BIODIVERSITY ASSOCIATED WITH ACTIVE AND

EXTIRPATED BLACK-TAILED PRAIRIE DOG COLONIES

by

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CHAPTER I

GENERAL INTRODUCTION

The purpose of this research was to determine differences in small mammal, amphibian, ground dwelling insect, and avian communities among active black-tailed prairie dog colonies, Phostoxin®-treated colonies, and non-colonized short-grass prairie. This study was conducted at the BWXT Pantex Plant in Carson County, Texas, on a seasonal basis from March 2000 to August 2001.

The Pantex Plant is the only facility in the United States assembling and disassembling nuclear weapons. The Plant also acts as an interim storage site for plutonium. Black-tailed prairie dogs at the Plant have been controlled in areas of special operational concern for both security and safety reasons and in some areas for agricultural concerns using aluminum phosphide (Phostoxin®). Due to the nature of operations at the Plant, control measures are necessary and will continue. However, Pantex would like to maintain biological diversity and manage for a functioning short-grass prairie ecosystem. In order to accomplish these goals, an understanding of the faunal communities associated with prairie dogs, and the effects of prairie dog control on these species was desired.

Results of this study are organized into 3 chapters. In Chapter II, species composition, diversity, and abundance of small mammals and amphibians were compared among active prairie dog colonies, aluminum phosphide treated colonies, and non-colonized short-grass prairie sites. Insect abundances and results of burrow probe and

spotlight sampling also were included in this chapter. Avian species diversity and

abundance were compared among active prairie dog colonies, aluminum phosphide

treated colonies, and non-colonized short-grass prairie sites. These data are presented in

Chapter III. Chapters II and III will be submitted for publication separately. The authors

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CHAPTER II

SMALL MAMMAL, AMPHIBIAN, AND GROUND

DWELLING INSECT BIODIVERSITY ASSOCIATED

WITH ACTIVE AND EXTIRPATED BLACK-TAILED

PRAIRIE DOG COLONIES

Abstract

Abundances and species diversity of small mammals, amphibians, and ground dwelling insects were measured on active black-tailed prairie dog (*Cynomys ludovicianus*) towns, Phostoxin®-treated prairie dog towns, and non-colonized short-grass prairie to determine the impacts of Phostoxin® use on non-target species. Eleven species of small mammals and 6 species of amphibians were captured. Total amphibian ($P=0.590$) and small mammal ($P=0.992$) abundance did not differ among active prairie dog colonies, Phostoxin®-treated colonies, and non-colonized sites. However, the number of amphibians captured on active colonies (6.22) was an order of magnitude greater than on Phostoxin®-treated colonies (0.67) and 3 times higher than on non-colonized sites (2.11). Abundances of northern grasshopper mice (*Onychomys leucogaster*) and ground dwelling insects were higher on active prairie dog colonies. Small mammal and amphibian species richness, evenness, and diversity were not different among treatments. Small mammal populations decreased ($P=0.023$) during summer of 2001 when rainfall at the site was appreciably lower than normal. Investigation of the interior of prairie dog burrows with a burrow probe system indicated

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that various amphibians and insects, as well as burrowing owls (*Athene cunicularia*) inhabited prairie dog burrows. Results of this study indicate that in short-grass prairie ecosystems vegetative alterations made by prairie dogs may not influence small mammal and amphibian populations as much as other studies have found in mixed-grass prairies. However, prairie dog burrow systems provide important sources of shelter for many small mammal, amphibian, and insect species, and long-term use of Phostoxin® to control prairie dog populations may impact these species.

Introduction

Prairie dogs (*Cynomys* spp.) once inhabited North American prairies from southern Canada to north-central Mexico, and from the eastern Rocky Mountains to the tall-grass prairies of the Great Plains (Hall 1981). They were among the most numerous grassland herbivores and had a significant impact on nutrient cycling, plant succession, and biodiversity in the prairie ecosystem (Potter and Hansen 1980, Copprock et al. 1983, Archer et al. 1987, Reading et al. 1989, Weltzin et al. 1997). Over the last century, prairie dog populations have decreased by 98% (Department of the Interior 1963, Miller and Ceballos 1994). In Texas, black-tailed prairie dog (*C. ludovicianus*) range was estimated to have declined from 800 million acres in 1905 to 90,000 acres in 1977 (Cheatam 1977). The decline in prairie dog abundance and distribution was principally the result of mass eradication programs, the introduction of sylvatic plague, unregulated shooting, and habitat loss (Cully 1993, Van Putten and Miller 1999). In February 2000, the United States Fish and Wildlife Service determined that listing of the black-tailed

prairie dog as a threatened species was "warranted but precluded" (United States Fish and Wildlife Service 2000). This designation indicates that the black-tailed prairie dog merits protection, but that under current circumstances other species are more in need of agencies resources. Status of black-tailed prairie dog will be annually reviewed by the United States Fish and Wildlife Service.

Use of toxicants to control prairie dogs remains a common practice. Previous studies have examined the impact of zinc phosphide and strychnine (common prairie rodenticides) on non-target species (Deisch et al. 1989, 1990, Apa et al. 1991). These toxicants are used with baits, commonly oats, that allow non-target species to ingest the rodenticides. Collins et al. (1984) reported that the control of prairie dogs using toxic bait may not be economically feasible, as the annual costs of control exceeded the value of the additional forage gained for livestock grazing. Aluminum phosphide, a burrow fumigant commonly known as Phostoxin® (Degeshe Company, Inc., Weyers Cave, VA), is now being used as a method of prairie dog control (Moline and Demarais 1988). Phostoxin® tablets are dropped into burrows, a small amount of water added, and burrow openings are plugged with newspaper and dirt. Tablets release hydrogen phosphide gas that acts as a toxic fumigant, suffocating burrow inhabitants. Phostoxin® was found to be approximately 95% effective in controlling black-tailed prairie dogs, and almost 100% effective in controlling ground squirrel (*Spermophilus* spp.) populations (Salmon et al. 1982, Moline and Demarais 1988). In addition to causing direct mortality to prairie dogs and non-target species inhabiting prairie dog burrows, Phostoxin® indirectly may effect them as treated burrows are closed and inaccessible for shelter and other uses. Non-

target species also may be impacted by the changes to the local vegetative community that may result from the elimination of prairie dogs from an area (Klatt and Hein 1978, Potter and Hansen 1980, Cid et al. 1991).

Many species are closely associated with prairie dog colonies. Black-tailed prairie dogs may even function as keystone species within the prairie ecosystem (Miller and Ceballos 1994, Kotliar et al. 1999, Van Putten and Miller 1999). Their burrow systems provide shelter for burrowing owls (*Athene cunicularia*), reptiles such as the prairie rattlesnake (*Crotalus viridis*), and amphibians including the tiger salamander (*Ambystoma tigrinum*) (Kotliar et al. 1999). Prairie dogs modify the vegetative structure and composition of their habitat, creating areas of altered habitat that affect other grassland species (Whicker and Detling 1988). Compared to non-colonized grasslands, prairie dog colonies support greater numbers of small mammals, arthropods, birds, and predators (O'Melia et al. 1982, Agnew et al. 1986, Krueger 1986, Miller et al. 1990, Sharps and Uresk 1990). Densities of deer mice (*Peromyscus maniculatus)* and Northern grasshopper mice (*Onychomys leucogaster*) have been found to be 3 to 4 times higher on prairie dog towns than on non-colonized areas (Agnew et al. 1986).

No studies have addressed the effects of aluminum phosphide fumigants on non-target species associated with prairie dogs. This study was designed to examine differences in small mammal, amphibian, and insect communities among Phostoxin®-treated sites, active prairie dog colonies, and non-colonized sites and by season. We also tested a burrow probe video system (Christensen Designs, Manteca, CA) to visually sample the interior of active, abandoned, and Phostoxin®-treated burrows for other

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vertebrate and invertebrate occupants. No previous studies have investigated prairie dog

burrows using such a system, which may detect non-target species affected by

Phostoxin® applications, but which would not be detected through traditional trapping

methods.

Materials and Methods

This study was conducted on the Pantex Plant located 27-km northeast of

Amarillo, Texas in Carson County (Figure 2.1). The main Plant encompassed 3,683 ha,

and an additional site at Pantex Lake, located 4 km northeast of the main Plant, occupied

436 ha. Topography at the site was relatively flat with several playa lakes, and had an

average elevation of 1,067 m. The climate was semi-arid and characterized by hot

summers and cold winters, with large variations in daily temperatures. Precipitation was

irregular and annually averaged 497 mm at Amarillo, Texas, with peaks in March and

October (Figure 2.2).

The study area was characterized by short-grass prairie dominated by buffalo

grass (*Buchloe dactyloides*) and blue grama (*Bouteloua gracilis*), with scattered clumps

of prickly pear (*Optunia* spp.). Other species commonly found at the site included

sideoats grama (*Bouteloua curtipendula*), western wheatgrass (*Agropyron smithii*), vine

mesquite (*Panicum obtusum*) and silver bluestem (*Bothriochloa laguriodes*) (Waste and

Environmental Damage Department 1996). Approximately 70% of the site was farmed

or grazed. Livestock were managed under a rotational grazing system at the main Plant,

with the sampling areas at Playa 1 (active and non-colonized) grazed at 80% from April-

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September 2001. At the Pantex Lake sampling areas (active and non-colonized) grazing intensity was adjusted to available forage. No other areas were grazed during the study. Additional areas of the Plant are mechanically shredded to reduce fire danger.

We compared small mammal, amphibian, and other species abundances, diversities and composition among active prairie dog towns, non-colonized short-grass prairie, and Phostoxin®-treated towns. Nine areas, representing 3 replications of each treatment type were selected (Figure 2.3). Sampling areas were separated by ≥ 250 m. Three areas had active prairie dog towns: playa 2, playa 3 (A), and Pantex Lake (A). Three areas were non-colonized short-grass prairie: playa 1, playa 3 (N), and Pantex Lake (N), and three areas were Phostoxin®-treated prairie dog towns: Zone 8, Zone 4 West, and Zone 12-36. Phostoxin® application occurred at each of these areas in early spring 1998, 1999, and between winter and spring sampling periods during 2000. Zone 4 West and Zone 8 were also treated with Phostoxin® in spring 2001, prior to the spring sampling period.

Trapping arrays of 100 m x 100 m were established at each area. Sherman live traps (n=100) were placed at 10 m intervals (Deisch et al. 1990, Jones et al. 1996). Six trapping sessions were conducted from May 2000 to August 2001 on a seasonal basis (Spring: May 8-29 2000 and April 20-May 28 2001, Summer: June 11-August 20 2000 and June 19-August 26 2001, Autumn: October 26-December 3 2000, and Winter: January 26-February 26 2001). Each area was trapped for 3 consecutive nights each session. Three or four sampling areas were trapped simultaneously. Traps were baited with a mix of rolled oats and sunflower seed hearts and set before dark. U-shaped metal

wires were placed over the traps and into the ground to prevent traps from being blown from their original location. All traps were checked the following morning. During autumn, winter, and early spring trapping sessions, cotton balls were placed in the traps to reduce the risk of hypothermia (Jones et al. 1996). Captured small mammals were marked with numbered ear tags (#1005 size 1, National Band and Tag Company, Newport, KY) weighed to the nearest gram, and identified to sex, age class (juvenile or adult) and species. This information was recorded along with trap location. Ear tag number and trap location was recorded for animals recaptured on subsequent nights or sessions.

An array of drift fences and pitfall traps was established at the center of each of the 9 small mammal arrays to capture amphibians (Corn 1994). Pitfall traps were arranged in arrays of 5 traps, with one 19-liter bucket in the center, and four 19-liter buckets extended 10 m from the center (Figure 2.4). Drift fences were placed between each of the buckets to direct animals into the pitfalls (Gibbons and Semlitsch 1982). Black cloth silt fencing approximately 0.7 m in height was used as drift fence (Specialty Converting & Supply, Nashville, GA). The base of the fencing was entrenched in the ground and covered with dirt to provide stability and to facilitate amphibian movement (Dodd and Scott 1994). Bucket openings were flush with the ground, with dirt and sand packed around the sides of the buckets to prevent animals from falling in crevices. Approximately 2 cm of water was kept in the buckets to prevent desiccation of captured amphibians (Daust 1991). Holes 1 cm in diameter were drilled at 5 cm in buckets and small blocks of untreated wood (approximately 7 cm^2) were placed in the bottom of

buckets to prevent drowning of non-target species (McComb et al. 1991). Buckets were covered with fitted lids between sampling periods to prevent unintentional captures (Corn 1994).

Pitfall traps at each site were opened for 3 consecutive nights per session. During periods of moderate weather, traps were opened the first evening and subsequently checked each morning and evening for the duration of the session. During periods with very hot (>30° C) daytime temperatures, traps were opened the first evening, but closed each morning and reopened each evening to prevent overheating of captured animals. All captured individuals (including small mammals and insects) were identified to species (small mammals) or family (insects). Amphibians were marked by toe clipping (Donnelly et al. 1994).

Spotlight surveys were performed along designated transects at each of the sampling areas from October 2000 to August 2001. Routes were driven at approximately 8 kph beginning 1 hour after sunset (Frylestam 1982). An observer scanned the trapping array with a spotlight and recorded all species observed on the sampling area. At each area, spotlight surveys were conducted 2 nights during each season (autumn, winter, spring, and summer). Surveys were conducted on clear nights when average wind speed was < 25 kph.

Sheets of plywood measuring approximately 60 cm x 90 cm were placed at the 4 corners of each of the trapping arrays (Simpson et al. 1996). On the final day of each trapping session, the cover-boards were lifted and all species observed beneath were identified and counted.

A Peeper™ (Christensen Designs, Manteca, CA) burrow probe with a 3.35 m semi-flexible cable was used to sample black-tailed prairie dog burrows. The burrow probe was equipped with infrared illumination allowing low-light observations through a video headset. A measuring tape was attached to the cable of the burrow probe to allow for depth measurements. Species observed were identified along with the depth at which they were observed, and whether the burrow was active or inactive. Three types of burrows (n=25 each type), post-Phostoxin®, abandoned and active, were randomly sampled each season as follows:

Burrows

Post-Phostoxin®. In March of 2000, 4 sites: Zone 8, Zone 12-36, Zone 4 west, and the shelterbelt area were treated with Phostoxin®. Within three days of Phostoxin® application, 25 burrows were examined with the burrow probe: 9 at Zone 8, 11 at Zone 12-36 and 5 in the shelterbelt. We used a stratified random sampling procedure based upon the total number of Phostoxin®-treated burrows on the sampling areas. Newspaper and dirt were removed from the burrow openings to allow for sampling with the burrow probe. Burrows were not replugged after observations were made. Twenty-five post-Phostoxin® burrows were sampled each season.

Abandoned. Abandoned burrows were defined as burrows in an area no longer used by prairie dogs. All of these burrows were located in the eastern portion of the playa 2 site, which was the only area where a large number of burrows had been abandoned. Twenty-five burrows were sampled at this site each season

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Active. Active burrows were defined as burrows where prairie dogs were observed entering and exiting burrows or sites where fresh prairie dog droppings were observed at burrow openings. We used a stratified random sampling procedure based upon the total number of active burrows on the sampling areas. Twelve burrows were sampled at playa 2, 7 burrows were sampled at playa 3, and 6 burrows were sampled at Pantex Lake on a seasonal basis.

Data Analysis

As small mammal numbers were consistently low during this study, there was not sufficient mark-recapture data to estimate population size using methods such as the Jolly-Seber model (Grant 1982). Relative abundances of small mammals at each sampling area were determined using catch-per-unit-effort method, where captured animals were "removed" from the population by marking (Lancia and Bishir 1996). Marked animals were ignored in subsequent trapping events, and the number of new captures were used to calculate population size. The number of unique captures in each session was divided by the total number of available traps (trap nights per session – closed traps – traps occupied by recaptured animals). For the three most commonly captured species, deer mice, plains harvest mice, and northern grasshopper mice, individual estimates of relative abundance were calculated. Relative abundance of amphibians was calculated as the number of captures per sampling session, as all sampling sites had equal numbers of trap nights. No amphibian species were captured frequently enough to allow for individual species comparisons of abundance. Insects

observed under cover-boards or captured in pitfall traps were combined to produce relative insect abundances for each site.

Small mammal and amphibian species diversity was calculated for each sampling area using the Shannon-Weiner (H') and Simpson (D) indices (Magurran 1988, Hanks 1995). These 2 different measures of diversity were chosen for ease of comparison to other studies and because each has a different emphasis: the Shannon-Weiner is an information statistic index weighted towards rare species, while the Simpson index is a dominance measure weighted towards abundant species (Krebs 1989). Values produced by the Simpson index were subtracted from 1 to ensure that the index increases with increasing diversity (Magurran 1988). Evenness (J'), an indication of how equally abundant the species are (Lloyd and Ghelardi 1964), was also calculated from small mammal and amphibian species capture data.

A two-way repeated measures analysis of variance (ANOVA) was used to test for differences in insect, small mammal and amphibian abundances, diversities and evenness through time (seasons) and among treatments (active, Phostoxin®-treated, and non-colonized). The PROC MIXED procedure was used to allow for missing data points (Littell et al. 1996). Data were tested for sphericity using Mauchley's Criterion, heterogeneity of variance using Levene's Test of equality of error variances, and for normality using Shapiro-Wilk Test. In cases where sphericity was violated, standard errors were hand calculated to correct for the violation (Milliken and Johnson 1984, Kirk 1995). We considered statistical tests significant when $P<0.05$. In cases where

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statistically significant differences among treatments or seasons were detected, differences of least square means were used to separate means.

Results

Small Mammals

Because of poor weather conditions that made some sites inaccessible, only 5 of 9 sites were trapped during the winter sampling period and 1 site was not trapped during the spring 2001 sampling period. Data from the winter sampling session are not included in these analyses.

Between May 2000 and August 2001, we captured 227 individual small mammals representing 11 species (Table 2.1). Six species were captured on active sites, 7 species were captured on Phostoxin® sites, and 11 species were captured on non-colonized sites. Six species were found on all 3 treatments. The hispid pocket mouse (*Chaetodipus hispidus*) was captured only on Phostoxin®-treated and non-colonized sites. The plains pocket mouse (*Perognathus flavescens*), house mouse (*Mus musculus*), Merriam's pocket mouse (*Perognathus merriami*), and prairie vole (*Microtus ochrogaster*) were recorded only at non-colonized sites. The most common species observed on all 3 treatments was the deer mouse representing 48% of captures at active sites, 53% at Phostoxin® sites, and 44% at non-colonized sites.

Number of small mammals captured during this study was relatively low (Beatley 1969, Yahner 1992), so we were only able to test for differences in relative abundance in the 3 most common species: deer mice, plains harvest mice, and northern grasshopper

mice (Table 2.2). Northern grasshopper mice were more abundant ($P=0.059$) on active

colonies than on Phostoxin®-treated or non-colonized sites (Table 2.3). Deer mice and

plains harvest mice abundances did not differ due to treatment ($P=0.859$ and $P=0.442$,

respectively), but were different among seasons ($P=0.008$ and $P=0.047$) (Tables 2.4 and

2.5, Figures 2.5 and 2.6). Total small mammal abundance showed a similar pattern, with

no treatment effect ($P=0.992$), but season ($P=0.023$) effects (Tables 2.6 and Figure 2.7).

Small mammal richness showed season ($P=0.019$), but no treatment effects ($P=0.697$)

(Table 2.7 and Figure 2.8). Small mammal evenness, Simpson diversity, and Shannon

diversity were not different over either treatment or season (Tables 2.8 and 2.9).

Summer 2001 differed from other seasons (Figures 2.5-2.8). Capture rates in

summer 2001 averaged 0.468 captures per 100 trap nights, while capture rates over the

previous seasons averaged 2.285 captures per 100 trap nights (Figure 2.7).

Amphibians

Pitfall trapping sessions (n=5) were conducted May 2000-August 2001. Data

from pitfall trapping during spring 2000, fall 2000, and winter 2001 are not included in

the analysis. During spring 2000, pitfall trapping occurred only on playa 3 (active and

non-colonized sites) and Zone 4 West because arrays were not yet in place at the other

sites. Pitfall trapping was not conducted at 6 of the areas (playa 3 (active and non-

colonized), playa 1, Pantex lake (active and non-colonized), and Zone 12-36) during

autumn and at all areas during winter due to freezing temperatures.

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We captured 81 individual amphibians representing 6 species during summer 2000, spring 2001, and summer 2001. No reptiles were captured during this study. Four amphibian species were recorded on active prairie dog colonies: the New Mexico spadefoot toad (*Scaphiopus multiplicatus*), plains spadefoot toad (*Scaphiopus bombifrons*), Couch's spadefoot toad (*Scaphiopus couchii*) and the spotted chorus frog (*Pseudacris clarkii*) (Table 2.10). On non-colonized sites, the Great Plains toad (*Bufo cognatus*), New Mexico spadefoot toad, plains spadefoot toad, and tiger salamander (*Ambystoma tigrinum mavortium*) were captured. The Great Plains toad, New Mexico spadefoot toad, plains spadefoot toad, and the spotted chorus frog were recorded on Phostoxin®-treated sites. New Mexico spadefoot toads were the most common species captured (n=68), with two capture events containing 63 juveniles.

Number of amphibians captured during this study was low, and therefore made differences in abundance, richness, evenness, and diversity difficult to detect. No treatment or seasonal effects were observed for any of the variables tested. (Tables 2.11-2.13). While not statistically significant (P=0.590) the abundance of amphibians captured on active colonies (6.22) was an order of magnitude greater than on Phostoxin®-treated colonies (0.67) and 3 times higher than on non-colonized sites (Figure 2.9).

Ground Dwelling Insects

We captured 167 individual ground dwelling insects representing five families in pitfall traps or under cover-boards during summer 2000, spring 2001, and summer 2001

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(Table 2.14). Four families, crickets and grasshoppers (Gryllacrididae), scarab beetles (Scarabaedidae), ground beetles (Carabidae), and wolf spiders (Lycosidae) were captured at each treatment. Ground beetles were the most abundant family, representing 42% of observed insects, while scarab beetles accounted for 27%, crickets and grasshoppers for 26%, and wolf spiders for 5%. Ground beetles were captured in all seasons on all treatments, while scarab beetles were captured in all seasons on all treatments except active prairie dog sites in summer 2000. A single tarantula (family Theraphosidae) was observed in summer 2001 at a non-colonized site. Ants (family Formicidae) were observed at 7 of the 9 of the sampled sites, but are not included here because accurate counts were not possible under cover-boards.

Overall abundance of ground dwelling insects collected from pitfall traps and cover-boards was higher ($P=0.015$) on active prairie dog colonies than on Phostoxin®-treated colonies or non-colonized sites (Table 2.15). Insect abundance was not different over time ($P=0.596$).

Burrow Probe

During spring 2001, 2 sites: Zone 4 west and north of playa 2 along Pantex Drive, were treated with Phostoxin®. To increase sampling effort, half of the Phostoxin®-treated burrows at each site were examined with the burrow probe within three days of treatment. Seventy-five burrows at Zone 4 west and 100 burrows at the site north of playa 2 on Pantex Drive were investigated. During summer 2001, 12 burrows at Zone 4 west and 13 burrows at the site north of playa 2 on Pantex Drive were examined

in conjunction with the sites treated in spring 2000. Abandoned burrows were not examined during summer 2000 when the burrow probe was being repaired. During winter 2001, active burrows at playa 3 and Pantex Lake were not sampled due to snow cover.

We observed 614 individuals representing insects, amphibians, rodents, and birds (Table 2.16). Five hundred and ninety-two insects of 4 types (Coleoptera, Gryllacrididae, Formicidae, and Lycosidae) were observed with the burrow probe. Families Scarabaeidae and Carabidae were combined into order Coleoptera, because it was difficult to distinguish the two families with a burrow probe. Crickets and grasshoppers represented 62% of observations, beetles represented 19%, ants represented 8%, and wolf spiders represented 2%. I also observed 14 pillbugs (*Armadillium* spp.), terrestrial crustaceans of the Isopod order, with the burrow probe. Other species observed included 3 tiger salamanders, 1 Great Plains toad, 3 prairie dogs, and 1 burrowing owl.

A total of 165 individuals were observed in burrows at active prairie dog sites, 100 individuals were observed in burrows treated with Phostoxin® during spring 2000, and 340 individuals were observed in abandoned burrows. We found only insects in abandoned burrows, and 291 of the individuals (86%) observed were crickets or grasshoppers. Numbers of individuals observed varied with season (Figure 2.10). During winter 2001, only 6 beetles were observed at the sampling sites, while 130 individuals were observed during spring 2000, 75 during summer 2000, 152 during autumn 2000, 129 during spring 2001, and 121 during summer 2001. Numbers of

individuals observed on Phostoxin® sites treated prior to spring 2000 also varied by time (Figure 2.11); with 7 during spring 2000, 12 during summer 2000, 19 during autumn 2000, 5 during winter, 38 during spring 2001 and 18 during summer 2001. At burrows treated with Phostoxin® before spring of 2001, 2 individuals were observed in 185 burrows sampled during spring 2001 and 8 in 25 burrows sampled during summer 2001. Numbers of individuals also varied seasonally at active and abandoned burrows, with the lowest numbers observed during winter sampling (Figures 2.12 and 2.13).

Spotlight Surveys

We documented 42 individuals during the spotlight surveys performed during autumn 2000 through summer 2001 (Table 2.17). Individuals observed included grassland songbirds, small mammal species, wolf spiders, cottontail rabbits (*Sylvilagus* spp.), coyotes (*Canis latrans*), burrowing owls, and a striped skunk (*Mephitis mephitis*). Wolf spiders, striped skunk, and grassland songbirds were observed only on active sites, while cottontail rabbits, burrowing owls and small mammal species were observed on all treatment types. Coyotes were observed only on active and Phostoxin®-treated prairie dog sites. Cottontail rabbits were the most common species, consisting of 55% of individuals observed. Numbers of individuals observed varied by treatment, with 21 individuals observed on active prairie dog sites, 18 on Phostoxin®-treated sites, and 3 on non-colonized short-grass prairie. Numbers of individuals also varied by season, with 18 individuals observed during autumn 2000, 4 during winter, 5 during spring 2001, and 15

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during summer 2001. No species were observed at non-colonized sites during winter, spring 2001, and summer 2001.

Discussion

Total rodent abundance, diversity, evenness, and richness did not differ among active prairie dog towns, Phostoxin®-treated prairie dog towns, and non-colonized short-grass prairie. Abundances of deer mice and plains harvest mice also were not different among treatments. These results differed from studies conducted in South Dakota and Oklahoma, which indicated overall rodent abundance and deer mouse abundance was greater on prairie dog colonies (O'Melia et al. 1982, Agnew 1983, Agnew et al. 1986, Deisch et al. 1990). These differences may be due to conditions under which each study was performed. Vegetation in our study area was extremely short in comparison to sites in South Dakota and Oklahoma, and this may have been a factor in determining small mammal distributions, which are influenced by changing habitat availability.

Prairie dogs alter vegetation on their colonies by decreasing canopy cover and plant height (Archer et al. 1984). In areas with taller grass, these activities provide areas of open space, which may attract species, such as deer mice that prefer this habitat type (Agnew et al. 1986, Deisch et al. 1990). At the Pantex site, prairie dog activities may have less of an impact on the structure of the vegetative community because canopy cover and plant height are already reduced (Sims et al. 1978). Additionally, significant portions of the site are grazed and mechanically shredded, further decreasing cover and plant height. As a result, areas of short-grass prairie are found over much of the site, not

just on prairie dog towns, and species that are adapted to this habitat may not concentrate on prairie dog towns.

Northern grasshopper mouse abundance was higher within active prairie dog colonies than on the Phostoxin®-treated or non-colonized sites. This pattern may be due to two factors. First, insects, which compose a significant portion of the northern grasshopper mouse's diet, were more abundant on prairie dog towns. Northern grasshopper mice are omnivores, feeding primarily on insects (mostly beetles and grasshoppers), plant material, and other species of mice (Flake 1973, Davis and Schmidley 1994). Beetle and grasshopper abundances were greater on active prairie dog towns according to our burrow probe and pitfall surveys. Koford (1958) suggested that prairie dog burrows were used by ground beetles and that grasshoppers preferred prairie dog towns due to the presence of bare ground and increased forbs. Olson (1985) found greater insect abundances on active prairie towns compared to adjacent prairie. The greater abundances of beetles and grasshoppers on active prairie dog towns may provide an incentive for the northern grasshopper mice to use these areas.

Northern grasshopper mice are also known to use burrows of other species for shelter and nesting sites (Agnew 1983, Agnew et al. 1986, Stapp 1997). Stapp (1997) reported that northern grasshopper mice preferentially selected for areas containing pocket gopher (*Thomomys, Geomys*) mounds over random sites. Other investigations found northern grasshopper mice abundances are higher on active prairie dog towns that non-colonized sites (O'Melia et al. 1982, Agnew et al. 1986). At the Pantex site, northern grasshopper mice populations may be impacted directly by use of Phostoxin®. It appears

likely that northern grasshopper mice inhabiting prairie dog burrows treated with Phostoxin® likely experience the same mortality rates (i.e., 95-100%) exhibited by ground squirrels and prairie dogs (Salmon et al. 1982, Moline and Demarais 1988). Phostoxin® treatment may result in an initial decrease in northern grasshopper mouse numbers through direct mortality, and long-term reductions in populations may result as the mice are unable to use the plugged burrows.

Small mammal populations showed a marked decrease during summer 2001. This pattern was likely the result of drought conditions during this period, as rainfall from June-August totaled only 8.68 cm compared to a 30-year average of 24.23 cm. These conditions also may have effected plant production, resulting in the failure of many plants to produce seeds (White et al. 1996). Seeds are an important part of granivorous rodent diets (e.g., deer mice and plains harvest mice), and a food shortage may have resulted in reduced rodent populations (Mutze et al. 1991, Morton et al. 1995). Packard (1972) found a similar reduction in small mammal populations on the Pantex Plant following drought conditions that caused a decrease in aboveground herbage in 1971.

Amphibian populations at the Pantex site were not significantly different among active prairie dog sites, Phostoxin®-treated sites, and non-colonized short-grass prairie. Sample sizes were small (n=81), and were dominated by the capture of two groups (n=48 and n=15) of juvenile New Mexico spadefoot toads. However, 68 of the 81 captures occurred on active prairie dog towns. Our results may not depict of a general patterns. Additionally, spadefoot toads burrow underground between major rainfalls to avoid temperature and moisture extremes (Kretzer 1999). Because of this activity, spadefoot

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species may be difficult to capture at times other than immediately after rainfalls. Because significant rainfall events make many of the clay roads at the Pantex Plant impassable, we rarely sampled during and directly after storms, and may have missed significant portions of the amphibian population.

Results from burrow probe sampling indicated that amphibians were using prairie dog burrows. Several studies have indicated that prairie dog burrows may provide high-humidity habitats for some amphibians (Kretzer 1999). Collins (1993) reported that tiger salamanders and several other amphibian species may use mammal burrows to escape harsh environmental conditions. In short-grass prairie habitat, prairie dog burrows may provide shelter unavailable in non-colonized areas. Amphibians were only captured in pitfall traps during the spring and summer seasons, and little is known about the role of prairie dog burrows in providing shelter for amphibians in cooler temperatures or humidity. Prairie dog burrows could also provide hibernation refugia for many species dependant on underground habitats for winter survival (Kretzer 1999).

The burrow probe served as a useful tool for examining the interior of prairie dog burrows, yet there were several limitations associated with its use. While insects appeared to be unbothered by the presence of the probe, larger species such as prairie dogs and tiger salamanders were observed actively fleeing further into the burrow upon introduction of the probe into the burrow. Prairie dog burrows may be > 4.25 m deep and > 33 m long (Sheets et al. 1971), and the length of the probe (3.35 m) only allowed us to partially sample prairie dog burrows. It is likely that many burrow occupants were present below this depth. This was supported by the fact that no carcasses of prairie dogs

or non-target species were observed in any of the burrows investigated immediately after Phostoxin® treatment. We were certain that a significant portion of the prairie dogs occupying the Phostoxin®-treated burrows were killed. It appeared that they may have retreated to nest chambers deep within the burrows, and were not observable with this burrow probe.

Our results suggest that while prairie dog burrows at the Pantex site provide important sources of shelter for northern grasshopper mice and ground dwelling insects, they appear to be less important to other small mammal species. Northern grasshopper mice and ground dwelling insects appeared to be negatively impacted by use of Phostoxin® to control prairie dog populations. We suspect that over a long-term period, control of prairie dogs with Phostoxin® may effect other species, as the exclusion of prairie dogs from an area will result in changes to the vegetative community. Additionally, without maintenance by prairie dogs, burrows deteriorate and become unusable to other species which may have used them for shelter. While the extent of the use is unknown, our burrow probe sampling indicates that several amphibian species as well as burrowing owls occupy prairie dog burrows.

Further investigations are needed to assess the long-term impacts of Phostoxin® use on non-target species. Additionally, more intense amphibian sampling is needed to gain a better understanding of how these species use prairie dog towns, and whether there are seasonal differences in these activities. Prairie dog burrows are also important to several snake species which may use them to avoid predation or weather extremes (Kretzer 1999). Our pitfall and cover-board sampling did not detect the presence of any

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reptiles, but several species have been observed on the study sites. Additional sampling is needed to determine the use of prairie dog towns by reptiles, and to quantify the impact of Phostoxin® on them. More intensive surveys are needed to assess the use of prairie dog towns by predators and other associated mammals. Our spotlight surveys did not detect enough individuals to determine any patterns of occurrence.

The use of a longer burrow probe system would allow for more complete sampling of prairie dog burrows, and may allow us to make direct observations of the impacts of Phostoxin® on non-target species. Additionally, a burrow probe with a smaller, more flexible head would enable the user to navigate the turns and splits of the burrows more efficiently.

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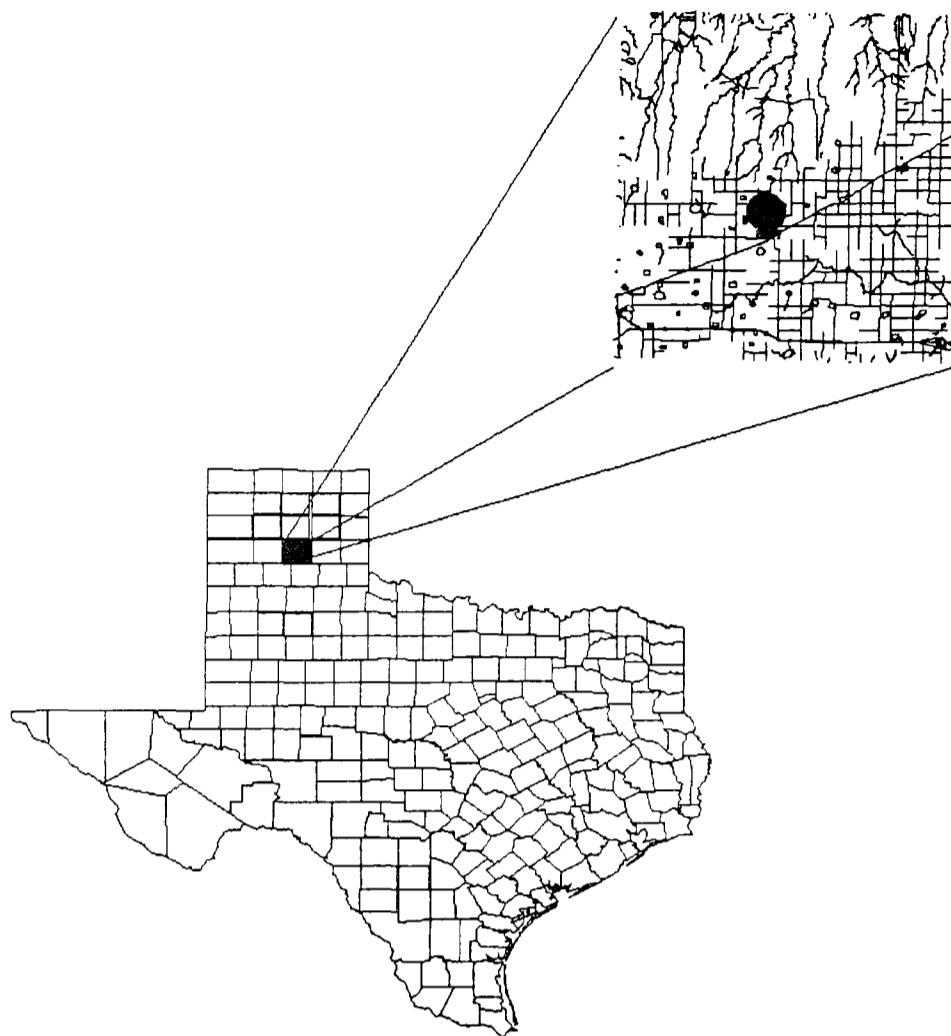
Figure 2.1. Location of Carson County, Texas (shaded square), and location of the Pantex Plant (shaded circle) within Carson County. Lines represent water features and roads.
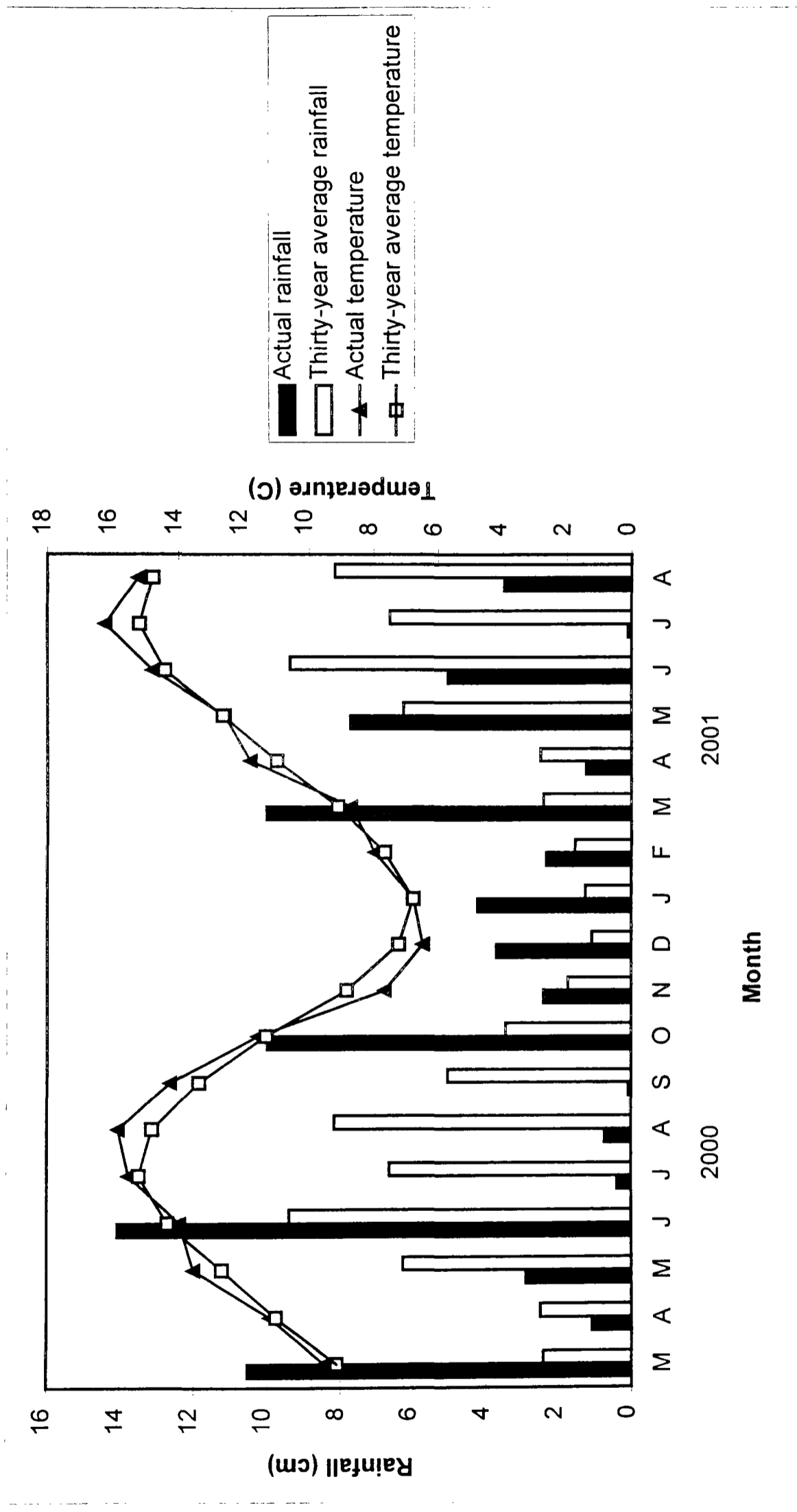
Figure 2.2. Thirty-year average rainfall and temperature at Amarillo, Texas compared to actual rainfall and temperatures recorded from March 2000-August 2001.
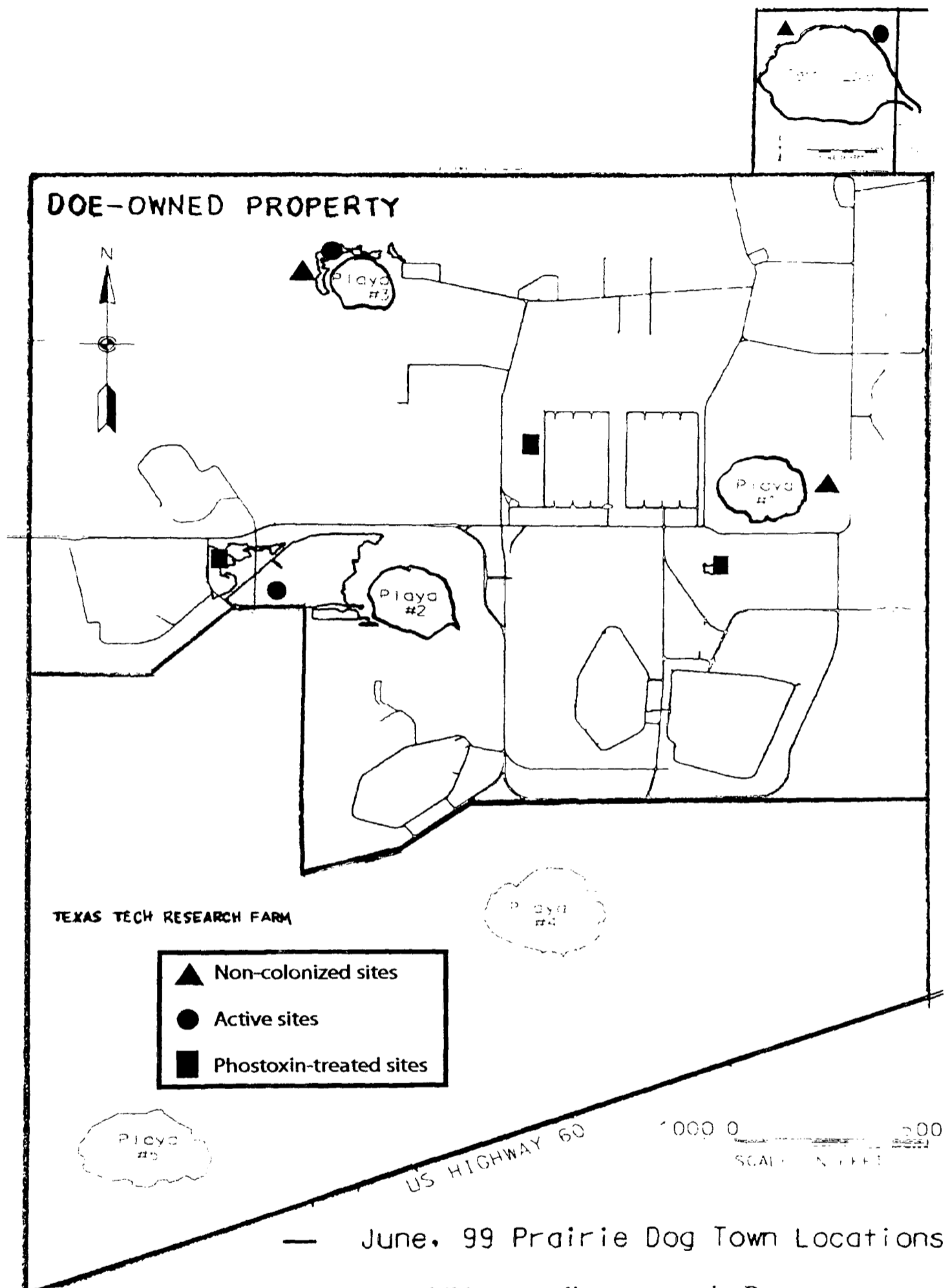
Figure 2.3. Small mammal and amphibian sampling areas at the Pantex
Plant, Carson County, Texas.
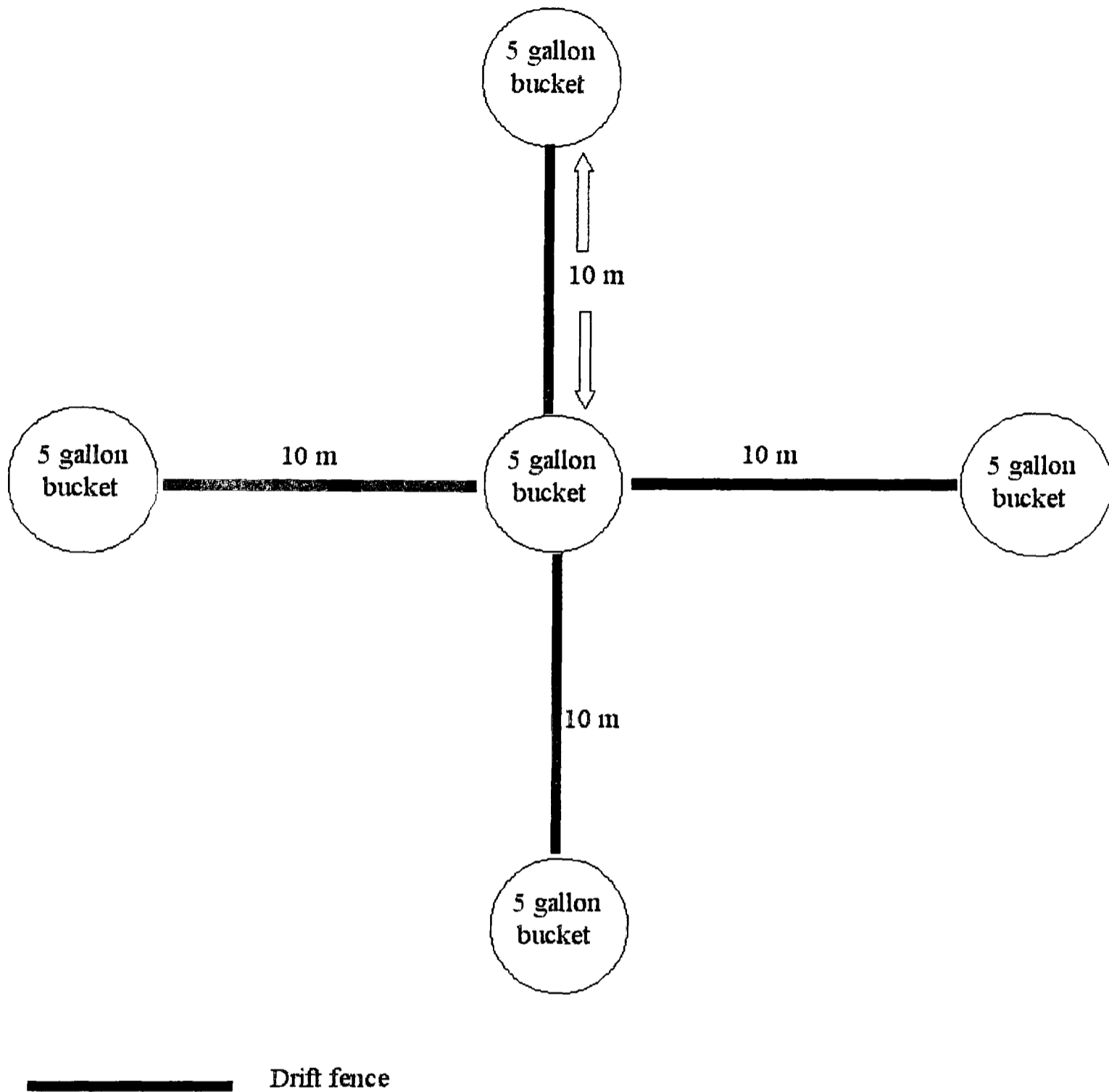
Figure 2.4. Pitfall trapping array used to capture amphibians and insects at the Pantex
Plant, Carson County, Texas from spring 2000-summer 2001.
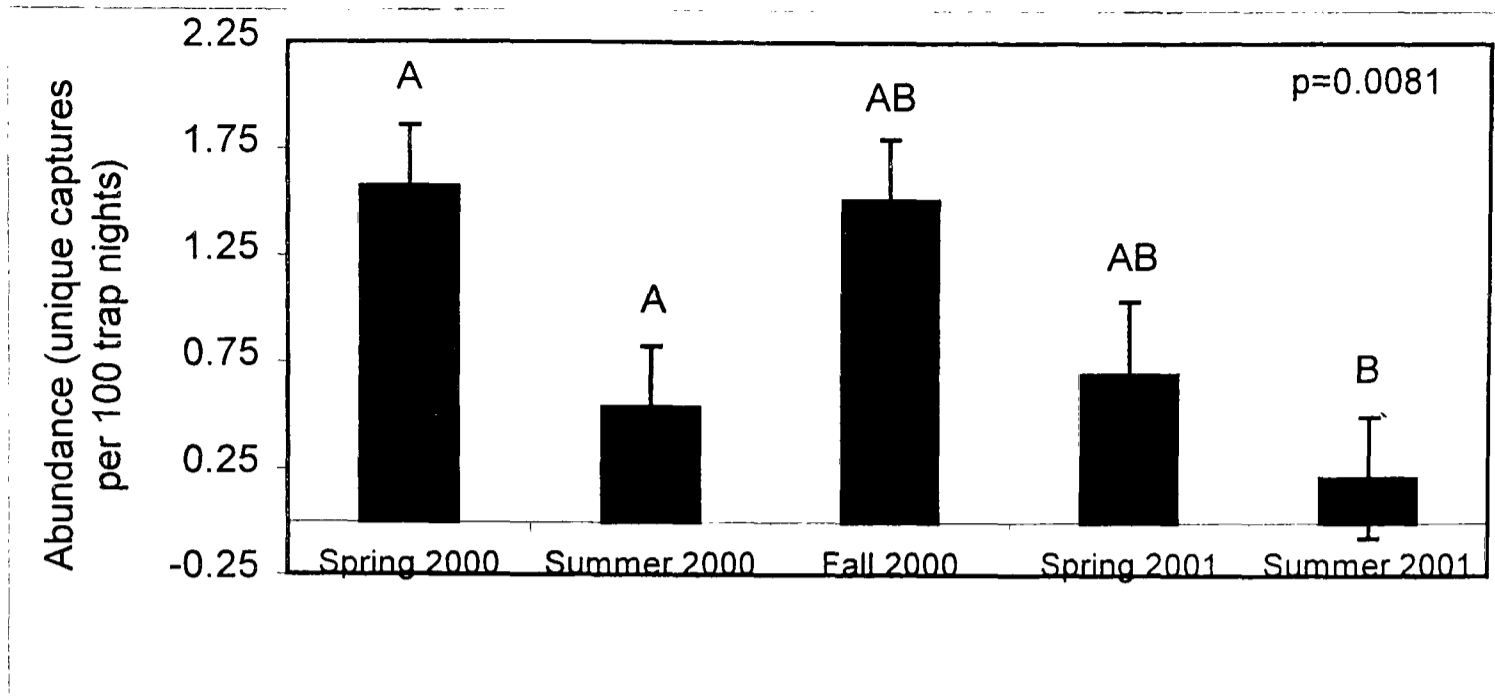
Figure 2.5. Deer mouse abundance means±SE spring 2000-summer 2001 at the Pantex Plant, Carson County, Texas. Columns with the same letter were not (P>0.05) different using mean separations.
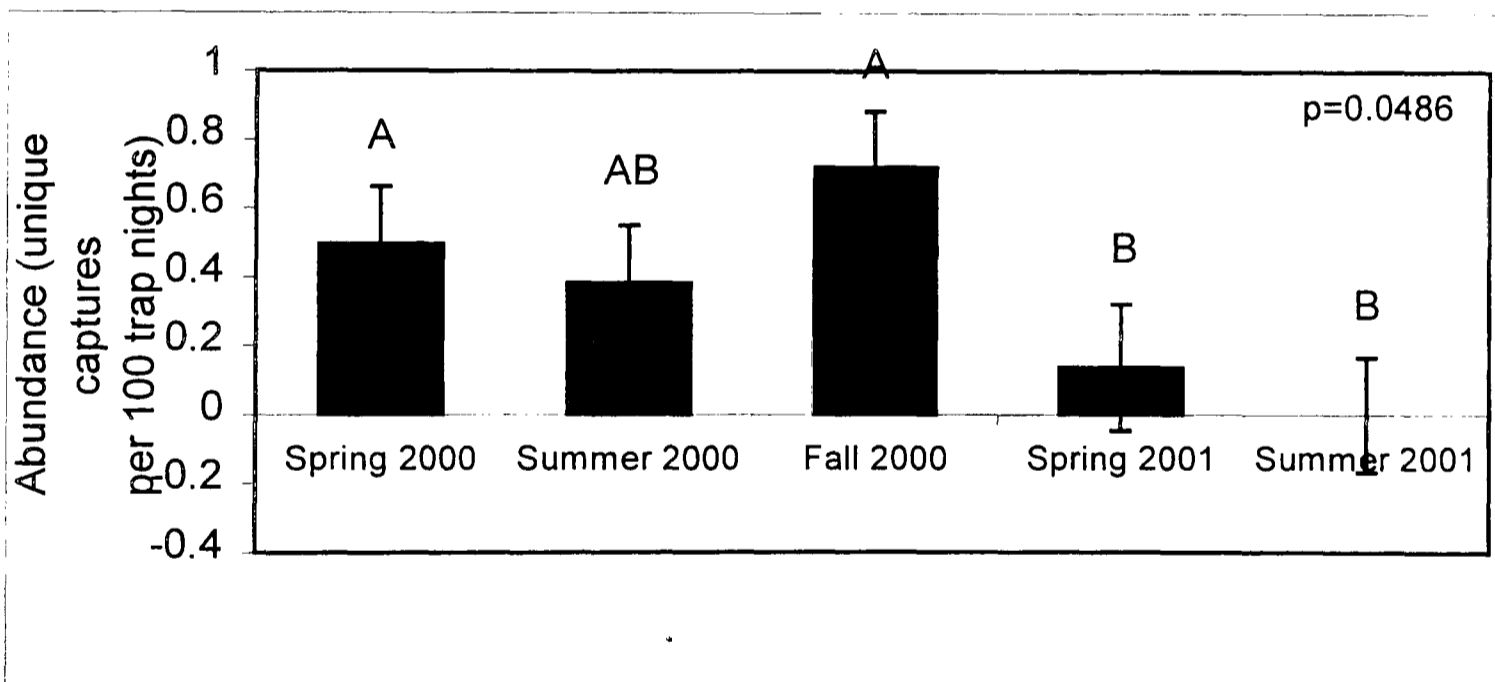
Figure 2.6. Plains harvest mouse abundance means±SE spring 2000-summer 2001 at the Pantex Plant, Carson County, Texas. Columns with the same letter were not (P>0.05) different using mean separations.
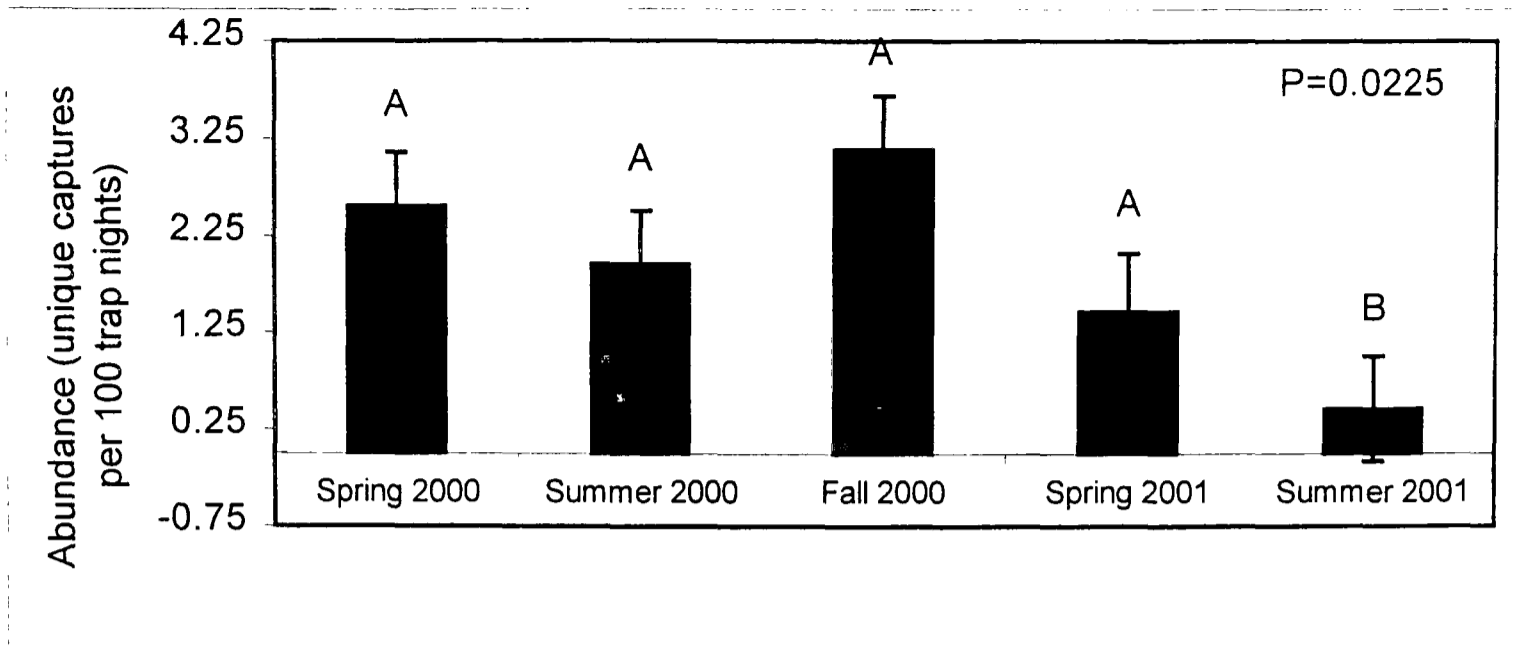
Figure 2.7. Overall small mammal abundance means±SE spring 2000-summer 2001 at the Pantex Plant, Carson County, Texas. Columns with the same letter were not (P>0.05) different using mean separations.
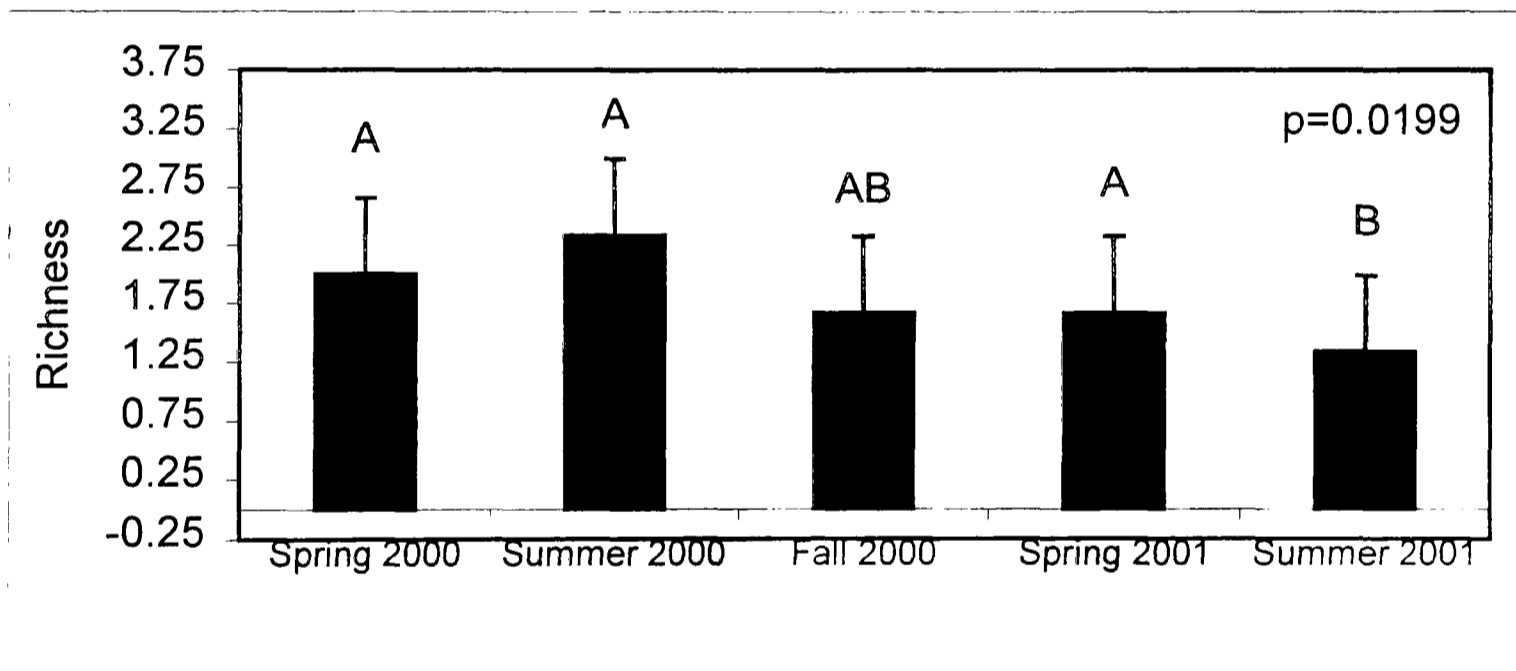
Figure 2.8. Small mammal species richness means±SE spring 2000-summer 2001 at the Pantex Plant, Carson County, Texas. Columns with the same letter were not (P>0.05) different using mean separations.
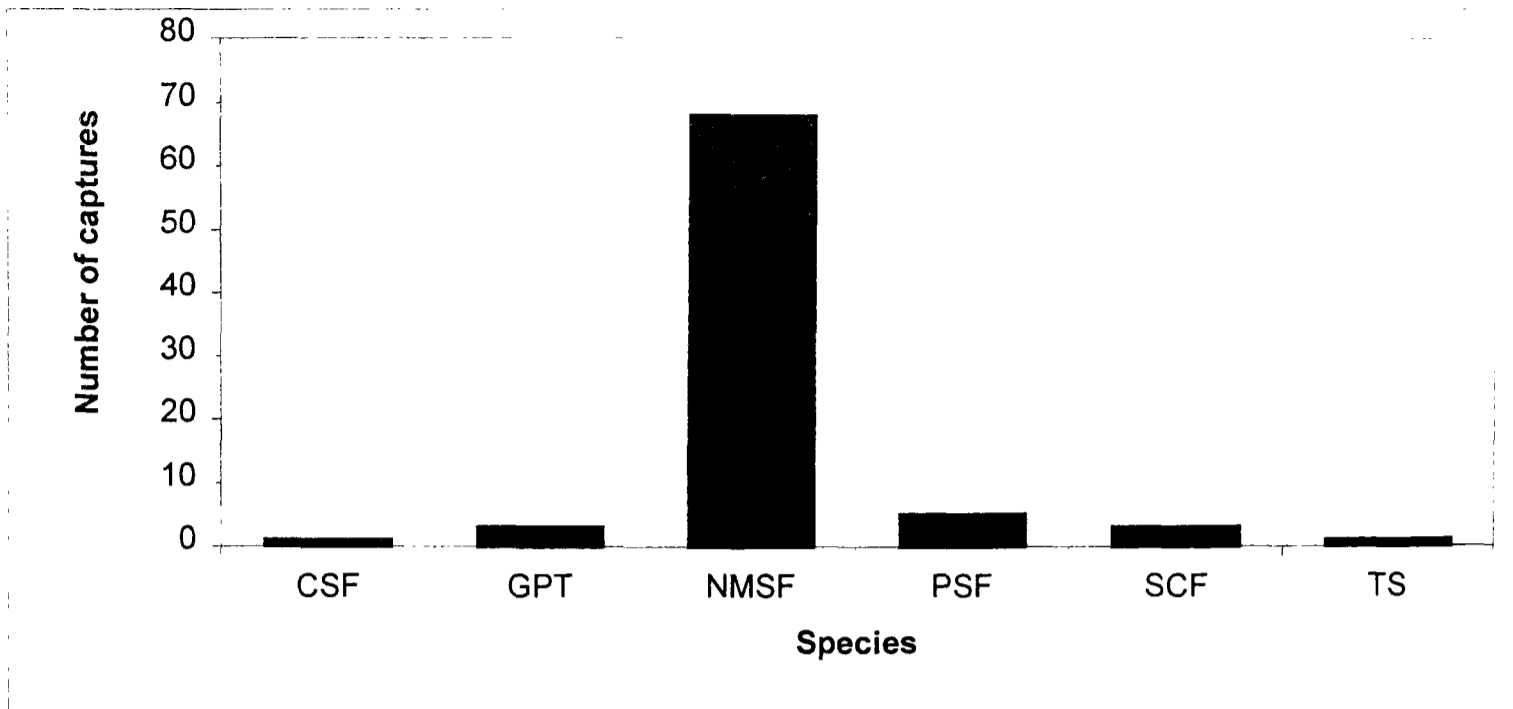
Figure 2.9. Amphibian captures by species during spring 2000, spring 2001, and summer 2001 at the Pantex Plant, Carson County, Texas. Species names are abbreviated as CSF=Couch's spadefoot, GPT=Great Plains toad, NMSF=New Mexico spadefoot, PSF=Plains spadefoot, SCF=Spotted chorus frog, and TS=Tiger salamander.
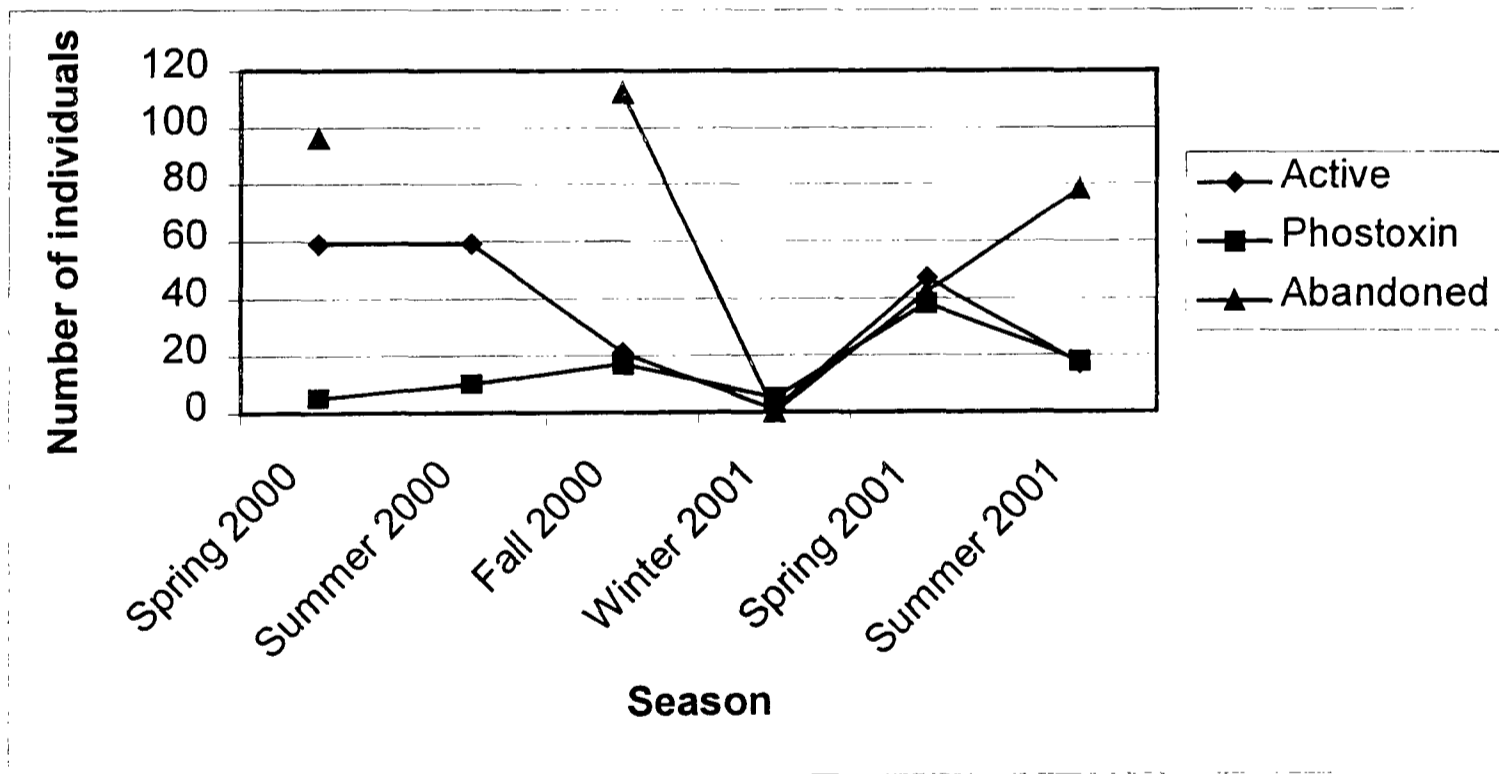
Figure 2.10. Total numbers of insects detected in active, phostoxin-treated, and abandoned burrows during spring 2000-summer 2001 at the Pantex Plant, Carson County, Texas.
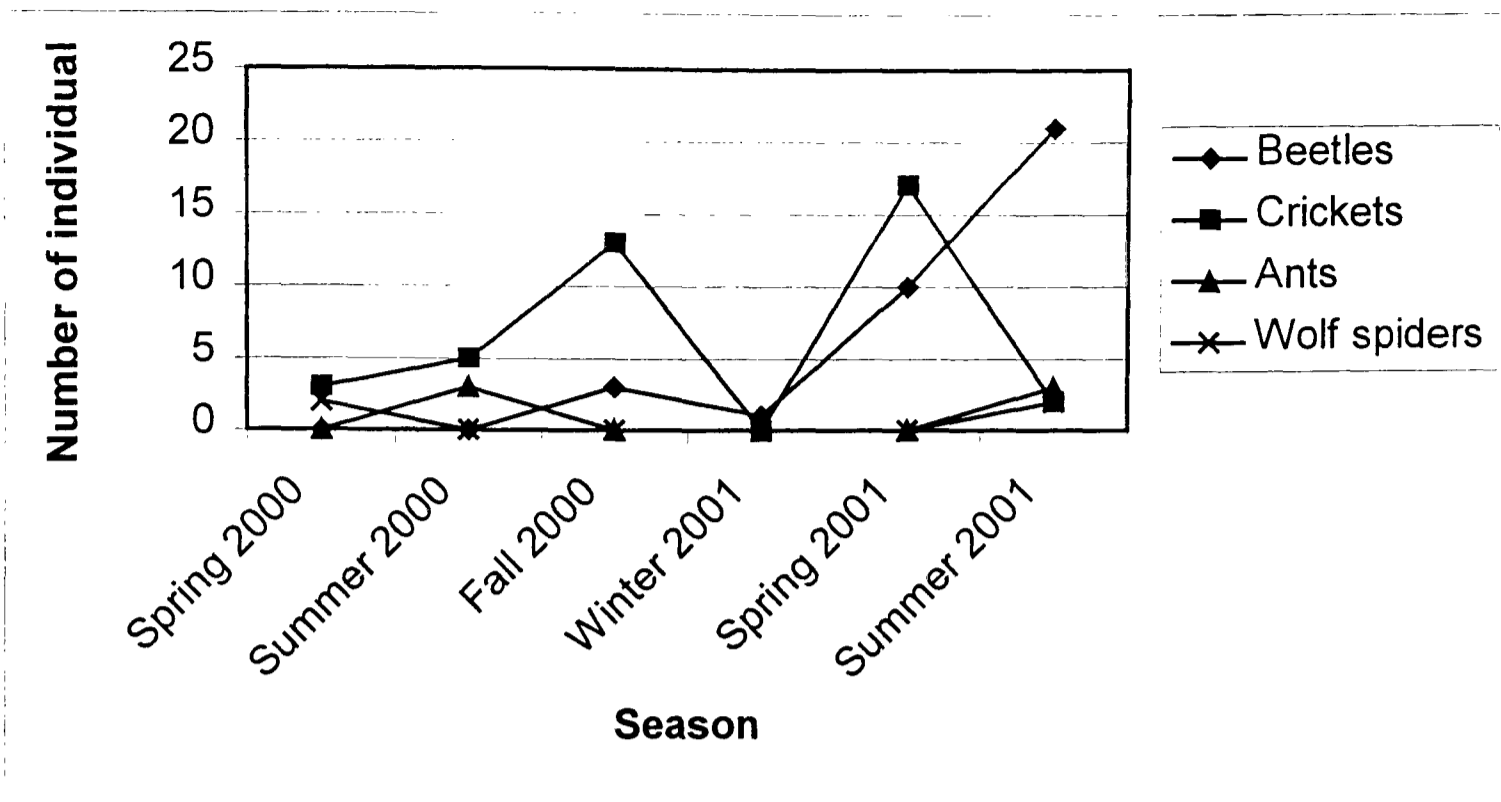
Figure 2.11. Insects observed in Phostoxin-treated prairie dog burrows using a burrow probe, during spring 2000-spring 2001 at the Pantex Plant, Carson County, Texas.
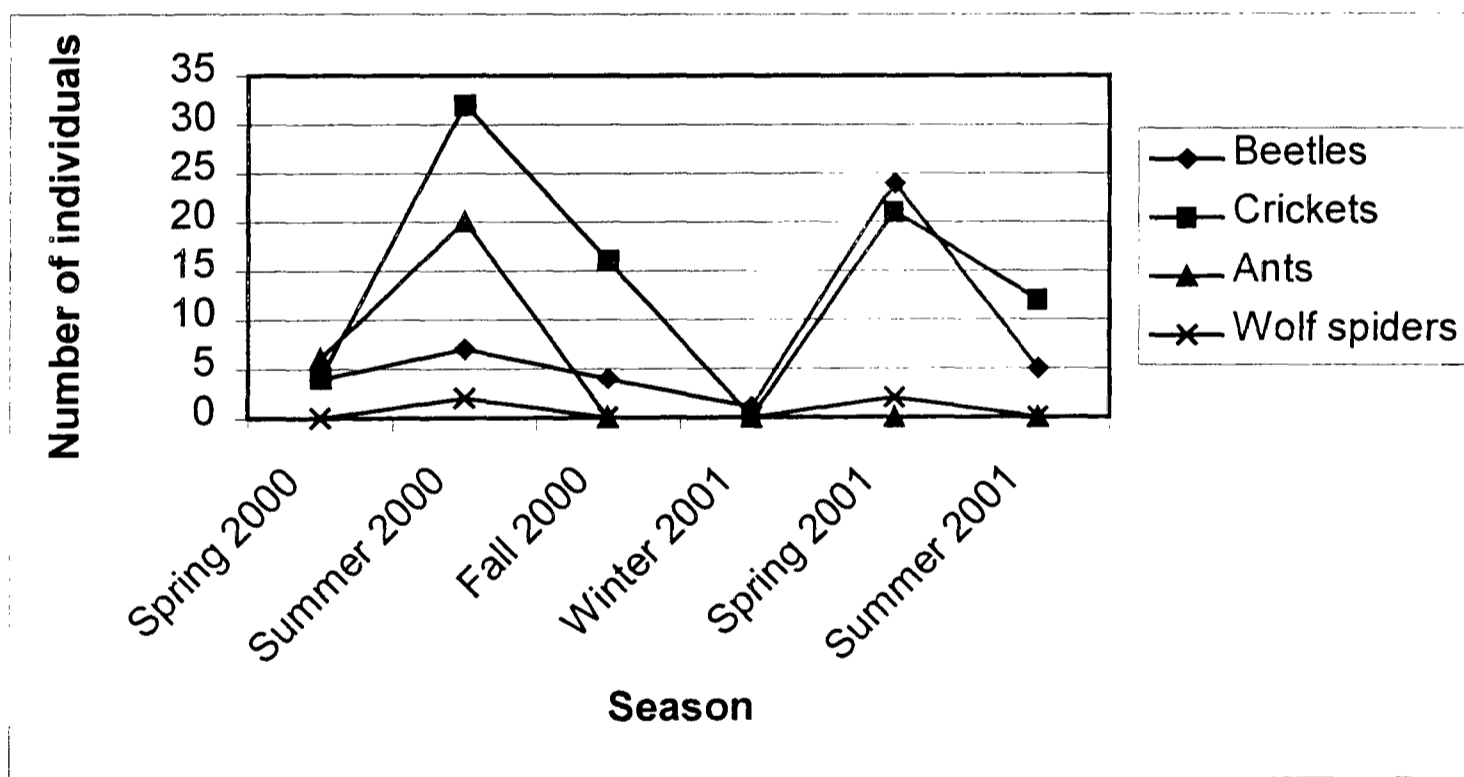
Figure 2.12. Insects observed in active prairie dog burrows using a burrow probe, during spring 2000-spring 2001 at the Pantex Plant, Carson County, Texas.
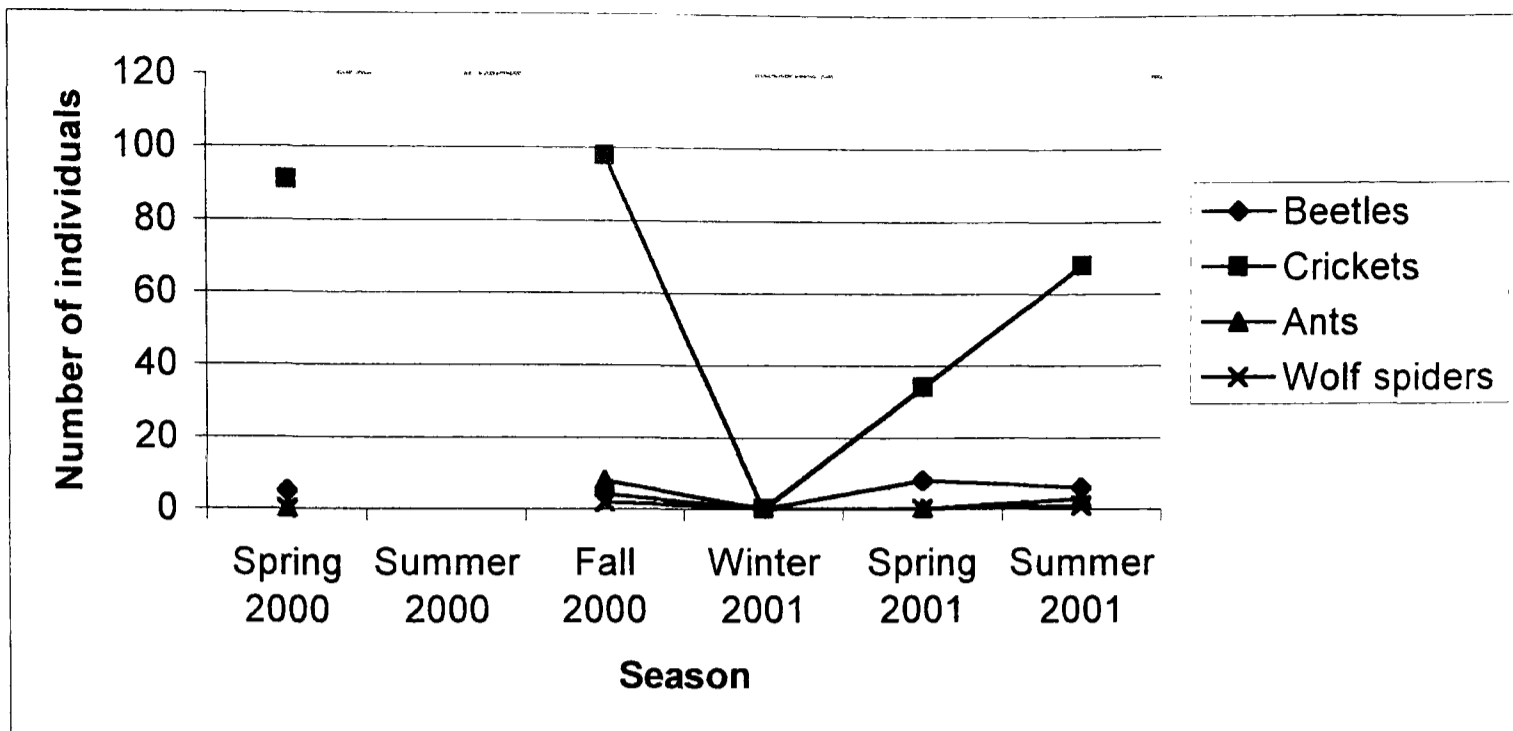
Figure 2.13. Insects observed in abandoned prairie dog burrows using a burrow probe, during spring 2000-spring 2001 at the Pantex Plant, Carson County, Texas. Burrow probing was not conducted at abandoned sites during summer 2000.

Table 2.1. Number of small mammal species captured at active (A), non-colonized (N), and phostoxin-treated (P) sites, during spring 2000-summer 2001 at the Pantex Plant, Carson County, Texas

| | 2000 | | | | | | | | | | | | 2001 | | | | | |
| | Spring | | | Summer | | | Fall | | | Winter* | | | Spring | | | Summer | | |
Species	A	N	P	A	N	P	A	N	P	A	N	P	A	N	P	A	N	P
Deer mouse	11	4	20	2	7	3	13	10	15	1	2	2	6	5	4	3	2	0
Hispid cotton rat	1	2	1	0	4	0	2	0	0	0	0	0	0	0	0	1	0	0
Hispid pocket mouse	1	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	1	0
House mouse	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Merriam's pocket mouse	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern grasshopper mouse	1	1	0	7	0	0	8	0	0	0	0	1	6	1	0	1	0	1
Northern pygmy mouse	0	1	0	0	4	0	1	0	10	0	0	0	0	0	0	0	0	0
Plains harvest mouse	1	8	2	1	4	3	5	6	8	0	0	4	0	0	3	0	0	0
Plains pocket mouse	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Prairie vole	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Thirteen-lined ground squirrel	0	0	0	1	1	2	0	0	0	0	0	0	0	0	3	0	1	0

* only five of nine sites were trapped during the winter: 1 active, 1 non-colonized, and 3 phostoxin-treated

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Table 2.2 Mean ± SE relative abundance (unique individuals/ 100 trap nights) and total number captured on active prairie dog colonies, phostoxin-treated colonies and non-colonized short grass prairie from May 2000 to August 2001 at the Pantex Plant, Carson County, Texas

Species	Active colonies		Phostoxin colonies		Non-colonized sites	
	mean±SE	#	mean±SE	#	mean±SE	#
Deer mouse	0.925±0.245	35	1.031±0.245	44	0.762±0.252	31
Hispid cotton rat	0.132±0.240	5	0.023±0.091	1	0.152±0.384	6
Hispid pocket mouse	0.064±0.174	2	0.023±0.089	1	0.080±0.169	2
House mouse	0	0	0	0	0.034±0.133	1
Merriam's pocket mouse	0	0	0	0	0.023±0.088	1
Northern grasshopper mouse	0.645±0.117	22	0.064±0.117	2	0.082±0.123	2
Northern pygmy mouse	0.023±0.091	1	0.229±0.721	10	0.117±0.373	5
Plains harvest mouse	0.146±0.129	6	0.406±0.129	20	0.486±0.136	18
Plains pocket mouse	0	0	0	1	0.023±0.087	1
Prairie vole	0	0	0	1	0.039±0.154	1
Thirteen-lined ground squirrel	0.059±0.161	2	0.125±0.334	5	0.062±0.172	3

Table 2.3. Analysis of variance for northern grasshopper mouse abundance (captures per 100 trap nights) with treatment and season as variables. Northern grasshopper mice were live-trapped during May 2000-August 2001 at the Pantex Plant in Carson County, Texas.

Source	DF	Mean square	F-value	P-value
Treatment	2	1.621	4.67	0.059*
Error (a)	6	0.347		
Season	4	0.119	0.69	0.603
Treatment*Season	8	0.239	1.39	0.252
Error (b)	23	0.172		

Table 2.4. Analysis of variance for deer mouse abundance (captures per 100 trap nights) with treatment and season as variables. Deer mice were live-trapped during May 2000-August 2001 at the Pantex Plant in Carson County, Texas.

Source	DF	Mean square	F-value	P-value
Treatment	2	0.249	0.16	0.859
Error (a)	6	1.595		
Season	4	3.297	4.47	0.008*
Treatment*Season	8	0.736	1.00	0.465
Error (b)	23	0.737		

Table 2.5. Analysis of variance for plains harvest mouse abundance (captures per 100 trap nights) with treatment and season as variables. Plains harvest mice were live-trapped during May 2000-August 2001 at the Pantex Plant in Carson County, Texas.

Source	DF	Mean square	F-value	P-value
Treatment	2	0.458	0.94	0.442
Error (a)	6	0.488		
Season	4	0.712	2.85	0.047*
Treatment*Season	8	0.208	0.83	0.584
Error (b)	23	0.249		

Table 2.6. Analysis of variance for small mammal abundance (captures per 100 trap nights) with treatment and season as variables. Small mammals were live-trapped during May 2000-August 2001 at the Pantex Plant in Carson County. Texas.

Source	DF	Mean square	F-value	P-value
Treatment	2	0.032	0.01	0.992
Error (a)	6	3.909		
Season	4	9.403	3.51	0.023*
Treatment*Season	8	1.635	0.61	0.761
Error (b)	23	2.683		

Table 2.7. Analysis of variance for small mammal richness with treatment and season as variables. Small mammals were live-trapped during May 2000-August 2001 at the Pantex Plant in Carson County, Texas.

Source	DF	Mean square	F-value	P-value
Treatment	2	0.904	0.38	0.697
Error (a)	6	2.356		
Season	4	4.661	3.61	0.020*
Treatment*Season	8	1.267	0.98	0.474
Error (b)	23	1.289		

Table 2.8. Overall small mammal abundance, species richness, evenness (J'), and Shannon (H') and Simpson (1-D) diversity on active prairie dog colonies, phostoxin-treated colonies and non-colonized short grass prairie sites. Small mammals were trapped from May 2000 to August 2001 at the Pantex Plant, Carson County, Texas.

Variable	Active colonies Mean±SE	Phostoxin colonies Mean±SE	Non-colonized sites Mean±SE	P-value Treatment
Overall Abundance	1.969±0.423	1.877±0.423	1.919±0.449	0.992
Species richness	2.133±0.293	1.799±0.293	2.292±0.311	0.697
Evenness	0.810±0.081	0.687±0.081	0.861±0.086	0.335
Shannon diversity	0.564±0.115	0.485±0.115	0.604±0.122	0.831
Simpson diversity	0.410±0.084	0.472±0.084	0.506±0.084	0.749

Table 2.9. Overall seasonal small mammal abundance, species richness, evenness (J'), and Shannon (H') and Simpson (1-D) diversity. Small mammals were trapped on active prairie dog colonies, phostoxin-treated colonies and non-colonized shortgrass prairie sites from May 2000 to August 2001 at the Pantex Plant, Carson County, Texas.

Variable	Spring 2000 Mean±SE	Summer 2000 Mean±SE	Fall 2000 Mean±SE	Spring 2001 Mean±SE	Summer 2001 Mean±SE	P-value Season
Overall Abundance	2.557±0.546	1.967±0.546	3.144±0.546	1.474±0.600	0.468±0.546	0.023*
Species richness	2.333±0.379	2.556±0.379	2.667±0.379	1.930±0.416	0.889±0.379	0.020*
Evenness	0.787±0.105	0.952±0.105	0.890±0.105	0.763±0.115	0.952±0.105	0.090
Shannon diversity	0.503±0.148	0.763±0.148	0.774±0.148	0.498±0.163	0.218±0.148	0.080
Simpson diversity	0.277±0.108	0.455±0.108	0.472±0.108	0.440±0.119	0.599±0108	0.372

Table 2.10. Amphibian species captured in pitfall traps at active (A), non-colonized (N), and phostoxin-treated (P) sites during spring (March-May) 2001 and summer (June-August) 2000 and 2001 at the Pantex Plant, Carson County, Texas.

Common name	Summer 2000			Spring 2001			Summer 2001			Total
	A	N	P	A	N	P	A	N	P	
Couch's spadefoot	0	0	0	1	0	0	0	0	0	1
Great Plains toad	0	2	1	0	0	0	0	0	0	3
New Mexico spadefoot	48	15	0	2	0	1	2	0	0	68
Plains spadefoot	0	1	0	1	0	2	0	0	1	5
Spotted chorus frog	0	0	1	2	0	0	0	0	0	3
Tiger salamander	0	0	0	0	0	0	2	1	1	1
Total	48	18	2	6	0	3	2	1	1	81

Table 2.11. Overall amphibian abundance, species richness, evenness (J'), and Shannon (H') and Simpson (1-D) diversity on active prairie dog colonies, phostoxin-treated colonies and non-colonized short grass prairie sites. Amphibians were trapped in spring 2000 and summer 2000 and 2001 at the Pantex Plant, Carson County, Texas. P-values are from F-tests on treatment and time.

Variable	Active colonies Mean±SE	Phostoxin colonies Mean±SE	Non-colonized Mean±SE	P-value Trt
Overall Abundance	6.222±3.265	0.667±2.111	2.111±3.269	0.589
Species richness	1.000±0.342	0.667±0.342	0.444±0.382	0.829
Evenness	0.555±0.169	0.556±0.169	0.267±0.176	0.746
Shannon diversity	0.154±0.106	0.077±0.106	0.044±0.115	0.841
Simpson diversity	0.527±0.184	0.500±0.185	0.524±0.198	0.975

Table 2.12. Overall amphibian abundance, species richness, evenness (J'), and Shannon (H') and Simpson (1-D) diversity on active prairie dog colonies, phostoxin-treated colonies and non-colonized short grass prairie sites. Amphibians were trapped in spring 2000 and summer 2000 and 2001 at the Pantex Plant, Carson County, Texas. P-values are from F-tests on treatment and time.

Variable	Summer 2000 Mean±SE	Spring 2001 Mean±SE	Summer 2001 Mean±SE	P-value Time
Overall Abundance	7.556±5.633	1.000±0.455	0.444±0.272	0.295
Species richness	0.778±0.333	1.000±0.455	0.333±0.248	0.076
Evenness	0.489±0.185	0.556±0.132	0.333±0.192	0.389
Shannon diversity	0.049±0.106	0.231±0.115	0.051±0.106	0.291
Simpson diversity	0.468±0.187	0.417±0.189	0.667±0.193	0.421

Table 2.13. Analysis of variance for amphibian abundance with treatment and season as variables. Amphibians were live-trapped during summer 2000 and spring and summer 2001 at the Pantex Plant in Carson County, Texas.

Source	DF	Mean square	F-value	P-value
Treatment	2	69.779	0.58	0.589
Error (a)	6	121.011		
Season	2	124.351	1.37	0.295
Treatment*Season	4	56.812	0.62	0.655
Error (b)	11	91.047		

Table 2.14. Insect species captured using pitfall traps and coverboards at active (A), non-colonized (N), and phostoxin-treated (P) sites during summer 2000 and 2001 and spring 2001 at the Pantex Plant, Carson County, Texas.

Species	Summer 2000			Spring 2001			Summer 2001			Total
	A	N	P	A	N	P	A	N	P	
Ground beetles	20	6	3	19	4	2	5	3	6	68
Wolf spiders	2	0	0	1	1	1	3	0	0	8
Crickets	7	6	0	0	0	3	12	7	9	44
Scarab beetles	0	1	1	8	1	10	10	10	5	46
Tarantulas	0	0	0	0	0	0	0	1	0	1
Total	29	13	4	28	6	16	30	21	20	167

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Table 2.15. Analysis of variance for insect abundance with treatment and season as variables. Insects were trapped in pitfall traps and under coverboards during summer 2000 and spring and summer 2001 at the Pantex Plant in Carson County, Texas.

Source	DF	Mean square	F-value	P-value
Treatment	2	71.363	8.50	0.015*
Error (a)	6	8.397		
Season	2	14.681	0.54	0.596
Treatment*Season	4	10.431	0.39	0.815
Error (b)	11	27.047		

Table 2.16: Species observed with burrow probe sampling during spring 2000-summer 2001 at the Pantex Plant, Carson County, Texas. Areas at playa 2, zone 12-36 and the shelterbelt were treated with phostoxin prior to spring 2000 sampling, and areas at zone 4 west and zone 8 were treated prior to spring 2001 sampling.

Treatment type	Site	No. of burrows	Spring 2000	Summer 2000	Fall 2000	Winter 2001	Spring 2001	Summer 2001
Active	Playa 2	12	No species observed	Beetles (1) Ants (20) Crickets (12)	Beetles (2) Crickets (7) W.spiders (2)	Beetles (1)	Beetles (1)	Beetles (3) Crickets (3) T. salamander (1)
	Playa 3	7	Beetles (1) Crickets (4)	Burrowing owl (1) Beetles (2) Crickets (6) T. salamander (1)	Crickets (3)	Not sampled	Beetles (23) Crickets (4) W.spiders (2)	Beetles (1) G.P. toad (1) Crickets (1)
	Pantex Lake	6	Beetles (3) Ants (6)	Beetles (4) Crickets (14) Prairie dog (2)	Beetles (1) Crickets (6)	Not sampled	Crickets (17)	Beetles (1) Crickets (8)
Phostoxin	Playa 2	9	No species observed	Beetles (1) Ants (3) Crickets (2)	Beetles (1) Crickets (3)	Beetles (3)	Beetles (3) Crickets (14)	Beetles (1) Ants (2)
	Zone 12-36	11	T. salamander (1)	Prairie dog (1) Unidentified (1)	Crickets (13)	Beetles (2)	Beetles (16) Crickets (2)	Beetles (12) Crickets (2) W.spiders (1)

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Table 2.16. Continued

Treatment type	Site	No. of burrows	Spring 2000	Summer 2000	Fall 2000	Winter 2001	Spring 2001	Summer 2001
Phostoxin	Shelter-belt	5	Crickets (3) Roly-poly (2) W.spiders (2)	Crickets (4)	Beetles (2)	No species observed	Beetles (3)	No species observed
	Zone 4 West	85/13	Not sampled	Not sampled	Not sampled	Not sampled	Beetles (1)	Ants (3) W.spiders (1)
	Zone 8	100/12	Not sampled	Not sampled	Not sampled	Not sampled	Crickets (1)	Beetles (2)
Abandoned	Playa 2	25	Beetles (5) Crickets (91) Roly-poly (12)	Not sampled	Beetles (4) Ants (8) Crickets (98) W.spiders (2)	No species observed	Beetles (8) Crickets (34)	Beetles (6) Ants (3) Crickets (68) W.spiders (1)

Table 2.17: Species observed during spotlight surveys conducted on trapping arrays, September 2000-August 2001 at the Pantex Plant, Carson County, Texas.

Treatment type	Site	Season			
		Fall	Winter	Spring	Summer
Active	Playa 2	Wolf spider (2) Cottontail rabbit (1)	Cottontail rabbit (1)	Cottontail rabbit (2)	Coyote (1)
	Playa 3	Grassland songbird (2) Cottontail rabbit (3)	No species observed	No species observed	Grassland songbird (1) Cottontail rabbit (1)
	Pantex Lake	Small mammal sp. (1) Cottontail rabbit (1)	No species observed	No species observed	Burrowing owl (1) Striped skunk (1) Cottontail rabbit (3)
Phostoxin	Playa 2	Cottontail rabbit (2)	Coytote (1) Cottontail rabbit (1)	Cottontail rabbit (3)	Coytote (1) Cottontail rabbit (3)
	Zone 12-36	Burrowing owl (2)	Coytote (1)	No species observed	Burrowing owl (2) Small mammal sp. (1)
	Zone 4 West	Cottontail rabbit (1)	No species observed	No species observed	No species observed
Non-colonized	Playa 3	Cottontail rabbit (1)	No species observed	No species observed	No species observed
	Playa 1	Small mammal sp. (1)	No species observed	No species observed	No species observed
	Pantex Lake	Burrowing owl (1)	No species observed	No species observed	No species observed

CHAPTER III

DIFFERENCES IN AVIAN POPULATIONS ON

BLACK-TAILED PRAIRIE DOG COLONIES AND

NON-COLONIZED SHORT-GRASS PRAIRIE IN THE

TEXAS PANHANDLE

Abstract

Abundance, diversity, and species composition of bird communities were measured on black-tailed prairie dog (*Cynomys ludovicianus*) colonies and non-colonized areas in the Texas panhandle. Avian community composition was different ($P<0.001$) between prairie dog colonies and non-colonized sites. Higher abundances of resident species ($P<0.001$) occured on prairie dog colonies and higher abundances of nearctic-neoptropical migrants ($P=0.003$) and nearctic-temperate migrants ($P<0.001$) occurred on non-colonized sites. Avian abundance was higher ($P<0.001$) on non-colonized sites than at prairie dog towns, and differed by season ($P<0.001$). Species diversity was not different between sites. Abundances of barn swallows (*Hirundo rustica*), red-winged blackbirds (*Agelaius phoenicerus*), horned larks (*Eremophila alpestris*), and chipping sparrows (*Spizella passerina*) were higher on non-colonized sites than on prairie dog colonies. Burrowing owl (*Athene cunicularia*), Cassin's sparrow (*Aimophila cassinnii*), and lark bunting (*Calamospiza melanocorus)* abundances were higher on prairie dog towns. In short-grass prairie ecosystems vegetative alterations made by prairie dogs may

not influence bird populations as much as other studies have found in mixed-grass prairies.

Introduction

Many species are closely associated with prairie dog (*Cynomys* spp.) colonies, and black-tailed prairie dogs (*C. ludovicianus*) may function as keystone species within the prairie ecosystem (Miller and Ceballos 1994, Kotliar et al. 1999, Van Putten and Miller 1999). Changes in vegetative structure and composition that prairie dogs induce through foraging activities creates patches of habitat that are important to many species that prefer areas of cropped vegetation (Campbell and Clark 1981, Agnew et al. 1986, Sharps and Uresk 1990). Prairie dog burrows also are used by small mammals, reptiles, and amphibians as well as by burrowing owls (*Athene cunicularia*) for shelter (Kotliar et al. 1999). Raptors, such as the ferruginous hawk (*Buteo regalis*), golden eagle (*Aquila chrysaetos*), and bald eagle (*Haliaeetus leucocephalus*), have been observed feeding on prairie dog colonies (Campbell and Clark 1981, Sharps and Uresk 1990, Allison et al. 1995). Other avian species, such as the mountain plover (*Charadrius montanus*), horned lark (*Eremophila alpestris*), and mourning dove (*Zenaida macroura*) have been found in higher densities on prairie dog towns than on non-colonized mixed-grass sites in South Dakota (Olson 1985, Agnew et al. 1986).

In mixed-grass prairie regions of South Dakota and Montana there were higher avian abundances and species richness' on active prairie dog towns (Agnew et al. 1986, Reading et al. 1989). In the short-grass Oklahoma panhandle there were higher avian

abundances on sites with prairie dog colonies during periods of with abundant vegetation, but no differences in abundance during periods of drought, when vegetation was reduced (Barko et al. 1999). There were no differences in avian species richness between prairie dog colonies and non-colonized sites on short-grass prairie of southwestern Kansas and southeastern Colorado (Winter 1999). Based on these studies, the effects of prairie dogs on avian abundance and diversity appears to be highly dependant on the vegetative community where the study is performed.

We compared whether avian community composition, abundance, species richness, and diversity were different on prairie dog colonies and non-colonized short-grass prairie in the Texas Panhandle. For individual species with a high number of occurrences, we compared abundances between prairie dog colonies and non-colonized sites. We evaluated the effect of prairie dog towns in the short-grass prairie of the Texas panhandle on avian abundances, diversity, and species occurence.

Materials and Methods

This study was conducted on the Pantex Plant located 27-km northeast of Amarillo, Texas in Carson County (Figure 3.1). The main plant encompassed 3,683 ha, and an additional site at Pantex Lake, located 4 km northeast of the main plant, occupied 436 ha. Topography at the site was relatively flat with several playa lakes, and an average elevation of 1,067 m. Climate was semi-arid and characterized by hot summers and cold winters, with large variations in daily temperatures. Precipitation was irregular

and annually averaged 497 mm at Amarillo, Texas, with peaks in March and October (Figure 3.2).

The study area was characterized by short-grass prairie dominated by buffalo grass (*Buchloe dactyloides*) and blue grama (*Bouteloua gracilis*), with scattered clumps of prickly pear (*Optunia* spp.). Other species commonly found at the site included sideoats grama (*Bouteloua curtipendula*), western wheatgrass (*Agropyron smithii*), vine mesquite (*Panicum obtusum*) and silver bluestem (*Bothriochloa laguriodes*) (Waste and Environmental Damage Department 1996). Approximately 70% of the site was farmed or grazed. Livestock were managed under a rotational grazing system at the main Plant, with the sampling areas at Playa 1 (active and non-colonized) grazed at 80% from April-September 2001. At the Pantex Lake sampling areas (active and non-colonized) grazing intensity was adjusted to available forage. No other areas were grazed during the study. Additional areas of the Plant are mechanically shredded to reduce fire danger.

Point counts along designated line transects were used to estimate abundances and evaluate species presence. Four sampling areas, three containing both active prairie dog colonies and non-colonized are as and one containing only non-colonized short-grass prairie were selected (Figure 3.3). Prairie dog towns ranged from 2.59-35.07 ha in size. Counts were performed during spring (May 19-27), summer (July 13-August 22), and autumn (September 18-November 2) of 2000 and during winter (February 19-20), spring (May 9-25) and summer (July 19-August 23) of 2001.

One transect was established at each of the four sites. Transects varied in length from 2400 m to 3300 m with point counts at 300 m intervals. Point counts were

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performed according to Hutto et al. (1986) and had fixed radiuses of 50 m. All birds seen and heard within the 50 m radius and beyond the 50 m radius were recorded with the type of site (active prairie dog or non-colonized short-grass prairie) where the bird was observed. Point counts were conducted for 5 minutes. Counts began immediately after sunrise and lasted for 1 to 2 hours. Counts were not carried out when wind speeds > 15 mph or when precipitation was falling.

Species were classified into one of three groups: (1) resident (species found year-round that do not migrate), (2) nearctic-neotropical (species that breed in temperate areas and winter in the neotropics), and (3) nearctic-temperate (species that breed in temperate areas and winter from the southern North Temperate Zone to the northern neotropics), according to Shackelford et al. (1999). Some species that were observed on site year-round were classified as part of the second and third groups because while some species may be maintaining a presence in the area, individuals may be migrating. To remove the influence of playa lakes found near the transects, waterfowl and other species whose presence was commonly associated water were not included in data analyses.

Chi-square (X^2) analyses were used to compare avian species composition between prairie dog colonies and non-colonized sites (Sokal and Rohlf 1995). Differences in avian abundance (total number of individuals) and abundance of frequently occuring species between prairie dog sites and non-colonized sites were evaluated with a chi-square test. For these tests, due to differences in sampling effort between the two treatments, the chi-square test compared the observed frequencies to the expected frequencies for each treatment based on the proportion of sampling effort

(Reynolds 1984, Mann 1998). If a significant chi-square value resulted from these tests, the interpretation was that abundance on treatment a or b was significantly higher than expected if birds were randomly selecting areas to use. Data were inspected visually for continuous patterns across seasons, and because abundances were consistently greater on one treatment, sites were pooled across all seasons. Comparisons of individual species abundances between treatments were performed only for species whose expected values were >5 (Reynolds 1984). The Yates continuity correction was applied to all chi-square tests to reduce the Type I error associated with small sample sizes (Sokal and Rohlf 1995).

Avian diversity was calculated for each treatment in each season using the Shannon-Weiner (H') and Simpson (D) indices (Magurran 1988, Hanks 1995). These 2 different measures of diversity were chosen for ease of comparison to other studies and because each has a different emphasis: the Shannon-Weiner is an information statistic index weighted towards abundant species, while the Simpson index is a dominance measure weighted towards abundant species (Krebs 1989). Values produced by the Simpson index were subtracted from 1 to ensure that indices increased with increasing diversity (Magurran 1988).

Data used for these analyses were collected from established transects and used to compare differences in avian communities on active prairie dog and non-colonized sites. As these transects were not designed expressly for this purpose, points designated as being within prairie dog towns and points designated as being within non-colonized sites could be as close as 300 m. As a result, some points are located near the edge of these

habitat types, and complicate the determination of species habitat preferences and use (Bibby et al. 1992). Species observed on non-colonized points adjacent to prairie dog towns actually may be selecting for the presence of the prairie dog town and vice-versa. Additional factors in data interpretation were that different numbers of samples were taken on active and non-colonized sites and during each season (Table 3.1), and that some transects ran closer to playa lakes than others did.

Results

A total of 5,957 individual bird sightings representing 47 species were recorded, with 26 species observed on prairie dog towns and 45 species on non-colonized sites (Table 3.2). Twenty-four species were common to both sites. Red-winged blackbirds (*Agelaius phoenicerus*) were the most common species, representing 52% of the overall abundance. On prairie dog towns, the most abundant species were red-winged blackbird, western meadowlark (*Sturnella neglecta*), lark bunting *(Calamospiza melanocorus)*, rock dove (*Columba livia*), and burrowing owls. On non-colonized sites, the most abundant species were red-winged blackbirds, western meadowlark, horned lark, grasshopper sparrow (*Ammodramus savannarum*), and mourning doves.

Total avian abundance was higher (X^2=37.723, df=1, p<0.001) on non-colonized sites than on prairie dog towns, and abundances varied with season (X^2=303.776, df=5, P<0.001) (Table 3.1). Abundances were greatest on both site types during autumn and lowest during winter. Avian abundances were greater on non-colonized sites during summer 2000, spring 2001, and summer 2001, but no differences among sites were

observed during spring 2000, autumn 2000, and winter 2001. Abundances of nearctic-neotropical migrants (X^2=13.093, df=1, P=0.003) and nearctic-temperate migrants (X^2=51.948, df=1, P<0.001) were higher than expected on non-colonized areas, while the abundance of resident species was higher than expected on prairie dog colonies (X^2=45.030, df=1, P<0.001).

Avian species composition differed between the two types of sites (X^2=756.980, df=17, P=<0.001). Among the individual species evaluated (Table 3.3), abundances of the barn swallow, Brewer's blackbird (*Euphagus cyanocephalus*), chipping sparrow (*Spizella passerina*), cliff swallow (*Petrochelidon pyrrhonota*), horned lark, red-winged blackbird, and yellow-headed blackbird were more abundant on non-colonized sites than expected. The burrowing owl, Cassin's sparrow (*Aimophila cassinii*), rock dove, and lark bunting were more abundant on prairie dog colonies than expected. No differences in abundance between treatments were observed for dicksissels (*Spiza americana*), grasshopper sparrows, mourning doves, northern harriers (*Circus cyaneus*), ring-necked pheasants (*Phasianus colchicus*), western kingbirds (*Tyrannus verticalis*), and western meadowlarks.

Species diversity was similar between prairie dog colonies and non-colonized areas; Shannon-Weiner index was 2.07 for prairie dog towns and 1.90 for non-colonized sites, while the Simpson index (1-D) was 0.79 for prairie dog towns and 0.67 for non-colonized sites.

Discussion

Prairie dog activities alter the prairie ecosystem, decreasing plant height, changing community composition, and increasing forb abundance (Bonham and Lerwick 1976, Copprock et al. 1983, Cincotta et al. 1989, Sharps and Uresk 1990). These changes result in conversion of mixed-grass prairie to areas of short-grass prairie (Winter 1999). Differences in vegetative species composition and height are the primary factors separating prairie dog colonies from adjacent non-colonized areas (Koford 1958, Archer et al. 1984, Cincotta et al. 1989). However, due to differences in climatic conditions and characteristic vegetation, it has been proposed that prairie dogs influence short-grass ecosystems differently than mixed-grass ecosystems (Winter 1999). Barko et al. (1999) suggested that the vegetational aspects of a prairie dog town might be what determines avian species use of these sites.

In this study, burrowing owls, Cassin's sparrows, rock doves, and lark buntings were more abundant on prairie dog colonies than on non-colonized sites. Barn swallows, Brewer's blackbirds, chipping sparrows, cliff swallows, horned larks, red-winged blackbirds, and yellow-headed blackbirds were more abundant on non-colonized sites. Western meadowlarks, western kingbirds, ring-necked pheasants, northern harriers, mourning doves, grasshopper sparrows, and dicksissels showed no preference between the sites. Higher abundances of resident species were found on prairie dog towns and higher abundances of nearctic-neotropical and nearctic-temperate migrants were found on non-colonized sites. Avian abundance and species richness was higher on non-colonized sites during this study. In contrast, avian abundances and species richness have been

found to be higher on prairie dog towns in mixed-grass prairie and during the growing season on short-grass prairie (Agnew et al. 1986, Barko et al. 1999). Presumably, in these situations, vegetation was different enough between prairie dog colonies and non-colonized sites that birds distinguished the two types as distinct habitat types (Agnew et al. 1986, Winter 1999). While vegetation was not measured during this study, our observations indicate that there were only small differences in plant height and cover between prairie dog colonies and non-colonized sites.

As part of the U.S. International Biome Project, Sims et al. (1978) evaluated the structure and function of grazed and un-grazed sites at ten grasslands, including Pantex. They found that compared to un-grazed mixed-grass prairie sites in South Dakota and North Dakota, total aboveground biomass, standing crop of litter, and total root biomass were lower at the un-grazed Pantex site. While birds may select for the vegetational characteristics of prairie dog towns in areas of mixed-grass prairie, in areas of short-grass prairie the differences on and off prairie dog towns may not be as dissimilar, and many birds may not actively select for prairie dog towns. This hypothesis has been supported by Barko (1999) and Winter (1999), who found no differences in total bird abundance between prairie dog towns and non-colonized sites during a drought period in Oklahoma and on short-grass prairie in Kansas.

Prairie dog colony size may correlate with species abundance and richness, and the colonies at our study site were relatively small (ranging from 2.59 ha to 35.07 ha). Clark et al. (1982) reported that as colony size increased, vertebrate abundance increased. A correlation between avian abundance and colony size was reported by Barko et al.

(1999), with species richness on the largest colony studied (302 ha) approximately twice that of smaller colonies studied. Also, Reading et al. (1989) reported that avian species richness increased with increased colony size. Due to the small size of the prairie dog colonies in this study, we suspect we had lower abundances and species richness because of the relatively small size of the colonies. Additionally, birds observed at non-colonized locations bordering prairie dog towns may have actually been using prairie dog colonies. A study design that paired non-colonized sites with prairie dog towns would have eliminated this concern, and is recommended for future studies of avian populations at the Pantex site. However, despite these complications, several species were found to be more abundant on prairie dog colonies than on non-colonized areas.

Prairie dog towns are important to burrowing owls (Desmond et al. 2000). Abundances of burrowing owls were higher on prairie dog towns (n=52) than on non-colonized sites (n=9). Burrowing owl abundances were not statistically different among the 2000 breeding season (spring and summer), 2000-2001 non-breeding season (autumn and winter), and 2001 breeding season, though populations of owls did show seasonal changes (Table 3.4). While no owls were recorded during point sampling on the study sites during winter, we observed burrowing owls using prairie dog towns throughout this period. Burrowing owls dig their own burrows in parts of their range, but they typically use the burrows of other animals (Sibley 2000), and at the Pantex Plant seem to use prairie dog burrows exclusively.

While the impacts of prairie dogs may be greater in areas of mixed-grass prairie, where they alter the vegetation more drastically, they still create patches of habitat

preferable to some species in short-grass prairie ecosystems. Burrowing owls, in particular, are highly dependant on the presence of prairie dogs towns. Other species such as the red-winged blackbird, horned lark, and mourning dove preferred non-colonized areas, but this choice may be due as much in part to the small size of prairie dog towns in the study area as to the differences in vegetation among the sites. Impacts of prairie dogs on avian abundances and species richness appears to vary throughout their range, mostly due to differences in climate, vegetative communities, and size of prairie dog town (Barko et al. 1999, Winter 1999).

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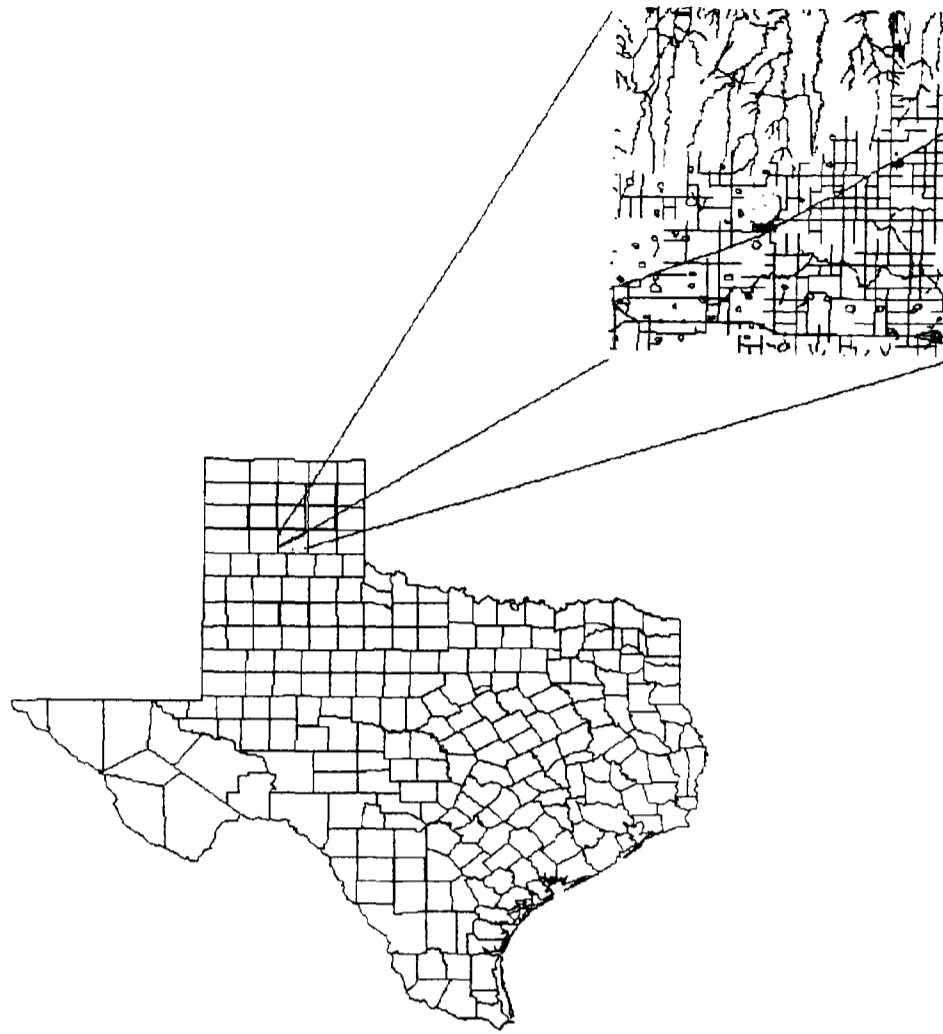
Figure 3.1. Location of Carson County, Texas (shaded square), and location of the Pantex Plant (shaded circle) within Carson County. Lines represent water features and roads.
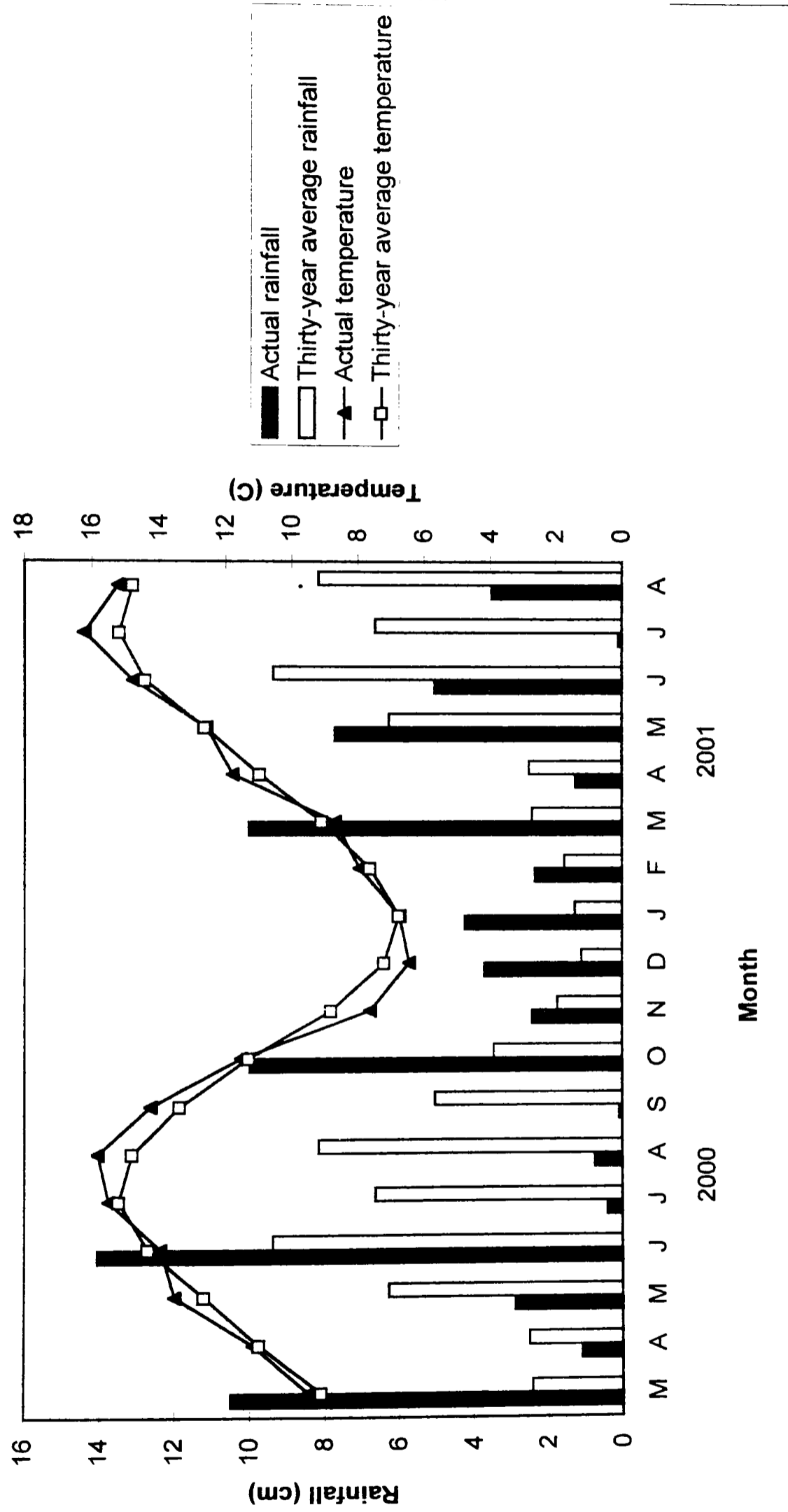
Figure 3.2. Thirty-year average rainfall and temperature at Amarillo, Texas compared to actual rainfall and temperatures recorded from March 2000-August 2001.

DOE-OWNED PROPERTY

TEXAS TECH RESEARCH FARM

- - - - **Avian sampling transects**

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— June. 99 Prairie Dog Town Locations

Figure 3.3 Avian sampling areas at the Pantex Plant, Carson County, Texas.
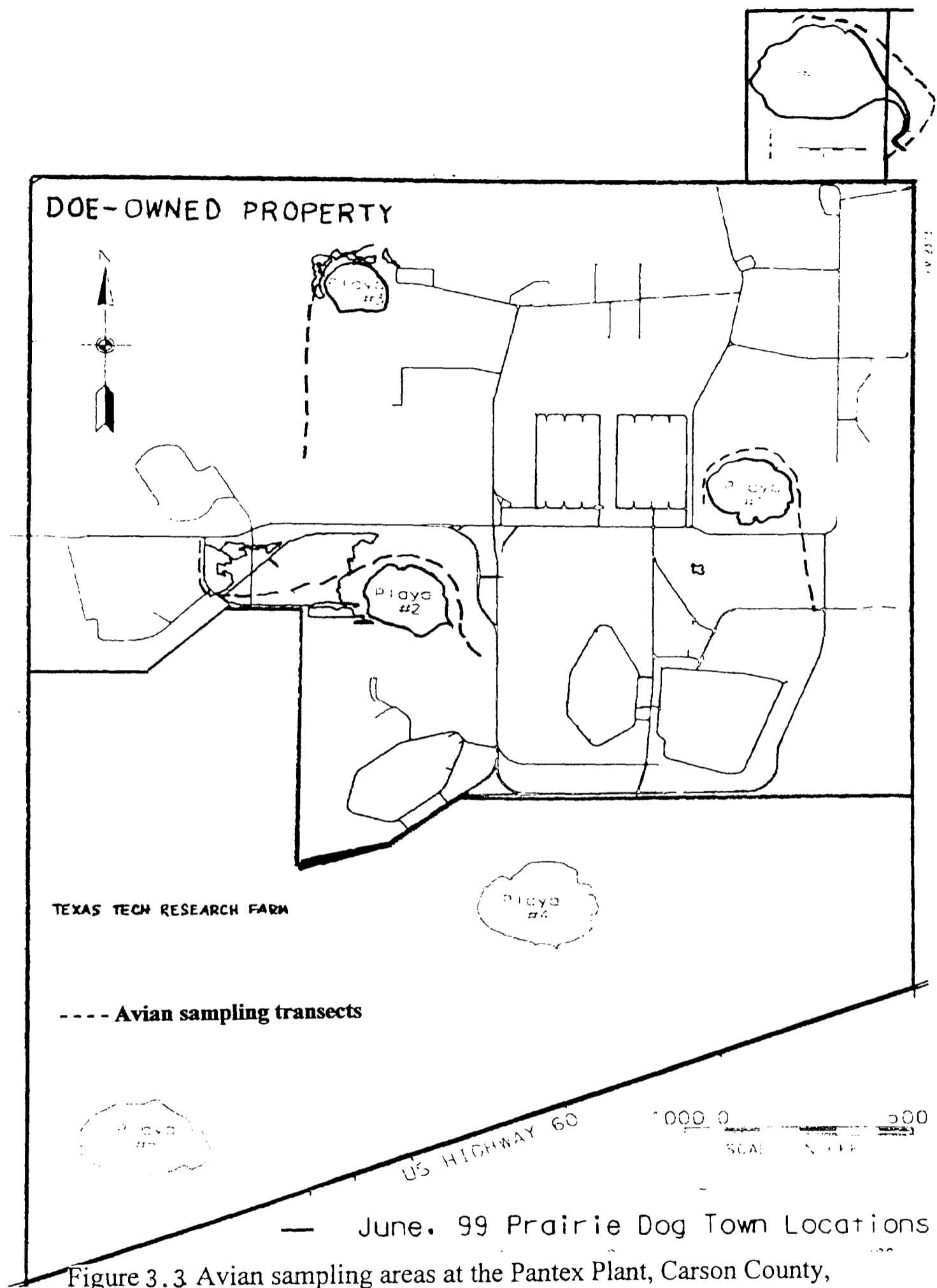
Table 3.1. Seasonal avian abundances (total numbers observed) and chi-square analyses between prairie dog towns and non-colonized sites at the Pantex site, Carson County, Texas, spring 2000 to summer 2001. Following the abundances in parentheses are the number of points sampled at each type in each season.

	Spring 2000	Summer 2000	Fall 2000	Winter 2001	Spring 2001	Summer 2001	Total
Prairie dog colonies	110 (9)	100 (11)	465 (8)	79 (5)	147 (10)	179 (6)	1080 (49)
Non-colonized sites	479 (33)	929 (35)	2266 (34)	187 (16)	821 (35)	195 (14)	4877 (167)
X^2 test statistic	1.227	73.073	3.638	2.064	15.291	24.347	37.723
P-value	0.2281	<0.001*	0.056	0.1508	<0.001*	<0.001*	<0.001*

Table 3.2. Avian species observed on prairie dog towns and non-colonized site types at the Pantex Plant, Carson County, Texas from spring 2000-summer 2001. Species type are indicated by NA-T= nearctic-temperate migrant, NA-NT=nearctic-neotropical migrant, or R=resident.

Species	Type	Prairie dog town	Non-colonized
American crow (*Corvus brachyrhynchos*)	NA-T	3	0
American kestrel (*Falco sparverius*)	NA-T	9	4
Bank swallow (*Riparia riparia*)	NA-NT	1	2
Barn swallow (*Hirundo rustica*)	NA-NT	7	77
Blue jay (*Cyanocitta cristata*)	NA-T	0	2
Brewer's blackbird (*Euphagus cyanocephalus*)	NA-T	0	130
Brown-headed cowbird (*Molothrus ater*)	NA-T	0	6
Burrowing owl (*Athene cunicularia*)	NA-T	52	9
Cassin's sparrow (*Aimophila cassinii*)	NA-T	26	15
Chihuahuan raven (*Corvus cryptoteucus*)	NA-T	2	2
Chipping sparrow (*Spizella passerina*)	NA-NT	0	30
Cliff swallow (*Petrochelidon pyrrhonota*)	NA-NT	2	66
Common grackle (*Quiscalus quiscula*)	NA-T	6	14
Dickcissel (*Spiza americana*)	NA-NT	3	41
Eastern kingbird (*Tyrannus tyrannus*)	NA-NT	0	2
European starling (*Sturnus vulgaris*)	R	5	11
Ferruginous hawk (*Buteo regalis*)	NA-T	2	0
Grasshopper sparrow (*Ammodramus savannarum*)	NA-NT	42	190
Horned lark (*Eremophila alpestris*)	NA-T	4	272
House finch (*Carpodacus mexicanus*)	NA-T	0	12
House sparrow (*Passer domesticus*)	NA-T	0	10
Lark bunting (*Calamospiza melanocorus*)	NA-T	73	125
Lark sparrow (*Chondestes grammacus*)	NA-T	0	14
Loggerhead shrike (*Lanius ludovicianus*)	NA-T	0	1
Longspur (Unid. Species)	NA-T	16	3
Mourning dove (*Zenaida macroura*)	NA-T	29	169
Northern flicker (*Colaptes auratus*)	NA-T	0	1
Northern harrier (*Circus cyaneus*)	NA-T	1	27
Northern mockingbird (*Mimus polyglottus*)	NA-T	0	3
Northern rough-winged swallow	NA-NT	0	2
Pine siskin (*Spinus pinus*)	NA-T	0	2
Red-headed woodpecker (*Melanerpes erythrocephalus*)	NA-T	0	1
Red-tailed hawk (*Buteo jamaicensis*)	NA-T	0	3
Red-winged blackbird (*Agelaius phoeniceus*)	NA-T	411	2696
Ring-necked pheasant (*Phasianus colchicus*)	NA-T	2	28
Rock dove (*Columba livia*)	R	156	137
Rough-winged swallow (*Stelgidopteryx ruficollis*)	R	0	3
Savanah sparrow (*Passerculus sandwichensis*)	NA-NT	0	2
Say's phoebe (*Sayornis saya*)	NA-T	0	5

Table 3.2 Continued

Species	Type	Prairie dog town	Non-colonized
Scrub jay (*Aphelocoma coerulescens*)	NA-T	0	2
Swainson's hawk (*Buteo swainsoni*)	R	4	12
Tree swallow (*Iridoprocne bicolor*)	NA-NT	7	1
Turkey vulture (*Cathartes aura*)	NA-T	0	1
Vesper sparrow (*Pooecetes gramineus*)	NA-T	2	2
Western kingbird (*Tyrannus verticalis*)	NA-T	21	61
Western meadowlark (*Sturnella neglecta*)	NA-NT	197	536
White-crowned sparrow (*Zonotrichia leucophrys*)	NA-T	0	1
White-winged dove (*Zenaida asiatica*)	NA-T	0	1
Yellow-headed blackbird (*Xanthocephalus xanthocephalus*)	NA-NT	0	73

Table 3. 3. Comparisons of species abundances between prairie dog towns and non-colonized sites at the Pantex Plant, Carson County, Texas from spring 2000-summer 2001. Chi-square tests with P-values with * were statistically significant. All tests had one degree of freedom.

Species	X^2	P-value
Barn swallow	5.547	0.019*
Brewer's blackbird	31.038	<0.001*
Burrowing owl	45.576	<0.001*
Cassin's sparrow	12.272	0.001*
Chipping sparrow	5.587	0.018*
Cliff swallow	10.158	0.001*
Dicksissel	3.232	0.072
Grasshopper sparrow	1.229	0.268
Horned lark	56.656	<0.001*
Lark bunting	8.859	0.003*
Mourning dove	3.670	0.054
Northern harrier	2.963	0.085
Red-winged blackbird	93.6125	<0.001*
Ring-necked pheasant	1.925	0.165
Rock dove	55.378	<0.001*
Western kingbird	0.066	0.798
Western meadowlark	3.237	0.072
Yellow-headed blackbird	16.491	<0.001*

Table 3.4. Number of burrowing owls observed during point counts on prairie dog towns and non-colonized short-grass prairie sites at the Pantex Plant, Carson County, Texas from spring 2000-summer 2001.

	2000				2001	
	Spring	Summer	Autumn	Winter	Spring	Summer
Prairie dog town	10	24	2	0	12	4
Non-colonized	0	3	1	0	5	0

APPENDIX A

TRAPPING SCHEDULES

Table A.1. Dates of small mammal trapping conducted at the Pantex plant, Carson County, Texas from spring 2000-summer 2001.

Site	Type	2000				2001	
		Spring	Summer	Fall	Winter	Spring	Summer
Playa 2	A	5/11-5/14	6/11-6/14	10/26-10/29	1/26-1/29	4/20-4/23	8/23-8/26
Playa 3	A	5/26-5/29	7/2-7/5	11/16-11/20	N/A	5/25-5/28	6/19-6/22
Pantex Lake	A	5/8-5/11	8/17-8/20	11/30-12/3	N/A	4/27-4/30	7/30-8/2
Playa 2	P	5/11-5/14	6/11-6/14	10/26-10/29	1/26-1/29	4/20-4/23	8/23-8/26
Zone 12-36	P	5/11-5/14	7/2-7/5	10/26-10/29	2/23-2/26	5/25-5/28	6/19-6/22
Zone 4 West	P	5/26-5/29	6/11-6/14	11/16-11/20	1/26-1/29	4/20-4/23	8/23-8/26
Playa 3	N	5/26-5/29	7/2-7/5	11/16-11/20	N/A	N/A	6/19-6/22
Playa 1	N	5/10-5/13	8/17-8/20	11/30-12/3	2/23-2/26	4/27-4/30	8/23-8/26
Pantex Lake	N	5/8-5/11	8/17-8/20	11/30-12/3	N/A	4/27-4/30	7/30-8/2

Table A.2. Dates of pitfall trapping conducted at the Pantex plant, Carson County, Texas from spring 2000 to summer 2001.

Site	Type	2000				2001	
		Spring	Summer	Fall	Winter	Spring	Summer
Playa 2	A	N/A	6/11-6/14	10/26-10/29	N/A	4/20-4/23	8/23-8/26
Playa 3	A	5/26-5/29	7/2-7/5	N/A	N/A	5/25-5/28	6/19-6/22
Pantex Lake	A	N/A	8/17-8/20	N/A	N/A	4/27-4/30	7/30-8/2
Playa 2	P	N/A	6/11-6/14	10/26-10/29	N/A	4/20-4/23	8/23-8/26
Zone 12-36	P	N/A	7/2-7/5	10/26-10/29	N/A	5/25-5/28	6/19-6/22
Zone 4 West	P	5/26-5/29	6/11-6/14	N/A	N/A	4/20-4/23	8/23-8/26
Playa 3	N	5/26-5/29	7/2-7/5	N/A	N/A	N/A	6/19-6/22
Playa 1	N	N/A	8/17-8/20	N/A	N/A	4/27-4/30	8/23-8/26
Pantex Lake	N	N/A	8/17-8/20	N/A	N/A	4/27-4/30	7/30-8/2

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APPENDIX B

PRAIRIE DOG POPULATIONS AT THE PANTEX PLANT

Table B.1. Prairie dog populations at the Pantex plant, Carson County, Texas, 2000 and 2001.

Population Estimate[1]		Site					
		Zone 12-36[5]	Zone 4 West[6]	Playa 2	Playa 3	Pantex Lake	Total
Adults[2]	2000	14	10	76	5	17	122
	2001	12	0	35	6	24	77
	Change	-14.3%	-100%	-53.9%	20%	41.2%	-36.9%
Juveniles[2]	2000	8	16	157	12	11	204
	2001	31	0	134	11	28	224
	Change	287.5%	-100%	-14.7%	-8.3%	154.5%	9.8%
Total[3]	2000	18	25	338	40	42	463
	2001	47	6	381	33	96	563
	Change	161.1%	-76%	12.7%	-17.5%	128.6%	21.6%
Productivity[4]	2000	0.57	1.60	2.07	2.40	0.65	1.67
	2001	2.58	0	3.83	1.86	2.00	2.91
	Change	352.6%	-100%	85%	-22.5%	207.7%	74.3%

[1] Based on high counts of juveniles, adults, and total prairie dogs observed over 12 counts.
[2] Presumed age.
[3] Includes individuals not assigned to age class.
[4] Crude index based only on individuals assigned an age (juveniles/adults).
[5] Site treated with phostoxin in 2000
[6] Site treated with phostoxin in 2000 and 2001

APPENDIX C

WILDLIFE SPECIES OBSERVED AT PANTEX

Table C.1. Wildlife species observed on prairie dog towns at the Pantex plant, Carson County, Texas 2000-2001

	Common name	Scientific name	2000	2001
Birds	American kestrel	*Falco sparverius*	●	●
	American pipit	*Anthus rubescens*	●	○
	Bald eagle	*Haliaeetus leucocephalus*	●	○
	Barn swallow	*Hirundo rustica*	●	●
	Brown-headed cowbird	*Molothrus ater*	○	●
	Burrowing owl	*Athene cunicularia*	●	●
	Cassin's sparrow	*Aimophila cassinii*	●	○
	Chihuahuan raven	*Corvus cryptoleucus*	○	●
	Cliff swallow	*Petrochelidon pyrrhonota*	○	●
	Common grackle	*Quiscalus quiscula*	○	●
	Dickcissel	*Spiza Americana*	●	○
	Ferruginous hawk	*Buteo regalis*	●	○
	Golden eagle	*Aquila chrysaetos*	●	○
	Grasshopper Sparrow	*Ammodramus savannarum*	●	●
	Horned lark	*Eremophila alpestris*	●	●
	Killdeer	*Charadrius vociferous*	●	●
	Lark bunting	*Calamospiza melanocorys*	○	●
	Loggerhead shrike	*Lanius ludovicianus*	○	●
	Mourning dove	*Zenaida macroura*	●	●
	Northern harrier	*Circus cyaneus*	○	●
	Northern mockingbird	*Mimus polyglottos*	●	○
	Northern pintail	*Anas acuta*	●	○
	Red-winged blackbird	*Agelaius phoeniceus*	●	●
	Ring-necked pheasant	*Phasianus colchicus*	○	●
	Say's phoebe	*Sayornis nigricans*	●	●
	Swainson's hawk	*Buteo swainsoni*	●	○
	Western kingbird	*Tyrannus verticalis*	●	●
	Western meadowlark	*Sturnella neglecta*	●	●
Mammals	Badger	*Taxidea taxus*	●	●
	Black-tailed prairie dog	*Cynomys ludovicianus*	●	○
	Cottontail	*Sylvilagus* spp.	●	●
	Coyote	*Canis latrans*	●	●
	Thirteen-lined groundsquirrel	*Spermophilus tridecemlineatus*	●	○
	Wood rat (spp.)	*Neotoma* spp.	●	○
Reptiles	Bullsnake	*Pituophis melanoleucus sayi*	○	●
	Eastern yellowbelly racer	*Coluber constrictor flaviventris*	●	○
	Plains hognose snake	*Heterodon nasicus nasicus*	●	●
	Prairie rattlesnake	*Crotalus virdis virdis*	●	○
	Texas horned lizard	*Phrynosoma cornutum*	●	○

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