithological Union in Ithaca, NY.

Publications:

-Elmore, R. D., F. J. Vilella, and P. Gerard. 2005. Landscape correlates along mourning dove call-count routes in Mississippi. Journal of Wildlife Management (under review).

-Elmore, R. D. 2001. Landscape Correlates and Variability in Mourning Dove Abundance along Call-Count Routes in Mississippi. Thesis, Mississippi State University, Mississippi State, Mississippi.

-Elmore, R. D., F. J. Vilella, and D. Godwin. 2002. The Eurasian collared-dove in Mississippi. Mississippi Woods and Waters 4(12).