February 1989

Kansas Attitudes on Prairie Dog Control

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Abstract.–In Kansas prairie dog management is primarily determined by private individuals and local government agencies. We conducted a mail survey of 350 affected landowners as a means to evaluate the effectiveness of current prairie dog control. The same survey was also sent to 350 randomly selected state residents within the general prairie dog range. We evaluated people's perceptions of prairie dogs, the effectiveness of control methods, costs of control, and reasons for poor response to control techniques. Results indicate people that have previously been involved in prairie dog control on lands they manage have different opinions about prairie dogs than general residents.

INTRODUCTION

In Kansas prairie dog management is primarily determined by private individuals and local government agencies. In 1901 and 1903, the Kansas legislature passed laws (K.S.A. 80-1201, 1203) authorizing townships to conduct prairie dog eradication programs and provide funds for Kansas State Agricultural College to hire a field agent to "direct and conduct experiments for the purpose of destroying prairie dogs and gophers" (Lantz 1903). In recent years seven counties have invoked "Home Rule" to take over authority for prairie dog control from the townships and impose mandatory control requirements on landowners. This came about mainly because of increasing prairie dog numbers and disputes over the problems created when prairie dogs dispersed into surrounding pastures.

Some counties have gone to an operational program where the landowner is first given the opportunity to control "his" prairie dogs and if he fails to do so it is done by the county at landowner expense. In several counties the county weed supervisor is given prairie dog control responsibility in the winter. Other counties contract with commercial pest control applicators to conduct the control program. If the landowner refuses to pay the costs, the costs may be extended to the property and extended on the property's tax roll.

Township boards and county commissioners in some cases mandate prairie dog elimination. A few landowners are being forced to eliminate prairie dogs on their acreage even though they may like and protect the prairie dogs.

In Kansas over 97% of the land is in private ownership. In Wallace County, Kansas, a Cooperative Extension Service (CES), estimate indicated over 14,000 acres inhabited with prairie dogs in 1979. CES again surveyed that county in 1988 and determined that there are less than 300 acres inhabited by prairie dogs. This type of reduction in acres has not occurred in other counties that have a county-wide control. However, Wallace county has had some very hardworking,

1 Paper presented at the Ninth Great Plains **Wildlife Damage Control** Workshop, Fort Collins, Colorado, April 18-20, 1989.

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persistent and dedicated employees involved in the prairie dog control program for the last 10 years.

Estimates of prairie dog acreage in Kansas are not very precise. Some states, including Kansas, are planning on conducting prairie dog surveys to locate sites for possible black-footed ferret reintroduction. Kansas Cooperative Extension Service surveyed eight counties for prairie dog colonies in Kansas in 1988. The purpose of this survey was, in part, to obtain bench mark data to measure prairie dog expansion 10 to 20 years in future as a result of CRP native grass plantings now taking place. This survey was conducted using Kansas Department of Revenue aerial photographs. These high quality photo's (1:4800) were accurate in locating prairie dog colonies. The photographs were taken in the spring of 1986 and colonies may have changed since then. Some researchers have noted inaccuracies in relying on aerial photos as population indicators (Bishop and Culbertson 1976 and Cheatheam 1973). However, there are not other known methods that involve less expense and offer at least trend data as accurate as this method. Kansas Department of Revenue plans to have photographs available on a 5 year rotation.

METHODS

KSU Extension conducted a mail survey in the fall of 1988 to gather information on Kansan's attitudes on prairie dogs. The survey was sent to 350 landowners who had previously received a permit from Kansas Wildlife and Parks to fumigate prairie dogs. This permit is required by Kansas law (K.S.A. 32-158). About 350 general residents in the prairie dog range were also mailed survey forms. Response rate was good with a 48$ return from the landowners with previous permits. Only 22$ of the general residents responded to the survey. No follow-up attempts were made to collect information.

RESULTS

The two segments of populations that were surveyed viewed prairie dogs differently. It is interesting to note that 95% of the people who had prairie dogs on their range view them as pests, and 78% of the general residents that responded believed prairie dogs were pests to rangeland. This contrasts with some views that prairie dogs are not as destructive to rangeland as once **believed and in some ways may be** beneficial to rangeland (0'Meilia et al 1982 and Uresk 1985).

Only 5$ of the people with prairie dogs viewed them as being ecologically important but, 18$ of the random sample had this belief. Lovaas (1973) reported that prairie dogs are probably the most popular wild animal in the National Park areas of the Great Plains.

The re-introduction of the blackfooted ferret is also an issue that concerns those involved with prairie dog management.

About 1/2 of those people who responded to the survey would like to see black-footed ferrets re-established in the wild. There was no significant differences between the two groups of Kansans. Comments about ferrets ranged from "I don't know much about ferrets, but sure haven't seen any good in prairie dogs" to "I'd go for the ferrets if they would wipe out pocket gophers." We believe a great deal of educational effort is needed so that public attitudes can change. Neither side in this problem seem to be embracing knowledge derived from scientific studies. It may be too late to bring about a change in public thinking before environmental factors start having detrimental effects on not only prairie dogs, but man too.

There are many different control methods being utilized in prairie dog control programs. In Kansas more people that responded to the survey used fumigants than any other method reported. Fumigants have the most detrimental effects on any ferrets that may be present, however, we believe the blackfooted ferret no longer exists in Kansas.

Zinc phosphide treated oats are now most often recommended as a control method and would have the least detrimental effect upon the black-footed ferret. Yet, only 9% of the respondents indicated they used that product.

Products that were reported to be used occasionally but are not registered for prairie dogs include gasoline, propane, anhydrous ammonia, poison peanuts, larvacide, and chloropicrin.

Sometimes lack of success in control methods by individuals is cited as a reason for county-wide control efforts. This survey indicates 538 of the individual respondents achieved a success rate greater than 90$. Reasons for lack of good success rates varied with the type of control program used, but 39% of the respondents believe the prairie dogs migrated into their land after they had controlled them.

Some thought could be given to an overall prairie dog management plan within given areas of the Kansas prairie dog range. Public monies could be used to keep prairie dogs within tolerable limits and at the same time demonstrations along with an educational program could be used to bring about better grazing management which would tend to limit prairie dog expansion.

If the general public wants prairie dogs at this particular point in time a cooperative plan with affected landowners needs to be started.

The "boom and bust" control programs are resulting in a reduction in prairie dogs, overgrazing, and no possible hope for restoring black-footed ferrets on private land in Kansas. This would seem to indicate support for control efforts over a large area as opposed to each individual landowner controlling prairie dogs on his property. But the question is, will the objective be "control" or eradication?

ECONOMICS

Costs to control prairie dogs ranged from $3.00/acre to over $100/acre. The average cost estimated by 114 respondents on this question was $32.84/ acre. The costs reported by users are higher than previous researchers have reported (Collins et al 1984).

The value of the grass lost due to prairie dogs differed widely among groups. Those people that had permits claimed prairie dogs consumed $30.05 worth of grass per acre and the general resident believed prairie dogs would consume $6.71/acre.

Shooting as a Control Method

Sometimes shooting of prairie dogs is recommended as a control method (Knowles, 1988). In Kansas, we in Extension often get requests for places to hunt.

Of the 87 of the respondents who allowed shooting of prairie dogs only 4 landowners wanted their land on a list as a place that allowed hunting of prairie dogs. Just 8 landowners wished to have their land listed as a place to shoot prairie dogs for a fee. The recommendation of shooting of prairie dogs does not seem to be a viable alternative for Kansas prairie dog managers who mist rely on personal contacts to fulfill the need of recreational hunting of prairie dogs.

SUMMARY

People attitudes play a large role in prairie dog management. This survey showed a majority of Kansans consider prairie dogs as pests and not ecologically or recreationally important. If the public does not consider the prairie dog as a valuable part of our natural resources, its future looks bleak. Kansans report excellent success in controlling prairie dogs. Since over 978 of Kansas is held in private lands, governmental agencies concerned with management of prairie dogs may have little to do.

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Effects of Two Prairie Dog Rodenticides on Ground-Dwelling Invertebrates in Western South Dakota[1]

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Abstract.--Immediate and long-term effects of 3 rodenticide treatments on nontarget invertebrates were evaluated on prairie dog colonies. Immediate impact) indicated zinc phosphi.de reduced ants, strychnine alone reduced wolf spiders, and prebaited strychnine had no impacts. Long-term changes showed increases in wolf spiders and ground beetles and densities were contributed to biotic and abiotic habitat alterations due to lack of prairie dog activities. Among comparisons for efficacy, zinc phosphide was more efficacious at immediately reducing ant densities than either strychnine treatment long term impacts for insects in general were minimal.

INTRODUCTION

Immediate and long-term effects of rodenticides on nontarget invertebrates has not been fully evaluated. Many rodenticides are nonspecific and a margin of safety to nontarget invertebrates is often overlooked by applicators when selecting toxic baits. Control of black-tailed prairie dogs (Cynomys ludovicianus) in western South Dakota provided an opportunity to study rodenticide impacts on nontarget invertebrates and to compare efficacy of 3 rodenticide treatments.

Prairie dogs create niches for invertebrates in rangeland ecosystems (Wilcomb 1954, Koford 1958, Smith 1967, 0'Meilia et al. 1982, Agnew 1983). For example, prairie dogs act as ecosystem regulators by maintaining habitat patches of diverse vegetation (De tling and Whicker 1987) suitable for invertebrates that are associated with bare soils, sparse vegetative cover, and short-grass habitats. Invertebrate habitat provided by burrows is disturbed when prairie dogs are poisoned and prairie dog activity ceases. Burrows are no longer maintained, soil erodes into the hole and vegetation recaptures mounds (Potter 1980). It is unknown how induced changes on short-grass habitat effects invertebrates associated with prairie dog burrows.

This study assessed immediate and long-term responses (1 year after rodenticide application) of invertebrate densities on poisoned prairie dog towns. Secondly, efficacy of zinc phosphide-with prebaiting, prebaited strychnine, and strychnine alone were compared for reduction of nontarget invertebrates. Information will provide further understanding of prairie dog town ecology and management guidelines for minimizing nontarget invertebrate losses due to prairie dog rodenticides.

STUDY AREA

The study was conducted south of Wall and east of Rapid City on Buffalo Gap National Grasslands and in the Badlands National Park of western South Dakota. Vegetated table top buttes and gently rolling mixed grasslands scattered throughout the Badlands formations characterize much of the area and support prairie dog towns (See Deisch 1986 for complete description).

The National Grasslands located in Conata Basin were grazed by cattle at stocking levels set by the Forest Service. American bison (Bison bison) were located in Badlands National Park but cattle were absent.

METHODS

Invertebrates were sampled with pitfall traps (Greenslade 1964, Gist and Crossley 1973). Eighteen permanent sites were established on 15 prairie dog colonies. Metal cans (15 cm x 15 cm) lined

'Paper presented at the 9th Wildlife Damage Control Workshop. (Fort Collins, C0, April 18-20, 1989).
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with plastic buckets were buried flush with soil surface. Pitfall traps were arranged within a grid design with 10 m spacing. Traps were opened (lid removed) for 4 consecutive nights (196 trap nights/session) on each site. Trapping sessions were from May through October of 1983 and May through August of 1984. Mean of each taxa per trap session was estimated for relative density.

Immediate impacts of rodenticides were sampled on each site 1 week before poison application in September 1983. Posttreatment counts were taken. the fourth day after rodenticides were applied. Long-term impacts of rodenticides were evaluated from data collected during September 1983 and all 1984 trap sessions. Rodenticides were not applied in 1984.

Rodenticides and Bait Application

Steam-rolled oats used for prebait (4 g) and poisoned bait (4 g) were formulated at U.S. Fish and Wildlife Service Pocatello Supply Depot. A 2.0% by weight active zinc phosphide and 1.5% Alcolec S (American Lecithin Co., Inc.)' adhesive were applied to oats. Strychnine alkaloid was applied to oats as 0.5% by weight. Nontreated oats were applied as prebait for zinc phosphide and for 1 strychnine treatment. Active rodenticides on oats were applied 3 days after prebaiting. Both prebait and rodenticides were applied to large areas from bait dispensers affixed to Honda ATV's (Schenbeck 1982). Smaller areas were poisoned on foot and bait was distributed onto mounds with teaspoons.

Statistical Analysis

Each rodenticide was evaluated for effects on nontarget invertebrates by comparing the change of mean relative density on each cluster of treated sites with the change observed on respective control sites. Five comparisons through time included immediate impacts (September 1983) measured between pretreatment and posttreatment poisoning. The remaining 4 comparisons were differences in years from pretreatment (1983) to posttreatment (1984). When a significant correlation existed between pretreatment and posttreatment observations, analysis of covariance was used (Deisch 1986, Uresk et al. 1987) and if non, significant, subtraction (Green 1979) was used.

Comparisons among rodenticides for efficacy were produced by forming pairwise contrasts of individual rodenticide treatments. Randomization procedure was used to estimate statistical significance of various contrasts (Edgington 1980, Romesburg 1981, Uresk et al. 1986, Uresk et al. 1987). Rejection of any rodenticide impact (Type II error) to nontarget invertebrates was considered more serious than potential incorrect acceptance of a significant treatment effect (Type I error) (Tacha et al. 1982).

°Reference to trade name does not imply

After significant (P=0.10) treatment differences were detected, Type II error protection was produced by testing each contrast individually. Type I error protection was afforded by testing for a significant (P=0.10) individual contrast of treatment differences with analysis of variance or covariance (Carmer and Swanson 1973).

Individual contrasts were considered biologically significant at P=0.20. Although an alpha of 0.20 is not a standard level of significance, it is becoming more accepted for ecological field studies (Hayne 1976). The number of sites available for this study produced a power of 0.80. This was an acceptable combination of Type I and Type II error protection (Carmer 1976) and allowed for reasonable biological inferences to be drawn from the data.

RESULTS

Five invertebrate classes were collected: Insecta, Arachnida. Chilopoda, Diplopoda, and Crustacea. The 7 most abundant invertebrate families used in statistical analysis were spider mites (Tetranychidae), ants (Formicidae), wolf spiders (Lycosidea), crickets (Gryllidae and Gryllacrididae), ground beetles (Carabidae), dung beetles (Scarabaeidae), and darkling beetles (Tenebrionidae).

Immediate Effects of Rodenticides

Zinc phosphide immediately reduced ant densities on treated sites (fig. 1). Spider mite, cricket, wolf spider, ground beetle. darkling beetle, and dung beetle densities were not immediately affected by zinc phosphide. There were no immediate effects of prebaited strychnine on the 7 invertebrate families (fig. 2). Only wolf spiders were immediately affected by strychnine (fig. 3). Densities decreased 13% on treated sites.

Long-term Effects of Rodenticides

Wolf spiders and ground beetles showed increases after one year on zinc phosphide and strychnine with pre baiting respectively (Deisch 1986). Other insects were variable among rodenticide treatments with no consistant patterns. Generally long-term impacts were minimal for these insects.

Efficacy of Rodenticides

Comparisons of efficacy among 3 rodenticide treatments were made when an immediate or long-term treatment effect was detected. Zinc phosphide was more efficacious at immediately reducing ant densities than either strychnine treatment. Other efficacy comparisons showed no significant differences in reductions of nontarget invertebrates. There were no efficacy differences between strychnine and prebaited strychnine treatments for immediate impacts. Long-term efficacy effects were extremely variable and no consistent pattern in rodenticide effectiveness was detected. Long-term "effects" were not directly related to rodenticides, but more to habitat changes (Deisch 1986).

Figure 1.--Comparisons of invertebrate means/196 trap nights on sites treated with zinc phosphide and control' sites, September 1983. Adjusted means (bars) were estimated by analysis of covariance.

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DUNG DARKLING

`Means followed by same letter were not significant at P=U.20 after F-protection at P=0.10. Pretreatment (covariate) means were used to adjust posttreatment means for statistical comparisons.

'Posttreatment minus pretreatment was used to adjust data for statistical analysis.

Figure 2.---Comparisons of invertebrate means/196 trap nights on sites treated with prebaited strychnine and control

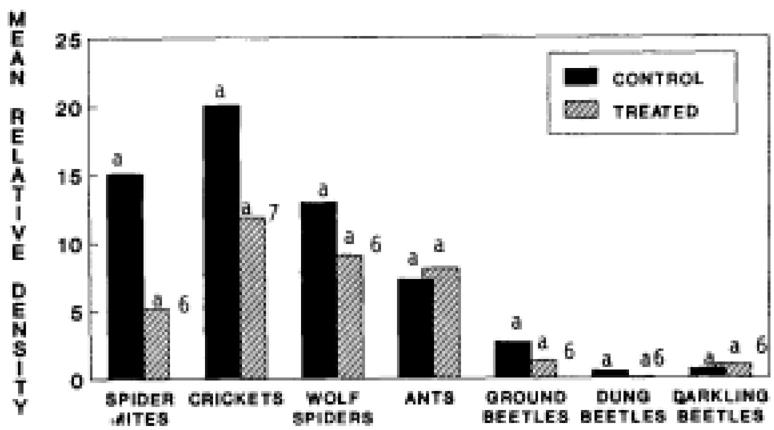

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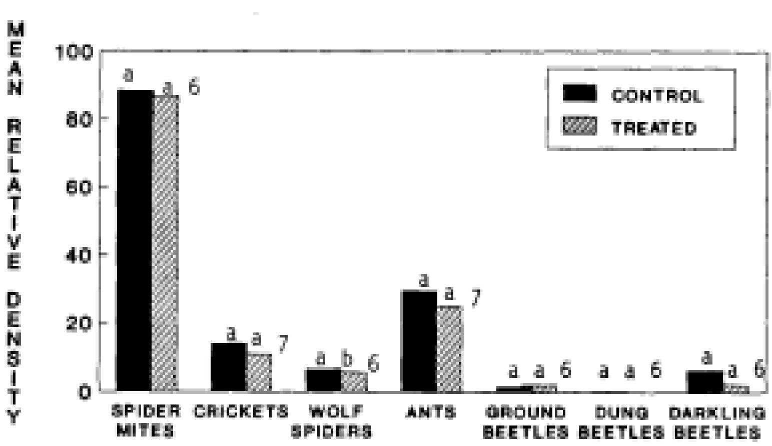
Figure comparisons . invertebrate means/,9'F trap nights on sites treated with strychnine and control sites. september Laos. Adjusted means (bars) were estimated by analysis of covariance.



"Means followed by same letter were not significant at P-=0.20 after F-protection at P=0.10. Pretreatment (covariate) means were used to adjust posttreatment means for statistical comparisons.

'Posttreatment minus pretreatment was used to adjust data for statistical analysis,

DISCUSSION

Immediate effects

Ecological literature lacks supportive information on direct and indirect effects of zinc phosphide and strychnine on nontarget invertebrates. Invertebrates will carry off and consume poisoned grain distributed for rodent control (Marsh 1962). Invertebrates on prairie dog towns that consume seeds were immediately effected by rodenticidal grain.

Ants were immediately reduced on zinc phosphide sites. Harvester ants (Pogonmyrex spp.) in western states feed principally on seeds and can be exterminated with poisoned grain (Furniss and Carolin 1977). Strychnine alone showed immediate reductions of wolf spider relative densities. It is questionable that strychnine directly reduced wolf spiders since these arachnids do not consume seeds (Lowrie 1973, Milne and Milne 1980). However, it is suggested that strychnine influenced the food base of the predatory spider.

Spider mites, crickets, darkling beetles, ground and dung beetles were not affected by the 3 rodenticides because of their food preference (Borror and White 1970, Milne and Milne 1980). Spider mites are equipped with piercing mouth parts for sucking plant juices and usually feed on live green vegetation. Crickets do not depend upon grain for their survival and feed on plant foliage, seedlings, dead and dying insects, hair, hide and carrion. Darkling beetles are detritivores but will consume small amounts of seeds (Kramm and Kramm 1972). Ground beetles are voracious predators. Dung beetles are scavengers and recycle dung, carrion, and decaying vegetative matter (Kramm and Kramm 1972).

Long-term impacts

In this study very few long term impacts occurred. Wolf spider densities increased the year following treatment with zinc phosphide and an increase ground beetles occured on the strychine treated areas. Vegetation height on treated prairie dog towns increases after elimination of prairie dogs (Klatt 1971, Potter 1980). Wolf spiders are active on soil surface and seek cover under vegetation and debris to hunt (Lowrie 1973). Change in vegetation structure provided greater cover and prey diversity (Murdock et al. 1972).

Dramatic ecological changes occur on prairie dog towns once these rodents have been poisoned and eliminated. Changes in plant communities (Uresk 1985). lack of suitable prairie dog borrows, and lack of continual soil mixing by prairie dogs, can influence insect density and diversity (Koford 1958).

Invertebrates have been overlooked in most ecological studies that pertain to nontarget losses due to rodenticides. These small fauna are important components of rangeland ecosystems (Hamm 1972. HeWitt et al. 1974, Agnew 1983, Sieg et al. 1985). Insects and archnids often make up a large percen tage of animal protein matter in diets of mammal species that are associated with prairie dog towns. These include swift fox (Vul es velox) (Uresk and Sharps 1986), burrowing owl (Athene cunicularis) (MacCracken et al. 1985), northern grasshopper mouse (Bailey and Sperry 1929), deer mouse (Flake 1973), and other insectivorous mammalian and avian species.

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Plant Compositional Change in a Colony of Black-Tailed Prairie Dogs in South Dakota[1]

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Abstract.--Peak season multi-species cover of vegetation and burrow mound density were estimated for 3 years along a transect that ran from the geometric center of a blacktailed prairie dog (Cynomys ludovicianus) colony, to its edge. The forb dominated core of the colony expanded 25 m in radius during the study, while plant composition changed dramatically in a small (<0.3 ha) zone midway between the edge and the core. We determined that year to year functional increases in multi-species canopy cover, described by the natural growth function (R^2=0.72, P<0.001), occurred only after shortgrasses were reduced below 75% cover. The density of burrow mounds was positively correlated to compositional change (r=0.58; P<0.01). We observed that burrow mounds provided early sites for the eatablishment of forbs. However, after the canopy cover of shortgrasses receded below 75% (in this location, probably from 4 to 7 years after initial inhabitancy by prairie dogs), extensive compositional changes occurred between burrow mounds.

INTRODUCTION

Largely because of the influence that the black-tailed prairie dog (Cynomys ludovicianus Ord) exerts on trend in rangeland vegetation, the species has been a target of extermination or intensive control since the early 1900's (Merriam 1902, Schenbeck 1982, Uresk 1987). Plant succession within colonies has been described as consisting of the initial disappearance of perennial grass cover, followed by an increase in shortgrasses (Bonham and Lerwick'1976), and an eventual increase and dominance by annual forbs and dwarf shrubs (Koford 1958, Garrett et al. 1982, Coppock et al. 1983, Archer et al. 1987). The pattern of plant composition appears to recapitulate colony expansion, i.e. as prairie dog colonies expand outward, a forb-dominated community follows. The objective of our study was to determine the extent, rate, and pattern of prairie dog induced changes in plant composition within a colony on mixed-grass prairie habitat.

MATERIALS AND METHODS

Study Area

The study was conducted in Badlands National Park, in southwestern South Dakota, in a colony of black-tailed prairie dogs situated in **mixed-grass** prairie, north of the edge of the White River Badlands. Vegetation of the area is wheatgrass-gramabuffalo grass type described by Kuchler (1975). Occurrence of flora and fauna in the area is described by Agnew et al. (1986). Descriptions of soils, topography and climate are available in Cincotta et al. (1987), and Uresk and Schenbeck (1987). The prairie dog colony selected was <10 years old at the beginning of the research. It was located approximately 1 km north of the valley ridge, or "wall", that marks the northern extent of

[1]Paper presented at the Ninth Great Plains Wildlife Damage Control Workshop. (Fort Collins, Colorado, April 17-20, 1989).

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the White River Badlands, about 16 km. south from Wall. South Dakota. When prairie dogs first became established, the location was a privately owned horse pasture. Livestock Bison (<u>Bison bison</u>) grazed on the colony, during the study, however livestock did not utilize the area.

Changes in Plant Composition

The colony was sampled once annually, from 1981 to 1983, during the peak period for biomass of ungrazed vegetation (the last week in July and first week in August). In order to intersect the full range of vegetation, the canopy cover of individual plant species was evaluated along three parallel center-to-edge transects, which we have collectively termed a profile. Five meters apart, the three replicates traced straight lines from the origin of the colony (the oldest burrows, pinpointed by the former property owner) near the geometric center of the colony, to points (525 m away) on the western edge of the colony.

Along the profile, we chose an interval of 25 m to separate sampling sites, S (S=0,1,2,..., 21), inside the colony (on-colony). At each S, we established three sampling transects, one on each replicate of the profile. To quantify local plant composition without prairie dogs, we extended the profile 50, 75, and 100 m beyond the colony, thus establishing a site, S', of nine sampling transects outside the colony (off-colony). Each transect was 29 m long, along which thirty (50 cm by 20 cm; 0.1 m') quadrats were placed, 1 m apart. Canopy cover per species was estimated by recording the appropriate class, from six possible cover classes (Daubenmire 1957), for each plant species present in the quadrat.

We defined plant composition as the canopy cover of plant species encountered, i.e. multiapecies cover. To compare multi-dimensional data (on-colony vs off-colony) with a computer algorithm for the multi-response permutation procedure (MRPP; Berry and Mielke 1983), we reduced the data to 20 plant species (from 75 encountered) by selecting the twenty species with the highest maximum cover among pooled sites. These species (common and scientific names according to Van Bruggen 1985) were: western wheatgrass (<u>Agropyron smithii</u> Rydb.), red threeawn (<u>Aristida purpurea</u> Steud.), dwarf sagebrush (<u>Artemisia cana</u> Pursh), <u>Aster falcatus</u> Lindl., Japanese chess (<u>Bromus japonicus</u> Thunb.), cheat grass (B. <u>tectorum</u> L.), buffalo grass (<u>Buchloe dactyloides</u> (Nutt.) Engelm.), <u>Carex eleocharis</u> Bailey, <u>Chenopodium strictum</u> Roth, horseweed (Con za <u>canadensis</u> (L.) Cronq.), sixweeks fescue (<u>Festuca octoflora</u> Walt.), summer cypress (<u>Kochia scoparia</u> (L.) Schrad.), poverty weed (<u>Monolepis nuttalliana</u> (Schultes) Greene), buckhorn (<u>Plantago patagonica</u> Jacq.), Russian thistle (<u>Salsola iberica</u> Sennen & Pau), tumblegrass (<u>Schedonnardus panniculatus</u> (Nutt.) Trel.), cut leaf nightshade (<u>Solanum triflorum</u> Nutt.). scarlet mallow (<u>Sphaeralcea coccinea</u> (Pursh) Rydb.j, sand dropseed (<u>Sporobolus cryptandrus</u> (Torn) A.Vray), and prostrate vervain (<u>Verbena bracteata</u> Lag. & Rodr.). All species with a cover value greater than 2.0% were retained, including nearly all local major forage species for livestock (Uresk 1986) and prairie dogs (Uresk 1984, Fagerstone et al. 1981). The absence of blue grama (<u>Bouteloua gracilis</u> (H.B.K.) Griffiths) from this list is due both to its paucity on this site and our inability to distinguish it from buffalo grass when the grasses were in a clipped condition.

The difference in cover between S and S', was calculated as the euclidean distance measure between multi-species means:

20

De=(E (Cse-Cts)Q)o.e i-1 where Cs is the

To test the null hypothesis, Ho:De=0 (ns=3, ns.=9), we used a permutation technique, MRPP (Mielke 1986, Mielke et al. 1981, Mielke et al. 1976). MRPP utilizes the sum of the euclidean distances (weighted for group size; Berry et al. 1983), d, between all possible within-group pairs to express concentration within a particular mutually exclusive, exhaustive grouping with group sizes g„ gm,...,g_ (Berry et al. 1983; for detailed example, see Zimmerman et al. 1985). The null hypothesis actually proposed with MRPP, that all permutations of gl,g$,...,gm are equally likely, is tested by: (1) ordering the computed values of d, (2) locating the relative position of the statistic on the list and (3) determining the P-value as the proportion of all values of d less than or equal to the observed value of the a priori grouping. We assumed that the group mean at each S was different from S' when the P of more extreme distances was _<0.05. The full set of species encountered in sampling was used in this computation.

Plant composition was further described by calculating the ratio of forb to grass cover at sampling sites. Forbs included all broad-leaved plants. Grasses included species from the taxonomic families of Poaceae and Cyperaceae (sedges). All species encountered during sampling were included in this computation.

Rate of Compositional Changes

Since we did not know the exact time of prairie dog establishment on all points along the profile, we calculated a growth rate relative to the previous year's state (Green 1979). Thus, we assumed that D[t+ t] was a function of D[t], where t equaled 1 year, and t was peak season during each of the first two study years. Since D has a finite upper limit (the maximum possible difference between compared cover samples), we fit a simple asymptotic growth curve, the natural growth function [f (x)=a(1-e-°=)], to this data. Parameters (a,b) were estimated by least squares estimate using a non-linear regression algorithm (Marquardt 1963).

Effects of Burrowing

During the same period, the number of burrow sounds were counted within a 25 m x 25 m square (0.0625 ha) of which the sampling site was the center. We determined the relationship between the density (ha-') of burrow mounds (independent variable, random effect) and D (dependent variable) by regression. For **calculations of r, significance (P<0.05) was evaluated using the** F-statistic (Cacoullos 1965).

RESULTS

Changes in Plant Composition

The off-colony site was dominated almost completely by buffalo grass, western wheatgrass, Japanese brome (Table 1), while sand dropseed and six-week fescue were minor community constituents (<5% cover). Other species present (<2.0% cover), though not among the 20 species use to calculate multi-species cover, were green needlegrass (Stipa viridula Trin.) and needle-and-thread (S. comata Trin. & Rupr.). On-colony sites near the edge had low forb:grass ratios (Fig. la) though most perennial mid-grasses, e.g. sand dropseed, green needlegrass and needle-and-thread were virtually absent (<0.5% cover). Forb: grass ratios were highest (1.73:1 in 1981, 1.62:1 in 1982, and 8.59:1 in 1983) in the core of the colony (from 0 to 50 m from the center). A taxonomically diverse array of annual forbs were dominant at the core, including prostrate vervain, buckhorn, cut leaf nightshade, rough pigweed (Amaranthus retroflexus L.), tumble- tumbleweed (A. albus L.), poverty weed and Russian thistle. Tumblegrass, a perennial graminoid that frequents disturbed soils, was also an important constituent of this community. Unexpectedly, forb: grass ratio increased from 0.08:1 (1981) to 1.21:1, two years later, in a small (<0.3 ha) mid-colony zone (MCZ) about 350 m from the colony center. This zone was completely surrounded by grass dominated communities. The dominant constituents of MCZ were prostrate vervain, horseweed, and red threeawn (a perennial grass).

TABLE 1. Canopy cover of plant species (>2.0% cover) in the off-colony site.

Species	Canopy cover (± SD) off-colony 1981	1982	1983
	n=9	n=9	n=9
Buffalo grass	80 (6)	79 (12)	86 (8)
Western wheatgrass	5 (4)	6 (2)	5 (3)
Sand dropseed	2 (2)	2 (<1)	2 (<1)
Six-week fescue	3 (1)	4 (1)	2 (2)

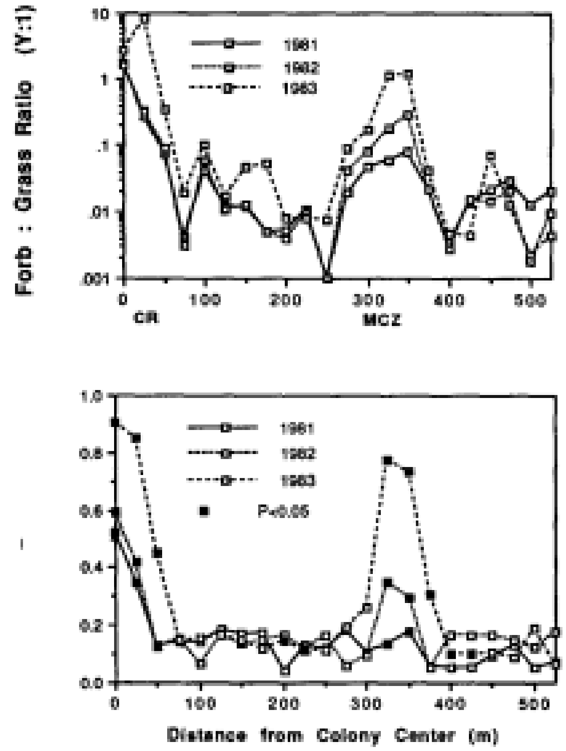

Figure 1.---Three year comparisons of: (a) the ratios of forb to grass cover along the colony profile; (b) the differences in multi-species (20 species) cover, D, between on-colony and off-colony sites along the profile. Locations of zones of extensive compositional change, the core (CR) and mid-colony zone (MCZ), are indicated.

During the study, D increased mainly in the core and surrounding MCZ (Fig. lb). Also. D increased oil sites adjacent to the original core, thus enlarging its radius by about 25 m in two years. Although there was a positive correlation between forb:grass ratio and D (r=0.72, F=6.14, 64 df. P<0.001), forb:grass ratio was not always a true indicator of change; some compositional changes involved the replacement of perennial grass species by other grasses (e.g., buffalo grass was sometimes replaced by red threeawn or tumblegrass).

Rate of Compositional Change

Upon plotting D[t+1] as a function of D[t], we noted a difference between points representing "highly disturbed" zones of the colony (the core and MCZ), and those from the remaining locations along the profile. Highly disturbed zones showed a high positive correlation between yearly states (r=0.84, F=11.5, 12 df, P<0.001). Application of the the natural growth function to these data (Fig. 2) yielded a good fit (Rz=0.72, P<0.001). The remaining points, where grasses dominated, were clumped near the origin. On these sites, yearly states were negat negatively correlated cr 0.53. F=3.32, 28 df. P<0.011.

Effect of Burrowing

The density of burrow mounds and D (Fig. 3) were positively correlated (r=0.58; F=3.76, 64 df, P<0.01). However, linear, exponential, and polynomial regressions of these variables yielded poor fits (RS<0.38). Burrow mounds, and disturbed soil directly adjacent to mounds were observed to be sites for initial establishment of annual forbs. In highly disturbed zones, annual forbs, dwarf shrubs (e.g., pasture sagebrush [Artemisia frigida Willd.]) and some "pioneer" perennial grasses (e.g., red threeawn and tumblegrass) occupied the ground surface between mounds.

Discussion

The differential extinction, replacement and resilience of plant species during prairie dog inhabitancy create the observed pattern of community change. Knowing the long-term response of similarly behaving plant species (**Harper** 1977; rather than taxonomic affinities) may help range and wildlife managers understand prairie dog induced succession. We considered species on the prairie dog colony to fall roughly into four categories: (1) perennials that quickly disappeared after initial prairie dog inhabitancy; primarily mid-grasses, e.g. sand dropseed, green needlegrass, and needle-and-thread; (2) shortgrasses that were initially resistant to the impacts of prairie dog grazing, e.g. buffalo grass (Fig. 4); (3) annuals that became established on recently disturbed soil associated with burrow mounds, e.g. buckhorn, prostrate vervain, and scarlet mallow; (4) annuals and perennials that only became established on the most disturbed sites. e.g. poverty weed. Although the

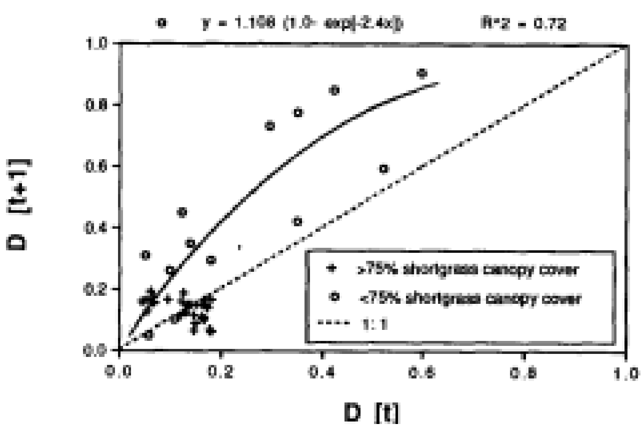

Figure 2.--Year to year changes in the difference between multi-species cover, D, between oncolony and off-colony sites. The natural growth function was fit to points (n=14) that went below 75% shortgrass canopy cover during the study. A year to year increase in D was not observed for points (n=30) above this threshold.

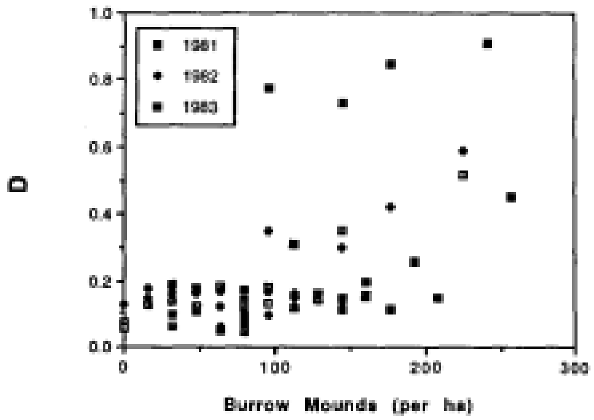

Figure 3.--The relationshp between the difference in multi-species cover between on-colony and off-colony sites, D, and the density of prairie dog burrow mounds.

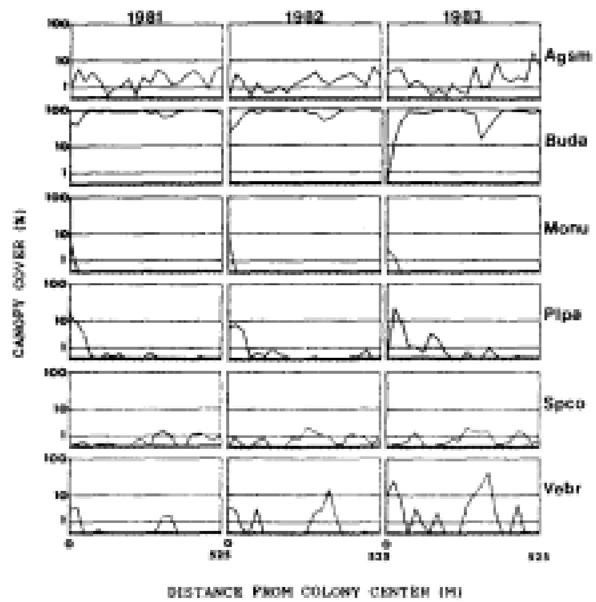

Figure 4. Mean canopy cover for six plant species along the colony profile for three consecutive years. The species are western wheatgrass (Agsm), buffalo grass (Buda), poverty weed (Monu), Patagonia Indianwheat (Plpa), scarlet mallow (Spco), and prostrate verfain (Vebr). The Y-axis is transformed using Log,.(Y+1). Distance from the colony center to an edge 525 m distant was measured in 25 m intervals.

cover of western wheatgrass initially decreased with prairie dog inhabitancy, the species was not displaced entirely as were all other mid-grasses. The ability of this species to maintain a presence under intense prairie dog grazing may be due to the survival of decumbent "grazing" ecotypes that are known to occur in some prairie dog colonies (Detling and Painter 1983).

At the colony edge, plant composition was not radically affected by the loss of mid-grasses. Reduction of mid-grass cover, resulting from prairie dogs clipping tall plants for predator avoidance rather than for forage (King 1955), may have a greater consequence on more mesic grasslands (Archer et al. 1987). The initial 2 yr period of soil disturbance, resulting from building burrow mounds and allowing the introduction of some annual forbs, had a minor impact on the plant community. However, long-term inhabitancy of prairie dogs on mixed-grass prairie vegetation in our location (we estimate from 11 to 13 yrs) can cause the complete disappearance of perennial shortgrasses between mounds.

The nature of soil disturbance and plant community structure varied markedly between the two characteristic types of burrow mounds (King 1955, Sheets et al. 1971), (1) dome mounds and (2) crater mounds. Whereas these structures may reach 1 m in height and 2.5 m in diameter in an old colony (King 1955), all were less than half these dimensions in our colony. Dome mounds were composed of loosely packed subterranean soil spread widely over the ground surrounding the entrance. These mounds became sites for the establishment of a variety of forbs that assumed a prostrate habit, either as a consequence of their natural growth form (Warwick and Briggs 1980) or because they were heavily clipped by prairie dogs. Prostrate vervain, tumbling mustard, buffalo bur (Solanum rostratum Dunal). and cut leaf nightshade were frequent occupants of dome mound sites i.1 our study colony.

"Crater mounds" were narrow, roughly coneshaped structures that prairie dogs constructed from uprooted vegetation, displaced litter, humus, and mineral soil which they scraped from a patch adjacent to the burrow entrance. After a rain, prairie dogs packed the material tightly with their noses. Thus, surfaces of the crater mounds made poor sites for seedling establishment. However, adjacent "quarried" patches were invaded by annual forbs, most frequently buckhorn, during the following spring.

On our colony, the buffalo grass dominated community experienced a resilient period (probably from 4 to 7 yrs) during which little change occurred. This may be a period during which root carbohydrate reserves were being depleted (Santos and Trlica 1978), both to supply above ground regrowth and from increased microbial grazers below ground (Ingham and Detling 1984). A decisive shift in composition was experienced when shortgrass was replaced by a mixture of armed and/or sprawling grasses and forbs, aromatic dicots, and bare ground. The shortgrass "threshold" at our location was 75% cover; sites that went below this level experienced abrupt changes in composition during the following year. Thus, sites below threshold slipped from temporary stability into the asymptotic increase in D that we have described.

Although compositional changes in colonies are likely to be most evident in an expanding core, irregular patches closer to the periphery may undergo change, as well. Archer et al. (1987) concluded that the formation of forb dominated communities in prairie dog colonies could be attributed mostly to the length of time of sustained prairie dog activity. The initial amount of shortgrass cover may also affect the rate of prairie dog induced succession. Since prairie dog colonies are aggregates of highly territorial family groups (coteries) rather than a cooperating colonial entity (King 1955, Hoogland 1981), population and activity of prairie dogs is non-uniformly distributed across the colony. Whereas territories at the core are contiguous. those at the edge of expanding colonies are often spread spaciously amongst relatively undisturbed vegetation. Thus, compositional changes outside the core are likely to be patchy. In our study site, compositional changes outside the core area (in MCZ) appeared to result from sustained inhabitancy of a single coterie on a site with below average shortgrass cover.

In many colonies in the Badlands area. the presence of a shortgrass understory imparts resiliency to the plant community, delaying the eventual shift to annual forbs that is usually incompatible with range livestock management objectives. It should be noted, however, that prairie dog colonies provide valuable forage resources for native ruminants; pronghorns (Antilocapra americana) prefer the high quality herbage in colony cores (Krueger 1986), while bison are attracted to the highly nitrogenous, low fiber regrowth of grasses at the edges of colonies (Coppock et al. 1983). Extrapolation of results from this study to other prairie dog colonies should be done cautiously. In fact, where plant composition and herbivore use is much different from the single colony studied. extreme care should be used in extrapolating these results to other areas.

ACKNOWLEDGEMENTS

This study was sponsored by a research grant from the National Park Service (Contract No. CX1200-1-8035) and logistic support from the US Forest Service Forest and Range Experiment Station in Rapid City, South Dakota. We thank Superintendent Gil Blinn, Chief Ranger Lloyd Kortje, District Ranger Mike Glass and the staff of Badlands National Park, as well as the US Forest Service Experiment Station technical staff, for their assistance. Invaluable assistance was rendered by colleagues in the field, including William Agnew, Debra Paul, Kelly Brown, Wangoi Migongo, and Bw. Mkuu S. Bauni. Monte Garrett and Layne Coppock at Wind Cave N.P. provided helpful suggestions based upon- their own field observations. William Agnew compiled plant specimens invaluable to the research.

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Abstracts

CARNIVORES

Effect of Coyote Removal on Mule Deer Survival in Colorado. White, Gary C., Richard M. Bartmann and Len H. Carpenter.

The effect of coyote (Canis latrans) removals on the survival of mule deer (Odocoileus hemionus) fawns was evaluated in the Piceance Basin of northwest Colorado. Fawns were radio collared during November and survival monitored through the following June for the winter of 1981-82 through 1987-88. Coyotes were removed during the winters of 1985-86 through 1987-88. Overwinter fawn survival ranged from 3.58 (SE 28) during the severe winter of 1983-84 up to 338 (SE 68) in 1982-83. The proportion of fawns dying from predation decreased (P - 0.001), and the proportion of fawns dying from malnutrition increased (P - 0.043), but overwinter fawn survival did not increase (P -0.36) during coyote removal.

Livestock Guard Dogs Protect Sheep from Coyote Predation in Colorado. Andelt, William F.

The effectiveness of livestock guard dogs for protecting domestic sheep (grazed in fenced pastures or on open range) from predators in Colorado was determined with two postal and two telephone surveys during 1986. A total of 174 of about 450 Colorado Wool Grower Association members responded to a general survey. Responses from 123 of the producers were used to estimate sheep losses for producers without guard dogs (respondents with guard dogs, individuals without sheep, and incomplete responses were eliminated). Responses from 21 of the non-respondents were obtained by telephone. Twenty-one of 30 producers suspected or known to use guard dogs with sheep responded to a second postal survey; the survey was completed by interviewing non-respondents by phone. Twenty-two responses were used to estimate sheep losses for producers using guard dogs with sheep (respondents without guard dogs or sheep, and incomplete responses were eliminated). Respondents and non-respondents to the postal survey that did not use guard dogs averaged 660 ewes and 846 lambs and 369 ewes and 460 lambs, respectively, whereas guard dog owners averaged 1217 ewes and 1518 lambs. Respondents and non-respondents without guard dogs reported an average of 1.18 and 1.18 of the ewes and 5.98 and 3.48 of the lambs lost to coyotes whereas producers using guard dogs reported 0.48 of the ewes and 0.98 of the lambs lost to coyotes during 1986.

URBAN

Controlling Raccoon Damage in Urban Areas. Riley, David G.

Raccons have become a serious problem in many urban and suburban areas. Damage to homes and buildings as well as the spread of diseases to pets are constant problems when high raccoon populations occur. Various control methods can be implemented with positive results.

An Evaluation of Hazing Methods for Urban Canada Geese. Aguilera, Elizabeth, Richard L.. Knight, and John L. Cummings.

The efficacy and latency period of two hazing methods of Canada geese (Branta canadensis) were tested in Fort Collins, Colorado urban areas between November 1988 and January 1989. The hazing methods evaluated were screamer shells and alarm calls. Five replications of each method were addressed for a total of 10 experimental field trials. Each trial consisted of three periods: pre-treatment, treatment, and post-treatment. The first `two periods lasted five days and the third depended on the time it took Canada geese to return to the area. Each method was applied for ten minutes two times a day until the geese left the area. The screamer shell was significant in reducing the number of geese at an area up to ten days after the treatment was stopped, however, the alarm call was not effective in hazing geese from an area.

Effects of Animal Welfare Philosophy on Wildlife Damage Control. Schmidt, Robert H.

Wildlife damage prevention and control activities are often criticized when they involve the deaths of wild animals. However, just as the nuclear industry has failed to convince the majority of the public that its industry is safe, education will fail to convince the public that all wildlife damage control techniques are humane. Animal welfare-related legislation, university rules on the use of wild animals for research, and litigation are changing the working environment of our profession. This paper reviews aspects of the animal welfare movement as they affect the wildlife damage prevention and control profession and discusses future strategies for living with it.

BIG GAME

Characteristic of Deer Damage to Experimental Orchards in Ohio. Mower, Kerry J., Thomas W. Townsend, and William J. Tyznik.

We measured newly established apple trees (1) to compare growth differences between trees damaged by browsing deer (Odocoileus virginianus) and trees protected from deer, (2) to determine seasonal patterns of browsing, and (3) to determine if deer browsed selectively among Ohio's 3 most commonly planted apple cultivars. Experimental trees were measured from June 1986 through May 1988.

Experimental orchards were planted at research farms representative of areas where apples are grown commercially. All experimental orchards contained 20 trees each of red delicious, golden delicious, and red rome. Trees were planted randomly by cultivar pairs and one tree of each pair was enclosed in a welded wire cylinder 1.5 m high to exclude deer. Eight orchards were planted the first year; 5 additional orchards were planted the second year. At the beginning of the second year half of the tree pairs in the 8 original orchards were randomly selected and the exclosures switched from control to treatment trees. Trees were measured monthly the first year but bimonthly the second year because the trees had become much larger. Variables measured included branch length, number of leaves/branch, number of leaves/cm of branch length, and browsing frequency. Radial growth was determined by measuring trunk diameter at time of planting and each autumn thereafter.

Length of branches in all orchards but 3 were significantly reduced by browsing deer and browsed trees in all but 2 orchards had significantly reduced numbers of leaves ($p < 0.05$). Browsed branches were observed in all but 1 orchard. The reduction in branch length ranged from 08 in the single undamaged orchard to 988 in one of the most severely browsed orchards; reduction in number of leaves/branch ranged from 08 to 858.

Significant seasonal effects were found in branch length, number of leaves/branch, and browsing frequency between browsed and control trees ($p < 0.05$). Two seasonal patterns existed among significantly browsed orchards. Browsing was concentrated either in early summer or autumn. Orchards with greatest branch and leaf reductions sustained significantly more browsing in early summer than any other season. Browsing in severely damaged orchards began as soon as trees began to grow and decreased only when trees failed to initiate new growth, became dormant, or died. Orchards with lower levels of browsing were damaged in late autumn and winter. Browsing began in the less severely damaged orchards at the time leaves dropped from trees in adjacent wooded areas. **Leaves persisted on apple** trees longer than in surrounding forest trees. Sporadic browsing continued into winter in such orchards.

No evidence was found that deer selectively feed on any of 3 cultivars tested. Browsing was severe enough to cause higher mortality among treated trees in 6 orchards ($p < 0.01$). Four orchards were moderately browsed; mortality rates between browsed and unbrowsed trees were not different but radial growth was reduced significantly among browsed trees. Three orchards were browsed lightly, but neither mortality rate nor radial growth was significantly different between browsed and unbrowsed trees.

After 2 growing seasons, most foliage was beyond the reach of deer. Browsing damage was most critical to small and immature trees. Under conditions of rapid growth, apple trees may reach a size beyond which deer browsing does not impact growth significantly. At some sites, protection might be needed only the first 2-3 years.

Impacts of Pronghorn Grazing on Winter Wheat. Torbit, Stephen C., R. Bruce Gill, James F. Liewer, and A. William Alldredge.

In 1983 a 3-year project was initiated to evaluate the impacts of pronghorn grazing on winter wheat in eastern Colorado. To fully assess the potential impacts of pronghorn grazing, the study was designed to achieve the following objectives:

1) Determine seasonal habitat use by pronghorn in areas containing both winter wheat fields and native grasslands;

2) Determine the relationship between winter wheat use by pronghorn and nutritional characteristics of winter wheat and native forage diets;

3)Measure the response of grain yield to foraging by free-ranging pronghorn;

4) Measure the response of grain yield to controlled foraging experiments with hand-reared pronghorn confined exclusively to wheat fields.

Systematic aerial surveys and reobservation of banded and telemetered pronghorn revealed a seasonal shift to wheat fields in November of each year, however, all pronghorn abandoned wheat fields by early May. Peak use of green wheat fields occurred from November through April. By radio-tracking pronghorn we also observed daily movements between wheat fields and native prairies. Native diet quality, as measured by percent cell contents and crude protein content, declined from October through February and increased after February. Forage quality of winter wheat increased from October through February and declined thereafter. By May, native forages were nutritionally superior to winter wheat. Free-ranging pronghorn were excluded from grazing on a winter wheat field by a paired plot experiment. The impact of grazing by these pronghorn on final grain yield was not measurable, Hand-reared pronghorn were allowed to graze in fenced wheat pastures from November through May ii a controlled experiment. Captive pronghorn removed measurable amounts of green biomass but this removal did not significantly (P - 0.19) reduce final grain yield. Grain yields were not affected despite a stocking rate approximately 80 times that observed with wild pronghorn. The alternating quality of native forage and winter wheat appear to induce a rotational grazing pattern with pronghorn. Wheat is exploited during its early growth when it is nutritionally superior to native forages. Wheat is also most resistant to grazing at this stage. By the time wheat reaches the elongation state when it is most susceptible to damage by grazing, native forages have eclipsed the nutritional quality of winter wheat and pronghorn shift their grazing from wheat to native grasslands. Our results demonstrate that pronghorn grazing on winter wheat is inconsequential when compared to other environmental factors (soil types, precipitation, etc.). It is apparent that winter wheat and pronghorn should be considered complementary resources in mixed rangeland-cropland habitats.

Analytical Chemistry in the Animal Damage Control Program. Mishalanie, Elizabeth A., and Edward W. Schafer, Jr.

Analytical methods related to current and potential Animal Damage Control (ADC) chemicals need to be developed and frequently updated to provide the necessary support for the research and registration-related activities of the ADC Program. Registration-related activities require the development of analytical methods to support the following: field efficacy trials; residue trials; laboratory feeding trials; quality control tests for baits and formulations; stability and longevity studies; soil, water, and vegetation accumulation and metabolism; animal metabolism; and the development of human health/application use restrictions. Other registration-related activities may involve one-time chemical studies such a hydrolysis and photodegradation studies. Analytical methods are also needed to assist in the search for new chemicals for use in vertebrate pest control, for the identification of safe and reliable physiological and mechanical markers used in tracking and migratory studies, and in the assessment of the efficacy and selectivity of baiting techniques.

BIRDS

Anthranilates as Bird Repellent Feed Additives for Reducing Feedlog Damage: An Overview. Glahn, James F.

Anthranilate derivatives, namely dimethy anthranilate (DMA) and methyl anthranilate (MA), which are human food flavorings, have a long history of study as potential bird repellents. Recent studies, initiated in 1984, investigating the potential use of these flavorings as bird repellent feed additives are summarized. These studies have included a number of laboratory, large pen, simulated field, and actual field studies at various concentrations of DMA and MA to evaluate their effectiveness in reducing feed loss damage by blackbirds and starlings. Companion studies on acceptance and performance of livestock with up to 1.08 DMA and MA in their rations are also summarized. Based on these studies and an economic assessment it appears that low concentrations of methyl anthranilate could be cost-effectively used to protect livestock feed with minimal effects on livestock.

RODENTS & LAGOMORPHS

Mound Building Rates of Plains Pocker gophers *Geomys bursarius*, introduced on alfalfa fields. Luchsinger, James C., and Ronald M. Case.

Pocket gophers reduce forage yields by consuming vegetation and by the adverse effects of their tunneling and mound building (reducing plant vigor, smothering plants, and changing species composition). We are investigating the response of two different alfalfa varieties to the presence of pocket gophers in order to assess the possibility of using cultural methods to lessen the impact of pocket gophers on alfalfa yields.

Four paired plots were established for each alfalfa variety, a tap-rooted variety (Wrangler) and a fibrous-rooted variety (Spredor II). Each pair consisted of a control (no gophers) and experimental (gophers present) plot. Pocket gophers were stocked at a density of 6/hectare. Tunnel construction as indicated by the presence of surface mounds pushed up by **pocket gophers, was** checked at 3 to 13 day intervals. Our **objective** was to determine whether there was a difference in tunnel construction by pocket gophers in either of the alfalfa varieties.

We gathered data on 8 plains pocket gophers over at least 50 days. Mound production per pocket gopher ranged from 59 (over 57 days) to 154 (over 85 days). Mean mound production for the eight gophers was 100. The four gophers on Wrangler produced an average 1.2 mounds/day. The four gophers on Spredor II produced an average 1.6 mounds/day. We were unable to detect any significant differences in the rate of mound building among sex, age, or body size.

Efficacy of Three Formulations of Zinc **Phosphide** for Black-tailed Prairie Dog Control. Hygnstrom, Scott E., and Peter M. McDonald.

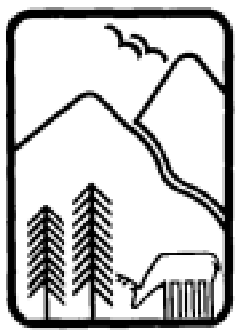
Studies have compared the efficacy of zinc phosphide to other toxicants, in particular strychnine and sodium monofluoroacetate, for controlling prairie dogs (Cynomys spp.). In most states, however, zinc phosphide is the only toxicant that is currently registered by **the EPA** for controlling black-tailed prairie dogs (C. ludovicianus). Various formulations of zinc phosphide are marketed but their relative efficacy is unknown. Prices and availability also **vary.** We compared the efficacy and cost of 3, 2.08 zinc phosphide baits for controlling black-tailed prairie dogs [2.0$ zinc phosphide-treated steam rolled oats (ZP-rolled oats), Pocatello Supply Depot, U. S. Fish and Wildlife Service, Pocatello, Ida.; ZP Rodent Bait-AG crimped oats (ZP-crimped oats), Bell Laboratories, Inc., Madison, Wis.; and ZP Rodent Bait-AG pellets (ZP-pellets), Bell Laboratories, Inc., Madison, Wis.). We conducted this study on 13 black-tailed prairie dog colonies in central Nebraska during November-December, 1988. We continuously searched the colonies (all were < 8 ha) during the study for evidence of black-footed ferrets (Mustela nigripes) but none was found. We established 66, 0.4-ha areas within these colonies to serve as treatment plots. A 0.4-ha control plot was established within 100 m of each treatment plot. We prebaited treatment plots with untreated stream-rolled oats according to zinc phosphide pesticide label recommendations. After 2-3 days, we randomly assigned and applied each zinc phosphide formulation, according to label recommendations, to 22 separate treatment plots. We used a plugged burrow technique to estimate the activity of prairie dogs 3 days after treatment. The differences in activity between the treatment and associated control plots were used to determine the relative efficacy of the 3 formulations. Active prairie dog burrows were reduced 808 with ZP-rolled oats, 78$ with ZP-crimped oats, and 718 with ZP-pellets. A one-factor ANOVA revealed that there were no significant differences (P - 0.322) in efficacy among the 3 treatments. Data were independent, normally distributed, and variances among treatments were homogeneous. Material costs varied among treatments (ZP-rolled oats-$1.04/kg, ZP-crimped oats-$1.32/kg, and ZP-pellets-$2.21/kg). The costs of labor (@ $5.00/hr) for applying the prebait and bait were $18.07/ha for each treatment. The total costs per ha for 70-808 control of black-tailed prairie dogs were $18.71 for ZP-rolled oats, $18.82 for ZP-crimped oats, and $19.16 for ZP-pellets.

Responses of a Black-tailed Prairie Dog Population to Experimental Exploitation. Cox, Mike X•, and William L. Franklin.

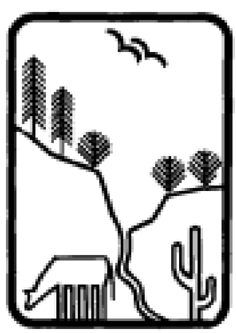
Survival, natality, movement, and body condition were examined in an exploited **black-tailed prairie** dog population in western Nebraska. Both colonies in the population **were exploited at an** average rate of 0.44 for two consecutive years. The nonremoval survival **rate for the old colony** decreased from 0.68 after **the first removal, to** 0.25 after the second removal. The new colony's nonremoval survival severely declined from 0.63 to 0.18, due in part to badger predation. The overall pregnancy rate of yearlings and adults in the population was 0.92, and the mean litter size ranged from 3.06 to 5.38 pup/lactating female. Because of the possible compensatory mortality in the winter months, disappearance in the summer months had the greatest impact on nonremoval survival.

Monofilament Lines Repel House Sparrows. Aguero, Danilo A., Ron J. Johnson, Kent M. Eskridge, James E. Knight, and Donald H. Steinegger.

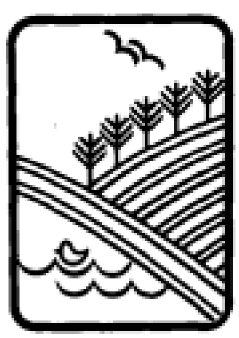
Observations in New Mexico indicated that clear 8-pound-test monofilament line spaced at 30.5 cm (1 foot) intervals excluded house sparrows (Passer domesticus) from strawberries and stopped bird (species undetermined) damage to grapes. In other uses, it protected sprouting plants and peach trees from house sparrow and other bird damage, and effectively stopped barn swallow (Hirundo rustica) nest-building under eaves of a house. Five follow-up experiments with controls were conducted at the University of Nebraska. In experiment 1, lines spaced 30.5 cm apart around grape plants did not reduce American robin (Turdus migratorius) and European starling (Sturnus vulgaris) entries into the plants nor damage to grapes. Experiments 2 through 5 used baited stations to evaluate size (4-, 12-, and 20-poundtest weight), orientation (north-south, east-west, horizontal, vertical), color (clear and florescent yellow-orange), and spacing (30.5 and 61 cm) of monofilament line. Results of food consumption and bird count data indicate that all treatments repelled house sparrows. Blue jays (Cyanocitta cristata) and northern cardinals (Cardinalis cardinalis) were repelled somewhat but numbers of observations were small. Eleven other species at baited stations appeared not to be repelled by the lines. Although current experiments to refine management applications and to understand the underlying mechanism are not completed, we conclude that monofilament lines may effectively reduce house sparrow problems at some sites.



Rocky Mountains



Southwest



Great Plains

U.S. Department of Agriculture
Forest Service

Rocky Mountain Forest and Range Experiment Station

The Rocky Mountain Station is one of eight regional experiment stations, plus the Forest Products Laboratory and the Washington Office Staff, that make up the Forest Service research organization.

RESEARCH FOCUS

Research programs at the Rocky Mountain Station are coordinated with area universities and with other institutions. Many studies are conducted on a cooperative basis to accelerate solutions to problems involving range, water, wildlife and fish habitat, human and community development, timber, recreation, protection, and multiresource evaluation.

RESEARCH LOCATIONS

Research Work Units of the Rocky Mountain Station are operated in cooperation with universities in the following cities:

Albuquerque, New Mexico
Flags taff, Arizona
Fort Collins, Colorado'
Laramie, Wyoming
Lincoln, Nebraska

'Station Headquarters: 240 W. Prospect Rd., Fort Collins, CO 80526