Coyote-prey relationships on the National Bison Range

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COYOTE-PREY RELATIONSHIPS ON THE
NATIONAL BISON RANGE

By
James D. Reichel
B.S., University of Wisconsin - Stevens Point, 1972

Presented in partial fulfillment of the requirements for the degree of
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Dean, Graduate School

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ABSTRACT

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This study, conducted from July 1974 through July 1975, used analysis of scats to determine coyote (Canis latrans) diets on the National Bison Range, Moiese, Montana. Microtus spp. were the most important food source throughout the year. During spring and early summer, native ungulate fawns were important; during late summer and early fall, insects, seeds, and berries; during winter, cattle (Bos taurus) as carrion.

Scent station lines, run monthly during summer and fall, were an effective method for monitoring the coyote population, which increased from about 20 to 29 during the study period. Results of Microtus trapping in four habitats and observations of hunting by coyotes showed that coyotes selected habitats with greater Microtus populations. Peromyscus maniculatus were trapped far more frequently than Microtus which are apparently more vulnerable to coyotes.

Proximity of coyote dens correlated with pronghorn (Antilocapra americana) fawn mortality. Eight of 19 radioed fawns died within 2.5 weeks of birth. Cause of death was determined for seven fawns; five deaths involved coyotes and two were attributed to weak calf syndrome. Fawns selecting bedding sites in habitats least hunted by coyotes had the highest survival rate.

Deer (Odocoileus spp.), pronghorns, and bighorn sheep (Ovis canadensis) were more available as food sources to coyotes than bison (Bison bison) and elk (Cervus elaphus).
ACKNOWLEDGEMENTS

I would like to thank my committee members, Drs. Bart O'Gara, Lee Metzgar, and Mark Behan. Dr. O'Gara, major advisor for this project, gave much time, assistance, and guidance throughout the study, and a critical review of the manuscript. Dr. Metzgar gave helpful suggestions for evaluating small rodent populations.

The National Bison Range provided lodging at the study site, and I appreciate the cooperation and encouragement offered by Marv Kaschke and Milt Haderlie.

The Denver Wildlife Research Center provided all radio-telemetry equipment and materials used on the scent station line. Erwin "Bud" Pearson spent a week helping me with the telemetry equipment and radiotracking, for which I am very grateful.

Thanks go to Skip Scaggs, my field assistant, for a lot of hard work. Funds for the assistant were given by the University of Montana Foundation and Hoffman-LaRoche, Inc. Numerous others aided in the field work and I appreciate their help.

Financial support for this project came from the Montana Cooperative Wildlife Research Unit (U.S. Fish and Wildlife Service, University of Montana, Montana Fish and Game Department, and
Wildlife Management Institute cooperating).

My parents have given me a great interest in wildlife and a love of the outdoors; for this, among many things, I will always be grateful.

Finally, I would like to thank my wife, Dianne, who helped with field work and, more importantly, gave much needed assistance in preparing this manuscript.
TABLE OF CONTENTS

ABSTRACT ........................................................................................................ ii
ACKNOWLEDGEMENTS ................................................................................ iii
LIST OF TABLES ........................................................................................... vii
LIST OF FIGURES ........................................................................................ viii

CHAPTER

I. INTRODUCTION ....................................................................................... 1
II. STUDY AREA ........................................................................................... 5
III. METHODS AND MATERIALS ............................................................... 8
    Coyotes ................................................................................................. 8
    Scats ..................................................................................................... 8
    Methods of Hunting .............................................................................. 9
    Populations .......................................................................................... 9
    Habitat Situations ............................................................................... 11
    Mouse Populations .............................................................................. 11
    Pronghorn Fawn Mortality ................................................................. 13
    Statistical Procedures ......................................................................... 18
IV. RESULTS ............................................................................................... 21
    Coyotes ............................................................................................... 21
    Diet ...................................................................................................... 21
    Observations ....................................................................................... 31
    Populations .......................................................................................... 32
    Mouse Populations .............................................................................. 35
    Pronghorn Populations and Observations ............................................ 42
    Presence of Other Food Items ............................................................. 48
    Populations of Prey Species vs. Proportion in Diet (c) ......................... 49
    Radio Equipment ................................................................................ 51

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V. DISCUSSION

1. Coyote Population
2. Food Habits
3. Analysis
4. Prey Items
5. Rodents
   a. In diet
   b. Mouse populations
   c. Habitat relationships
6. Lagomorphs
7. Birds
8. Insects
9. Fruits and Seeds
10. Cattle
11. Domestic Sheep
12. Bison
13. Elk
14. Bighorn Sheep
15. Deer
16. Pronghorns
   a. In coyote diet
   b. Habitat relationships
   c. Fawn mortality

VI. SUMMARY
74

REFERENCES CITED
77

APPENDIX

A. DATUM SHEETS USED IN THE STUDY
83

B. TOTAL POPULATION, YOUNG:100 FEMALES
   RATIO, AND HARVEST FOR UNGULATES ON
   THE RANGE
88
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Percent frequency of occurrence of items found in 940 coyote scats collected on the National Bison Range</td>
<td>22</td>
</tr>
<tr>
<td>2.</td>
<td>Comparison of percent frequency of occurrence of ungulates and <em>Microtus</em> in scats between identical periods in 1972-73 and 1974-75 using a $X^2$ test of independence</td>
<td>25</td>
</tr>
<tr>
<td>3.</td>
<td>Comparison of percent frequency of occurrence of ungulates and <em>Microtus</em> in scats between identical periods in 1973-74 and 1974-75 using a $X^2$ test of independence</td>
<td>25</td>
</tr>
<tr>
<td>4.</td>
<td>Habitat used by hunting coyotes compared to habitat available to them (z-test)</td>
<td>32</td>
</tr>
<tr>
<td>5.</td>
<td>Mouse captures per 1,000 trap nights for each habitat</td>
<td>42</td>
</tr>
<tr>
<td>6.</td>
<td>Numbers of adult pronghorn does and fawns, and fawn mortality rates, in 1974 and 1975</td>
<td>43</td>
</tr>
<tr>
<td>7.</td>
<td>Numbers and locations of pronghorn fawns and pregnant does, and fawn mortality rates, in 1975</td>
<td>44</td>
</tr>
<tr>
<td>8.</td>
<td>Age at death and cause of death for radioed pronghorn fawns</td>
<td>45</td>
</tr>
<tr>
<td>9.</td>
<td>Habitat used by pronghorn fawns compared to habitat available to them (z-test)</td>
<td>47</td>
</tr>
<tr>
<td>10.</td>
<td>Available pronghorn habitat, in percent, in each doe-fawn herd's home range</td>
<td>48</td>
</tr>
<tr>
<td>11.</td>
<td>Comparison of selected prey species to determine c values</td>
<td>50</td>
</tr>
</tbody>
</table>
LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Map of the National Bison Range.</td>
<td>6</td>
</tr>
<tr>
<td>2. Locations of the North Area (shaded) and standard scent station line (heavy black line) on the National Bison Range.</td>
<td>10</td>
</tr>
<tr>
<td>3. Distribution of habitat types on the North Area and on doe herds' home ranges on the National Bison Range.</td>
<td>12</td>
</tr>
<tr>
<td>4. Home ranges of doe herds on the National Bison Range.</td>
<td>15</td>
</tr>
<tr>
<td>5. Position of transmitter on pronghorn fawn</td>
<td>17</td>
</tr>
<tr>
<td>6. Percent frequency of occurrence of major food categories in 593 coyote scats.</td>
<td>23</td>
</tr>
<tr>
<td>7. Percent frequency of occurrence of rodents in 593 coyote scats</td>
<td>24</td>
</tr>
<tr>
<td>8. Percent frequency of occurrence of Microtus in 706 coyote scats deposited during fall, winter, and spring</td>
<td>26</td>
</tr>
<tr>
<td>9. Percent frequency of occurrence of ungulates in 593 coyote scats</td>
<td>28</td>
</tr>
<tr>
<td>10. Percent frequency of occurrence of native ungulates in 593 coyote scats</td>
<td>29</td>
</tr>
<tr>
<td>11. Percent frequency of occurrence of ungulates in 706 coyote scats deposited during fall, winter, and spring</td>
<td>30</td>
</tr>
</tbody>
</table>
12. Location of dens or den areas in 1974 on the National Bison Range ........................................ 33
13. Location of dens or den areas in 1975 on the National Bison Range ........................................ 34
14. Index of coyote population as determined by scent station line ............................................. 36
15. Microtine abundance on the Range from 1959-70 and 1973-75 .................................................. 37
17. Number of rodents trapped in 208 snap traps set for four nights at approximately monthly intervals . . 40
18. Fall coyote population estimates from 1959 through 1975 ....................................................... 53
CHAPTER I

INTRODUCTION

Predator-prey relationships have long been controversial topics. The coyote, in particular, has been the subject of heated discussions. Zoologists, wildlife biologists, government trappers, farmers, ranchers, and environmentalists have widely diverse opinions concerning food habits of the coyote. Some say he is a wanton killer of stock and big game while others are convinced he takes nothing but the sick, weak, or aged animals. Still others maintain he gets stock and big game only as carrion, asserting that his primary food is cottontails (Sylvilagus spp.) or jackrabbits (Lepus spp.), microtines (Microtus spp.), or gophers (Thomomys spp.).

Through all these contentions run threads of truth and a review of the literature reveals the coyote to be an extremely adaptable creature.

The conflict between man and coyote is an enduring and serious problem. One of the early Biological Survey publications (Lantz 1905) dealt with economic considerations involving the coyote. Since that time, many other people have investigated coyote food habits. Most researchers only analyzed scat and/or stomach contents with little or no regard for other factors involved. Some studies
involved large geographical areas (Dixon 1925, Sperry 1941, Murie 1945, Ferrel et al. 1953, Gipson 1974) while others were restricted to portions of states, parks, or refuges (Murie 1935, Bond 1939, Murie 1940, Fitch 1948, Murie 1951, Hawthorne 1972, Hamilton 1974). Still other studies concerned specific seasons (Sperry 1933, 1934) and pegleg coyotes (Sperry 1939).

Since the mid-1950's, some researchers have attempted to relate scat and/or stomach analyses to behavior patterns of coyotes (Ozoga and Harger 1966), predator density (Clark 1972), and habitat (Fichter et al. 1955, Ozoga and Harger 1966). All of the above factors, with the addition of prey behavior and prey density (Gier 1957, Korschgen 1957, Clark 1972), must affect predator-prey interactions. This information is essential to predict the effect of coyotes on prey, both wild and domestic.

Many studies concentrated on effects of predation on big game animals (Robinson 1952), especially mule deer (Horn 1941, Salwasser 1974) and white-tailed deer (Aiton 1938, Knowlton 1964, Cook et al. 1971, Ogle 1971). Whether the coyote affects pronghorn populations has been a continuing controversy. Many researchers considered this problem (Riter 1941, Buechner 1950a and 1950b, Arrington and Edwards 1951, Udy 1953, Yoakum 1957, Compton 1958, Beale and Smith 1970, Larson 1970), but little concrete data were found before a study by Beale and Smith in 1973. They found that
bobcat (*Lynx rufus*) predation was the most important cause of fawn loss and the greatest single decimating factor affecting net productivity.

Personnel of the National Bison Range attempted to regulate the coyote population through 1962, although poisoning was discontinued on the Range in 1956. It is possible that coyotes were occasionally shot during the ungulate removal program which lasted until 1971. Apparently, the coyote population remained low until 1970 when it began increasing; it peaked in 1973. The mortality rate of pronghorn fawns between 1962 and 1970 reached a high of 32 percent. In 1970, the mortality rate jumped to 66 percent and was 62 percent in 1971. In 1973, the mortality rate rose to 80 percent (Anonymous 1956-75). These data were based on censuses by Range personnel. The number of surviving fawns was probably accurate, but the number of fawns born was underestimated until at least 1970. The number of fawns born was estimated from only the number of fawns seen in early summer. The number of does was not taken into account. The rise in the coyote population and in pronghorn fawn mortality aroused questions by Range personnel concerning both food habits of the coyotes on the Range and the cause of the high mortality rate among the pronghorn fawns.

My study took place on the National Bison Range from July 1974 through July 1975. Specific objectives were to:
1) determine density of coyotes on the National Bison Range;
2) determine relative densities of prey species in the area
   not predominated by coniferous forests;
3) relate coyote food habits to density and availability of
   prey species;
4) relate hunting techniques to prey species sought;
5) evaluate the standard scent-post census technique, run
   at different times of the year, in an area with known
   numbers of coyotes; and
6) examine causes and degree of pronghorn fawn mortality.
CHAPTER II

STUDY AREA

The National Bison Range (Fig. 1) is located near the southern end of the Flathead Valley, in Lake and Sanders counties, Montana. Encompassing more than 7,700 ha, it is completely enclosed, restricting big game movements, and divided into pastures to control bison movements. Other species move with relative freedom between pastures. Elevations range from 696 m to 1,361 m, and much of the southern half of the area is composed of small, rugged rocky canyons. The majority of the observational work was conducted on the northern half of the Range where grasslands predominate and low ridges separate small basins.

Big game animals present include bison, elk, white-tailed deer, mule deer, mountain goats (Oreamnus americanus), bighorn sheep, and pronghorns. No cattle are grazed on the Range.

Climate on the Range is generally mild. Winter temperatures seldom fall below -20°C and there is little wind. Snow cover melts quickly at lower elevations. In summer, temperature rarely exceeds 38°C. Average annual precipitation is 32 cm (Anonymous undated).
Fig. 1. Map of the National Bison Range.
The Bison Range is primarily Palouse prairie, typified by bluebunch wheatgrass (*Agropyron spicatum*), Idaho fescue (*Festuca idahocensis*), and rough fescue (*F. scabrella*). The major forb species include balsamroot (*Balsamorrhiza sagittata*) and aster (*Aster falcatus*). Swales and drainage courses contain snowberry (*Symphoricarpos occidentalis*), hawthorne (*Crataegus douglasii*), and wild rose (*Rosa* spp.). Major tree species are Douglas-fir (*Pseudotsuga menzesii*) and ponderosa pine (*Pinus ponderosa*) in park-like stands mostly at higher elevations and juniper (*Juniperus scopulorum*) along Mission Creek. Rocky out-crops and stony areas support scattered stands of chokecherry (*Prunus demissa*), serviceberry (*Amelanchier alnifolia*), and mockorange (*Philadelphus lewisii*) (Morris and Schwartz 1957, Anonymous 1967, Kitchen 1974).
CHAPTER III

METHODS AND MATERIALS

Coyotes

Scats

At the beginning of the study, roads were cleared of old scats. Thus, scats were deposited during a known time period. During May, June, and July, scats were gathered biweekly. Collections from July 1975 were combined because few scats were located that month. All other scats were collected at monthly intervals. Data from January and February were lumped because snow conditions made separation of scats from those months impossible in many cases. All scats considered to be one defecation were placed in a small paper envelope on which time period and location were recorded. Red foxes (Vulpes vulpes) and bobcats were the only animals on the Range whose scats could be mistaken for those of coyotes. Since foxes and bobcats were rare there, discrimination between scats was not a problem.

In the laboratory, scats were soaked in quart jars filled with water, then washed over screening to remove the fecal matrix from identifiable remains. The scats were then air dried.

Mice were identified to genus, and sometimes species, using
tooth and jaw characteristics (Hoffman and Pattie 1968). Hair of other mammals was identified by comparison to a collection of locally procured specimens using standard identification techniques (Moore et al. 1974) with binocular and compound microscopes when necessary. Percent frequency was calculated for all diet remains.

**Methods of Hunting**

Data concerning methods of hunting were recorded on a standard datum sheet (Appendix A). During the last half of the study, I used a portable tape recorder in the field and later transferred the data to standard forms.

Coyotes were usually observed from a vehicle or from a position on a ridge or hill with 7x binoculars or a 15-60x variable power spotting scope. Coyotes seen hunting were watched until they went out of sight or ceased hunting, or until darkness made further observations impossible. Ninety-five percent of hunting observations occurred in the North Area (Fig. 2).

**Populations**

Two methods were used to estimate coyote populations on the Range. The first method was direct count through observations of coyotes which were recognized as individuals by pelage variations. Drawings and/or descriptions of individuals, and den locations during spring and summer, were recorded. I determined the numbers of
Fig. 2. Locations of the North Area (shaded) and standard scent station line (heavy black line) on the National Bison Range.
pups through observations at dens. This method gives either an underestimate or the exact number of coyotes.

The second method, the standard scent station line, was used as an index to the coyote population (Linhart and Knowlton 1975). The route was run monthly, weather permitting, and had a gap in it of 0.6 km (Fig. 2). The Denver Wildlife Research Laboratory provided materials identical to those used in the annual western predator survey of the U.S. Fish and Wildlife Service.

Habitat Situations

The following five habitat situations were distinguished for this study: GB was open grassland basin areas; BW was brushy dry washes and swales both in basins and on slopes; GS was open grassland slopes; and R was riparian areas along Mission Creek (Fig. 3). The final habitat, upland coniferous areas, was not trapped for mice and other animals could not be observed in it; therefore, it was not considered when comparing animal use in a given habitat to available habitat. To determine percent of area covered by the various habitat situations, a planimeter was used in conjunction with aerial photographs.

Mouse Populations

Mouse populations were sampled using snap traps. Thirteen numbered stations, set at least 0.3 km apart to minimize affect on
Fig. 3. Distribution of habitat types on the North Area and on doe herds' home ranges on the National Bison Range.
each other, were randomly placed in each of four habitats (GB, BW, GS, and R) during each trapping period.

Each station consisted of a stake for location and four snap traps baited with a mixture of peanut butter and oatmeal. The traps were placed within 0.9 m of the stake in positions to maximize effectiveness. Traps were prebaited for 2 days, then set for 4 days. Traps were checked daily and reset, rebaited, or replaced as needed. Condition of traps and number and genus of mice caught were recorded. Mice were placed in envelopes labeled with station number and date. In the laboratory, species and other pertinent data were recorded on a datum sheet (Appendix A). Trapping was done monthly, weather permitting. During January and February, a minimum number of mice for each month was extrapolated from 1 day's data because weather conditions made checking traps impossible. This was done by letting the number of mice trapped on the first day equal 42 percent of the total extrapolated figure. During other months, the first day's trapping accounted for 12 to 42 percent of the total catch.

Pronghorn Fawn Mortality

Observers on ridges overlooking Alexander Basin, the Amphitheater, and Gut Coulee used spotting scopes and binoculars to locate pronghorn fawns (Fig. 1). A pregnant doe indicated impending parturition by raising her tail, self-licking of belly and flank areas,
humping her back, and frequent alternations of standing and lying. Postparturient does were watched until they nursed their fawns.

When a fawn was spotted, an observer remained on the ridge while I went down to make the capture. The observer gave me directions to the fawn via walkie-talkie. Fawns were not handled until at least 3 hours after birth to allow mother-young imprinting to take place (Autenrieth and Fichter 1975). Fawns less than 1 day old were easily caught by hand, while older fawns often required the use of a salmon net 0.8 m in diameter with a 1.8 m handle.

Fawns were blindfolded immediately upon capture to quiet them. Data were recorded on a datum sheet (Appendix A). Fawns were marked for permanent identification with colored and numbered ear tags. Colors indicated area of capture and sex, numbers indicated individuals. Each fawn belonging to the Alexander Basin and Northside doe herds (Fig. 4) was outfitted with a miniature 30 MHz radio transmitter (Corner and Pearson 1972) and a 1.2 V, 640T2 mercury battery with a 500-mA·h rating. The Denver Wildlife Research Laboratory provided the antenna, transmitters, and receivers. Each transmitter package was attached to two pieces of 1.27 cm rayon elastic, one around the fawn's neck, the other around the fawn's chest just behind the front legs. Two staples fastened the ends of the elastic securing the package to the fawn. Hopefully, the staples would come out as the fawn grew and the elastic stretched,
Fig. 4. Home ranges of doe herds on the National Bison Range (Kitchen 1974:49).
allowing recovery of the transmitter. After the transmitter was placed between the base of the neck and the shoulder blades (Fig. 5), a dab of cattle-back-tag cement on the fawn's hair under the transmitter kept it from shifting position. The fawn was then returned to its bedding site.

I attempted to locate all radio-collared fawns daily, using a Johnson Messenger 350/DF, 30 MHz receiver with a 15 V battery and a hand-held loop antenna. Areas were covered first by car, as well as possible, and then on foot or horseback. Data recorded for all live fawns included date and time sighted, location, activity, condition, response to observers, habitat of bedding sites, distance between twins, and slope aspect on which each fawn was found. Forty bedding sites and four birth sites were photographed. Dead fawns were examined, photographed, and collected with notations on date, time, slope aspect, location, and habitat. Predator species on the Range have characteristic patterns of attacking and feeding on prey species. These patterns, as described by Giles (1971) and Henne (1975), were used to determine what predator had fed on or killed a fawn. If a coyote had killed or fed on a fawn, cause of death was classified as "coyote involved."

This phase of the study continued until the batteries in the transmitters became too weak to give an adequate signal. The number of fawns surviving until August was determined using binoculars and
Fig. 5. Position of transmitter on pronghorn fawn.
spotting scopes. During August, the entire Range was censused on several consecutive days for continuous 6- to 8-hour periods to eliminate counting the same fawn more than once.

The number of pregnant pronghorn does was found by using binoculars and spotting scopes. During early May, the entire Range was censused several times in continuous 6-hour periods to eliminate counting the same animal more than once. Since over 95 percent of does on the Range have twins (O'Gara 1968), the number of fawns born was estimated by doubling the number of adult does (in 1974) or pregnant does (in 1975).

Statistical Procedures

Percent frequency of a particular prey item is the percentage of scats in a time period that contains that prey item.

An index of relative abundance of coyotes was calculated as follows:

\[
\frac{\text{Total coyote visits}}{\text{Total operative station nights}} \times 1,000
\]

(Linhart and Knowlton 1975).

The z-test of significance of a binomial proportion (Neu et al. 1974) was used to test whether habitat types were used significantly more or less by coyotes and antelope fawns than the availability of those habitats. The following convention was used in reporting significance between comparisons: NSD means no significant
difference, $p > 0.05$; + or - indicates animal use was significantly greater or less than available, $p \leq 0.05$; ++ or -- indicates use was significantly greater or less than available, $p \leq 0.01$. The entire North Area was considered available to coyotes. The home range of the doe herd was considered available to the fawns in that herd.

The $X^2$ goodness of fit test and test of independence (Snedecor and Cochran 1967) were used throughout the results.

In a predator's diet the proportion of a prey item is dependent on the population of the prey and its availability to the predator. The proportionality constant $c$ reflects two basic properties of predator-prey interactions: 1) the behavior of the prey, which makes it more or less "available"; and 2) the behavior of the predator, i.e., its "preference" for a prey species. It is calculated from the equation

$$\frac{N_1}{N_2} c = \frac{P_1}{P_2}$$

where: $N_1 =$ total population of the first prey species;

$N_2 =$ total population of the second prey species;

$P_1 =$ proportion of the diet constituted by the first prey species; and

$P_2 =$ proportion of the diet constituted by the second prey species (Murdoch 1969).
Within this paper, when it is stated, "Species A has a c value of ( ) when compared to species B," \( N_1 \) and \( P_1 \) will be indicated by species A.
CHAPTER IV

RESULTS

Coyotes

Diet

Analyses of 593 coyote scats collected during my study and 347 collected prior to it (Vivion 1973, Hallsten 1974, Smith 1974) are shown in Table 1. Rodents were the most important food items in the coyotes' diet (Fig. 6); Microtus spp. were the most important rodents (Fig. 7). ("Importance," within this paper, refers to frequency of occurrence regarding scat analysis and/or volume regarding analysis of stomach contents. This definition should be distinguished from "ecological importance.") Rodents were more important during the winter than during the summer. Microtus were used significantly less during 1974-75 than during the same periods in 1972-73 (Table 2, Fig. 8) and 1973-74 (Table 3, Fig. 8). Percent frequency of occurrence of Microtus during July 1974 was lower than during July 1975. $X^2$ tests comparing percent frequency were run using a 2 x 2 contingency table with presence or absence of the item in scats on one axis and time periods considered on the other axis.
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<tr>
<td><strong>RODENTS</strong></td>
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<td>7.1</td>
<td>5.8</td>
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<td>75.0</td>
<td>66.0</td>
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<td>3.5</td>
<td>7.3</td>
<td>4.8</td>
<td>8.0</td>
<td>10.6</td>
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</tr>
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<td>Golden-mantled ground squirrel</td>
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<td>1.4</td>
<td>0.6</td>
<td>2.0</td>
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<td>1.1</td>
<td>3.3</td>
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<tr>
<td>Columbian ground squirrel</td>
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<td>1.4</td>
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</tr>
<tr>
<td>Sprague's ground squirrel</td>
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<td>White-tailed deer</td>
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<td>Mule deer</td>
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</tr>
<tr>
<td>Dry-meadow mouse (Microtus ochrogaster)</td>
<td>0.6</td>
<td>1.4</td>
<td>0.6</td>
<td>2.0</td>
<td>0.6</td>
<td>1.1</td>
<td>1.1</td>
<td>3.3</td>
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</tr>
<tr>
<td>Yellow-bellied marmot</td>
<td>0.6</td>
<td>1.4</td>
<td>0.6</td>
<td>2.0</td>
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<tr>
<td>Least shrew (Blarina brevicauda)</td>
<td>0.6</td>
<td>1.4</td>
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<td>2.0</td>
<td>0.6</td>
<td>1.1</td>
<td>1.1</td>
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</tr>
<tr>
<td>Fisher (Martes pennanti)</td>
<td>0.6</td>
<td>1.4</td>
<td>0.6</td>
<td>2.0</td>
<td>0.6</td>
<td>1.1</td>
<td>1.1</td>
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</tbody>
</table>
Fig. 7. Percent frequency of occurrence of rodents in 593 coyote scats.
Fig. 6. Percent frequency of occurrence of major food categories in 593 coyote scats.
Table 2. Comparison of percent frequency of occurrence of ungulates and *Microtus* in scats between identical periods in 1972-73 and 1974-75 using a $X^2$ test of independence.

<table>
<thead>
<tr>
<th>Food item</th>
<th>Time period</th>
<th>% Frequency occurrence</th>
<th>$X^2$</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Microtus</em> spp.</td>
<td>Oct. '72-Apr. '73</td>
<td>85.0</td>
<td>15.49</td>
<td>$p &lt; 0.01$</td>
</tr>
<tr>
<td></td>
<td>Oct. '74-Apr. '75</td>
<td>69.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native ungulate</td>
<td>Oct. '72-Apr. '73</td>
<td>4.4</td>
<td>18.98</td>
<td>$p &lt; 0.01$</td>
</tr>
<tr>
<td></td>
<td>Oct. '74-Apr. '75</td>
<td>17.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic ungulate</td>
<td>Oct. '72-Apr. '73</td>
<td>3.1</td>
<td>16.99</td>
<td>$p &lt; 0.01$</td>
</tr>
<tr>
<td></td>
<td>Oct. '74-Apr. '75</td>
<td>14.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Table 3. Comparison of percent frequency of occurrence of ungulates and *Microtus* in scats between identical periods in 1973-74 and 1974-75 using a $X^2$ test of independence.

<table>
<thead>
<tr>
<th>Food item</th>
<th>Time period</th>
<th>% Frequency occurrence</th>
<th>$X^2$</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Microtus</em> spp.</td>
<td>Sep. '73-15 May '74</td>
<td>75.8</td>
<td>4.60</td>
<td>$p &lt; 0.05$</td>
</tr>
<tr>
<td></td>
<td>Sep. '74-15 May '75</td>
<td>65.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native ungulate</td>
<td>Sep. '73-15 May '74</td>
<td>6.7</td>
<td>9.66</td>
<td>$p &lt; 0.01$</td>
</tr>
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<td></td>
<td>Sep. '74-15 May '75</td>
<td>19.2</td>
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<tr>
<td>Domestic ungulate</td>
<td>Sep. '73-15 May '74</td>
<td>14.4</td>
<td>17.87</td>
<td>$p &lt; 0.01$</td>
</tr>
<tr>
<td></td>
<td>Sep. '74-15 May '75</td>
<td>0.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 8. Percent frequency of occurrence of *Microtus* in 706 coyote scats deposited during fall, winter, and spring. Data for 1972-73 and 1973-74 are from Vivion (1973), Hallsten (1974), and Smith (1974). Time blocks in the 1972-73 period end at 19 Jan. and 2 April, respectively. Time blocks in the 1973-74 period end at 30 Nov., mid-March, and mid-May, respectively. Time blocks in the 1974-75 period end at 31 Dec., 31 March, and 15 May, respectively.
Insects, fruits, and seeds were important during the late summer and early fall (Fig. 6). Birds and birds' eggs were most important during spring and summer (Fig. 6).

Cattle were a sporadically important food item in the diet of coyotes on the Range. In November and from January through April, only rodents were more important (Fig. 9). Occasionally, the rancher to the immediate north of the Range dumped cattle carcasses along the north boundary fence, and these were a major food source for the coyotes. However, cattle were a very minor item (1.2 percent frequency) in the coyotes' diet during the two preceding winters on the Range (Vivion 1973, Hallsten 1974, Smith 1974). These easily available food sources during the winter of 1974-75 may explain why coyotes used significantly less Microtus than during the winters of 1972-73 and 1973-74 (Tables 2 and 3).

Native ungulates were most important during early summer (Fig. 9). Pronghorn reached a peak of importance before deer, which were the most important native ungulates (Fig. 10). Other native ungulates were used sporadically throughout the year (Table 1). Both native and domestic ungulates were used significantly more in 1974-75 than during the same period in 1972-73 (Table 2, Fig. 11) or 1973-74 (Table 3, Fig. 11).
Fig. 9. Percent frequency of occurrence of ungulates in 593 coyote scats.
Fig. 10. Percent frequency of occurrence of native ungulates in 593 coyote scats.
Fig. 11. Percent frequency of occurrence of ungulates in 706 coyote scats deposited during fall, winter, and spring. Data for 1972-73 and 1973-74 are from Vivion (1973), Hallsten (1974), and Smith (1974). Time blocks in the 1972-73 period end at 19 Jan. and 2 April, respectively. Time blocks in the 1973-74 period end at 30 Nov., mid-March, and mid-May, respectively. Time blocks in the 1974-75 period end at 31 Dec., 31 March, and 15 May, respectively.
Observations

I observed coyotes on 173 occasions for a total of 8,115 minutes. Coyotes hunted during 64 of those observations for a total of 842 minutes, and 98 percent of the hunting observations occurred in the North Area.

The number of minutes coyotes were seen hunting in each habitat in the North Area and the correlation of hunting with available habitat (z-test) are shown in Table 4. Coyotes did not hunt in habitat types in relation to their availability ($X^2 = 1,403., p < 0.001$, 3 df). Coyotes were observed with greater difficulty in Habitats R and BW than in Habitats GB and GS because trees and brush obscured my vision. If this difficulty could be incorporated into the data in Table 4, it would increase the differences already present. Differences between May-September and October-April hunting locations were significant ($X^2 = 264., p < 0.01$, 3 df).

Coyotes were only seen killing small rodents, so behavioral differences between hunting small and large prey could not be compared. Observations were also made on coyotes eating fruit and grasshoppers.
Table 4. Habitat used by hunting coyotes compared to habitat available to them (z-test).

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Availability %</th>
<th>May-Sept. % use</th>
<th>Oct.-April % use</th>
<th>Year % use</th>
</tr>
</thead>
<tbody>
<tr>
<td>GB</td>
<td>41</td>
<td>35</td>
<td>31</td>
<td>32</td>
</tr>
<tr>
<td>BW</td>
<td>2</td>
<td>5</td>
<td>11</td>
<td>8</td>
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<tr>
<td>GS</td>
<td>51</td>
<td>3</td>
<td>44</td>
<td>25</td>
</tr>
<tr>
<td>R</td>
<td>6</td>
<td>57</td>
<td>14</td>
<td>34</td>
</tr>
</tbody>
</table>

*+ or - = p ≤ 0.05.

++ or -- = p ≤ 0.01.

Populations

The adult and yearling coyote population living primarily on the Range during the summer of 1974 consisted of four mated pairs and one apparently unmated male. A fifth pair had a den on the Range just prior to this study, but moved the den off the Range to the west about mid-June. Number of pups in this family was unknown. Numbers of pups in three litters on the Range were four, three, and one, with approximately three to five pups in the last litter, making the total Range population 20 to 22 in late summer 1974. Locations of dens or denning areas are shown in Figs. 12 and 13.

During fall and winter, most of the pups ceased to frequent the Range, and by spring only three remained. Two of these were in
Fig. 12. Location of dens (circles) or den areas (shaded) in 1974 on the National Bison Range. Arrows indicate movement of a family from one area to another.
Fig. 13. Location of dens (circles) or den areas (shaded) in 1975 on the National Bison Range. Arrows indicate movement of a family from one area to another.
the North Area and were often seen with their parents.

During spring and summer of 1975, five mated pairs and three unmated yearlings were on the Range. Three of the litter sizes were eight, four, and four (same pairs having four, three, and one, respectively, in 1974). The other den sites were not found and sizes of the litters were unknown. Total Range population was estimated at over 29.

Coyote indices on the Range increased from July through October 1974. Between July 1974 and July 1975, the indices rose from 41 to 55, an increase of 34 percent (Fig. 14). This is comparable to an increase from 9 to 13, or 44 percent, in non-pup coyotes, found by observations. Scent stations were ineffective and/or impossible to run from November through April because of snow and freezing nighttime temperatures. During May and early June, the ground was too wet to set up stations. For these reasons, the scent stations were effective only during summer and fall.

Mouse Populations

Range personnel have recorded general observations on annual microtine populations for over 20 years. Fig. 15 shows relative abundance; abundance is given only in ratings of high, medium, and low, but the ratings are sufficient to indicate annual fluctuations.

Microtine populations have also been indexed annually from
Fig. 14. Index of coyote population as determined by scent station line.
Fig. 15. Microtine abundance on the Range from 1959-70 (Anonymous 1956-75). Estimates of 1974 and 1975 abundance are mine. Estimate for 1973 from M. Haderlie (personal communication).
from 1949 to 1962 and from 1964 to 1974 by P. L. Wright (unpublished data). Snap traps were placed in grid arrangements on, when possible, three separate study plots on the Range. Traps were set for one 24-hour period in the first half of July. Data are presented in Fig. 16 as probability of capture in a 24-hour trapping period. Prior to the mid-1960's, the study plots were not grazed; since then, they have been heavily grazed by horses and bison. This may be the cause of the less clear population variations from the mid-1960's and on (P. L. Wright, pers. comm.). Figs. 15 and 16 show the Microtus population at medium density during the winter of 1972-73, and at low density during the winters of 1973-74 and 1974-75. In winter 1974-75, Microtus density may have been higher than in winter 1973-74. Fig. 8 and Tables 2 and 3 show that Microtus were significantly more important in the coyotes' diet during both 1972-73 and 1973-74 than in 1974-75. Because Microtus density in 1973-74 was less than, or equal to, the 1974-75 density, the relationship between density of Microtus and use by coyotes is caused, at least partially, by other factors. However, even in years of low density, Microtus were still the most important item in the coyotes' diet on the Range. Numbers trapped of both Peromyscus maniculatus and Microtus spp. showed a general rising trend during the study period (Fig. 17). Significantly more mice were caught, both Microtus ($X^2 = 18.70, p < 0.01, 1 df$) and $P$. maniculatus ($X^2 = 26.47, p < 0.01, 1 df$), during the trapping.
Fig. 16. Microtine abundance on the Range from 1949-62 and 1964-74. Unpublished data of P. L. Wright. Trap success based on one 24-hour trap day. Open circles indicate rain during the trap period.
Fig. 17. Number of rodents trapped in 208 snap traps set for four nights at approximately monthly intervals. Data from January and February (circles) are extrapolated from 1 day's data.
period 24 to 27 June 1975 than during the period 8 to 11 July 1974. This apparently relates to the fact that more Microtus were in the coyotes' diet in July 1975 than in July 1974. The only trapping periods that were conducted at comparable times during both years were the 8 to 11 July period in 1974 and either the 24 to 27 June or the 21 to 24 July period in 1975. I chose the June 1975 period for comparison with the July 1974 period because weather was similar during these two periods and there was less difference in numbers of mice trapped.

$X^2$ tests, comparing numbers of a species between the two time periods, were run using a 2 x 2 contingency table with presence or absence of the species in a working trap on one axis and time periods considered on the other axis. Significantly more $P. maniculatus$ were trapped than Microtus ($X^2 = 479, p < 0.01, 1 \text{ df}$). $X^2$ was calculated using the $X^2$ goodness of fit test.

$P. maniculatus$ were trapped in the highest numbers in Habitat R. This habitat was hunted by coyotes more than all other habitats during the year (Table 4). In the period from October to April, coyotes hunted most in Habitat GS; in this habitat, second highest numbers of $P. maniculatus$ were trapped. Since $P. maniculatus$ had denser populations than Microtus in all habitat situations (Table 5), gross habitat differences could not account for variations between these rodents in the coyotes' diets.

Microtines were not trapped in equal numbers in the four
habitats ($X^2 = 71.16, p < 0.01, 3 \text{ df}$). More Microtus were trapped in Habitat R than in Habitat BW, and in Habitat BW than in Habitats GB or GS. There was little difference in the number trapped in GB and GS (Table 5). During the year, coyotes hunted in Habitats BW and R significantly more than they were available (Table 4). Throughout the entire year, coyotes hunted more in Habitat R than in any other. Since Microtus was the most important prey item for the coyote, coyotes selected hunting areas which corresponded to areas of greatest Microtus abundance.

<table>
<thead>
<tr>
<th>Animal</th>
<th>GB</th>
<th>BW</th>
<th>GS</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microtus spp.</td>
<td>1.94</td>
<td>14.19</td>
<td>1.93</td>
<td>24.85</td>
</tr>
<tr>
<td>P. maniculatus</td>
<td>79.53</td>
<td>78.28</td>
<td>87.71</td>
<td>98.39</td>
</tr>
</tbody>
</table>

**Pronghorn Populations and Observations**

Pronghorn fawn mortality was high on the Range during the study period (Table 6). Fawns from the Alexander Basin herd were outfitted with radio transmitters in the spring of 1975, and fawns from the Lower West herd were only eartagged (Table 7). Eight sets of twins comprised 16 of the 19 radioed fawns. One of a set of twins was radioed in Alexander Basin and its unmarked twin was still alive.
at 10 days of age. Possibly it was one of the unmarked survivors in that herd (Table 7). The unmarked siblings of two fawns radioed in the Northside herd apparently died within several days of birth since neither was seen after its sibling was marked.


<table>
<thead>
<tr>
<th>Year</th>
<th>Adult ♀</th>
<th>No. fawns born (est.)</th>
<th>Fawns alive in mid-Aug.</th>
<th>Mortality rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1974</td>
<td>32</td>
<td>64</td>
<td>17</td>
<td>73</td>
</tr>
<tr>
<td>1975</td>
<td>38</td>
<td>70*</td>
<td>21</td>
<td>69**</td>
</tr>
</tbody>
</table>

*Three adult does were not pregnant in 1975.

**Does not include three fawns removed for physiological study.

Fifty percent of the mortalities of radioed antelope, prior to August 1975, occurred within the first 17 days of birth. Cause of death was determined for only seven of 16 fawns because of transmitter failures. Five of these deaths involved coyotes; in two, weak calf syndrome was suspected (Table 8). Of the five fawns assigned to the "coyote involved" category, only one (Alexander Basin herd) could be definitely attributed to coyote predation (Henne 1975). The other four were over 95 percent consumed or removed from the site where the radio was found. In three of these cases, some fresh bones were in the immediate area, with large bones and skulls almost
Table 7. Numbers and locations of pronghorn fawns and pregnant does, and fawn mortality rates, in 1975.

<table>
<thead>
<tr>
<th>Location</th>
<th>Pregnant ♀</th>
<th>Fawns born</th>
<th>Fawns radioed</th>
<th>Ear tag only</th>
<th>Fawns alive 6 Aug. 1975</th>
<th>Mortality rate in %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Marked</td>
<td>Unmarked</td>
</tr>
<tr>
<td>Alexander Basin</td>
<td>10</td>
<td>20</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Northside</td>
<td>10</td>
<td>20</td>
<td>8</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Lower West</td>
<td>12</td>
<td>24*</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>35</td>
<td>70</td>
<td>19</td>
<td>3</td>
<td>4</td>
<td>17</td>
</tr>
</tbody>
</table>

*Three removed for physiological study.*
completely eaten. In the fourth case, the radio, with blood and tooth marks on it, was found within 60 m of an active coyote den on the north side of Mission Creek, where pronghorn does with fawns were never seen. Four of the five fawn mortalities in the "coyote involved" category were from the Northside herd. One of the surviving fawns and its doe moved from the Northside herd to the Lower West herd when the fawn was 10 to 11 days old, 6 to 7 days after its sibling died. This was the only known case of a doe changing herds during my study. By 6 August 1975, the doe and fawn had returned to the Northside herd.

Table 8. Age at death and cause of death for radioed pronghorn fawns.

<table>
<thead>
<tr>
<th>Age at death or last observation (in days)</th>
<th>Herd</th>
<th>Alexander Basin</th>
<th>Northside</th>
<th>Cause</th>
<th>Coyote involved</th>
<th>Weak calf syndrome*</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-07</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>08-17</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>18-24</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>25+</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Alive 6 Aug. 1975</td>
<td>0</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*B. W. O'Gara, personal communication.
During censuses conducted in early May 1975, 35 pregnant pronghorn does were counted. Numbers and location are listed in Table 7. Three of the does in the Alexander Basin herd were out of their usual range near Ravalli Ponds (Fig. 1) from mid-May to mid-June, when they returned. Possibly the two unmarked surviving fawns spent their early life in the vicinity of Ravalli Ponds.

Censuses conducted on 5 and 6 August 1975 revealed 21 surviving fawns (Table 7), for a 31 percent survival rate.

Daily locations of fawn sites are compared with available habitat types in Table 9 (z-test). Habitat availability within the home range of each of the three herds is given in Table 10. Radioed fawns that were alive on 6 August used Habitat GB significantly less ($X^2 = 15.76, \ p < 0.01, \ 1 \ df$), and Habitat GS significantly more ($X^2 = 25.71, \ p < 0.01, \ 1 \ df$) than those that died prior to that date. There was no significant difference in the use of Habitat BW between surviving and nonsurviving fawns. Coyotes also used Habitat GB significantly more than Habitat GS during summer months. Fawns selecting bedding sites in Habitat GB may be predisposed to predation.

Significantly more fawns survived in the Lower West herd than in either the Alexander Basin herd ($X^2 = 13.83, \ p < 0.01, \ 1 \ df$) or the Northside herd ($X^2 = 8.62, \ p < 0.01, \ 1 \ df$). The difference between survival of fawns in the Alexander Basin herd and the Northside herd was not significant, nor was the difference in survival.
Table 9. Habitat used by pronghorn fawns compared to habitat available to them (z-test).

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Fawns alive on 6 Aug. 1975</th>
<th>Fawns dead by 6 Aug. 1975</th>
<th>Total fawns</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avail.</td>
<td>Observed</td>
<td>z-test</td>
</tr>
<tr>
<td>GB</td>
<td>60</td>
<td>53.8</td>
<td>NSD</td>
</tr>
<tr>
<td>BW</td>
<td>2</td>
<td>7.7</td>
<td>NSD</td>
</tr>
<tr>
<td>GS</td>
<td>38</td>
<td>38.5</td>
<td>NSD</td>
</tr>
</tbody>
</table>

*NSD = p > 0.05
+ or - = p ≤ 0.05
++ or -- = p ≤ 0.01
between marked and unmarked fawns. Available habitat in each of the three doe-herd home ranges was not greatly different (Table 10). Habitat availability does not explain the higher fawn survival rate in the Lower West herd. Spatial distribution of fawns may be a major mortality factor. In 1975, mortality in the Alexander Basin and Northside herds was significantly higher than in the Lower West herd (Table 7). Coyote den sites that year were located in, or adjacent to, the Alexander Basin and Northside ranges; none were found in the immediate vicinity of the Lower West herd (Fig. 13).

In two instances, does were observed chasing coyotes away from the vicinity of fawns.

Table 10. Available pronghorn habitat, in percent, in each doe-fawn herd's home range.

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Lower West</th>
<th>Alexander Basin</th>
<th>Northside</th>
</tr>
</thead>
<tbody>
<tr>
<td>GB</td>
<td>56</td>
<td>54</td>
<td>60</td>
</tr>
<tr>
<td>BW</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>GS</td>
<td>37</td>
<td>44</td>
<td>38</td>
</tr>
</tbody>
</table>

Presence of Other Food Items

The food items in this section were not specifically censused or measured, but general observations were noted during the course of field work.
Mountain cottontail were present on the Range during the summer of 1974. I rarely saw more than one rabbit per week. By July 1975, the population had increased somewhat although rabbits were still far from numerous. A few localities of concentration occurred near corrals and buildings, and often one or two rabbits were seen near cattle guards. Cottontails appeared to require a safe escape haven for survival. They were unimportant in the coyotes' diets.

Columbian ground squirrels, yellow-bellied marmots, and northern pocket gophers resided in a few local concentrations, but they were never seen on much of the Range.

During late summer 1974, cherries, serviceberries, and rosehips were present in moderate amounts.

Grasshoppers (Orthoptera) were abundant on the Range from late July through late September 1974.

*Populations of Prey Species vs. Proportion in Diet (c)*

P. *maniculatus* is much less vulnerable to coyote predation than *Microtus* spp. (*c = 0.004*). Bison and elk are not as available to coyotes as pronghorn, deer, and bighorn sheep. However, between bison and elk the differences are quite small, as are the differences between pronghorn, deer, and bighorn sheep (Table 11). The availability of mule deer when compared to white-tailed deer is moderately
Table 11. Comparison of selected prey species to determine c values.

<table>
<thead>
<tr>
<th>Species</th>
<th>$\frac{N_1}{N_2}$</th>
<th>$\frac{P_1}{N_2}$</th>
<th>c</th>
<th>$\frac{1}{c}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peromyscus</td>
<td>8.59</td>
<td>.022</td>
<td>.004</td>
<td>259.56</td>
</tr>
<tr>
<td>Microtus</td>
<td>1.05</td>
<td>.698</td>
<td>.004</td>
<td>259.56</td>
</tr>
<tr>
<td>Bison</td>
<td>307</td>
<td>.008</td>
<td>.712</td>
<td>1.40</td>
</tr>
<tr>
<td>Elk</td>
<td>82</td>
<td>.003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bison</td>
<td>307</td>
<td>.008</td>
<td>.040</td>
<td>25.03</td>
</tr>
<tr>
<td>Bighorn Sheep</td>
<td>46</td>
<td>.030</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bison</td>
<td>307</td>
<td>.008</td>
<td>.049</td>
<td>20.25</td>
</tr>
<tr>
<td>Deer</td>
<td>360</td>
<td>.190</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bison</td>
<td>307</td>
<td>.008</td>
<td>.055</td>
<td>18.12</td>
</tr>
<tr>
<td>Pronghorn</td>
<td>108</td>
<td>.051</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elk</td>
<td>82</td>
<td>.003</td>
<td>.056</td>
<td>17.83</td>
</tr>
<tr>
<td>Bighorn Sheep</td>
<td>46</td>
<td>.030</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elk</td>
<td>82</td>
<td>.003</td>
<td>.069</td>
<td>14.43</td>
</tr>
<tr>
<td>Deer</td>
<td>360</td>
<td>.190</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elk</td>
<td>82</td>
<td>.003</td>
<td>.077</td>
<td>12.91</td>
</tr>
<tr>
<td>Pronghorn</td>
<td>108</td>
<td>.051</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pronghorn</td>
<td>108</td>
<td>.051</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deer</td>
<td>360</td>
<td>.190</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pronghorn</td>
<td>108</td>
<td>.051</td>
<td>.724</td>
<td>1.38</td>
</tr>
<tr>
<td>Bighorn Sheep</td>
<td>46</td>
<td>.030</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deer</td>
<td>360</td>
<td>.190</td>
<td>.809</td>
<td>1.24</td>
</tr>
<tr>
<td>Bighorn Sheep</td>
<td>46</td>
<td>.030</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mule Deer**</td>
<td>200</td>
<td>.037</td>
<td>.370</td>
<td>2.70</td>
</tr>
<tr>
<td>White-tailed Deer</td>
<td>160</td>
<td>.080</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Mouse population figures are number trapped/100 trap nights; ungulate populations are for March 1975 (Anonymous 1956-75).

**Value of $1/c$ is the same as the c value for the inverse of the species considered.

***Based on only those deer remains that could be identified to species.
low \( (c = 0.370) \). Because of the high number of undifferentiated scats (between deer species), this figure should be viewed cautiously. It is not possible to compare mice to ungulates because no data is available on absolute numbers of mice.

**Radio Equipment**

Transmitters, when first attached to a battery, transmitted signals from 100 to 400 m and had an effective life (able to transmit signals over 75 m) of 10 to 28 days. Only one transmitter dropped off before it became ineffective (at 26 days). Of the three radioed fawns still alive on 6 August 1975, one still wore the transmitter. This transmitter dropped off by 5 September 1975.
CHAPTER V

DISCUSSION

Coyote Population

Big game censuses have been conducted annually on the Range, during early spring, for over 20 years. To accomplish this, a large number of people walk simultaneously over the Range, individuals remaining in sight of the person to their immediate left and right. Animals are counted as they pass from ahead to behind an individual and between him and the person immediately to his left. All ungulates, except bison, are counted. Coyotes were recorded only sporadically until 1975-76, when participants in the censuses were instructed to count them. These counts, along with other observations made throughout the year, are used to determine an estimated population of big game animals (M. Haderlie, personal communication). The coyote population estimates (Fig. 18) until 1973 were only the product of casual observations by Range personnel. No systematic censuses were made. Therefore, it is possible that the increase in coyote numbers occurred earlier than the Range records indicate, or that the population during the 1960's was lower than estimated. The decline of coyotes between the summers of 1973 and 1974 was probably
Fig. 18. Fall coyote population estimates from 1959 through 1975 (Anonymous 1956-75). Estimates of 1974 and 1975 populations are mine.
caused by a die-off of coyotes rather than by emigration. In spring 1974 three dead coyotes were found on the Range and three more were found to the immediate north of the Range.

Studies giving the absolute number of coyotes have been conducted over large areas, often resulting, necessarily, in educated guesses at the population sizes. Gier (1957) gave a figure of 1.7 coyotes per mi² (one per 152 ha) for post-welping populations over a six county area in Kansas. Knowlton (1972) reported a population of four to six coyotes per mi² (one per 43 to 65 ha) in south Texas. The population on the Range is lower than these, but higher than the one coyote per 2 to 4 mi² (one per 518 to 1,036 ha) which Clark (1972) reported for the Curlew Valley of Idaho and Utah, and higher than 0.07 to 0.56 per mi² (one per 462 to 3,700 ha) as reported by Bennitt (1948) for some areas in Missouri. The coyote population on the Bison Range is within the usual density of 0.5 to 1.0 per mi² (one per 259 to 518 ha) for coyotes over most of their range (Knowlton 1972).

Fall coyote population surveys are conducted annually in 17 western states. In 1972, most survey lines were run in late September; since then, they have been run in early September. Mean state indices have ranged from 47 (North Dakota in 1973) to 237 (Nebraska in 1973). Indices for individual lines ranged from none in several areas, to over 500 in south Texas. The mean indices for

The index on the Range line increased from 41 in mid-July 1974 to 63 in early September, then rose abruptly to 100 in mid-October. This is probably the result of increased independence and movement of pups throughout this period.

Nine of the 17 state surveys conducted showed decreases in mean indexes from 1972 to 1973, while eight showed increases (Linhart and Knowlton 1975). Because the survey was taken earlier in 1973 than in 1972, the increases may be more numerous and larger than shown by the restrictive numerical comparison alone.

Coyote movement and distribution are affected by topography, vegetative cover, and food habits. There are reports both of coyotes ignoring scent stations and of a single coyote visiting a series of stations. Thus, relative indices between areas are probably less comparable than those between years in the same area (Linhart and Knowlton 1975). Between July 1974 and July 1975, the Range index rose from 41 to 55, an increase of 34 percent. This is comparable to an increase from nine to 13, or 44 percent, in non-pup coyotes. The scent station line seems to be an effective technique for following coyote population trends on the Bison Range, but only during summer and fall.
Food Habits

Many factors must be considered in the examination of a predator's food habits. Geographical location determines, in a general manner, which prey species a predator may encounter. Because some prey items are available only seasonally, a winter food habits study may never show certain prey items which may be critical in the summer. Predators hunt specific habitats, so they may never encounter prey species found in differing habitats. Certainly, the abundance and behavior of prey species affects utilization by predators. Other more subtle differences, such as taste, conspicuousness, microhabitat use, presence of alternate prey species, and size of prey, may have major effects on a predator's use of prey items. These factors and others must be considered when evaluating the meaning of data from a predator food habits study (Royama 1970).

Analysis

Several methods have been used for determining food habits of coyotes. Analyses of scat and/or stomach contents have been the most common; direct observations and/or following tracks have been used on a more limited scale. Each of these methods has advantages and disadvantages.

Only one major food habits study was done by observation (following tracks of coyotes in snow) (Ozoga and Harger 1966). This
method produces good behavioral information to correlate with food habits, but it provides only limited information on the food habits themselves. It is a good supplementary tool but can not supply complete data.

Analysis of stomach contents is probably the most direct and accurate method of determining food habits. Stomach contents are more easily identified than scat remains. It is possible to determine the volume of each food item consumed, rather than simply its presence or absence in the diet as determined in scat analyses. However, large numbers of coyotes must be killed, necessitating a very large study area. Because availability of food items is important, as well as food items actually consumed, the size of the study area precludes accurate determination of available prey.

I was interested not only in food consumed, but also in size of prey populations, and therefore chose a small study area. Scat analysis, with its limitations, seemed the most suitable method.

Scat analysis tends to overestimate the quantity of small food items, such as mice and insects, in comparison to large items such as ungulates (Bond 1939, Fichter et al. 1955, Gier 1957, Korschgen 1957, Clark 1972).
Prey Items

Rodents

In diet. Rodents were the most important prey group in the diet of the coyotes on the Range. *Microtus*, with a 69.8 percent frequency of occurrence, were far more important than yellow-bellied marmots (4.0 percent), pocket gophers (3.4 percent), or deer mice (2.2 percent) (Table 1). In California (Ferrel et al. 1953, Hawthorne 1972) and Yellowstone National Park (Murie 1940), *Microtus* was the most important food item in the diet of coyotes. Numerous other researchers have found *Microtus* very important, following only rabbits and deer. In some areas, other rodents, especially ground squirrels (*Spermophiles* spp.) and pocket gophers, were found as important food items (Murie 1940, Murie 1945, Fitch 1948, Ogle 1971). On the Range, *Microtus* were most important during the winter months, while in Yellowstone and Sagehen Creek Basin in California, they were the staple food item from April through November. This is probably the result of deep snow which makes mice unavailable in those areas during the winter (Murie 1940, Hawthorne 1972).

Mouse populations. There is great variation in mouse populations on the Range between years. *Microtus* spp. and *P. maniculatus* had higher densities in June 1975 than in July 1974. *P. maniculatus* had higher densities than *Microtus* throughout the study.
**Microtus pennsylvanicus** is said to have an intermediate rate of removal (Barbahenn 1974 in Golley et al. 1975), and **P. maniculatus** a fast to intermediate rate of removal (Nabholz 1973 in Golley et al. 1975). Because prebaiting increases the rate of capture while decreasing its variance (Gentry et al. 1971), traps on the Range were prebaited during the study to reduce the effect of numerous variables.

**Microtus** were more important in the coyotes' diets during July 1975 than July 1974. However, coyote use of **Microtus** did not correspond to **Microtus** populations during winter periods of 1972-73, 1973-74, and 1974-75. Even in periods of low density, **Microtus** were still the most important item in coyotes' diets on the Range.

**Microtus montanus** were an important part of coyotes' diets in Lava Beds National Monument, California, during years of both high and low populations (Bond 1939). Bond attributes this to the existence of local concentrations, where coyotes can easily catch **Microtus** even during low population years. Where rabbits are the most important food, their importance is proportionate to their population (Fichter et al. 1955, Gier 1957, Korschgen 1957). Only in Utah were jackrabbits found to be the most important food item even in low population years (Clark 1972).

On the Range, **P. maniculatus** are relatively unimportant in the coyote diet although they have a higher population density than **Microtus**. Compared to **Microtus**, they have a very low c value.
(0.0039) (Table 11). They are relatively unavailable to the coyote. This is not the result of gross habitat use differences. Reasons for their unavailability were beyond the scope of this study, but several possible explanations are: (1) different use of microhabitats; (2) different activity periods; and (3) different responses to predators. Gier (1957) showed a 7.5 percent frequency of occurrence for Peromyscus, and in other major studies, frequency of occurrence was less than 6 percent. While a common rodent through much of the coyote's range, Peromyscus spp. is relatively unimportant as a prey species.

Habitat relationships. Microtus was the most important prey item for the coyote on the Range, and coyotes hunted selectively in habitats with greatest Microtus abundance.

Where hares are a major prey item, coyotes are known to hunt mostly in areas of high hare density (Hilton and Richens 1975). Craighead and Craighead (1956) found that high raptor densities were almost always associated with high microtine densities. Raptor numbers were related directly to vulnerability of prey. Microtine density and the nature of the habitat were the basic conditions influencing vulnerability. Habitat conditions increased vulnerability either directly by exposing animals, or indirectly by causing increased movements of animals.
Coyotes hunted significantly more in Habitat GS and significantly less in Habitat R in the period from October to April than from May to September. This is possibly the result of differential rates of snow melt. Snow melts off the sunny, exposed grassland slopes more quickly than the shaded river bottom areas. Deep snow makes mice relatively unavailable during winter months (Murie 1940, Hawthorne 1972).

**Lagomorphs**

Cottontails were an unimportant food item to the coyotes on the Range during this study (Table 1). The population was low throughout the study period. Where rabbits are present in larger numbers, they are an important food item. In many studies, rabbits or hares were the most important single prey item (Sperry 1941, Murie 1945, Fichter et al. 1955, Gier 1957, Korschgen 1957, Clark 1972, Hamilton 1974). When an area has a moderate to high coyote population, coyotes could play a significant role in holding a low rabbit population at a low level (Wagner and Stoddart 1972). This situation may be present on the Range.

**Birds**

During spring and summer, birds and bird eggs provide a relatively small, but steady, portion of the coyotes' diets on the Range (Table 1; Fig. 6). They are probably taken incidentally to the
staple prey species during hunting. Most of the birds identified in scats were those which spend much time on the ground, such as meadowlarks (*Sturnella neglecta*) and gallinaceous species. This situation is typical of many others in food habits studies previously cited.

**Insects**

Insects, especially several species of beetle (Coleoptera), were of minor importance in the coyotes' diet during spring and early summer. When grasshoppers were abundant, they became an important item in the diet (Table 1; Fig. 6). Most other studies have shown similar results. In studies showing volume of food items in stomach contents, insects are less important. However, on the Range, many scats were found in which grasshoppers comprised most or all of the remains. It is probable that insects, along with fruits and seeds, are ecologically more important than their presence indicates. Pups learn to hunt for themselves and become independent during late summer and fall. Insects may be important to them for sharpening accuracy of pounces, since many grasshoppers would be required for a meal and search time would be minimal.

**Fruits and Seeds**

Rodents, fruits, and seeds are the most important food items for coyotes on the Range during late summer (Table 1; Fig. 6). Many
scats at this time were composed entirely of the remains of various fruit species, especially cherries and serviceberries. Plant material is apparently quite variable in importance from one place and time to another. Some researchers have found it to be less than 2 percent of the coyote's diet (Sperry 1941, Fitch 1948). On the Texas plains, fruits from nine species of native plants collectively contributed 46 percent of the mean annual diet (Meinzer et al. 1975). Most researchers showed results similar to mine, with fruits only seasonally important.

When the pups learn to hunt, fruits may be ecologically important as an alternate food source when other prey species prove too difficult to catch. When fruits were moderately abundant, pups would never need to be hungry. These readily available food items may be important to pups during the transition from dependence to independence.

Cattle

Cattle were a sporadically important food item in the diets of coyotes on the Range. In November and from January through April, only rodents were more important.

The importance of cattle as a coyote food item is widely variable between places and times. Some researchers have found it a very important food source (Sperry 1941, Murie 1951, Fichter et al.
1955, Gier 1957, Hawthorne 1972, Meinzer et al. 1975), especially during winter. Others have found cattle a minor food item (Bond 1939, Murie 1945, Fitch 1948, Ozoga and Harger 1966, Hamilton 1974). There is general agreement that cattle are usually taken as carrion, and there is no evidence indicating otherwise in the area of the Range.

**Domestic Sheep**

Sheep ranchers in the vicinity of the Range have, in recent years, complained about the Range policy that leaves coyote numbers unregulated. They believe that coyotes from the Range visit their ranches, kill and eat sheep, then return to the refuge. The data obtained do not support this belief. Only four of 593 scats collected during 1974-75, and none of the 347 collected in prior Range studies (Vivion 1973, Hallsten 1974, Smith 1974) contained remains of sheep (Table 1). The four scats may easily have resulted from carrion and, in any case, do not indicate serious depredations.

In some areas, serious depredations do occur. Henne (1975) found that predators killed 20.8 percent of a herd of 2,041 sheep, including 29.3 percent of the lamb crop exposed to predation. Coyotes were responsible for 97.1 percent of all predator losses in his study.

**Bison**

Bison were a minor item in the coyote's diet during this study. Those consumed were probably taken as carrion. Murie
(1940) thought bison may, at times, be an important source of carrion to the coyote in Yellowstone National Park. The bison compared to other ungulates on the Range has a $c$ value of less than 1.0. This is probably the result of several factors. Adult bison are simply too large for a coyote to kill. Bison calves follow their mothers and are in groups of other bison from minutes after birth. Thus, adults could easily protect their young from coyotes. Finally, since bison are intensively managed on the Range, there is proportionately less carrion available from them than from other, less intensively managed ungulates.

Populations, cow-calf ratios, and harvests from 1959 through 1975 are shown in Appendix B. Harvests of these and other ungulates include all man-caused mortality approved by Range personnel, and animals removed from the Range for specific purposes.

Elk

Elk form a minor portion of coyotes' diets on the Range. The only elk remains found were the remains of calves in scats collected in June (Table 1). Elk as compared to bison have a $c$ value of 1.40; elk compared to the smaller ungulates have a $c$ value of less than 0.1. The availability of elk is similar to that of bison and less than that of the smaller ungulates.

In Yellowstone, only rodents are more important than elk in
the coyote's diet. During winter, elk, usually taken as carrion, become more important than even rodents. Little, if any, predation on elk occurs as calves are also taken primarily as carrion. Probably this is the result of several factors: their large size allows all but very young calves to defend themselves from single coyotes; and cows frequently stay in close proximity to their calves, especially to the very young, and can easily defend them from coyotes (Murie 1940). These factors, and the good condition of the Bison Range herd, contribute to their unavailability to coyotes.

Populations, cow-calf ratios, and harvests from 1959 through 1970 are given in Appendix B.

**Bighorn Sheep**

Bighorn sheep are a minor part of the coyote's diet on the Range. Bighorns appear slightly more available to coyotes than deer or pronghorns. Bighorns are much more available than bison or elk. Elk and bison are relatively unavailable to coyotes; bighorns, deer, and pronghorns are relatively available (Table 11).

The seasonal distribution of bighorns in coyotes' diets is different from that of deer or pronghorns. Deer and pronghorns show a definite peak of use in early summer (Fig. 10); bighorns are consumed on a fairly uniform basis throughout the year (Table 1), indicating the components of availability are different between these
groups. These differences are not great and might not be reflected in data covering more than one season.

Murie (1940) considered coyote predation on bighorns an unimportant mortality factor, despite a dense coyote population on bighorn ranges in Yellowstone. Bighorns approached by coyotes moved to secure clifty areas. When far from cliffs, bighorns were able to drive coyotes away, but this was seldom necessary. Coyotes usually ignored bighorns.

Ewe:lamb ratios have been subject to wide fluctuations on the Range (Appendix B). In 1964, no lambs survived. From 1970 to 1972, another severe decline in ewe:lamb ratios occurred. These declines began prior to coyote increases, suggesting that a high coyote population was not the cause. A subsequent rise in ewe:lamb ratios in 1973 and 1974 further substantiates this projection.

Deer

Both white-tailed and mule deer were important in the coyote's diet on the Range (Table 1). It is uncertain which species is more important because of difficulty in distinguishing between these species' remains in scat analyses.

The importance of deer in the coyote's diet is variable throughout the country. In some areas, they are only a very minor component (Sperry 1941, Fichter et al. 1955, Korschgen 1957,
Gipson 1974). In most areas, however, deer are at least seasonally important.

On the Range, many of the deer consumed by coyotes are fawns. Most of the deer in coyotes' diets are consumed during early summer; in winter, deer are least important. Some other researchers have found similar patterns of seasonal use (Ferrel et al. 1953). Salwasser (1974) used coyote scats to determine time of mortality of deer fawns. He found that little fawn mortality occurred after the immediate postnatal period. On the Range, however, deer remains were found in many scats throughout the summer and fall. In most areas, deer are most important as a coyote food source during winter. Most researchers believe that coyotes do not significantly affect deer populations during this season (Aiton 1938, Ozoga and Harger 1966, Ogle 1971, Hawthorne 1972, Hamilton 1974). Even during winter, fawns and yearlings seemed most vulnerable to coyotes. This is, perhaps, caused by their relative inexperience, weakness, and dependency upon adults as compared to deer in older age classes (Ogle 1971).

During the last 17 years, mule deer doe:fawn ratios on the Range have suffered two serious declines (Appendix B). The first was in 1963, well before the increase in coyote numbers. The second, in 1972, coincided with the beginning of the rise in coyote numbers. However, doe:fawn ratios increased in 1973 and 1975, while coyote
populations were even higher than in 1972. High coyote numbers, therefore, were not the primary cause of the decline. In Oregon, predation by coyotes, and to a lesser degree bobcats, was the major direct cause of mortality during both winter and summer; poor nutrition appeared to predispose fawns to predation during the winter period (Trainer 1975).

White-tailed deer on the Range suffered a severe decline in doe:fawn ratio in 1973 (Appendix B). During that year, coyote populations reached a peak. Coyotes were suspected as the cause, when a second year of low doe:fawn ratios followed. Cook et al. (1971) found coyote predation was the major cause of mortality in white-tailed fawns. This was in an area where summer losses often included over half the fawn crop. In 1975, with the Range coyote population still very high, the doe:fawn ratio increased greatly. Because the *Microtus* population increased in 1975 (Figs. 15-17), coyotes possibly fed more heavily on *Microtus* and less on deer fawns. Prey-switching behavior of this type was recorded in other predator-prey systems (Murdoch 1969, Royama 1970). To determine exact causes of fawn mortality on the Range, a radiotelemetry study would be necessary.

**Pronghorns**

In coyote diet. The pronghorn is an important part of the diet
only during late May and June on the Range (Fig. 10). Fawns are
born in late May and early June. In Yellowstone, coyotes took
pronghorns both in early summer and during the winter, but prong-
horns comprised only a very minor part of the coyote's diet (Murie
1940). Others researching coyote food habits found pronghorns an
insignificant part of the diet, or did not mention them at all.

**Habitat relationships.** Fawns on the Range used Habitat BW
less than 9 percent of the time (Table 9). Most observations were of
bedded fawns. Woody vegetation, mostly snowberry, was available
for cover mainly in Habitat BW. Pyrah (1974) found that fawns
selected only vegetation types containing sagebrush for bedding sites.
Fawn survival depended largely on cover, especially shrubs. On the
Range, fawns commonly selected bedding sites in balsamroot patches
which camouflaged them effectively, at least from human vision. In
areas with excellent range conditions, thick stands of forbs may
provide the needed cover for fawns.

Fawns on the Range selecting bedding sites in Habitat GB
may be predisposed to predation. Examining bobcat predation, Beale
and Smith (1973) found that 63 percent of pronghorn fawn kills
occurred in or near washes. Jackrabbits, the major food item of
bobcats in that area, were most abundant along washes. Beale and
Smith hypothesized that bobcats hunting intensively along washes
increased predation on the pronghorn fawns bedded there.

**Fawn mortality.** Pronghorn fawn mortality was high on the Range during the study period (Table 7). Fifty percent of the mortalities prior to August 1975 occurred within the first 17 days after birth. Cause of death was determined for only seven of 16 fawns because of transmitter failures. Five of these deaths involved coyotes; in two, weak calf syndrome was suspected. Coyote predation accounted for the largest loss of young white-tailed deer fawns in south Texas (Cook et al. 1971). They found no conclusive evidence of coyotes scavenging fawns killed by other causes during the height of the fawning season.

Spatial distribution of fawns may be a major mortality factor. In 1975, mortality in the Alexander Basin and Northside herds was significantly higher than in the Lower West herd (Table 7). Coyote den sites that year were located in, or adjacent to, the Alexander Basin and Northside ranges; none were found in the immediate vicinity of the Lower West herd (Fig. 13).

Several researchers found that predator control, or lack of it, correlated directly with doe:fawn ratios or population fluctuations in pronghorns (Riter 1941, Buechner 1950a, Arrington and Edwards 1951, Udy 1953). In some areas, predator control could not be completely correlated to pronghorn populations (Buechner 1950b, Compton 1958, Larsen 1970). Howard et al. (1973) believed that predator
populations in Arizona were not a major limiting factor for pronghorns. Beale and Smith (1973) finally showed that predators could be the major cause of pronghorn fawn mortality; predators, mainly bobcats, accounted for 66 percent of the fawn mortality. Their study area, like the Bison Range, was an enclosure. They speculated that this may have increased losses to predation. In unrestricted areas, many pronghorn does change fawning sites periodically. Once an individual predator recognizes a species as a prey item, it will probably continue to prey on that species. Knowlton (1968) believed that the presence of fences in an area would facilitate coyotes in capturing pronghorns, especially the young, who would be less familiar with the area than adults. He suspected the advantage to predators increased as the size of the enclosed area decreased. In a heavily fenced area, like the Range, this may be an important factor in degree of predation.

Doe:fawn ratios on the Range dropped drastically from 1969 to 1972 (Appendix B). Range Narrative Reports (Anonymous 1959-75) indicate that coyote numbers did not begin to rise until 1972. Thus, the increase in coyotes is not suspected as the reason for the decline. But coyote predation should not be eliminated as the cause. With a small, enclosed pronghorn herd, individual coyotes, adept at finding and killing fawns, could be more important than a large number of coyotes. Since 1972, doe:fawn ratios have increased only slightly.
each year. Coyotes may play a significant role in keeping fawn survival low, even if not responsible for the original decline. However, on the National Bison Range, this need not be considered a problem. Because human harvest of pronghorns is not a goal, coyotes might reasonably be allowed to take surplus fawns. Pronghorn survival is at least high enough to maintain a stable population; thus, the coyote may be solving the problem of removing surplus animals. Coyotes on the Range might be considered a partial answer to a problem, not a new one.
CHAPTER VI

SUMMARY

From July 1974 through July 1975, I studied coyote/prey relationships on the National Bison Range at Moiese, Montana. Historical population data were compiled from Range records for ungulate species, Microtus, and coyotes.

Scats, collected periodically, indicated that Microtus was the most important single food source for coyotes throughout the year. Native ungulates, especially fawns, were important during late spring and early summer. Insects, seeds, and berries were important in late summer and early fall, while cattle, presumably carrion, were important during winter.

Numbers of coyotes on the Range increased from 20 or 22 during the summer of 1974 to over 29 during the summer of 1975. Scent station lines were run monthly from July through October 1974 and in July 1975. Coyote indices increased monthly during 1974 and were higher in July 1975 than in July 1974. The scent station line was an effective measure of the coyote population on the Range when run during summer or fall.

Coyotes hunted in Habitats BW (brushy washes and swales)
and R (riparian areas) significantly more than those habitats were available. *Microtus* were trapped with significantly greater frequency in Habitats BW and R than in GB (grassland basins) and GS (grassland slopes). I hypothesized that coyotes selectively hunted in habitats which had high numbers of *Microtus*.

Mouse populations were sampled with snap traps in four habitat situations. *Peromyscus* were trapped with far greater frequency than *Microtus* in all habitats. Since *Microtus* formed a much larger part of the coyote's diet than *Peromyscus*, *Microtus* are apparently more vulnerable to coyotes.

I censused pronghorns on the Range in May 1975 and August 1974 and 1975 to determine the numbers of does and fawns. The adult doe:fawn ratio for 1974 was 100:53. The breeding doe:fawn ratio for 1975 was 100:60. Proximity of coyote dens correlated to fawn mortality in the three Range herds. Radio transmitters were placed on 19 pronghorn fawns, but short battery life allowed cause of death to be determined in only seven cases. Five mortalities involved coyotes, and two apparently resulted from weak calf syndrome. Half of the mortalities occurring prior to mid-August took place within the first 2.5 weeks after birth. Fawns that lived past 8 August 1975 frequented Habitat GS significantly more than fawns that died before that date. Coyotes hunted in Habitat GS less than in any other habitat during late spring and summer. Coyote predation may be a major
cause of fawn mortality. With a small, enclosed pronghorn herd, individual coyotes, adept at finding and killing fawns, could be more important than a large number of coyotes.

Coyote population increases were compared to ungulate doe:fawn ratio decreases. In all cases but white-tailed deer, increased numbers of coyotes did not appear to be the major cause of declines. Deer, bighorn sheep, and pronghorns are apparently more available to coyotes than elk or bison are.
REFERENCES CITED


77


APPENDIX A

DATUM SHEETS USED IN THE STUDY
Datum sheet for recording coyote observation.
<table>
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<th>ODIS TYPE</th>
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</table>
Key for recording coyote observations on datum sheets.
1. Type of observations
   0: Scent post-auto
   1: Scent post-walking
   2: Rodent trap-auto
   3: Rodent trap-walking
   4: Gear
   5: General watching
   6: General sitting
   7: Coyote watching
   8: Coyote sitting

2. Observer location
   0: Ridge top
   1: Hill top
   2: N. Slope
   3: NE
   4: E
   5: SE
   6: S
   7: SW
   8: W
   9: NW
   10: Basin bottom

3. No. of days involved in the season or observation period

4. Observations
   11-13: Date
   14: Weather
   15: Min. Temp
   16: Max. Temp
   17: Wind speed

5. Area
   19-21: Direction
   22: Snow

6. Behavior
   23-27: Time

7. Section
   28-30: Section

8. 31-33: Area
   34-36: Species

9. 37-39: Species
Datum sheet used while examining mice in the laboratory.

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Datum card used at time of capture and marking of pronghorn fawns.

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General condition:

Habitat:

Behavior:

Misc.
Standard area information for predator survey line. These information sheets are filled out for all lines on the annual Western States Predator Survey.
1975 AREA INFORMATION FOR PREDATOR SURVEY LINE

Observer **REICHEL**  County and State ________________________________

Line No. __________________ Dates Survey Run _____________________________

I. LAND SURFACE (enter number): Primary ___ Secondary ___

1. Flat
2. Irregular or rolling
3. Sand dunes or sand hills
4. Hilly, foothills, buttes, mesas
5. Mountains
6. Canyon lands
7. Badlands, river breaks
8. River or stream bottoms
9. Shorelines (lakes, ocean)
10. Other ________________________________

II. LAND USE (enter number): Primary ___ Secondary ___

1. Livestock grazing
2. Farming
3. Timber production, timbered national forests
4. Military
5. Mining
6. National refuge, national park, national grassland
7. Other ________________________________

III. VEGETATION (enter number): Primary ___ Secondary ___

1. Conifer forest
2. Broadleaf or deciduous forest
3. Mixed conifer and broadleaf forest
4. Shrubs
5. Grasslands
6. Mixed forest and grasslands
7. Mixed shrubs and grasslands
8. Marsh
9. Agricultural croplands
10. Mixed agric. cropland and conifer forest
11. Mixed agric. cropland and broadleaf forest
12. Mixed agric. croplands and shrubs
13. Mixed agric. croplands and grasslands
14. Other ________________________________

IV. COYOTE CONTROL

Degree of coyote population reduction achieved from July 1974 to June 1975

(circle one): 1 none  2. poor  3. moderate  4. good

Degree of coyote damage suppression achieved from July 1974 to June 1975

(circle one): 1 none  2. poor  3. moderate  4. good
APPENDIX B

TOTAL POPULATION, YOUNG:100 FEMALES RATIO, AND HARVEST FOR UNGULATES ON THE RANGE

(Anonymous 1956-75)

<table>
<thead>
<tr>
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<th>Total winter population</th>
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<td>Young:100 females in Sept. - Oct.</td>
<td>- - - - - -</td>
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<tr>
<td>Harvest for entire year</td>
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</table>
Instructions

Complete one of these forms for each predator survey line. Fill in your name, county, state, line number, and inclusive dates you checked your survey line.

I. LAND SURFACE

This information refers to the land features or surface of the land in the general vicinity of your 15-mile survey line—whether it is flat, hilly, mountainous, etc. By general vicinity, we mean the land surface approximately 3 miles on either side and along the entire length of your survey line. It does not refer to the vegetation present. Select the appropriate category describing the primary land surface in the general vicinity of your line and enter the category number in the space provided. If a secondary (less prevalent) land surface category is also present, indicate the appropriate category number in the space provided. If none of the categories apply to your line, briefly describe as best you can after the category "Other."

II. LAND USE

This refers to the primary and secondary uses of the land in the general vicinity of your survey line. Indicate, by number, how the land is used. If none of the categories apply, indicate the type of use in the "Other" category.

III. VEGETATION

This refers to the primary and secondary predominant classes of vegetation in the general vicinity of your line (approximately 3 miles on either side and along its entire length). As an example, the major portion of your line may run through grasslands. You would therefore place the number 5 in the "Primary" space. However, in one or two places, the line runs through some pine forest (conifer forest). You would therefore enter the number 1 in the "Secondary" space provided.

Under some circumstances, none of the land surface, land use, or vegetation categories will fit conditions along some of the survey lines. When this is the situation, the "Other" category should be used.

IV. COYOTE CONTROL

Under this heading, you should estimate what, in your opinion, is the single best or most appropriate category. Again, consider the amount of coyote reduction or damage suppression in the general vicinity of your line during the period July 1974 through June 1975. Take into account control work carried out by stockmen as well as by government agencies.

By "coyote population reduction," we mean the extent or degree to which overall coyote numbers have been reduced in the general vicinity of your line. "Degree of coyote damage suppression" means to what extent stock killing has been affected by predator control activities during the period July 1974 through June 1975.

If you have any questions concerning this questionnaire, ask your supervisor for help in filling it out.

Return this form, along with your five daily report forms, to your supervisor.