AN ABSTRACT OF THE THESIS OF

Shannon L. Rothchild for the Master of Science

in Biology presented on April 30, 1993

Title: Mortality, Home Range, and Habitat Use of Pronghorn Fawns within Tallgrass Prairie of Eastern Kansas

Abstract approved: Elmer J. Finck

During 1991 and 1992, 12 and 34 pronghorn fawns (Antilocapra americana), respectively, were captured in tallgrass prairie of east central Kansas and monitored through August of each year. Ten fawns captured during 1991 and 31 fawns captured during 1992 were fitted with ear tag radio transmitters. Summer natural mortality rates were calculated from all fawns captured, bedding site vegetation characteristics were quantified, and home ranges were calculated from fawns fitted with radio transmitters. A natural mortality rate of 58% and 90% was found in 1991 and 1992, respectively. Six fawn carcasses were found, 1 in 1991 and 5 in 1992, with enough evidence to determine that coyotes (Canis latrans) were the cause of death. Hair, bone, and/or the transmitter were recovered from 19 dead fawns, 4 during 1991 and 15 during 1992. These fawns were partially consumed by coyotes. Moisture and cool temperatures did not appear to contribute to fawn mortality. Fawn home range size increased significantly ($P < 0.001$) with age during both years. Home ranges were larger ($P = 0.0046$) at 24 days of age and smaller ($P = 0.0038$) at 60 days of age in 1992.

Mean cover values for grasses and forbs and mean vegetation heights for 49 and 94 actual and random fawn bedding peripheral sites were analyzed during 1991 and 1992, respectively. The cover of forbs for actual surviving fawn peripheral sites was greater ($P = 0.0039$) than those of non-surviving fawns in 1991. The height of vegetation at surviving fawn peripheral sites was greater ($P = 0.0127$) than those of non-surviving during 1991. The vegetation height in actual peripheral sites for non-surviving fawns was greater ($P = 0.0012$) than random peripheral sites for non-surviving fawns in 1992. During 1991 ($P = 0.0097$) and 1992 ($P < 0.0001$) vegetation within 0.5 m of actual bedding sites of all fawns was significantly taller than vegetation within 0.5 m of random bedding sites. Bedding sites were more prevalent on slopes during 1991 ($X^2 = 37.01$, $P < 0.001$) and 1992 ($X^2 = 215.47$, $P < 0.001$). Bedding site cover appears to be adequate for pronghorn fawns in tallgrass prairie. I suggest the increased mortality of 1992 compared to 1991 was a result of a different vegetation distribution and increased movements by fawns during 1992.

MORTALITY, HOME RANGE, AND HABITAT USE OF PRONGHORN FAWNS WITHIN TALLGRASS PRAIRIE OF EASTERN KANSAS

A Thesis

Submitted to the

Division of Biological Sciences

Emporia State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Shannon L. Rothchild

May 1993

Approved for Major Department

Faye N. Vowell
Approved for Graduate Council

Elmer J. Finck
Approved by Major Advisor

Approved by Committee Member

Approved by Committee Member

Approved by Committee Member

ACKNOWLEDGMENTS

I thank my major advisor, Dr. Elmer J. Finck,for his field assistance, helpful comments, suggestions, and patience throughout this study. Thanks to my committee members Dr. Gaylen Neufeld, Keith Sexson, Jr., and Dr. James L. Wolfe for additional comments and suggestions. I also thank Dr. Larry Scott for assistance with statistical analyses. Dr. Lloyd B. Fox, Mike Houck, Jeremy Lawrence, Timothy B. Lindskog, Mary Nelson, Bernard E. Sietman, and Bradley D. Simpson receive thanks for their reliable and patient field assistance. I thank Dr. Johna Veatch for conducting necropsies of selected pronghorn fawns.

An exceptional thanks goes to my wife, Kristi, for her field assistance, support, and sacrifice throughout the completion of my M. S. degree. Thanks also to my parents Glenda and Delmer Rothchild for their support and my father for his assistance in fawn capture.

Monetary support and equipment for my research was provided by Wichita and Kansas City Chapters of Safari Club International, Division of Biological Sciences, Emporia State University, and Kansas Department of Wildlife and Parks. My research could not have been conducted without the cooperation of landowners and tenants of the study area and so I also thank them.

PREFACE

This thesis has been prepared in the style appropriate for the Journal of Wildlife Management. Running heading is pronghorn fawn mortality and habitat use. Key words: include *Antilocapra americana*, fawn, mortality, radio telemetry, home range, bedding sites, tallgrass prairie, and Kansas.

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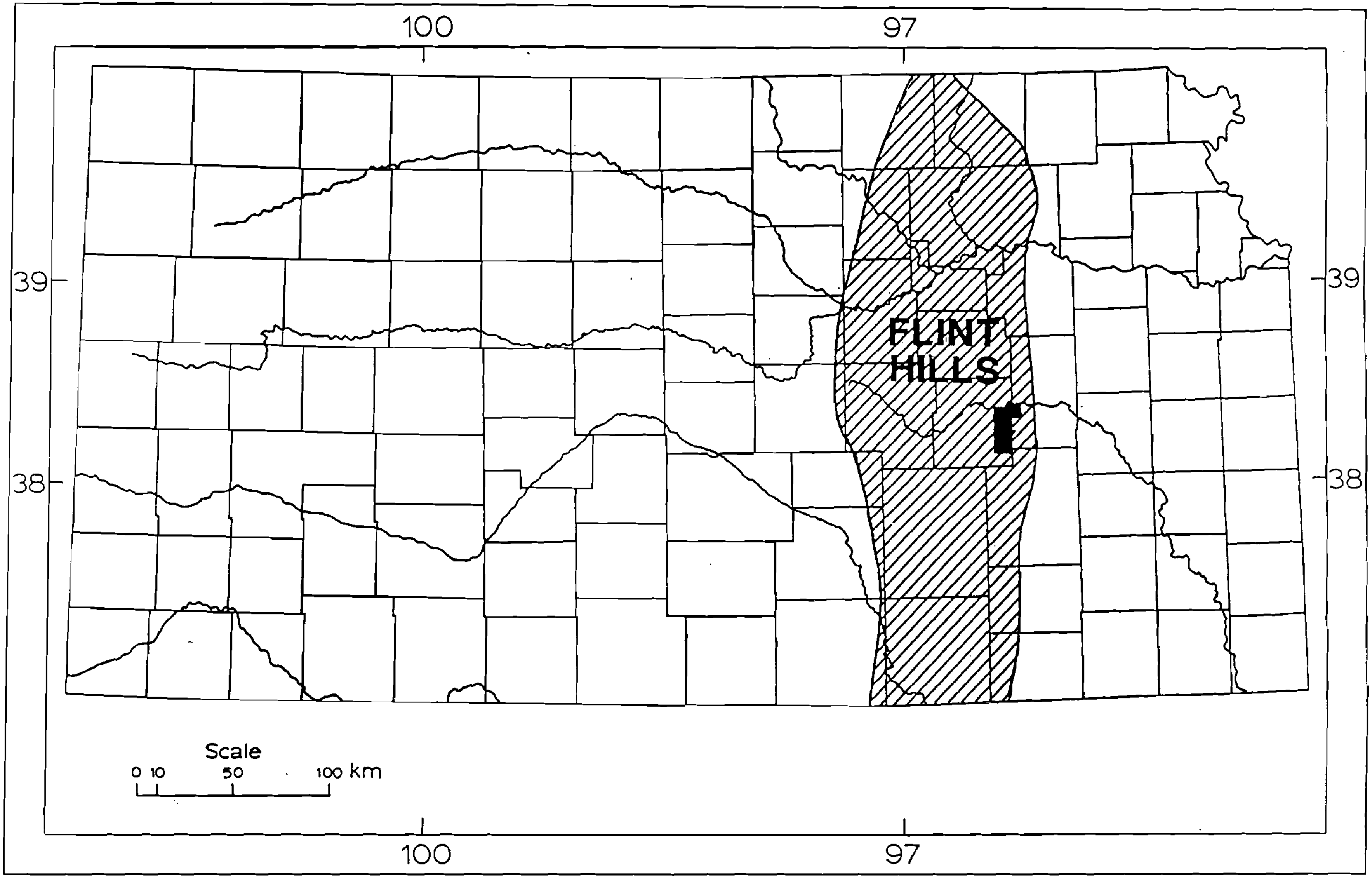
INTRODUCTION

Prior to the advancement of European settlers across the continent in the late 1800's, pronghorn flourished in western North America, with an estimated total population of 30-40 million (Nelson 1925). The area inhabited by pronghorn included parts of the tallgrass prairie ecosystem in west central North America (Einarsen 1948, Yoakum 1978). Because of unregulated harvest and the manipulation of rangelands, the number of pronghorn in North America fell to 13,000 by the early 1920's (Nelson 1925, Yoakum 1978), with 10 pronghorn in southwestern Kansas (Yoakum 1986).

Since the drastic decline in pronghorn numbers, proper management techniques increased the total U. S. population to 406,400 by 1976 (Yoakum 1978) and today the total population is estimated to be greater than 500,000. The population regrowth occurred with the assistance of successful translocations of pronghorn into what once was native range, e.g., western Kansas (Sexson and Choate 1981). However, today pronghorn are not prolific in all areas of their native range. One of these areas includes the tallgrass prairie ecosystem, which is at the eastern edge of the former pronghorn range.

The Kansas Department of Wildlife and Parks (KDWP) made efforts to restore a viable population of pronghorn into the largest remaining continuous tract of tallgrass prairie in North America, the Flint Hills region of eastern Kansas (Fig. 1). Thirty-seven, 98, 127, and 24 pronghorn, were translocated to Chase County, Kansas during 1978, 1979, 1982, and 1983, respectively (Sexson and Choate 1981, K. Sexson, pers. commun.). The success or failure of these translocations is unknown. Aerial surveys conducted from 1986-1990 estimated the population in Chase County, Kansas at 46 animals. More recently, in 1991 and 1992, the KDWP carried out additional translocations to enhance the existing population in Chase County. However, prior to these translocation efforts, major objectives were stated to determine possible factors affecting the success of the translocation and subsequent population increase or decrease. These objectives included: (1) obtaining information on the ecology of pronghorn in the tallgrass prairie ecosystem, which is largely unknown, (2) determining procedures for trapping, transporting and releasing pronghorn to minimize stress and mortality, (3) determining mortality rates by sex and age, and cause of mortality for translocated animals, (4) determining post-release dispersal, behavior, and home range establishments, (5) determining productivity rates and factors influencing production, (6) determining food habits, (7) monitoring population density and land use changes, and (8) providing recommendations for future restorations of pronghorn to tallgrass prairie (K. Sexson, pers. commun.).

Fig. 1. Location of Flint Hills region (shaded area) and area of restoration efforts (darken area) in eastern Kansas, (taken from Simpson 1992).


100
97
39
39
38
38
FLINT HILLS
Scale
0 10 50 100 km
100
97

One important factor to be assessed, following restoration, is the reproductive success of the translocated females and the establishment of a viable population (O'Gara and Yoakum unpublished data). In order to assess reproductive success one must have an understanding of summer fawn mortality (Vriend and Barrett 1978).

Pronghorn fawns spend up to 90% of their time during the first three weeks of life lying in seclusion (Autenrieth and Fichter 1975, Byers and Byers 1983). Pronghorn fawns are hiders; they increase their chance of survival by relying on their ability to seclude themselves from predators (Lent 1974). Alldredge et al. (1991) suggested that hider neonates act independently in their selection of bedding sites, but that they are dependent upon their parental females to initiate activity such as nursing bouts. The ability of the fawn to hide to survive is based on 4 intrinsic factors: cryptic coloration, the ability to lie motionless for long periods of time, the ability to select proper concealment (Alldredge et al. 1991), and the lack of early scent gland development (Carl and Robbins 1988). The ability to select proper concealment would depend largely upon habitat.

Previous literature indicates conflicting findings on pronghorn fawn mortality. Early investigators of fawn mortality such as Einarsen (1948), Buechner (1950), and

Compton (1958) considered depredation an insignificant mortality factor. Some researchers reported that poor habitat (Howard et al. 1973), starvation/disease (Bodie 1978), precipitation (Halloran and Glass 1959, Beale and Smith 1970, Howard et al. 1973, Bodie 1978, Kindschy et al. 1978, Yoakum 1978, McNay 1980), and food supply (Buechner 1950) affected fawn mortality. However, other research has shown that depredation is a leading cause of pronghorn fawn mortality (Autenrieth 1984, 1984, Beale and Smith 1973, Barrett 1978, Von Gunten 1978b, Corneli 1980, McNay 1980, Neff and Woolsey 1980, Trainer et al. 1983, O'Gara and Malcolm 1988). Connolly (1978) has concluded that depredation could be a major source of mortality in ungulate fawns and subsequently limits the growth of ungulate populations.

Fawn bedding sites have been studied in sagebrush dominated rangelands in Wyoming (Alldredge et al. 1991), Oregon (Trainer et al. 1983), Idaho (Autenrieth 1976), and Montana (Pyrah 1974). Barrett (1981) studied fawn bedding sites in the mixed-grass prairie of southeastern Alberta. However, no researchers have studied the characteristics of fawn bedding sites in tallgrass prairie.

Few researchers have studied movements and home range of pronghorn fawns. Tucker (1979) in Brewster County, Texas, Barrett (1984) in southeastern Alberta, and McNay (1980) in northwestern Nevada have shown that fawn home range size increases with age. Because pronghorn fawns are hiders, movements possibly make them more vulnerable to predators, and thus reduce survival (Trainer et al. 1983, O'Gara et al 1988).

Recent translocations of pronghorn by KDWP, provided a unique opportunity to study fawn movement and mortality and also to examine fawn bed site selection in a tallgrass prairie ecosystem. Therefore, the purpose of my study was to ascertain fawn summer mortality rates, location and vegetation characteristics of bedding sites, and to monitor fawn summer home ranges in tallgrass prairie.

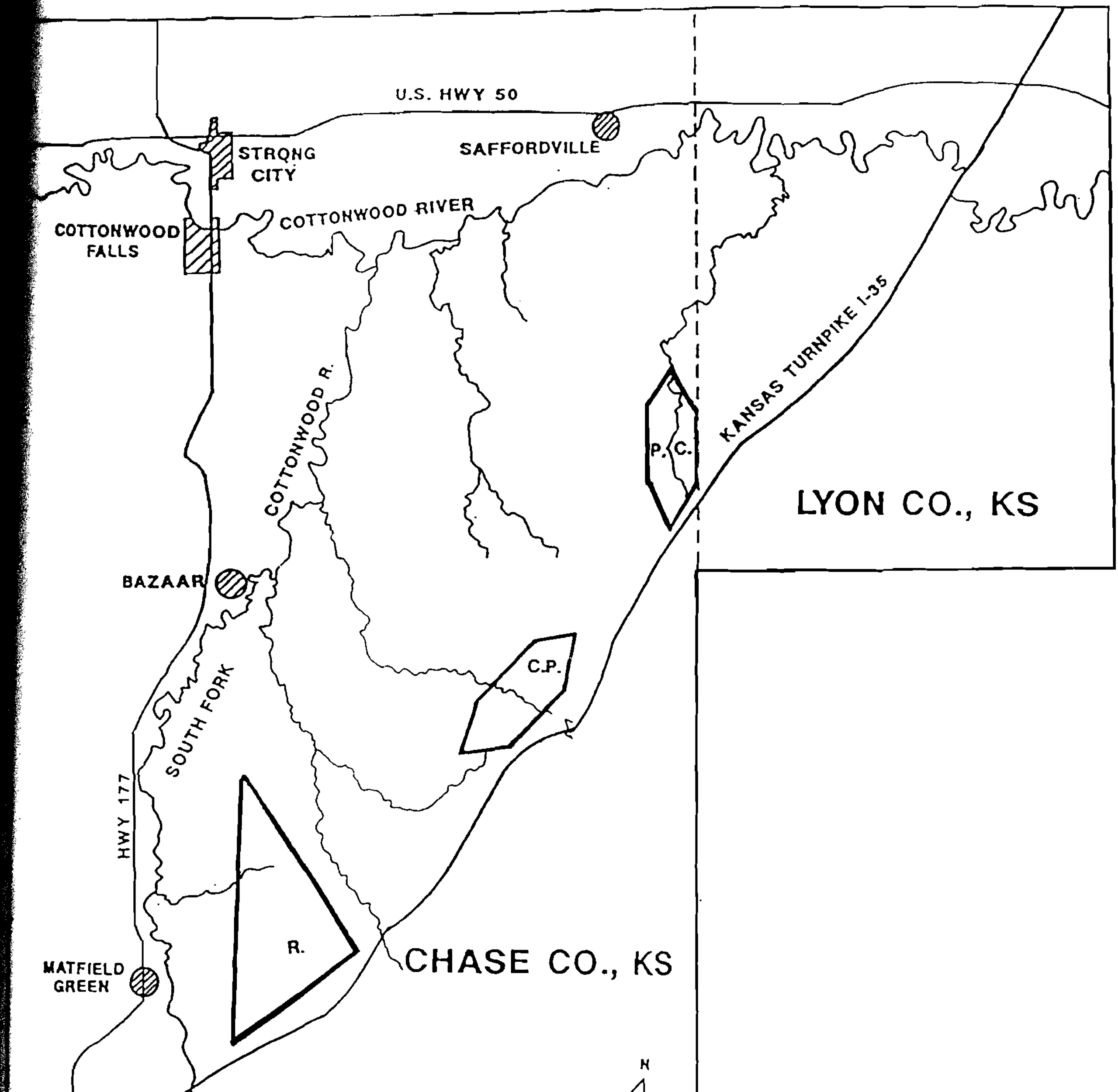
STUDY AREA

The study area was located in southeastern Chase County and southwestern Lyon County in the Osage Cuesta Plain section of the Central Lowlands, and the Flint Hills Uplands of eastern Kansas (O'Connor et al. 1951). The study area (Fig. 2) consisted of 335 km^2 and was semi-confined by the Cottonwood River on the northern, the South Fork of the Cottonwood River on the western and the Kansas Turnpike on the southern and eastern sides (Horak 1985). The river channels on the western and northern sides of the study area were bordered by riparian habitat which is typically avoided by pronghorn. The Kansas Turnpike was fenced with a net-woven wire fence flush with the ground to prohibit pronghorn access across the Kansas Turnpike.

The area consisted of approximately 86% upland and sloping areas and 14% lowland areas. The soils were shallow to moderately deep and consisted of silty clay and shallow clay loam subsoils. Cultivation occurred in less than 2% of the study area. Elevation ranged from approximately 335 - 460 m above sea level (Neill 1974).

There were three fawning areas within my study site. The Rogler area was located in the southwestern portion of the study area, the Cattle Pens area was located in the south central portion of the study area, and the Phenis Creek area was located along the Chase and Lyon counties line in the eastern part of my study site (Fig. 2).

Fig. 2. Total pronghorn fawn study area shown with the three fawning areas (R = Rogler Area, C. P. = Cattle Pens Area, and P. C. = Phenis Creek Area) within Chase and Lyon counties, Kansas, (adapted from Simpson 1992).


U.S. HWY 50
STRONG
CITY
SAFFORDVILLE
COTTONWOOD
FALLS
COTTONWOOD RIVER
KANSAS TURNPIKE I-35
COTTONWOOD R.
P. C.
LYON CO., KS
BAZAAR
C.P.
SOUTH FORK
HWY 177
R.
MATFIELD
GREEN
CHASE CO., KS
0 2 4 km
N

The climate of the study area was continental, characterized by long, hot summers and long, cold winters with relatively short springs and autumns. The mean annual maximum temperature was 20.2 C and the mean annual minimum temperature was 6.5 C. The average yearly rainfall was 80.4 cm, with 71% occurring between April and September (Neill 1974). The average snowfall per year was 42.5 cm. The occurrence of very heavy snowfall was rare, and usually melted within a week of falling. Soils were composed of silty clay and shallow silty clay loam (Neill 1974).

The major vegetation of the fawning areas included grasses such as Indian grass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), Scribner's panicum (*P. scribnerianum*), big bluestem (*Andropogon gerardii*), little bluestem (*A. scoparius*), Canada wild rye (*Elymus canadensis*), and June grass (*Koeleria cristata*). Some common forbs in the area included goldenrods (*Solidago* spp.), purple prairie clover (*Dalea purpurea*), scurfy pea (*Psoralea tenuiflora*), pitcher sage (*Salvia pitcheri*), common ragweed (*Ambrosia artemisiifolia*), western ironweed (*Vernonia baldwinii*), and broomweed (*Gutierrezia dracunculoides*). Lead plant (*Amorpha canescens*) was the most replete shrub found in the study area.

The study area was privately owned by individual landowners and human access was limited. Two north/south running roads flanked the eastern and western edges of the total study area and a trail was maintained for Williams Pipeline Company of Tulsa, Oklahoma in the southern portion of the study area.

Traditional four or five strand barbed wire fence separated the study area into large pastures. Annual burning during March and April occurred across the total area and custom grazing of cattle (*Bos taurus*) occurred from mid April through mid October throughout the majority of the study area. Approximately half the cattle were removed from the area by early to mid August (L. Pinkston pers. commun.) during both years of the study.

MATERIALS AND METHODS

Fawn Capture

In January 1991, 19 adult and 11 yearling pronghorn females were translocated to the study area. Thirteen adults and 10 yearlings were fitted with radio collars. Nineteen of the females fitted with radio collars survived to the 1991 fawning season (Simpson 1992). During February 1992, 22 adult and 2 yearling females, all fitted with radio collars were translocated to the study area. Seventeen females released in 1992, along with 17 radio-collared females released in 1991 survived to the 1992 fawning season. It was from these animals, along with unmarked females that existed on the study area prior to the 1991 translocation, that fawns were captured for my study.

Pronghorn fawns, approximately 4 hr to 10 days of age, were captured on the Rogler and Cattle Pens areas in 1991, and on all three fawning areas in 1992. One crew during 1991, and 2 crews in 1992, located and captured fawns. A capture crew of 2 to 3 persons would locate post-parturient females and then strategically locate themselves on hilltops to observe, with binoculars and spotting scopes, the female until a nursing bout occurred. Post-parturient females were isolated from other females, possessed a fully developed udder, and showed no obvious swelling anterior to the flanks and no convex belly surface as they did when pregnant.

When parturition was witnessed, fawns were not captured until at least 4 hr old to allow for doe-fawn imprinting (Autenrieth and Fichter 1975). Parturition was observed once in 1991 and on 4 occasions during 1992. This was characterized by frequent alterations of lying and standing, humping the back, raising and lowering the tail and self licking of flank areas.

When a nursing bout was complete, fawns would move away from their mother and select a bedding site. Using a hand held radio, the observer of the bedded fawn would direct the capture crew to the fawn. Fawns were captured in their bedding sites with a net measuring 1.2 m X 1 m, with a 3.1 m handle and placed in a canvas bag. For each fawn captured, the age, sex, weight to the nearest 0.1 kg, and capture location were recorded. Ages were determined by pelage and umbilical cord condition and behavior during capture according to Bromley's (1977) criteria. Fawns less than one day old possessed matted pelage on their backs and non-dried umbilical cords and made very little or no effort to flee at capture. Fawns 1 to 5 days old had dried umbilical cords and were readily captured, but would struggle somewhat after capture. Fawns greater than 5 days old attempted to flee when approached by a capture crew and struggled vigorously once captured.

Fawns were fitted with solar (7 panels with 0.5 volts/panel, 30 ma maximum full sunlight, pulse rate varied with light intensity, 151 MHz, Advanced Telemetry Systems, Ibanti, MN) or battery powered (190 ma lithium battery, 45 pulses per minute, 150-151 MHz, Wildlife Materials, Inc. Carbondale, IL) ear tag radio transmitters weighing 16 g and 10 g, respectively, and colored, numbered ear tags weighing 3 g in the opposite ear. The expected life of the solar powered transmitters was 720 days and 60 days for the battery powered transmitters. Some fawns were fitted with colored, numbered ear tags only. After ear tags were fitted, the fawn was placed back into the canvas bag, moved approximately 40 m from the processing site, and released.

Fawn Location

I attempted to record visual locations of fawns fitted with radio transmitters daily or every other day. I used a Wildlife Materials (Carbondale, IL) 150-151 MHz receiver and H-element antenna. Efforts were made not to flush fawns from bedding sites. Fawn locations were recorded through 31 August or until death. Data recorded for each visual observation of a living fawn included date, location, topographic site, and age of fawn. Locations were recorded to the nearest 1 ha on 7.5 minute United States Geological Survey (USGS) maps using Universal Transverse Mercator coordinates. Topographic sites were recorded as uplands, slopes, and lowlands.

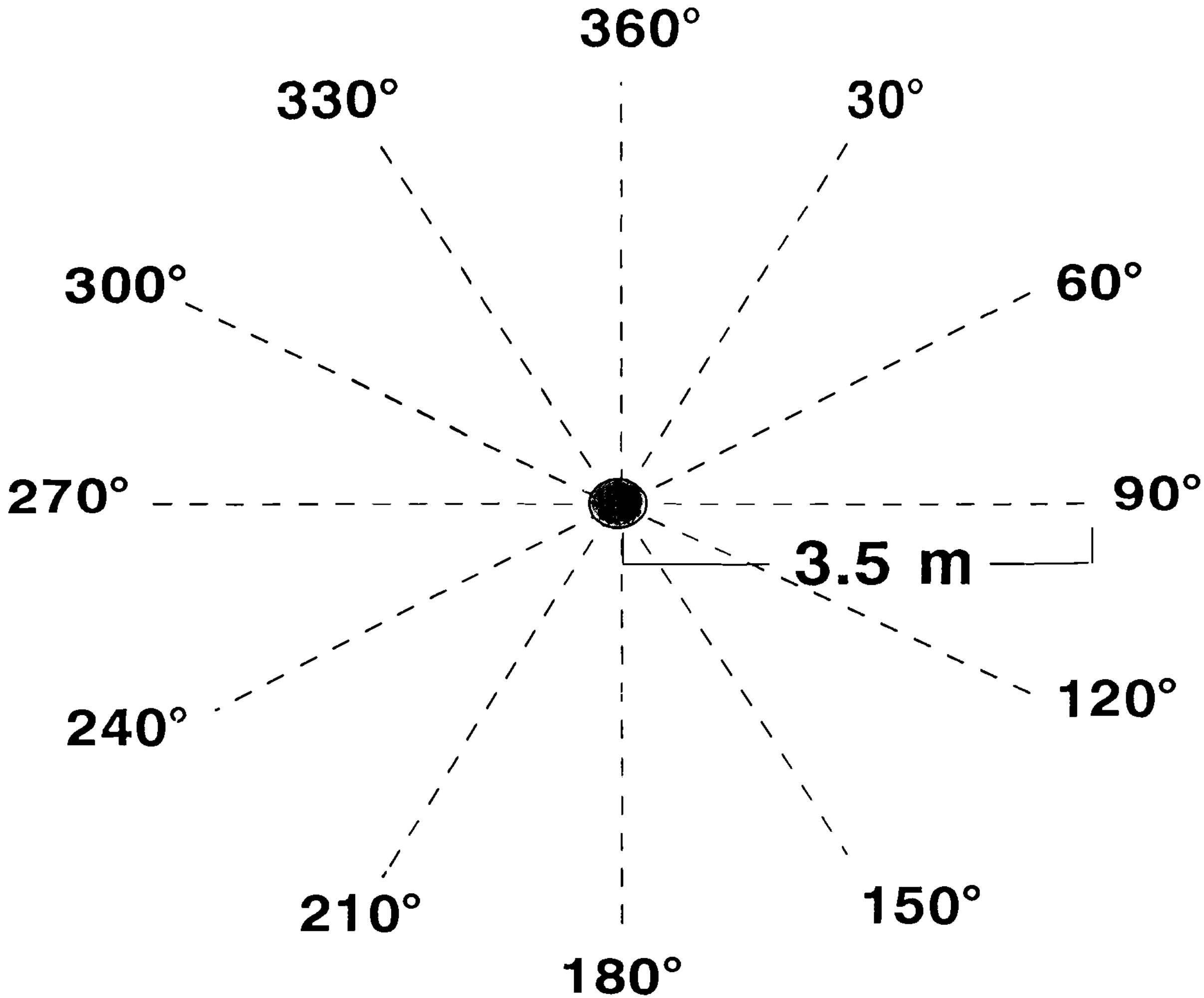
When a dead fawn was found, the appearance and location of remains were noted and photographed. The immediate area of the dead fawn was searched for predator signs, such as hair and tracks. If the dead fawn was not entirely consumed it was taken to the School of Veterinarian Medicine, at Kansas State University for necropsy.

Fawn Bedding Sites

When a bedded fawn was located, the bedding site was marked with an iron stake or marking tape at a distance of 15-25 m and a general description of the bedding site was noted. When individual bedding sites of twin fawns were located in succession during the same day, the distance (m) between the two sites was recorded. I returned within 10 days to the exact location of the bedding site and took vegetation measurements.

Because fawns up to 5 weeks of age were frequently seen bedded away from their mother and other females, vegetation analysis of bedding sites was conducted through 15 July both years. Vegetation within a 3.5 m periphery of bedding site centers (peripheral site) was quantified using a 20 X 50 cm Daubenmire (1959) plot frame. Twelve, 3.5 m transects radiating out from the bedding site center in 30^0 increments from north composed the peripheral site. Five of the possible 12 transects were randomly selected and the Daubenmire plot frame was dropped at 4 random locations along each transect (Fig. 3). There were 20

Fig. 3. Pronghorn fawn peripheral site within 3.5 m of bedding site center and fawn proximate site (shaded area) within 0.5 m of bedding site center.


360°
330°
30°
300°
60°
270°
90°
3.5 m
240°
120°
210°
150°
180°

total drops for each peripheral site. Within each plot frame the cover of grasses and forbs was recorded using classes assigned by Daubenmire (1959). The height (cm) of the tallest vegetation within each plot frame was also recorded. The height (cm) of the tallest vegetation within 0.5 m of the bedding site center (proximate site) was recorded.

For each fawn bedding site examined, a random site was also selected and examined using the same methods. Random sites were selected by walking in a random direction 40 paces from the actual bedding site center and tossing the plot frame over my shoulder. The location where the plot frame first made contact with the ground, determined the center of the random bedding site. Random bedding sites were located in the same topographic class as actual bedding sites.

Home Range and Bedding Site Analyses

Cumulative home ranges for individual fawns were calculated at 7, 15, 24, 40, and 60 days of age with the minimum convex polygon method described by Mohr (1947) using McPAAL software (Stuwe and Blohowiak 1985). A minimum of 6 locations were used to determine individual home ranges. A 3-way analysis of variance (ANOVA) with general linear models (GLM) (SAS 1985) was used to test the effects of age class, sex, year (1991 and 1992), and interactions among these factors, on fawn home range sizes.

A mean height and a mean Daubenmire class for the cover of grasses and cover of forbs were calculated for the peripheral site at each bedding site. These means of actual and random peripheral sites were then grouped into surviving, those living to 15 July, or non-surviving fawn types. Pre-planned comparisons for the 3-way ANOVA with GLM (SAS 1985) included: (1) mean vegetation height between actual peripheral sites within years of surviving and non-surviving fawn groups, (2) mean vegetation height between random and actual peripheral sites within each of the surviving and non-surviving fawn groups within years, (3) mean Daubenmire class for cover of grasses and cover of forbs between years for all peripheral sites (actual and random of survivors and non-survivors) combined, (4) mean Daubenmire class for cover of grasses and cover of forbs between random and actual peripheral sites within each of the surviving and non-surviving fawn groups within each year, and (5) mean Daubenmire class for cover of grasses and cover of forbs between actual peripheral sites of surviving and non-surviving fawns within each year. The means of the Daubenmire class for the cover of grasses and forbs generated by the GLM procedure were used to extrapolate a percent cover of grasses and forbs for the peripheral site. Pre-planned comparisons carried out within each year using 2-way ANOVA with GLM (SAS 1985) consisted of: (1) the height of the tallest vegetation of actual proximate sites between surviving and non-surviving fawn groups, and (2) the height of the tallest vegetation between all random and actual proximate sites.

Regression analysis (SAS 1985) was used to ascertain the relationship between fawn ages and the distance between sibling fawn bedding sites. To test the null hypothesis that fawn bedding sites were evenly distributed among topographic sites, chi-square goodness of fit analysis was used. A Mann-Whitney U test was used to detect differences in total rainfall between 1991 and 1992 during the period 15 May through 15 July. A 2-way ANOVA with GLM using SAS (1985) was used to detect differences between the weights of fawns captured in 1991 and 1992 and between male and female fawns from both years combined.

For the period 15 May through 15 July, 1991 and 1992, daily high and low temperatures and rainfall were recorded. Rainfall was recorded (cm) on each of the three fawning areas. Daily high and low temperatures were recorded at Cottonwood Falls, Kansas, and compiled by the National Oceanic and Atmospheric Administration (NOAA) (1991 and 1992). All data collected on the three fawning areas were pooled for analysis.

RESULTS

Fawn Capture

A total of 46 pronghorn fawns, 23 females and 23 males, were captured during my study (Table 1). All fawns captured appeared strong and healthy. During 1991 the fawning period was 28 May through 12 June with a mean fawning date of 6 June. In 1992 the fawning period was 17 May through 15 June with a mean fawning date of 3 June. During 1991, 5 were fitted with solar powered transmitters, 5 with battery powered transmitters, and 2 fawns were fitted with ear tags only. During 1992, 28 fawns were fitted with solar powered transmitters, 3 with battery powered transmitters, and 3 fawns were fitted with ear tags only. Fawns were captured during the period 28 May through 12 June in 1991 and 17 May through 14 June 1992 (Appendix A).

The mean weight of 23 female fawns (4.3 ± 0.17 kg) was not significantly different (F = 0.47; 1, 42 df; P = 0.3568) than the mean weight of 23 male fawns (4.0 ± 0.19 kg). The mean weight of fawns captured in 1992 (4.5 ± 0.13 kg) was significantly greater (F = 7.90; 1, 42 df; P = 0.0074) than the mean weight of fawns captured in 1991 (3.78 ± 0.22).

Five females were observed giving birth, 1 in 1991 and 4 in 1992. Three on the Rogler area and 2 on the Cattle Pens area. All observed births were twins except a single fawn birth was observed on the Rogler area in 1992.

Table 1. Distribution of twin sets and fawns captured during 1991 and 1992 in Chase County, Kansas.

	1991		1992		Total	
	Fawns	Twin Sets	Fawns	Twin Sets	Fawns	Twin Sets
Phenis Creek	0	0	10	2	10	2
Cattle Pens	3	0	12	4	15	4
Rogler	9	4	12	4	21	8
Total	12	4	34	10	46	14

Fetal membranes were consumed at the birth site and normal doe-fawn imprinting was observed following 4 of the births. The fifth female observed giving birth left the birth site and never returned to the newborn fawn. However, she gave birth to a second fawn, at a second site, where normal doe-fawn imprinting occurred.

Fawn Mortality

Data on 43 of the 46 marked fawns were used for mortality analysis. Because I was interested in documenting natural mortality, three of the fawns captured in 1992 were excluded from the analysis since they were abandoned by the female shortly after capture.

At capture the three abandoned fawns appeared normal and heathy. I was unable to verify reacceptance of these fawns after capture. The three abandoned fawns died within 2-4 days after capture and within 100 m of the capture site. Necropsy revealed these fawns had marked depletion of fat reserves, no milk was present in their abomasum and one fawn's abomasum contained small flecks of plant material. Histologically, the lung, liver, heart, kidney, intestines, abomasum, and cerebrum appeared normal in all three fawns. Thoracic fluid from one fawn tested positive for antibodies to bluetongue and epizootic hemorrhagic disease (EHD). This indicates the fawn was exposed to these viruses in utero after its immune system was competent. Pericardial fluid from a second fawn showed titer levels of bovine virus diarrhea (BVD) and parainfluenza significant enough to suggest an infection. However, because all three fawns showed depleted fat reserves and no signs of nursing, I assumed they were rejected or abandoned by the female and starved to death.

By the end of August 1991, 7 of 12 marked fawns were dead, a 58% mortality rate. By 31 August 1992, 28 of 31 marked fawns were dead, a 90% natural mortality rate. Six carcasses were found, 1 in 1991 and 5 in 1992, with enough evidence to determine that coyotes were the cause of death. Once in 1991 (No. 008) and twice in 1992, (Nos. 005, 022) fawns were found cached by coyotes. These fawns had been torn in two, and the head, neck, and forelegs were found below ground level and covered with soil and/or vegetational debris. On two occasions during 1992, (Fawn Nos. 001, 021) ear tags, hair, and bone were found near the area that had been used for a cache site by coyotes (Appendix A). All five of these findings were located in lowland areas dominated by (Symphoricarpos orbiclatus). In one instance in 1992 a fawn (No. 031) missing all internal organs was found on a sloping area. Necropsy revealed two punctures present in the back region of the skull causing fractures of the bone that extended to the brain. The second and third to fourth vertebrae were also fractured. These lesions were consistent with bite wounds of coyotes (O'Gara 1978).

Small portions of hair, bones, and/or the transmitter were recovered from 57% (4 of 7), and 54% (15 of 28) of the dead fawns in 1991 and 1992, respectively. All 19 of these fawns were fitted with solar powered transmitters and appeared healthy prior to finding the remains. I was unable to receive a transmitter signal from these 19 fawns for a period ranging from 2 to 5 days following the visual of the living fawn and the finding of the remains. This suggests the fawns were cached by coyotes during this period and the solar powered transmitter was not transmitting because it was not receiving light. Therefore, I was unable to locate the transmitter until the coyotes returned to the cache site, consumed the fawn and allowed the transmitter to receive light and produce a signal so that I could locate the fawn remains. The cause of death for these fawns has been labeled coyote involved in Appendix B.

In 1991 one fawn was found dead at 19 days old. A necropsy was not performed; however the week prior to its death it was observed with dysentery and appeared weak and unhealthy. Thus, this mortality was labeled as a disease related death.

Data pertaining to the cause of death for 9 fawns, 1 in 1991 and 8 in 1992, were not determined. Four of these fawns were fitted with colored ear tags only and their remains were never recovered. The transmitters of 3 fawns failed prior to their death and their remains were never found. Working transmitters of two fawns were never found following their deaths. All of these fawns were known to be dead because their parental females were marked and seen frequently without the marked fawns.

Data from the 28 radio marked fawns indicated that natural mortality occurred in greater percentages at an earlier age in 1991 than in 1992. Eighty-three percent of the fawns that died in 1991, did so within approximately the first three weeks of life. However, only 52% of the natural mortality in 1992 occurred within approximately the first three weeks of life (Table 2). Known or probable depredation accounted for 83% and 71% of the natural mortality that occurred in 1991 and 1992, respectively.

Although not an objective of this study, data were collected on fall and winter mortality of fawns born in 1991. Of the 5 fawns surviving the summer, 1 died in mid October, and another perished in early November. The cause of death was not ascertained for either fawn. Three fawns captured in 1991 survived to 31 August 1992.

Home Range

The three-way ANOVA indicated no significant ($\underline{F}$ = 1.3; 4, 78 df; $\underline{P}$ = 0.2816) interactions among the three factors of age class, sex, and year on mean fawn home range size. However, there were significant interactions

Table 2. Natural mortality of radio-ear tagged pronghorn fawns in Chase County, Kansas, during summers 1991 and 1992.

Age Class (Days)	Year	No. Monitored	MORTALITY n	Cumul. %
1 - 7	1991	10	0	0
	1992	28	0	0
8 - 15	1991	10	2	20
	1992	28	7	21
16 - 24	1991	7	3	50
	1992	21	6	46
25 - 40	1991	5	1	60
	1992	15	8	78
41 - 60	1991	4	0	60
	1992	7	3	89
60 - 90	1991	4	0	60
	1992	4	1	93

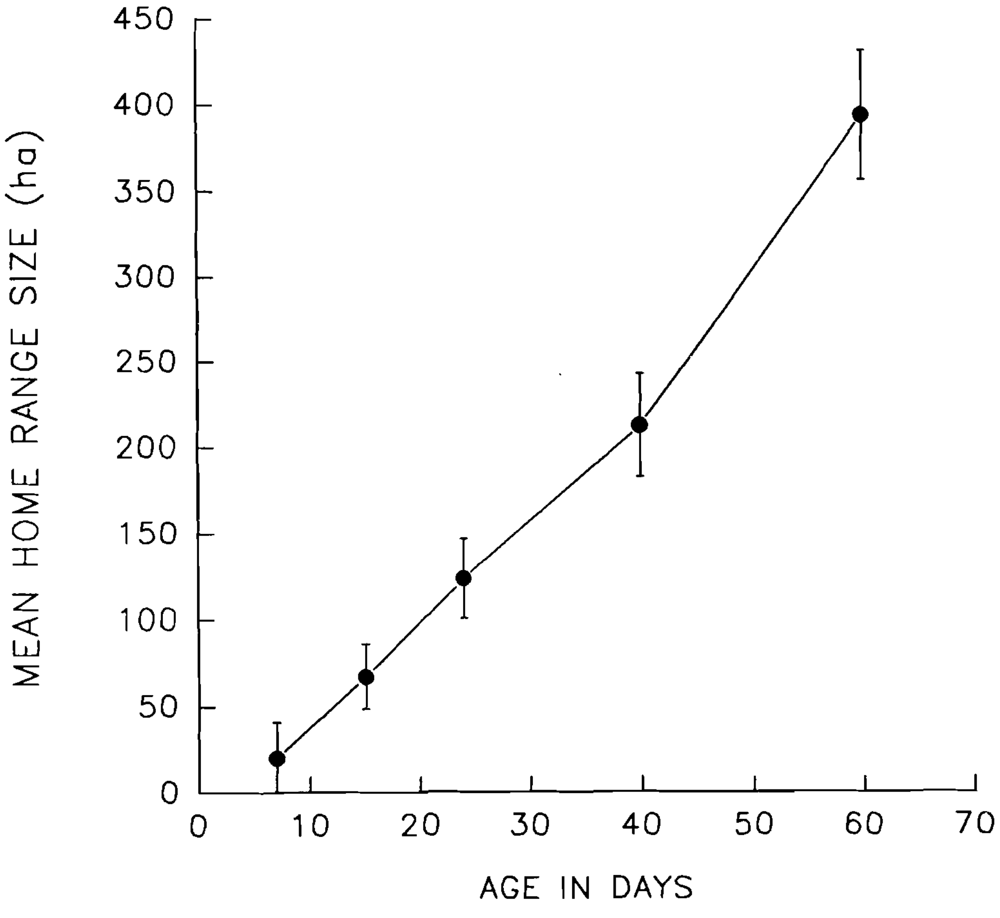
of the two factors of age class and year (F = 4.6; 4, 78 df; P = 0.0021), and sex and year (F = 7.7; 1, 78 df; P = 0.0068) on mean fawn home range size. There was also a significant (F = 23.5; 4, 78 df; P < 0.0001) effect of the age class of fawns on mean home range size. During both years of the study, cumulative mean home range sizes of radio-ear tagged fawns increased significantly with age. Mean home range sizes for both years combined ranged from 19.9 ha at 7 days of age up to 392.8 ha at 60 days of age. Significant increases in mean home range size occurred between age groups of fawns at 25 to 40 (P = 0.0209), and 41 to 60 (P = 0.0003) days of age (Fig. 4).

Mean home range size for radio-ear tagged fawns in 1992 was significantly (P = 0.0046) larger at 24 days of age, and significantly (P = 0.0038) smaller at 60 days of age than 1991 fawns (Fig. 5). During 1992 mean home range size across all age groups for female fawns was significantly (P = 0.0031) larger than mean home range size across all age groups for male fawns. However, in 1991 male fawn mean home range size for all age groups was slightly, but not significantly (P = 0.2448), larger than female fawn mean home range size for all age groups (Table 3).

Vegetation Characteristics

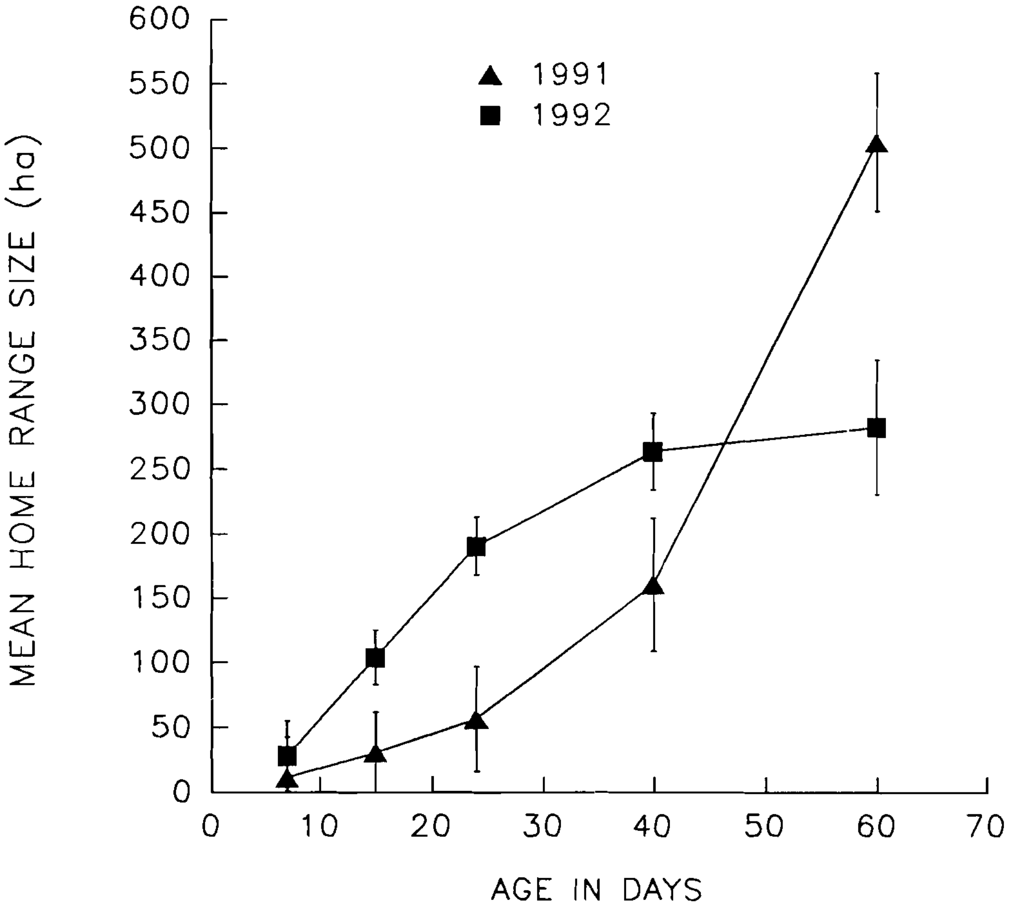
During 1991 and 1992, 49 and 94 actual and random peripheral sites were examined, respectively. In 1991 and

Fig. 4. Mean, with standard error, of summer home range sizes at five age classes of radio-ear tagged pronghorn fawns captured in Chase County, Kansas, summers 1991 and 1992 combined.



MEAN HOME RANGE SIZE (ha)
450
400
350
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
AGE IN DAYS

Fig. 5. Mean, with standard error, of summer home range sizes at five age classes of radio-ear tagged pronghorn fawns captured in Chase County, Kansas, summers 1991 and 1992.



600
550
500
450
400
350
300
250
200
150
100
50
0
MEAN HOME RANGE SIZE (ha)
1991
1992
0
10
20
30
40
50
60
70
AGE IN DAYS

Table 3. Mean home range size (ha) across all age groups for male and female pronghorn fawns radio-ear tagged in Chase County, Kansas, summers 1991 and 1992.

			Home Range Size	
Year	Sex	n	$\bar{x}$	SE
1991	F	5	130.3	20.6 A[a]
1991	M	4	175.0	32.1 ABC
1992	F	12	217.9	16.2 BC
1992	M	9	129.4	23.9 A

[a] Means followed by like letter are not significantly different ($P > 0.05$) within sex and year using ANOVA.

1992, 58% (7 of 12) and 80% (25 of 31) of the natural mortality had occurred by 15 July, respectively. A significant effect of year on the cover of grasses was detected. The mean Daubenmire class for the cover of grasses across all peripheral site types was greater in 1991 (3.14 ± 0.03) than in 1992 (2.88 ± 0.03) (F = 38; 1, 278 df; P < 0.0001). These values were extrapolated to 30 percent cover of grasses in 1991 compared to 24 percent in 1992.

The means for the Daubenmire values for the cover of grasses and forbs between actual and random peripheral sites for surviving fawns were similar in 1991, P = 0.2949 for grasses and P = 0.3292 for forbs, and 1992 P = 0.6997 for grasses and P = 0.1517 for forbs (Table 4). The means for the Daubenmire values for the cover of grasses and forbs between actual and random peripheral sites for non-surviving fawns were similar in 1991, P = 0.2840 for grasses and P = 0.9493 for forbs, and 1992 P = 0.4904 for grasses and P = 0.0992 for forbs (Table 5). The means for the cover of grasses between actual surviving and non-surviving fawn peripheral sites were similar in 1991 (P = 0.8578) and 1992 (P = 0.1191) (Table 6). The means for the cover of forbs between actual surviving and non-surviving fawn peripheral sites were significantly different (P = 0.0039) in 1991, but similar (P = 0.5255) in 1992 (Table 6). The means for the vegetation height

Table 4. Mean Daubenmire class and mean percent cover of grass and forbs in peripheral sites of actual and random surviving radio-ear tagged pronghorn fawn bedding sites in Chase County, Kansas, summers 1991 and 1992. GRS = grasses and FRB = forbs.

		Actual Sites			Random Sites		
		Daubenmire Class			Daubenmire Class		
Year	Veg. Type	$\bar{x}$	SE	% Cover	$\bar{x}$	SE	% Cover
1991	GRS	3.18	0.06 A[a]	29	3.10	0.06 A	28
1992	GRS	2.96	0.06 A	25	2.84	0.06 A	24
1991	FRB	2.70	0.05 A	20	2.64	0.05 A	19
1992	FRB	2.70	0.05 A	20	2.59	0.05 A	18

[a] Means followed by like letter within row are not significantly different ($P > 0.05$) using ANOVA.

Table 5. Mean Daubenmire class and mean percent cover of grass and forbs in peripheral sites of actual and random non-surviving radio-ear tagged pronghorn fawn bedding sites in Chase County, Kansas, summers 1991 and 1992. GRS = grasses and FRB = forbs.

		Actual Sites			Random Sites		
		Daubenmire Class		%	Daubenmire Class		%
Year	Veg. Type	$\bar{x}$	SE	Cover	$\bar{x}$	SE	Cover
1991	GRS	3.20	0.06 A[a]	30	3.10	0.06 A	28
1992	GRS	2.84	0.03 A	23	2.80	0.03 A	22
1991	FRB	2.48	0.06 A	15	2.47	0.06 A	15
1992	FRB	2.66	0.03 A	19	2.58	0.03 A	18

[a] Means followed by like letter within row are not significantly different ($P > 0.05$) using ANOVA.

Table 6. Mean Daubenmire class and mean percent cover of grass and forbs in peripheral sites of actual surviving and non-surviving radio-ear tagged pronghorn fawn bedding sites in Chase County, Kansas, summers 1991 and 1992. GRS = grasses and FRB = forbs.

		Survivors			Non-Survivors		
		Daubenmire Class		%	Daubenmire Class		%
Year	Veg. Type	$\bar{x}$	SE	Cover	$\bar{x}$	SE	Cover
1991	GRS	3.18	0.06 A[a]	29	3.20	0.06 A	30
1992	GRS	2.95	0.63 A	25	2.84	0.04 A	23
1991	FRB	2.70	0.05 A	20	2.48	0.06 B	15
1992	FRB	2.70	0.05 A	20	2.66	0.03 A	19

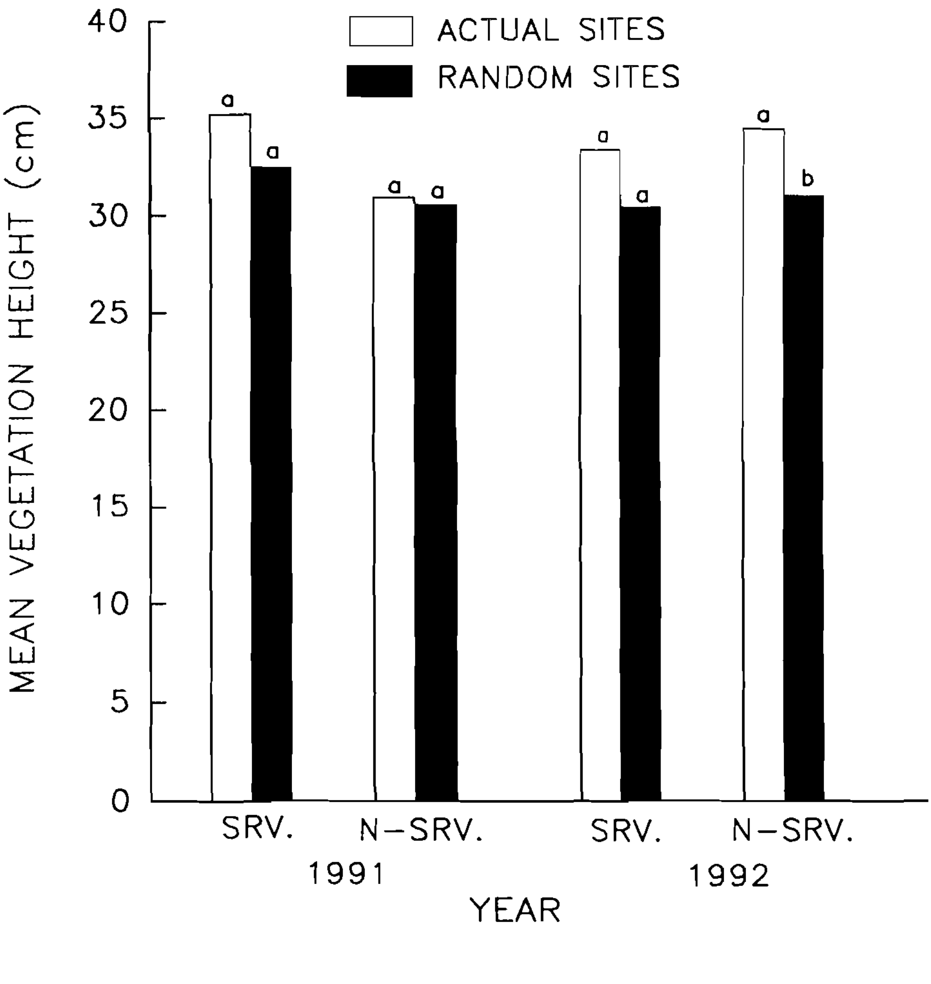
[a] Means followed by like letter within row are not significantly different ($P > 0.05$) using ANOVA.

between actual and random peripheral sites for surviving fawns were similar in 1991 (P = 0.0976) and 1992 (P = 0.0839) (Fig. 6). The means for the vegetation height between actual and random peripheral sites for non-surviving fawns were similar (P = 0.8764) in 1991, but significantly different (P = 0.0012) in 1992 (Fig. 6) The means for the height of vegetation at actual surviving and non-surviving fawn peripheral sites were different (P = 0.0127) in 1991 and similar (P = 0.4305) in 1992 (Fig. 7).

During 1991 and 1992, 48 and 94 actual and random proximate sites were examined, respectively. The means for the height of the tallest vegetation in actual proximate sites between surviving and non-surviving fawns were similar during 1991 (P = 0.3837) and 1992 (P = 0.8851) (Fig. 7). During 1991, (F = 7.17; 1 92 df; P = 0.0097) and 1992 (F = 96.31; 1 184 df; P < 0.0001) the means of the tallest vegetation in actual proximate sites of all fawns were significantly taller than in random proximate sites (Fig. 8).

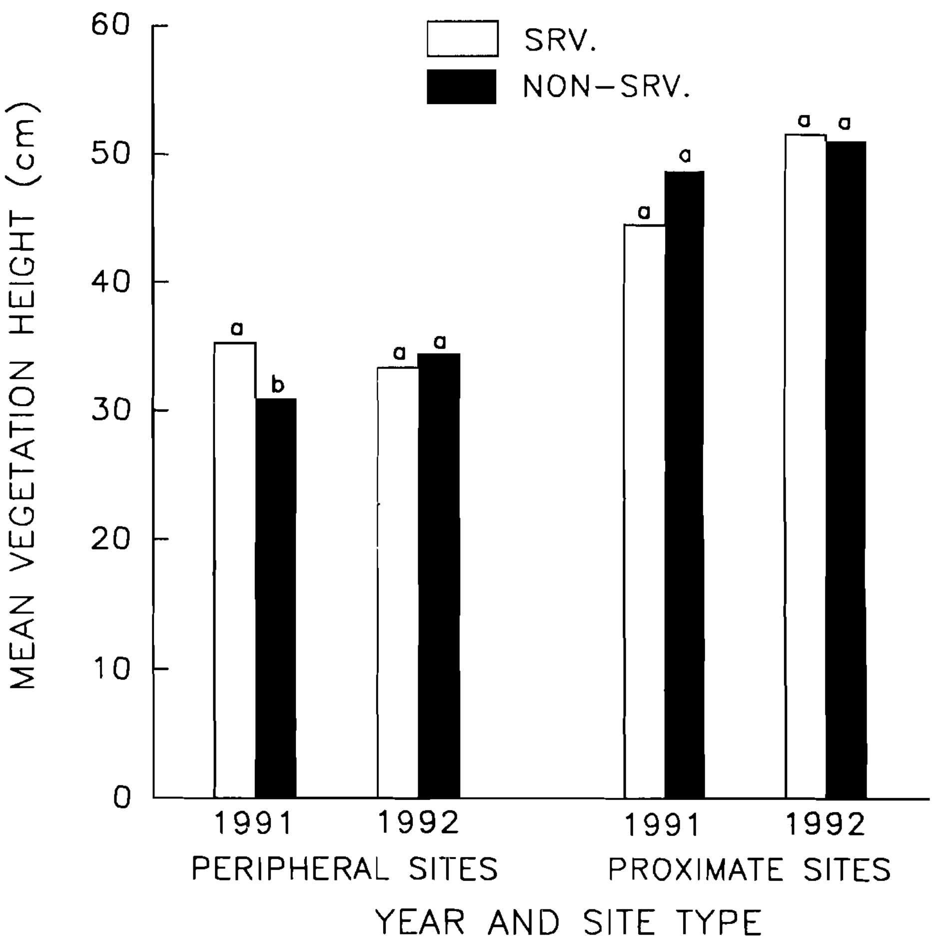
During 1991 and 1992 the location of fawn bedding sites was not evenly distributed among the three topographic areas of lowlands, slopes, and uplands. Locations of fawn bedding sites indicated a heavy preference for sloping areas (Table 7). Regression analysis demonstrated a quadratic relationship between the age of sibling fawns and the distance between their

Fig. 6. Mean vegetation heights of actual and random peripheral sites of surviving (SRV.) and non-surviving (N-SRV.) pronghorn fawns radio-ear tagged in Chase County, Kansas, summers 1991 and 1992. Means with like letter within each histogram pair are not significantly different ($\underline{P} > 0.05$) using ANOVA.



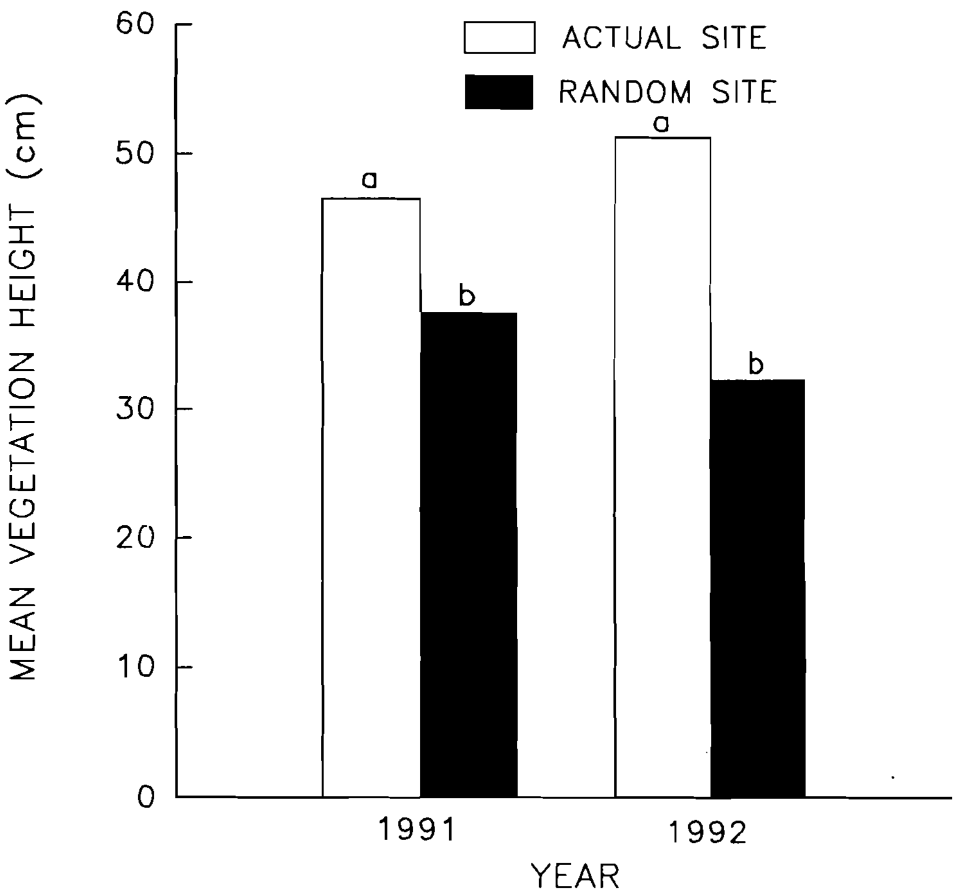
ACTUAL SITES
RANDOM SITES
MEAN VEGETATION HEIGHT (cm)
40
35
30
25
20
15
10
5
0
a
a
a
a
a
a
a
b
SRV.
N-SRV.
SRV.
N-SRV.
1991
1992
YEAR

Fig. 7. Mean vegetation heights of actual surviving (SRV.) and non-surviving (NON-SRV.) radio-ear tagged pronghorn fawn peripheral and proximate sites in Chase County, Kansas, summers 1991 and 1992. Means with like letter within each histogram pair are not significantly different ($\underline{P}$ > 0.05) using ANOVA.



60
50
40
30
20
10
0
MEAN VEGETATION HEIGHT (cm)
SRV.
NON-SRV.
a
b
a
a
a
a
a
a
1991
1992
1991
1992
PERIPHERAL SITES
PROXIMATE SITES
YEAR AND SITE TYPE

Fig. 8. Means of tallest vegetation in actual and random proximate sites of radio-ear tagged fawns captured in Chase County, Kansas, summers 1991 and 1992. Means with like letter within each histogram pair are not significantly different ($\underline{P} > 0.05$) using ANOVA.



ACTUAL SITE
RANDOM SITE
MEAN VEGETATION HEIGHT (cm)
60
50
40
30
20
10
0
a
b
a
b
1991
1992
YEAR

Table 7. Observations (n) of radio-ear tagged pronghorn fawns during summers 1991, and 1992 by topographic site.

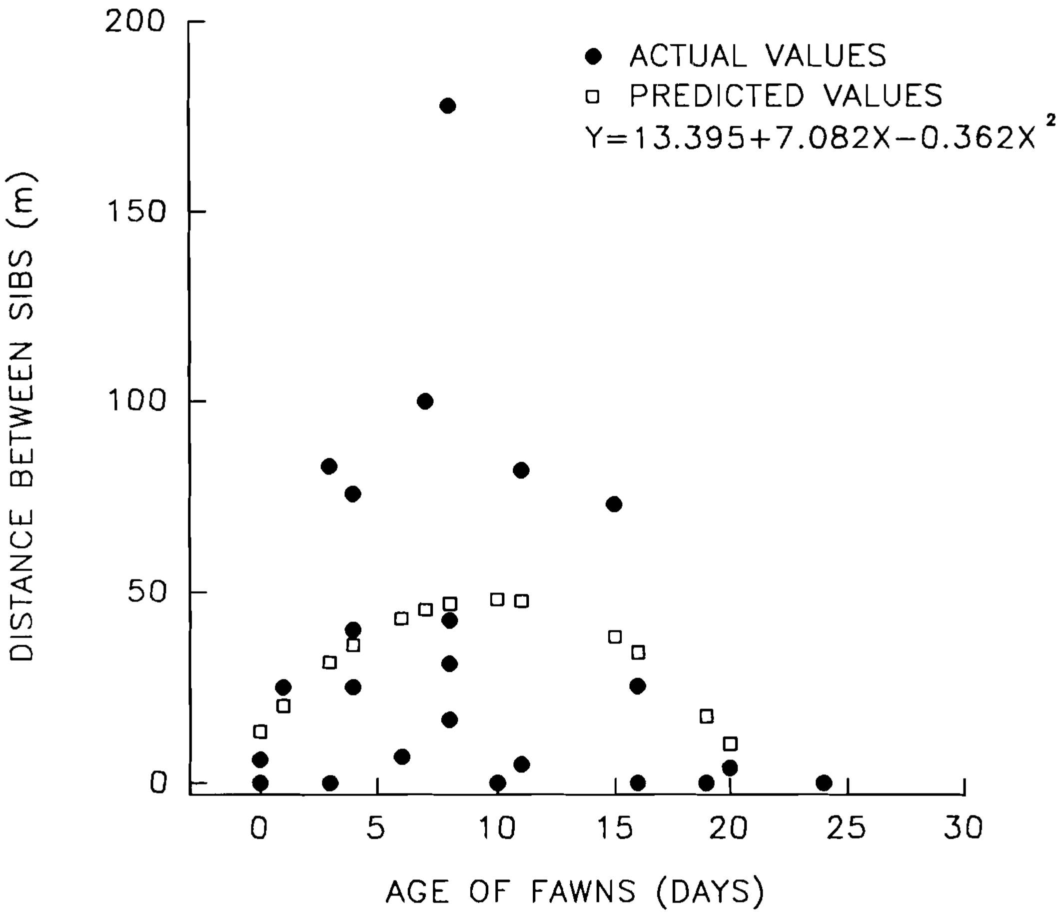
Year	Upland	Lowland	Slope
1991	18	7	48[a]
1992	23	4	151

[a] Fawn bedding sites not evenly distributed during 1991 ($\underline{X}^2 = 37.01$, $\underline{P} < 0.001$) and 1992 ($\underline{X}^2 = 215.47$, $\underline{P} < 0.001$).

individual bedding sites (Fig. 9).

Approximately 40% above average rainfall occurred during the period 15 May - 31 July 1992 (NOAA 1992). A Mann-Whitney U test showed this to be significantly greater ($U = 163.5$, $P < 0.05$) than the slightly below normal rainfall during 1991 (NOAA 1991) (Fig. 10). Temperatures during 1992 were slightly cooler than in 1991 (Fig. 11).

Fig. 9. The relationship of distance between bedded sibling pronghorn fawns radio-ear tagged in Chase County, Kansas, during summers 1991 and 1992 expressed as a function of age.



ACTUAL VALUES
PREDICTED VALUES
Y=13.395+7.082X−0.362X²
DISTANCE BETWEEN SIBS (m)
AGE OF FAWNS (DAYS)
200
150
100
50
0
0
5
10
15
20
25
30

Fig. 10 Daily minimum temperatures and rainfall amounts in Chase County, Kansas, summer 1991, a = days when one fawn died, b = days when two fawns died.

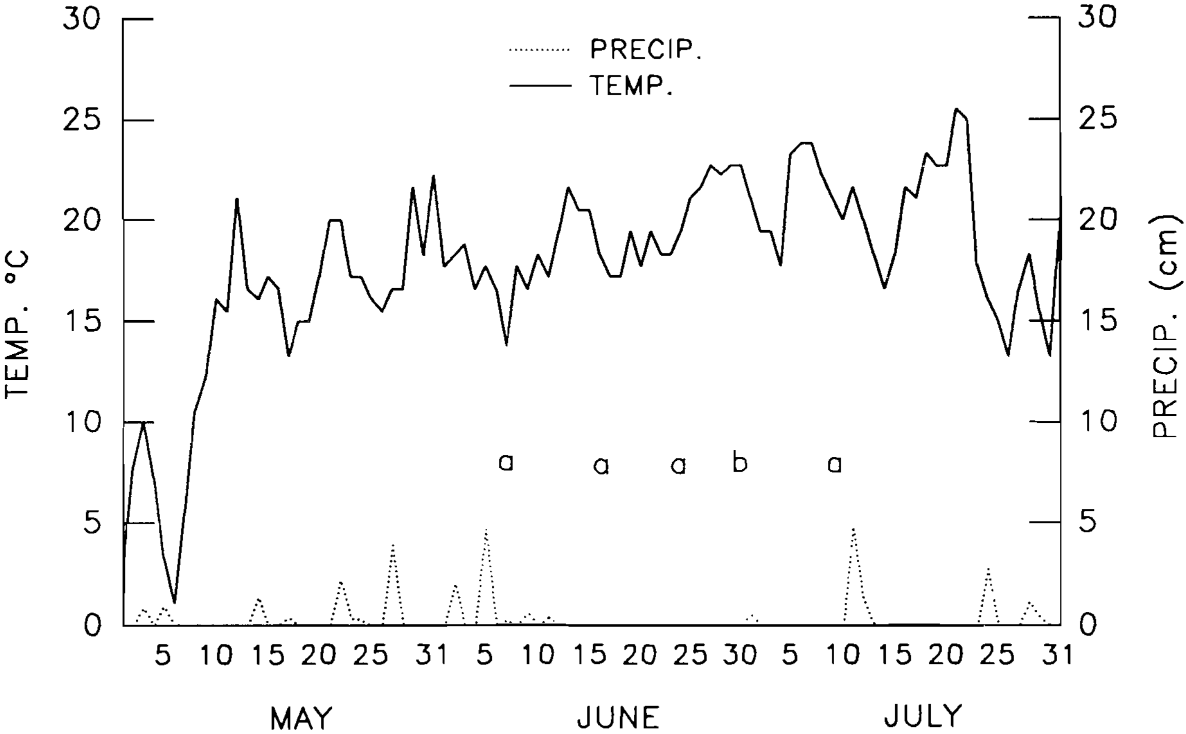
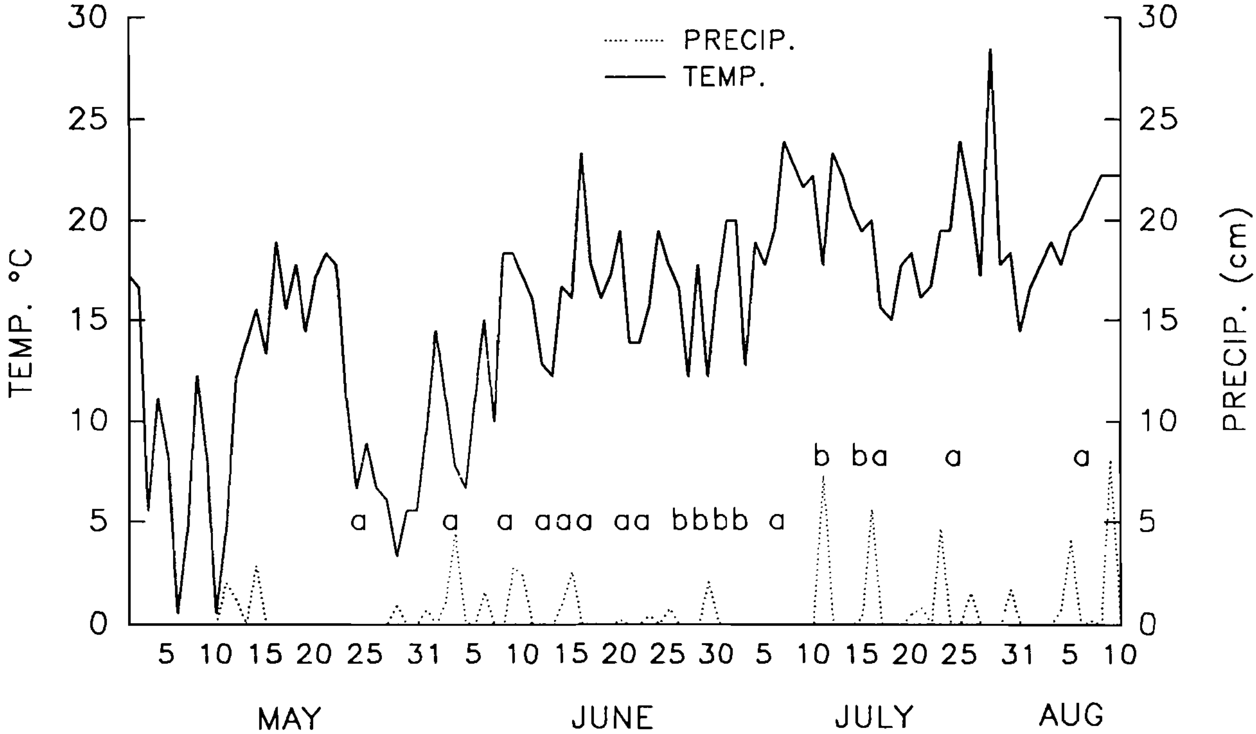

PRECIP.
TEMP.
TEMP. °C
PRECIP. (cm)
30
25
20
15
10
5
0
a
a
a
b
a
5 10 15 20 25 31 5 10 15 20 25 30 5 10 15 20 25 31
MAY
JUNE
JULY

Fig. 11. Daily minimum temperatures and rainfall amounts in Chase County, Kansas, summer 1992, a = days when one fawn died, b = days when two fawns died.



PRECIP.
TEMP.
TEMP. °C
PRECIP. (cm)
30
25
20
15
10
5
0
a a a aaa aa bbbb a
b ba a a
5 10 15 20 25 31 5 10 15 20 25 30 5 10 15 20 25 31 5 10
MAY
JUNE
JULY
AUG

DISCUSSION

Fawn Capture

The fawning period in Chase County, Kansas occurred later than those reported in some parts of pronghorn range. McNay (1980) reported a fawning period of 12 - 24 May in Nevada, Trainer et al. (1983) reported fawns born between 14 May and 2 June in Oregon, Von Gunten (1978a) reported a mean fawning date of 25 May in Montana, and Tucker (1979) reported a peak in the fawning season between 3 - 13 May in Texas. However, other researchers have reported fawning periods similar to those in Chase County, Kansas. In Colorado Hoover et al. (1959) reported a peak in fawning activity between 1 and 12 June and Fairbanks (1993) reported fawning between 29 May and 28 June. Bodie (1979) found a mean fawning date of 31 May in Idaho. The timing of the fawning season in different parts of pronghorn range seems to depend upon individual populations. There is no evidence to suggest the fawning season is dependent upon geographical location related to latitude or longitude, nor to environmental conditions of the geographic location.

Mean capture weights from my study are comparable to other studies (Corneli 1980, Autenrieth 1982, Fairbanks 1993). However, the mean capture weight of fawns in 1992 was slightly greater than those from other studies because fawns that were captured at greater than 3 days of age were included in my analysis.

Fawn Mortality

Vriend and Barrett (1978) indicated high fetal rates of 1.70 - 1.90 fawns per mature female with high fawn mortality of 25 - 65%, up to 80%, during the summer following parturition throughout pronghorn ranges. This trend of moderate to high fawn loss after parturition was apparent in the population of pronghorn in Chase County, Kansas.

Some researchers speculate cold, wet weather during the fawning season and the period of lying secluded may decrease fawn survival (Halloran and Glass 1959, Bodie 1978, Kindschy et al. 1978, McNay 1980). During my study, the fawning season and period of lying secluded in 1991 was near normal in both rainfall and temperature, but 1992 was a year with below normal temperatures and above average rainfall (NOAA 1992). When mortality events from 1991 and 1992 are compared with temperatures and rainfall from each year there are no apparent trends to suggest that neither rainfall nor temperature affected fawn survival (Fig. 10 and 11). These results, coupled with the findings of fawns cached by coyotes and the findings of whole or partially consumed fawn remains, indicated that coyote depredation was the primary cause of fawn mortality during my study.

Seventeen percent of fawn deaths were definitely caused by coyotes. Fifty-four percent of the fawn deaths were "coyote involved", and were consumed by coyotes. No data pertaining to coyote distribution, densities, or denning sites on the study area are available. However, 11 coyotes were captured in a period of 7 nights trapping on the study area (Jorgensen 1992), which indicates that coyotes are prominent in the area. Numerous studies have shown that depredation of pronghorn fawns by coyotes, bobcats (Lynx rufus), and golden eagles (Aquila chrysaetos) cause moderate to high mortality levels (Beale and Smith 1973, Barrett 1978, Von Gunten 1978b, Corneli 1980, McNay 1980, Neff and Woolsey 1980, Trainer et al. 1983, Autenrieth 1984, Barrett 1984, O'Gara and Malcolm 1988).

Knowlton (1968) assumed that coyotes could take advantage of fences when capturing pronghorn fawns. McNay (1980) observed a coyote using a fence line as an aid in capturing a pronghorn fawn. Simpson (1992) reported the average height of the bottom wire of fences in the study area to be slightly below the recommended height for pronghorn use. Though no such activity by coyotes was observed during my study, the lower than recommended fences could have created a greater advantage for coyotes and thus may have contributed to high coyote depredation.

An unknown disease caused the death of one fawn during my study. In Utah, Beale and Smith (1973) reported two fawns dying from salmonellosis and three from pneumonia. Bodie (1979) in Idaho and Reichel (1976) in Montana suspected weak calf syndrome to cause fawn mortality. No studies of pronghorn fawn mortality have indicated disease as a major mortality factor.

Researcher influenced mortality is always a possibility when handling wild animals, especially mortality due to abandonment by the mother after new-borns are handled. Beale and Smith (1973) had 11 of 117 fawns perish from abandonment. Trainer et al. (1983) reported 10 of 144 fawns were abandoned and eventually starved to death. In my study one fawn was most likely abandoned because the female left the birth site. However, because the other two fawns were handled in the same manner as those fawns not rejected, there was no evidence to suggest why they were abandoned due to handling.

Home Range

During my study individual and mean fawn home range sizes increased with age, coinciding with the findings of other researchers (Tucker 1979, McNay 1980, Barrett 1984). Mean home range sizes of 57.9 ha and 127 ha at 2 and 3 weeks of age, respectively, reported by Tucker (1979) are very comparable with the mean sizes of 67.3 ha and 123.5 ha at 2 and 3 weeks of age, respectively, found during my study. However, these mean home ranges are considerably smaller than the 438 ha mean home range sizes for 3 week old fawns reported by McNay (1980) in Nevada, and Barrett

(1984) in southeastern Alberta. Two-thirds of Tucker's (1979) study area was surrounded by 1 m high woven wire fence which was flush to the ground and restricted pronghorn movements. Pronghorn were never observed moving off his study area. Thus, the similarity of fawn home range sizes from my study and Tucker's (1979) study and differences from my study compared to McNay's (1980) and Barrett's (1984) findings may be attributed to the density and distribution of barbed wire fences as hypothesized by M. Barrett (Alberta Environmental Centre, pers. commun.).

The significant increase in home range size of fawns between age classes reported for 1991 and 1992 represents increased activity and movement by fawns. Five to six week old fawns begin to join with parental females and form fawn/doe groups (Autenrieth and Fichter 1975). Thus, mean home range sizes during both years of my study during this time period began to resemble parental female home ranges. The increased female fawn mean home range size over all age classes compared to male fawns in 1992 may be more reflective of parental female home ranges rather than fawn home ranges because of the existence of fawn/doe groups in the older age classes. Therefore, individual parental does of female fawns may have had larger home ranges than parental females of male fawns in the older age classes and thus the significant difference between the 2 sexes. The amount of rainfall that occurred during 1992 may have had an indirect effect on fawn movements and therefore accounted for the significant increase in home range size at the 24 day old age class during that year compared to 1991. The difference in home range size at the 60 day old class compared to the 40 day old class may have been reflective of a difference in parental female home range size rather than individual fawn home range sizes because of the existence of doe/fawn groups during this time period.

Vegetation Characteristics

Bromley (1967) hypothesized selective pressure applied by predators, in combination with the ability of vegetative cover to protect fawns from severe weather, may determine the characteristics of fawn bedding sites. If these speculations are true, the mortality rate of pronghorn fawns may partially be reflective of an individual fawn's ability to select adequate bedding sites.

During the first week of life sibling fawns are usually not together during nursing bouts or at bedding sites except for the first few hours of life. From the beginning of the second week through the fourth week of life sibling fawns are usually observed displaying increased interactions until they are together 100% of the time by the fourth week of life (Autenrieth and Fichter 1975). Barrett (1984) showed a negative linear correlation between the age and distance between bedded siblings. The relationship between age and distance between bedded siblings in my study was curveilinear probably due to the limited sample size and because one set of sibling fawns was bedded together during every observation.

The bedding sites selected by fawns during my study were not chosen at random and were usually located on sloping areas (Table 7) in grass proximate to a forb such as scurfy pea, western ironweed, goldenrod, and the shrub lead plant which were greater in height than the surrounding area as shown in Fig. 10. This indicates fawns are attempting to find the best suitable habitat for seclusion. Fawns were occasionally seen bedded on or next to large rocks. Fawns have been reported to select bedding sites with similar characteristics to those I found in Chase County, Kansas. However, big sagebrush (*Artemisia tridentata*), which did not occur on my study site, is the shrub proximate to bedding sites in the majority of pronghorn range (Pyrah 1974, Autenrieth and Fichter 1975, Autenrieth 1976, McNay 1980, Barrett 1981).

The findings of similar values for the height and cover of grasses and forbs in the periphery of actual and random bedding sites in my study are not consistent with the findings of other researchers (Autenrieth 1976, Alldredge et al. 1991) which may be an effect of a different ecosystem type in Chase County, Kansas. However, the results of fawns selecting bedding sites with significantly taller vegetation proximate to the bedding site center compared to random sites in my study supports Barrett's (1981:128) statement that in areas "where brush cover available to fawns is limited, the tendency to select bedding sites using other features to satisfy both vertical and horizontal sign stimuli may be more apparent."

My findings also indicate and agree with Alldredge et al. (1991) that vegetation in the periphery of a bedding site may also be an important component to the fawn bedding site, even though no differences were detected between actual and random bedding sites. This was supported by my findings in 1991 when mortality rates were lower than 1992 and those fawns that survived in 1991 selected bedding sites with a greater coverage of forbs and taller vegetation compared to non-survivors. Therefore, fawns that survived in 1991 may have increased their chance of survival by selecting bedding sites with not only taller proximate vegetation compared to random sites, but also had greater cover of forbs and taller vegetation in the periphery of their bedding sites. The following combination of results indicate there may have been a more homogeneous cover of forbs and vegetation height during 1992 comparable to levels selected by 1991 surviving fawns: (1) greater cover of grasses in 1991, (2) mean height and cover values of 1991 surviving fawn peripheral sites were similar to non-surviving fawn peripheral sites during 1992, (3) surviving fawns of 1991 selected areas with increased cover of forbs and taller vegetation compared to non-survivors, and (4) surviving and non-surviving fawns in 1992 selected areas with peripheral sites that were similar in height and cover of forbs compared to 1991 surviving fawns. Surviving fawns during 1991 selected bedding sites with greater cover of forbs and taller vegetation in peripheral sites in what may have been a more heterogeneous environment, with significantly greater grass cover and fewer areas of increased forb cover compared to 1992.

The difference in rainfall between the two years may have affected the distribution of vegetative cover and vegetation height. The increased moisture during 1992 may have provided a homogeneous distribution of vegetation cover and height. Therefore, the heterogeneous distribution of vegetation during 1991, when rainfall was below normal, that may have allowed surviving fawns to select bedding sites with significantly greater cover of forbs and taller vegetation, did not occur in 1992.

The first three weeks of life are the most crucial for survival of pronghorn fawns (Fichter 1974, Autenrieth and Fichter 1975, Alldredge et al. 1991). If a pronghorn fawn can survive this period of lying secluded it has a good chance of survival within most populations (McNay 1980, Trainer et al. 1983). Bedding site cover seems to be adequate for pronghorn fawns in tallgrass prairie because fawn mortality for my study was near or below normal levels (Vriend and Barrett 1978) at approximately 3 weeks of age during 1991 and 1992.

The homogeneous distribution of vegetation cover and height during 1992, compared to 1991 may have also affected fawn home range size. If vegetation is evenly distributed with no distinct areas greater in cover or height, pronghorn fawns may extend normal movements searching for areas greater in cover and height to satisfy their horizontal and vertical stimuli to become secluded from predators and protected from the weather. If this occurs, it would explain the significant increase in home range size during 1992 compared to 1991. As discussed by Trainer et al. (1983), Carl and Robbins (1988) and, O'Gara et al. (1988), fawns have little scent during the first few weeks of life and predators most likely locate fawns visually. Thus, fawns that move more are probably more susceptible to depredation by visual predators. Fawns from this study moved more during 1992 than 1991 and there was a marked increase in mortality in 1992 compared to 1991. Thus, the increased mortality of 1992 may be a partial result of the increased home range size of fawns during 1992. The increased home range size may have been a result of the distribution of vegetative cover and height. Therefore, the increased rainfall of 1992 may have been an indirect cause of increased fawn home range sizes during 1992 as discussed previously.

The occurrence of 83% of total fawn mortality within approximately the first three weeks of life during 1991 is comparable to findings by other researchers (McNay 1980, Trainer et al. 1983, Autenrieth 1984, Fairbanks 1993). However, only 52% of the natural mortality in 1992 occurred within approximately the first three weeks of life, which supports the suggestion that home range size affects mortality. The majority of the remaining mortality in 1992 occurred when fawns were approximately 3 - 5 weeks old. Home range sizes were larger during this period in 1992 compared to 1991, which supports the hypothesis of fawns with greater movements are more susceptible to depredation.

The results of my study appear to indicate coyotes are a major cause of fawn mortality. During 1991 the fawn mortality rate was near an "acceptable" level (Vriend and Barrett 1978). During 1992 the mortality rate was above normal levels and most deaths were attributed to coyotes. However, fawns in 1992 had larger home ranges than 1991 and this may have made them more susceptible to depredation. Therefore, factors affecting home range size may have contributed to the rate of coyote depredation, more than just coyotes acting independent of other factors.

Researchers have shown a relationship between reduction of coyote numbers and subsequent increase in fawn survival (Uddy 1953, Hailey 1979, Smith et al. 1986). Connolly (1978) concluded that predator removal may result in increased ungulate populations if the population is below carrying capacity, if predation is the main cause of mortality, and control is extensive enough to remove large numbers of predators over vast areas. Smith et al. (1986) are the only researchers to propose coyote suppression as an economical benefit for pronghorn fawn survival through selective, time specific application of aerial gunning.

Because my study indicated that fawn movements may have an impact on fawn mortality, rather than just coyotes acting alone, a better understanding of what factors are affecting pronghorn fawn movements within the study area must be fully understood before a recommendation on predator control can be made. Therefore, I recommend not only the continuation of monitoring fawn mortality in the area, but also more definitive attempts should be made to assess the relationship between fawn movements and the cause or causes of fawn mortality in the area.

MANAGEMENT IMPLICATIONS

Franklin (1980) suggested a minimum of 50 breeding adults to maintain a viable population. The population within my study area was larger than this minimum requirement. O'Gara and Yoakum (unpubl. data) considered an increase of 20% to 30% in the numbers of restored animals within a 5 to 10 year period after the initial release to be necessary for the restoration effort to be successful. Therefore, it would be pre-mature to suggest that the restoration effort has been a success and pronghorn can maintain a viable population in Chase County, Kansas based on the data I collected. If mortality rates for fawns in the study area remain at or below the accepted normal level of 60% in up-coming years, the current population should remain stable. If population growth is to occur in the area and mortality levels remain at approximately 60%, more reproductively active females will need to be translocated to the area in order to have a larger number of fawns recruited into the population. I recommend a continuation of monitoring pronghorn fawn survival and subsequent population level changes for at least the next five years in order to understand if the restoration effort was a success in establishing a viable population.

The total area for my study was grazed by cattle and grazing practices have been shown to affect pronghorn reproduction and fawn survival (Barrett 1978, McNay 1980).

It was not an objective of my study to relate cattle grazing to fawn survival, however casual observations during winter indicate pronghorn in Chase County, Kansas depend upon areas heavily grazed by cattle during summer for winter forage. The understanding of carrying capacity of rangeland for pronghorn is an important and essential part of pronghorn management. Currently, no knowledge exists about the carrying capacity of pronghorn in the tallgrass prairie ecosystem. Land management practices such as grazing and burning probably affect the carrying capacity of pronghorn in tallgrass prairie. Whether this effect is positive or negative is not understood. Therefore, I not only recommend future research of pronghorn fawn mortality and causes of fawn mortality, but also land management practices and their effects on pronghorn ecology within the tallgrass prairie ecosystem.

The findings of my study illustrate that pronghorn fawns within the tallgrass prairie ecosystem can survive at rates comparable to other pronghorn ranges. The probable causes of relatively high mortality rates due to depredation that I found in Chase County, Kansas are similar to those of other pronghorn ranges. This indicates that a successful restoration effort can occur in Chase County, Kansas given the tremendous increase in pronghorn numbers since the 1920's (Yoakum 1986). However, factors such as habitat suitability and current rangeland practices in tallgrass prairie and their effect on carrying capacity need to be understood before proper management guidelines for pronghorn in tallgrass prairie can be written.

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APPENDICES

Appendix A. Characteristics of pronghorn fawns captured on Rogler, Cattle Pens, and Phenis Creek areas, 1991 and 1992.

Fawn No.	Capture Date	Age (Days)	Sex	Twin No.	Weight (kg)
		-Rogler, 1991-			
001	29 May	1	♂	002	3.5
002	29 May	1	♂	001	4.2
003	4 June	<1	♀	004	3.5
004	4 June	<1	♂	003	4.0
005	6 June	1	♀	---	4.4
006	9 June	1	♂	007	3.6
007	9 June	1	♀	006	4.0
011	13 June	1	♂	012	2.9
012	13 June	1	♀	011	2.8
		-Cattle Pens, 1991-			
008	11 June	5	♀	---	3.9
009	12 June	3	♀	[a]	4.1
010	12 June	4	♀	---	4.8
		-Rogler, 1992-			
001	19 May	2	♀	---	4.1
017	7 June	8	♂	[a]	5.8
018	8 June	<1	♀	019	3.4
019	8 June	<1	♀	018	4.9
020	8 June	3	♂	028	3.3

Appendix A (continued)

021	8 June	<1	♀	[a]	3.6
023	9 June	3	♀	024	4.2
024	9 June	3	♂	023	4.6
027	11 June	2	♂	---	3.5
028	12 June	7	♀	020	4.9
030	16 June	12	♀	031	6.0
031	16 June	12	♂	030	6.4
032	17 June	3	♀	033	4.5
033	17 June	3	♀	032	4.4
		-Cattle Pens, 1992-			
002	25 May	2	♂	---	4.0
003	28 May	<1	♂	004	4.0
004	28 May	<1	♀	003	4.1
005	29 May	2	♂	006	4.5
006	29 May	2	♂	005	4.4
007	29 May	4	♂	---	4.9
008	30 May	2	♂	---	3.9
009	1 June	<1	♀	010	4.0
010	1 June	<1	♂	009	4.1
016	6 June	2	♂	---	4.2
022	5 June	5	♀	[a]	5.1
		-Phenis Creek, 1992-			
011	3 June	4	♂	---	4.8
012	4 June	3	♀	013	4.2
013	5 June	4	♀	012	4.9

Appendix A (continued)

014	5 June	4	♀	015	5.5
015	5 June	4	♀	014	4.6
025	9 June	3	♀	---	3.5
026	11 June	7	♂	---	4.3
029	12 June	6	♂	---	3.6
034	20 June	10	♂	---	5.3

[a] Twin unmarked

Appendix B. Fates of pronghorn fawns captured in Chase County Kansas, 1991 and 1992.

Fawn No.	Days Surviving	Cause of Death	Remains
		-1991-	
001	17	Coyote involved	Transmitter, bone fragments
002	11	Coyote involved	Transmitter, bone fragments
003	28	Coyote involved	Transmitter, bone fragments
004	90+	Alive on 31 August	
005	19	Disease related	Whole carcass
006	16	Coyote involved	Transmitter, bone fragments
007	90+	Alive on 31 August	
008	13	Coyote	Head, neck, forelegs
009	90+	Alive on 31 August	
010	4+	Unknown	
011	90+	Alive on 31 August	
012	90+	Alive on 31 August	

Appendix B. (continued)

-1992-

001	8	Coyote	Transmitter, bone fragments
002	10	Coyote involved	Transmitter
003	2	Abandon	Whole carcass
004	30	Coyote involved	Transmitter
005	16	Coyote	Head, neck, foreleg
006	10	Coyote involved	Transmitter, bone fragments
007	90+	Alive 31 August	
008	6	Abandon	Whole carcass
009	53	Unknown	
010	11	Coyote involved	Transmitter, bone fragments
011	34	Coyote involved	Transmitter
012	30	Coyote involved	Transmitter
013	90+	Alive 31 August	
014	26	Unknown	
015	16	Coyote involved	Transmitter

Appendix B (Continued)

016	44	Coyote involved	Transmitter, bone fragments
017	41	Coyote involved	Transmitter
018	23	Coyote involved	Transmitter, bone fragments
019	14	Coyote involved	Transmitter
020	63	Unknown	
021	26	Coyote	Transmitter, bone fragments
022	19	Coyote	Head, neck, forelegs
023	24	Coyote involved	Transmitter, bone fragments
024	24-40	Unknown	
025	90+	Alive 31 August	
026	10	Unknown	
027	6	Abandon	Whole carcass
028	16	Coyote involved	Transmitter
029	6+	Unknown	
030	24	Coyote involved	Transmitter, bone fragments
031	32	Coyote	Partially consumed carcass

Appendix B (Continued)

032	26	Coyote involved	Transmitter
033	35	Unknown	
034	10+	Unknown	

Signature of Graduate Student

Signature of Major Advisor

I, Shannon L. Rothchild, hereby submit this thesis to Emporia State University as partial fulfillment of the requirements of an advanced degree. I agree that the Library of the University may make it available for use in accordance with its regulations governing materials of this type. I further agree that quoting, photocopying, or other reproduction of this document is allowed for private study, scholarship (including teaching), and research purposes of a nonprofit nature. No copying which involves potential financial gain will be allowed without written permission of the author.

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Mortality, Home Range, and Habitat Use of Pronghorn Fawns within Tallgrass Prairie of Eastern Kansas

Title of Thesis

Signature of Graduate Office Staff Member

April 29, 1993

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