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SARPY BASIN
WILDLIFE ECOLOGY STUDY
FINAL REPORT

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ACKNOWLEDGEMENTS

This project was sponsored by the Montana Department of Fish, Wildlife and Parks and the Cormorant Corporation.

I would like to thank all of the following who cooperated so willingly in the study and assisted me in so many ways: the landowners; Lee Howard, my pilot; David Simpson, Westmoreland Inc.; Robert Greene, MFWP; Robert Martinka, MFWP; Robert Carroll, ECON, Inc.; William Schwarzkoph, WECO; Faye Ruffatto, MFWP; and my wife, Susan.

ABSTRACT

A four year wildlife study (September 1973-November 1977) was conducted on approximately 465 square miles of the Sarpy Creek drainage in portions of Treasure, Big Horn and Rosebud counties in southeastern Montana.

Six soil associations were mapped along with the five major vegetation types: ponderosa pine, sagebrush, grassland, creek bottom and agricultural.

Three wildlife species, mule deer (*Odocoileus hemionus*), pronghorn antelope (*Antilocapra americana*) and coyotes (*Canis latrans*) were given yearlong attention. Distribution, population characteristics, and seasonal usage of soil association, vegetation type, topography, slope and exposure for each of the species were addressed. Ten years of mule deer and antelope hunting statistics were examined. Seasonal work was done with sharp-tailed grouse (*Pediacetes phasianellus*), sage grouse (*Centrocercus urophasianus*) and ring-necked pheasant (*Phasianus colchicus*). Sharp-tailed grouse banding and radio telemetry studies were conducted in conjunction with the Westmoreland and Western Energy coal mining operations in the Sarpy Creek and Colstrip vicinities, respectively.

Sarpy Basin Wildlife Ecology Study

Final Report

INTRODUCTION

The use of "energy" in the United States has historically been associated with yearly increased levels of demand and consumption. The "demand" has been met by yearly increased production and continued exploitation and depletion of our non-renewable natural resources, primarily coal and crude oil. Whether this approach is correct or not aside, the environmental effects of energy production have, in past decades, either been completely ignored or been given only token consideration.

Southeast Montana is rich in both non-renewable natural resources and renewable resources. By anyone's standards, the 32 billion tons of strippable coal located in Big Horn, Custer, Powder River and Rosebud counties (Matson and Blumer 1973) is a massive reserve. The presence of mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), pronghorn antelope (*Antilocapra americana*), sharp-tailed grouse (*Pediacetes phasianellus*), sage grouse (*Centrocercus urophasianus*), ring-necked pheasants (*Phasianus colchicus*), Merriam's turkey (*Meleagris gallopavo merriami*) and numerous small mammal, waterfowl, raptor, and passerine species, by the same standard, demonstrates a rich and valuable wildlife ecosystem.

With the opening of the "Absaloka" strip mine in the Sarpy Creek drainage, the expansion of Colstrip operations and other strip mines seemingly imminent, the Sarpy Basin Wildlife Ecology Study was begun in September 1973, with the following objectives:

- (1) To determine the impact of existing and future surface mining operations on wildlife resources in the area.
- (2) To insure that fish and wildlife habitat values receive full recognition in any surface reclamation efforts that follow surface mining operations.
- (3) To investigate possible modifications, additions or innovations in the surface mining reclamation process to avoid unnecessary loss of wildlife habitat and develop techniques and procedures to enhance habitat through reclamation.

Field observations were conducted over a four year period ending in November 1977.

PROCEDURES

Climatological data were taken from the Hysham 25 SSE weather station (USDC 1973-1978). Soils information was obtained from the Soil Conservation Service offices of Big Horn, Treasure and Rosebud counties.

Vegetation types were determined through aerial and vehicular observations. A vegetation map was drawn from 1:24,000 false color infrared (CIR) photographs using a light table and a Sokkisha Lietz M8-27 stereoscope. The photographs, taken in 1975 by Mark Hurd, Aerial Surveys Inc., Minneapolis, Minn., are the property of ECON Inc., Helena, Montana.

Observations of wildlife were made during low-level fixed-wing aerial flights. The study area was covered once during each of the four seasons: winter (December-February), spring (March-May), summer (June-August) and fall (September-November). North-south flight lines at 1/2 mile intervals were used after the first year. A helicopter was used to supplement the winter observations in 1976. Observations were also made during vehicular surveys and while afoot. Vegetation type, activity, type of terrain, slope, exposure, time of day and pertinent population data were recorded at each observation. Each observation was plotted on a 1/2 inch to the mile map to determine distribution patterns.

Mule deer, antelope and coyote observations were overlain by a soil association transparency to determine seasonal soil association usage. A chi-square (χ^2) value was calculated for each species usage of each soil and vegetation type in all seasons to determine statistically significant preferences. The formula $\chi^2 = 4d^2/n$ (Snedecor and Cochran 1967), where d = the absolute value of the deviation between the number observed and the number expected and n = the total number observed was used. Histograms showing the distribution of chi-square values were drawn to show the comparison between significant and other relationships.

All area measurements were obtained with a digitized planimeter located in the Civil Engineering and Engineering Mechanics Department of Montana State University, Bozeman.

STUDY AREA

Location

The Sarpy Creek study area (Figure 1) is located in southeastern Montana south of the Yellowstone River and east of the Bighorn River. In airline miles, it is approximately 18 northeast of Hardin, 57 southwest of Miles City, 65 east of Billings and 65 north of Sheridan, Wyoming. Sarpy Creek flows nearly 70 miles from its headwaters on the Crow Indian Reservation in Big Horn County north through Treasure County to its confluence with the Yellowstone River east of Hysham, Montana.

There are approximately 464.3 square miles in the study area which is bounded by Interstate Highway 94 on the north, the Tullock Creek divide on the west and southwest, the Armells and Reservation Creek divides on the east and the Rosebud Creek divide on the south-east. A discrepancy of 42 square miles exists between the total study

Figure 1. Sarpy Basin wildlife ecology study area.

area as determined from the measurement of Figure 2, drawn from 1:500,000 USGS topographic maps, and Figure 3 which was drawn from 1:24,000 aerial photographs.

The study area was divided into three sub-units during the 1976 field season to facilitate comparisons of various wildlife population characteristics within the Sarpy drainage. These boundaries were arbitrarily placed to make the sub-units approximately equal in area, to maintain rough vegetation type integrity and to follow easily identifiable terrain features. The two lower units were named Bear Creek and Horse Creek after prominent side drainages. The upper unit was named after Westmoreland's "Absaloka" coal mine.

Physiography and Climate

The area is described as a maturely dissected upland that is part of the non-glaciated Missouri Plateau section of the northern Great Plains (Krenzke 1976). Elevation ranges from 4820 feet in the Little Wolf Mountains along the southeast boundary to 2650 feet at the Intersection of Sarpy Creek and Interstate 94.

Average annual precipitation is 10 to 14 inches over much of the area with 14 to 20 inches normal at higher elevations in the southern portion and along the Armells Creek divide (Jackson 1971). The average length of the frost-free season ranges from 130 days in the northern to 195 days in the southern portions of the study area (Caprio 1965). Monthly climatological data from the Hysham 25 SSE weather station for the first three years of the study are presented in earlier reports (Martin 1976, 1977). The data for the fourth year are in Appendix Table 1. Seasonal temperature and precipitation data for the study area are presented in Table 1.

The winter weather (average 23.7°F and 2.27" moisture) varied from warm (1973-74) to quite cool (1974-75). Generally winters were mild with a few days of intense cold and sparse snow cover. In 1974-75 there were 32 days in which the maximum temperature was below freezing, while only 22 such days were recorded in the winter of 1976-77. The winter of 1975-76 was the worst during the study period. While the temperature remained quite high (25.1°F average), over 47 inches of snow fell (Martin 1977).

The spring of 1974 was cold and wet. It had 15 days in which the maximum temperature was below freezing. That was more than twice as many such days as any of the other years. The spring of 1976 was the driest, 3.63 inches, and the spring of 1977 was the warmest (45.4°F).

While the summer of 1975 was the coolest with an average of 65.4°F, it was by far the driest as only 3.39 inches of rain fell. It was the beginning of a mild drought period which extended until

Figure 3a. Major vegetation types of the Sarpy Creek drainage.
(Bear Creek subunit)

Figure 3b. Major vegetation types of the Sarny Creek drainage (Horse Creek subunit).

Figure 3c. Major vegetation types of the Sarpy Creek drainage. (Absaloka subunit).

the fall of 1977, the last season of the study period, and was not really broken until the winter and spring of 1978. The summer of 1976, during the middle of the dry spell, was the hottest with 67.4°F for the average temperature.

The fall period was slightly warmer than spring but exhibited a wider range of temperatures. Generally the fall periods were quite warm and dry. Only the winter season received less moisture. The fall of 1974 had the most hot days, 9 over 90°F while the most cold days were recorded in 1975 when the high temperature reading was below freezing 5 days.

Table 1. Seasonal temperature and precipitation data from the Hysham 25 SSE weather station 1973-1977.

AVERAGE TEMPERATURE ^{1/}					
Season	1973-74	1974-75	1975-76	1976-77	Average
Winter	25.3	20.9	25.1	23.3	23.7
Spring	43.1	38.3	43.9	45.4	42.7
Summer	66.0	65.4	67.4	66.5	66.3
Fall	44.4	43.2	43.9	43.8	43.8
TOTAL PRECIPITATION ^{2/}					
Winter	2.30	2.52	2.75	1.52	2.27
Spring	5.97	5.58	3.63	5.28	5.12
Summer	6.18	3.39	5.37	4.65	4.90
Fall	4.18	4.03	3.21	3.87	3.82
Yearly Avg. Temp.	44.7	42.0	45.1	44.8	44.1
Total Precip.	18.63	15.52	14.96	15.32	16.11

^{1/} Temperature in degrees Fahrenheit

^{2/} Precipitation in inches received

The yearly precipitation ranged from 18.63 in 1974 to 14.96 in 1976 with a four year average of 16.11 inches. This compares to an annual average precipitation of 11.2 inches at Hysham (Moshier and Fielder 1967), 12.6 inches at Busby 10 miles south of the study area (Dightman 1972) and 15.0 inches at Colstrip approximately 15 miles east of the study area (Krenzke 1976). The temperature ranged from 104°F in July of 1975 to -31°F in January of 1974.

Edaphic Characteristics

There are six general soil associations (Figure 2) within the drainage area. These are grouped into three major headings:

- (1) Soils of high terraces, which include the Wanetta-Hesper association.
- (2) Soils of rolling to hilly uplands on clay shale, which include the Pierre-Lismas association.
- (3) Soils of rolling to rough, broken uplands on soft shale which include the Flasher-Bainville association in Treasure County and the Nelson-Alice association in Big Horn County. The Bainville-Midway association in Treasure County and the Wibaux-Thedalund-Spearman association in Big Horn County are also in this grouping. Complete details of all these soil associations are reported by Moshier and Fielder (1967) and Meshnick et al. (1972). Brief topography, surface runoff and vegetative descriptions from these surveys are included in Appendix Table 2.

The Bainville-Midway (T)/Thedalund-Midway (B) association makes up 64.6 percent of the study area (Table 2). It is followed by the Wibaux-Thedalund-Spearman (B) and Flasher-Bainville (T)/Nelson-Alice (B) associations with 9.7 percent and 9.2 percent, respectively. The Pierre-Lismas (T) association has 7.8 percent. The Wayden-Regent (B) association with 5.0 percent, and the Wanetta-Hesper (T) association with 3.7 percent comprise the remainder of the study area.

Vegetation Characteristics

For the purposes of this study, five broad vegetation types were identified within the Sarpy Creek drainage. Four of these represent native vegetation and include the ponderosa pine, sagebrush, grassland and creek bottom types. The fifth type, agricultural, was defined as those areas where crops were being produced. Alfalfa, wheat, barley and corn were the primary species produced.

A vegetation map (Figure 3) was drawn from 1975 false-color infrared photographs. Ponderosa pine, creek bottom, sagebrush/grassland and agricultural types were delineated. The areas and percentages of each type in the three sub-units are shown in Table 3.

Table 2. Soil association areas, in square miles, acres, hectares, and percent of total for the Sarpy Creek drainage.

Soil Association	AREA			
	Square Miles	Acres	Hectares	Percent
1. Wanetta-Hesper (T) ^{1/}	18.9	12,068	4,884	3.7
2. Pierre-Lismas (T)	39.4	25,202	10,199	7.8
3. Flasher-Bainville (T)/ Nelson-Alice	46.4	29,724	12,029	9.2
4. Bainville-Midway (T)/ Thedalund-Midway (B)	327.3	209,462	84,769	64.6
5. Wayden-Regent (B)	25.4	16,224	6,566	5.0
6. Wibaux-Thedalund-Spearman (B)	48.9	31,281	12,659	9.7
Sarpy Study Area	506.3	323,961	131,106	100.0

^{1/} T - Treasure County

B - Big Horn County

The ponderosa pine type was the most extensive, covering 154,465 acres (52 percent) followed by the combined sagebrush/grassland type with 117,555 acres (39.6 percent). Ponderosa pine was the most extensive type in the two large sub-units, Bear Creek and Absaloka. The sagebrush/grassland type was the largest in the Horse Creek sub-unit.

The creek bottom type consistently comprised between 2 and 3 percent of the total area. A total of 7,576 acres of this type was measured.

The percentage of area developed for agricultural interests varied from 3.7 percent in the Bear Creek sub-unit to 6.6 percent in the Horse Creek sub-unit. Most of this type occurred in a creek bottom situation. The total was 16,150 acres.

County roads and railroads each occupied about 0.2 percent of the study area. At the time the photographs were taken, the Absaloka Coal Mine covered 414 acres or about 0.1 percent of the total Sarpy Creek drainage.

Table 3. Acres and percentage of total area of vegetation types, county roads, railroads and mine sites by sub-unit in the Sarpy Creek Study area.

Vegetation Type	Bear Creek Sub-unit		Horse Creek Sub-unit		Absaloka Sub-unit		Sarpy Creek Study Area	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Ponderosa pine	58,685	54.4	25,785	32.5	69,995	63.6	154,465	52.0
Sagebrush/ grassland	42,514	39.4	45,733	57.6	29,308	26.7	117,555	39.6
Creek bottom	2,213	2.1	2,281	2.9	3,082	2.8	7,576	2.5
Agricultural	4,032	3.7	5,225	6.6	6,893	6.3	16,150	5.4
County road	185	0.2	188	0.2	165	0.2	538	0.2
Railroad	215	0.2	146	0.2	112	0.1	473	0.2
Mine	-	-	-	-	414	0.4	414	0.1
Total	107,844	100.0	79,358	100.0	109,969	100.1	297,171	100.0

Ponderosa Pine Vegetation Type

This type was the most diversified with six subtypes. It occupied the greatest amount of area within the Sarpy Creek drainage. It was defined as all areas in which ponderosa pine (*Pinus ponderosa*) occurred. The subtypes were determined by the dominant shrub in the understory. Edwards (1977) described a ponderosa pine mosaic vegetation type with four subtypes based on categories described by Pfister et al. (1974).

(1) Ponderosa pine subtype

This subtype was defined as dense stands of ponderosa pine occurring without a well developed understory. Krenzke (1976) referred to this subtype as "dog hair" thickets.

(2) Sagebrush subtype

In this subtype, big sagebrush (*Artemisia tridentata*) or silver sagebrush (*Artemisia cana*) were the dominant understory shrub. Usually big sage occurred on upland benches while silver sage was confined to mesic bottoms.

(3) Grassland subtype

The grassland subtype occurred in thin stands of ponderosa pine where no shrub development occurred. Some grasses associated with this savannah-like vegetation type include bluebunch wheatgrass (*Agropyron spicatum*), Idaho fescue (*Festuca idahoensis*), sideoats grama (*Bouteloua curtipendula*), little bluestem (*Andropogon scoparius*), western wheatgrass (*Agropyron smithii*), blue grama (*Bouteloua gracilis*) and Japanese chess (*Bromus japonicus*) (Edwards 1977; Krenzke 1976).

(4) Skunkbush subtype

The development of skunkbush sumac (*Rhus trilobata*), usually on steep south facing slopes, with sparse stands of ponderosa pine describe this subtype. Edwards (1976) described this type as *Rhus-Yucca* vegetation type. Martin (1972) described skunkbush vegetation associations in detail. On his sites, skunkbush was the dominant shrub species while bluebunch wheatgrass was the dominant grass species. Other grasses associated with skunkbush stands in southeastern Montana include cheatgrass (*Bromus tectorum*), little bluestem, Japanese chess and Junegrass (*Koeleria cristata*). Fringed sagewort (*Artemisia frigida*) was the primary forb species. Western yarrow (*Achillea millefolium*), common salsify (*Tragopogon dubius*), desert alyssum (*Alyssum desertorum*) and broom snakeweed (*Gutierrezia sarothrae*) were also of some importance.

Edwards (1977) reported Japanese chess, blue grama, and western ragweed (*Ambrosia psilostachya*) as the most frequently encountered grasses and forb species.

(5) Juniper subtype

This subtype occurred on north facing slopes and appeared to be the smallest of the subtypes. Rocky mountain juniper (*Juniperus scopulorum*) was the understory dominant. Creeping juniper (*Juniperus horizontalis*) also occurred in the study area.

(6) Snowberry subtype

The dominant shrub in the snowberry subtype was common snowberry (*Symphoricarpos albus*). Edwards (1975) reported western snowberry (*Symphoricarpos occidentalis*) as occurring in the area. This type occurred in creek bottoms, coulee bottoms, north slopes and other mesic sites within the ponderosa pine vegetation type.

Sagebrush Vegetation Type

In this type either big sagebrush or silver sagebrush occurred as the dominant shrub species. It was the second largest type and was found in two main portions within the study area. The largest expanse occurred west of Sarpy Creek in the Horse Creek sub-unit. A substantial stand was located east of Sarpy Creek in the northern portion of the Bear Creek sub-unit. Two vegetation subtypes were defined for this study.

(1) Sagebrush subtype

This subtype occurred where big sage or silver sagebrush comprised most of the canopy coverage. False-tarragon sawwort (*Artemisia dracunculus*), greasewood (*Sarcobatus vermiculatus*), and occasionally prairie rose (*Rosa arkansana*) were found in this type (Edwards 1977). Japanese chess was the most common grass in Edwards' study area, while field chickweed (*Cerastium arvense*), Hoods phlox (*Phlox hoodii*) and salsify were the primary forb species.

(2) Grassland subtype

The subtype occurred as islands of grass surrounded by sagebrush. The most common grasses found in this situation were western wheatgrass, Japanese chess, blue-bunch wheatgrass, blue grama, needle-and-thread (*Stipa comata*) and green needlegrass (*Stipa viridula*) (Edwards 1977).

Grassland Vegetation Type

Like the sagebrush vegetation type, this type has two subtypes. In this type, open grasslands were dominant with isolated patches of sagebrush.

(1) Grassland subtype

There was much variety in the grasses present. Generally bluebunch wheatgrass, western wheatgrass, Idaho fescue, needle-and-thread, blue grama, prairie sandreed grass [*Calamovilfa longifolia*], thread leaf sedge (*Carex filifolia*) and junegrass were the dominant grass species (Krenzke 1976). The more common forbs included low ragweed (*Ambrosia artemisiifolia*), yarrow, yellow sweet clover (*Melilotus officinale*), fringed sagewort, cudweed sagewort (*Artemisia ludoviciana*) and chickweed (*Cerastium arvense*).

(2) Sagebrush subtype

This subtype has vegetation similar to that described for the sagebrush subtype of the sagebrush vegetation type. It occurred as islands of sagebrush surrounded by grass.

Creek Bottom Vegetation Type

This type was found on the Sarpy Creek bottom lands and the bottoms of side drainages and coulees. The primary species found in this type were plains cottonwood (*Populus deltoides*), box-elder (*Acer negundo*), green ash (*Fraxinus pennsylvanica*), hawthorn (*Crataegus succulenta*), chokecherry (*Prunus virginiana*), buffalo berry (*Shepherdia argentea*), snowberry, grease wood, rose and currants (*Ribes* spp.) (Edwards 1977; Krenzke 1977). A large variety of grasses and forbs also occurred in the mesic creek bottom vegetation types. Two subtypes were defined for this vegetation type.

(1) Cottonwood subtype

All those areas which contained any of the three tree species, cottonwood, box elder or green ash, were placed in this subtype.

(2) Shrub subtype

Those creek bottom, coulee bottom or otherwise mesic areas with a well developed shrub cover and none of the three tree species listed above were included in this vegetative subtype.

Agricultural Vegetation Type

This vegetation type occurred within the natural types. It included all the areas involved in crop production. The primary crops raised in the Sarpy Creek area were alfalfa, barley, wheat and corn. Three subtypes were arbitrarily selected based on the proximity of the agricultural field to a natural vegetation type. The three subtypes were:

- (1) Ponderosa pine
- (2) Sagebrush/grassland
- (3) Creek bottom

WILDLIFE ECOLOGY

Three species, mule deer, antelope, and coyote (*Canis latrans*) were given year-long attention through most of the study period. Sharp-tailed grouse, sage grouse and ring-necked pheasants were given special attention during the spring breeding season. White-tailed deer and Merriam's turkey observations were made incidentally throughout the study period.

Mule Deer

Mule deer are the most abundant big game species on the study area. Because of their importance, a major portion of this study was devoted to gathering mule deer related data. During the four year study period 1,055 groups of mule deer were observed. In all, 4,906 mule deer were included in analyses for this report. The total observed varied considerably between seasons but was fairly consistent between years. The 1973-74 total was low because of less effort and time expended in data collection (Table 4).

Table 4. Mule deer observations by season and year during the Sarpy Creek study 1973-1977.

Year	Season				Total
	Winter	Spring	Summer	Fall	
1973-74	132	184	-	215	531
1974-75	312	387	75	693	1,467
1975-76	341	424	149	503	1,417
1976-77	335	578	215	363	1,491
Total	1,120	1,573	439	1,774	4,906

Distribution

The mule deer population appeared to be non-migratory. This is consistent with other deer herds in eastern Montana. Dusek (1978) reported mule deer in the Bull Mountains were non-migratory and had average home range sizes of 602 acres for does and 767 acres for bucks. Mule deer distribution in the Sarpy Creek area is shown by season in Figure 4. The movement of deer within their home ranges seemed to follow a seasonal pattern. During winter the deer were spread out over most of the study area with few concentration areas. During spring they made more use of the creek bottoms as they were the first to "greenup". Summer brought another dispersal, though not as wide as winter. The dry late summer and fall season resulted in the greatest concentrations of deer. These occurred in the moist coulees and creek bottoms.

Winter: Mule deer were observed throughout the study area during the winter months (Figure 4a). The heaviest concentration areas appear to be in the Horse Creek sub-unit between Beaver and Minnehaha creeks to the east of Sarpy Creek and in the Absaloka sub-unit between the head of Spring Creek and East Fork Sarpy Creek. Both of these areas were flown with a helicopter during the 1975-76 winter. Over 200 mule deer were observed on these two wintering areas (Martin 1977). This represents a density figure of approximately 21.3 deer per square mile. Considerably lesser density figures were realized utilizing the regular fixed-wing survey data. The reason is that these areas are timbered draws and breaks with open sagebrush/grassland ridges and plateaus. The observability bias of mule deer in ponderosa pine and juniper is well known. Because of the bias introduced by the inclusion of helicopter obtained observations it is possible that other wintering areas may be at least as important as the two described above. Two other important wintering areas are found astride West Bear Creek in the Bear Creek sub-unit and in northwest portion of the Absaloka sub-unit between Sarpy Creek and the Sarpy-Tullock Creek divide.

Spring: A substantial increase in the number of observations made along the Sarpy bottom land is shown in Figure 4b. Many of these observations were of mule deer feeding in the agricultural creek bottom vegetation type. They were undoubtedly taking advantage of the early appearance of newly green herbaceous material (Lovaas 1958, Mackie 1970, Dusek 1978). Many were observations of deer returning to the protective cover of the ponderosa pine vegetation type from feeding on the open creek bottom.

Observations were made over most of the study area. Again the range astride West Bear Creek seemed to support a large number of deer. Two lesser concentration areas were in the northwest portion of the Absaloka sub-unit and between East Fork Sarpy Creek and Horse Creek in the Horse Creek sub-unit.

Figure 4b. Deer distribution in the Sarpy Creek study area.
(Spring observations: 1974 through 1977).

Summer: Mule deer were most difficult to find during the summer season. Less than 9 percent of all observations were made during the three summer months of June, July and August. The primary reason is probably the ready availability of forage throughout the study area and the resultant dispersal of animals. Average group sizes for mule deer are substantially smaller during the summer season (Dusek 1978, Knowles 1975).

The trend toward concentration along creek bottoms seems to be more pronounced (Figure 4c). The area north of West Bear Creek sported several mule deer observations in 1976 while the area west of Sarpy Creek in the Absaloka sub-unit received heavy use by mule deer in 1977.

Fall: The fall season revealed the highest numbers of mule deer observed (Table 4). This increase is due to at least two factors. First, there are more deer to see as the young of the year are now traveling with the adults. Secondly, and most important, the deer are heavily concentrated along the major creek bottoms and coulee bottoms (Figure 4d) where they are more observable.

The dryness of the uplands forced deer to seek out the bottomlands in search of succulent vegetation. Perhaps this season is the most critical on the prairies of eastern Montana because just when deer are trying to build up their reserves to survive the rigors of winter they must face the highest intra-specific competition in terms of density. The potential for additional stress from domestic livestock which seek out the more mesic bottom land vegetation also exists. Knowles (1975) stated that "the limited mobility of mule deer made them vulnerable to any situation which resulted in intensive use of their home range by other ungulates."

Population Characteristics

Historically, mule deer in the Sarpy Creek area experienced a population low during the 1920's while their highest levels were observed in the 1950's (Martin 1975). The local residents reported a gradual decline during the 1960's followed by a sharp decline between 1972 and 1973. Swenson (1978) includes this study area within the "declining mule deer population" portions of Fish and Game management Region 7. He contends that mule deer populations were over exploited by hunters in relation to recruitment rates during the 1971-1975 period, resulting in a present population level below what would have been without the high hunting pressure.

One method of determining population trend is the indices of relative abundance (Odum 1959). Mule deer observations per hour of aerial survey are shown in Table 5. Examination of fall observations per hour indicate a large reduction in the

Figure 4d. Deer distribution in the Sarpy Creek study area. (Fall observations: 1974 through 1977).

Table 5. Mule deer, antelope and coyote aerial observations per hour 1975-1977.

Season	Hours ^{1/}	Observations			Observations Per hour		
		Mule Deer	Antelope	Coyote	Mule Deer	Antelope	Coyote
Summer	7.9	49	197	3	6.2	24.9	0.4
Fall	15.8	569	235	30	36.0	14.9	1.9
1975	23.7	618	432	33	26.1	18.2	1.4
Winter	11.4	139	60	21	12.2	5.3	1.8
	5.0 ^{2/}	202	0	6	40.4	0	1.2
Spring	15.9	300	219	15	18.9	13.8	0.9
Summer	18.1	111	318	15	6.1	17.6	0.8
Fall	20.3	375	247	46	18.5	12.2	2.3
1976	65.7 ^{3/}	925	822	97	14.1	12.8	1.5
Winter	18.0	328	180	15	18.2	10.0	0.8
Spring	17.8	319	230	14	17.9	12.9	0.8
Summer	11.6	175	193	18	15.1	16.6	1.6
Fall	12.9	327	181	28	25.3	14.0	2.2
1977	60.3	1149	784	70	19.1	13.0	1.2

^{1/} Hours of fixed-wing flight

^{2/} Helicopter hours

^{3/} Excludes helicopter hours

mule deer population from 1975 to 1976 followed by an increase in 1977 (Figure 5). The 1977 observations per hour were increased over 1976 by 49 percent in winter, 115 percent in summer and 37 percent in fall. Hamlin (1977) reported a 40 percent increase in winter mule deer numbers from 1975-76 to 1976-77 for a prairie-agricultural mule deer population near Terry, Montana. These very similar concurrent increases in two areas approximately 100 miles distant indicate widespread mule deer population increases during the two year period. If one assumes that mule deer were equally observable in 1976 and 1977, then the increase of 5 deer observed per hour indicates an increase in the deer population.

Fall (pre-hunting season) mule deer population characteristics for the five year period, 1973-1977, are listed in Table 6. Population structure and reproduction are shown in Figure 6. Several trends are evident. The fawn per 100 does figure decreased from 86 in 1973 to 63 in 1976, a 27 percent drop in productivity over the four year span. The fawn per 100 adult figure dropped from 62 to 51, a 17 percent decline, during the same time frame. The percent of fawns in the population was fairly stable during the four years, decreasing from 38 to 35 percent. However, this is below the 40 percent level needed to maintain population stability (Swenson 1978). The percentage of does in the population increased steadily from 45 percent in 1973 to 55 percent in 1976. Meanwhile the percentage of bucks decreased from 17 to 11 percent. Then came 1977 and a host of changes. The percentage of does decreased 8 percent while the percentage of fawns increased 10 percent. Production figures skyrocketed from 63 to 94 fawns:100 does and 51 to 81 fawns:100 adults. The only indices which contained its former trend was seen as the percentage of bucks in the population reached its lowest point of the study, 8 percent.

What happened? Elimination of the "B" tag and initiation of a buck-only season for mule deer in 1976 resulted in a 68 percent decline in the number of deer hunters and a 77 percent reduction in mule deer harvested throughout Fish and Game Region 7 (Swenson 1978). A review of 10 years of harvest data compiled by the Montana Fish and Game Department (Eustace and Swenson 1977; Swenson 1978) is shown in Table 7.

A tremendous fluctuation in the number of hunters in southeastern Montana occurred during the early seventies. The peak numbers occurred in 1971 and 1972 in the Sarpy Creek area which is contained within districts 720 and 722 (Figure 7). The regional peak occurred later, 1973-1975, with over 51,000 hunters afield in 1974. Greater restrictions initiated in other regions of the state were one important reason for this increase (Eustace and Swenson 1977). The earlier peaks noticed within the Sarpy Creek area are probably related to the population boom in Rosebud, Treasure and Big Horn counties caused by increased

Figure 5. Fall mule deer, antelope and coyote observations per hour of fixed-wing aerial survey 1975-1977.

Figure 6. Fall mule deer population structure (percent bucks, does and fawns-bar graph) and production (fawns per 100 adults - line graph) in the Sarpy Creek drainage from 1973 through 1976.

Figure 7. Deer hunters in Fish and Game Region 7 and hunting districts 720 and 722, 1968-1977.

Table 6. Fall mule deer population characteristics in the Sarpy Creek drainage 1973-1977.

	Bucks	Does	Fawns	Total	Fawns:100		Bucks:	Population Structure		
					Does	Adults	100 Does	Bucks	Does	Fawns
1973 ^{1/}	8	21	18	47	86 ^{2/}	62	38	17	45	38
1974	31	104	80	215	77	59	30	14	48	37
1975	69	364	260	693	71	60	19	10	53	37
1976	54	275	174	503	63	51	20	11	55	35
1977	29	172	162	363	94	81	17	8	47	45
Average					78	63	25	12	50	38

^{1/} Based on observations of Stephen J. Knapp, Biologist, Montana Department of Fish, Wildlife and Parks. All other years observations by Peter R. Martin, author.

^{2/} All percentages rounded to nearest whole number.

Table 7. Mule deer hunter and harvest parameters for Fish and Game Region 7 and hunting districts 720 and 722, 1968-1977.

Year	Deer Hunters ^{1/}	Mule Deer Harvested	Percent Success ^{2/}	Deer Hunters: Mule Deer Kills Square Mile	Square Mile
HD 720					
1968	349	236	72 ^{3/}	0.5 ^{4/}	0.4 ^{4/}
1969	308	235	79	0.5	0.4
1970	281	166	59	0.4	0.3
1971	756	385	60	1.2	0.6
1972	1,123	396	45	1.8	0.6
1973	1,000	300	43	1.6	0.5
1974	830	264	48	1.3	0.4
1975	1,253	391	45	2.0	0.6
1976	379	73	32	0.6	0.1
1977	402	109	44	0.6	0.2

HD 722

1968	382	282	77	0.3	0.2
1969	676	643	100	0.5	0.5
1970	928	858	101	0.7	0.7
1971	1,932	1,264	71	1.6	1.0
1972	1,921	1,052	57	1.6	0.8
1973	1,474	739	53	1.2	0.6
1974	1,286	503	49	1.0	0.4
1975	1,452	490	40	1.2	0.4
1976	637	191	34	0.5	0.2
1977	526	195	42	0.4	0.2

Region 7

1968	13,379	10,148	95	0.5	0.4
1969	19,304	16,421	104	0.7	0.6
1970	19,102	16,590	106	0.7	0.6
1971	33,756	22,490	83	1.2	0.8
1972	41,439	26,308	78	1.5	0.9
1973	50,595	30,690	78	1.8	1.1
1974	51,253	26,585	76	1.6	0.8
1975	48,876	18,344	62	1.5	0.6
1976	15,766	4,115	57	0.5	0.1
1977	15,842	5,076	59	0.5	0.2

^{1/} Includes whitetail deer hunters

^{2/} Computed from both mule deer and whitetail deer harvest.

^{3/} Percentages rounded to nearest whole number

^{4/} Density figures rounded to nearest tenth.

coal mining activities near Colstrip and Hardin. Rosebud County experienced a 72.5 percent increase in population from 1970 to 1975 (Cumin Associates 1976).

As the number of hunters went up, the number of mule deer harvested also went up until the effects of over-harvesting began to appear. In 1972 numbers harvested in hunting unit 722 began to drop (Figure 8) and the trend continued until 1977 when they stabilized. The percent success figures began dropping in 1970 and 1971 (Figure 8) and have now rebounded slightly after two years of buck-only hunting.

A comparison in density terms of hunters and mule deer killed can be seen in Figure 9. The excessive number of hunters during the 1971-1975 period is easily seen. A proper relation between the number of hunters and the number of mule deer harvested occurred during 1968-1970. As long as the deer herd was not over-harvested the number of deer killed per square mile remained directly related to the amount of pressure put on them. When hunting pressure became too great for the population to maintain stability, the disparity between harvest and unit of effort increased and continued to increase until something was done. In this case a conservative buck-only season was adopted by the Fish and Game department and many private landowners closed their property to hunting.

Taking all of the above data into account the following can be said concerning the Sarpy Creek mule deer population:

- (1) It was relative stable until 1970.
- (2) In 1971 increased pressure by hunters began to over-harvest the herd.
- (3) By 1972 and 1973 numbers decreased substantially.
- (4) Continued harvesting of adult does contributed to depressed productivity and reduced herd recruitment.
- (5) Continued high hunting pressure removed more bucks than does from the herd resulting in decreasing percentages of bucks and increasing percentages of does in the population structure.
- (6) Population numbers and productivity bottomed out in 1976, the year more restrictive hunting regulations were adopted.
- (7) Protection of adult does resulted in increased herd productivity and the recruitment rate increased.
- (8) The percentage of bucks decreased further as they received all of the hunting pressure. Albeit there was a greatly reduced number of hunters from the

Figure 8. Deer hunters and mule deer kill per square mile in Fish and Game Region 7 and hunting districts 720 and 722, 1968-1977.

Figure 9. Deer hunters and mule deer kill per square mile in Fish and Game Region 7 and hunting districts 720 and 722, 1968-1977.

1971-75 levels, there were more hunters in 1977 than in 1968.

- (9) Mule deer numbers increased in 1977.

Seasonal Use of Soil Associations

The most used soil type by mule deer during the four year period was the Bainville-Midway/Thedalund-Midway (B-M/T-M) type. It had 74 percent of the 4,827 mule deer observations (Table 8). Even though this type was the largest of the six outlined (Table 2), it was the only one to exhibit positive statistical preference ($p=.05$) by mule deer. Three types received significantly ($p=.05$) less use than could be expected if the deer were randomly distributed over the study area: the Wanetta-Hesper (W-H), the Pierre-Lismas (P-L) and the Wayden-Regent (W-R). These accounted for 8 percent of the mule deer observed. The Wibaux-Thedalund-Spearman (W-T-S) association supported 10 percent of the observations. This was not significantly ($p=.05$) different from its 9.7 percentage of total area.

The distribution of chi-square values by frequency of occurrence within ten probability levels for mule deer usage of soil associations is shown in Figure 10. Antelope and coyote frequency distributions are given for comparisons among the three species. The graph shows a near normal distribution pattern over the non-significant portion (above $p=.05$) of the graph for mule deer. This is followed by a marked upswing in the extremely significant (very large chi-square value) portion of the figure. This indicates the frequency (26.6 percent) mule deer actively selected either for or against certain soil associations during the sixteen seasons of the study. The graph shows antelope to be more selective, 45.5 percent of chi-square values in the $p=.05$ or lower category, and coyotes to be less selective, 4.1 percent $\leq p=.05$, than mule deer.

Winter: Mule deer were observed in all soil associations during the course of the study. Positive preference was recorded for the B-M/T-M and W-T-S associations with overall averages of 78 percent and 11 percent, respectively. The B-M/T-M association received the most usage in all years ranging from 87 to 63 percent. The W-T-S association was the most variable ranging from no use in 1973-74 to 18 percent in 1974-75. The P-L and W-R associations had significant negative usage.

Spring: Again mule deer were seen in all six soil associations and the B-M/T-M accounted for the highest percentage. The 77 percent figure (significant positive use at $p=.05$) was nearly identical to the winter percentage, 78 percent. The F-B/N-A association had the second highest percentage (8 percent) but no preference was indicated. Likewise no significant usage

Figure 10. Frequency of mule deer, antelope and coyote seasonal soil type usage chi-square values by probability of greater value categories, 1974-1977.

was recorded for the W-T-S and W-R associations with 7 percent and 4 percent of the observations, respectively. Significant negative usage was observed in the W-H and P-L associations. The F-B/N-A and B-M/T-M associations were used all four years by mule deer.

Summer: Three significant positive usage levels were detected during the study. They were the F-B/N-A association (29%) in 1975, the B-M/T-M association (83%) in 1976 and the W-T-S association (20%) in 1977. No negative preferences were calculated. The B-M/T-M association had the highest seasonal average (67%) while the W-H and W-R associations (2% respectively) received the least use. No association's summer seasonal usage percentage was significantly high or low.

Fall: The B-M/T-M association received the most usage. Its 74 percent figure demonstrated positive significant preference. Three associations, the W-T-S with 6 percent, the W-R with 3 percent and the W-H with 1 percent, exhibited significant negative usage. Usage of F-B/N-A and P-L associations with 9 and 7 percent of the mule deer observations was not significantly different from expected levels.

In summary, the Bainville-Midway/Thedalund-Midway soil association received the highest usage by mule deer in all seasons of all years. It exhibited significant positive usage in all seasons except summer.

The Wibaux-Thedalund-Spearman association received significant positive usage during winter, exhibited no significant usage during spring and summer seasons, and received significantly less use than expected during the fall.

The Flasher-Bainville/Nelson-Alice association had one negative and two positive usage percentages reach significant levels during the study. No seasonal averages were significantly different from the expected.

The Pierre-Lismas association received significantly less deer use during winter and spring than expected. The total number observed on this association was also less than expected.

A negative preference was shown for the Wayden-Regent association for the winter seasons, the fall seasons and the overall total. Negative preference significant at the $p=0.05$ level was also exhibited in the Wanetta-Hesper association for the spring seasons, the fall seasons and the overall total.

Mule deer actively selected for or against certain soil associations 26.6 percent of the time. They were less particular than antelope and more selective than coyotes.

Seasonal Use of Vegetation Types

During the four years of study 4,906 mule deer were observed in the various vegetation types. The ponderosa pine type supported the highest number of observations, 53 percent (Table 9). The second highest number was observed on the sagebrush/grassland types, 23 percent. Agricultural and creek bottom types supported 14 and 10 percent, respectively. When these numbers were compared to the areas covered by each vegetation type (Table 3) via chi-square analysis, it was discovered that mule deer were seen in significantly larger numbers than expected in the agricultural and creek bottom types. Significantly fewer mule deer were observed in the ponderosa pine and sagebrush/grassland types. Most of the survey work was conducted during the early morning hours when the deer were feeding or returning from feeding. Also mule deer were much harder to spot under the cover of the ponderosa pine canopy. These biases cause the importance of the ponderosa pine type to be underestimated. Likewise, the ease of observation and the use of agricultural fields for feeding, especially in the spring, result in an upward bias in observations in the agricultural type. Despite relatively easy observation of deer in the sagebrush/grassland types, significantly fewer deer than expected were observed. The implication is that in the Sarpy area, mule deer are actively selecting against this habitat type. The creek bottom type, with its dense shrub layer and canopy of green ash and cottonwood trees, afforded good escape cover for deer and they are relatively difficult to see. Despite this bias, which like the ponderosa pine type, probably down-graded the importance of the creek bottom type, it supported significantly higher mule deer numbers than could be expected from the 2.5 percent of total area it occupied within the Sarpy Creek ecosystem (Table 3).

The distribution of chi-square values by frequency of occurrence within the ten probability categories for mule deer, coyote and antelope usage of the vegetation types is shown in Figure 11. This graph shows both mule deer and antelope are highly selective for (or against) the various vegetation types. Mule deer exhibited a significant preference or avoidance 48.0 percent of the time. Antelope and coyotes followed with 46.7 and 35.0 percent respectively. From this it seems that mule deer and antelope are more actively selecting vegetation types than are coyotes. Comparing the mule deer vegetation usage graph (Figure 11) with the soil association usage graph (Figure 10) reveals a shift towards the extremes in the former over the latter. This indicates that mule deer are more influenced by vegetation type than soil association in their choice of habitat.

Winter: During the winter months the ponderosa pine type was the most important vegetation type (Figure 12). Usage ranged from 63 percent in 1975-76 to 89 percent in 1973-74 (Table 9).

Figure 11. Frequency of mule deer, antelope, and coyote seasonal vegetation type usage chi-square values by probability of greater value categories, 1974-1977.

Figure 12. Seasonal mule deer vegetation type usage 1974-1977.

Table 9. Seasonal mule deer vegetation type usage in the Sarpy Creek drainage 1974-1977.

	Ponderosa Pine							Sagebrush			Grassland			Creek Bottom			Agricultural				
	Observed	Pond- erosa Pine	Sage- Brush	Grass- Land	Skunk Bush	Juniper	Snow- Berry	Total	Sage- Brush	Grass Land	Total	Grass Land	Sage- Brush	Total	Cotton Wood	Shrub	Total	Pond- erosa Pine	Sagebrush/ Grassland	Creek Bottom	Total
Winter																					
1972-74	132	27 ^{1/}	4	15	42	-	-	89+	-	2	2*	-	-	-*	-	2	2	-	-	8	8
1974-75	312	23	28	4	22	6	-	84+	9	-	9*	1	-	1*	3	-	3	3	-	-	3
1975-76	341	23	12	7	13	8	-	63+	10	-	10*	15	-	15*	-	8	8	5	-	-	5
1976-77	335	6	30	12	27	2	4	79+	9	-	9	2	-	2*	1	5	6	3	2	-	4
Total	1,120	20 ^{2/}	18	12	26	4	1	79+	7	1	8*	4	-	4*	1	4	5	3	tr	2	5
Spring																					
1974	184	17	32	14	4	4	-	70+	-	16	16*	4	2	7*	-	2	2	6	-	-	6
1975	387	2	11	7	5	-	-	25*	21	4	25	11	3	14	1	3	4	2	10	21	32+
1976	424	5	10	13	6	2	7	43*	27	2	29	10	2	12	2	2	4	6	3	2	11+
1977	578	2	21	10	9	1	2	45*	25	6	31	8	-	8	2	tr	2	2	2	10	14+
Total	1,573	6	18	11	6	2	2	46*	18	7	25	8	2	10	1	2	3	4	3	8	16+
Summer																					
1974	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1975	75	16	7	-	24	4	-	51	20	9	29	8	-	8	3	1	4	-	-	8	8
1976	149	13	11	3	9	1	11	47	17	3	20*	5	-	5*	5	9	13+	1	-	14	15+
1977	215	4	11	1	25	1	12	53	12	4	16*	2	1	3*	2	4	6	9	-	14	23+
Total	439	11	9	1	19	2	7	50	16	6	22*	5	tr ^{4/}	5*	3	5	8+	3	-	12	15+
Fall																					
1974	215	6	-	2	-	-	-	8*	-	1	1*	6	-	6*	27	31	58+	22	-	6	27+
1975	693	17	8	7	4	2	-	36*	15	1	16*	6	tr	6*	8	13	21+	4	2	15	21+
1976	503	10	7	7	10	-	8	41*	11	-	11*	2	-	2*	3	12	15+	8	1	24	32+
1977	363	7	9	11	20	3	12	62+	14	8	23*	3	-	3*	1	7	8+	1	4	tr	5
Total	1,774	10	6	6	8	1	5	37*	10	3	13*	4	tr	4*	9	16	26+	9	2	11	21+
Study Total	4,906	12 ^{3/}	13	8	15	2	4	53*	13	4	17*	5	1	6*	4	7	10+	5	2	8	14

1/ Percentage of years observations

2/ Average of yearly percentages

3/ Average of seasonal percentages

4/ tr = trace; a percentage less than 0.5

+ - Positive usage significant at $p=.05$ * - Negative usage significant at $p=.05$

In every year the number of deer observed in the ponderosa pine type was significantly higher than expected. Although deer were easier to see with a good snow cover, the ponderosa pine type was undoubtedly important for food and cover during the winter months.

The sagebrush/grassland which offered neither a critical forage supply nor shelter from the cold supported significantly less mule deer than expected during the winter months. The combined number observed was the second highest at 12 percent. Yearly figures ranged from 2 percent in 1973-74 to 25 percent in 1975-76. The 1975-76 winter was the only one in which usage of the sagebrush/grassland types exceeded 11 percent. A large snowfall that season may have forced the deer to seek out wind blown ridges and hilltops in search of forage (Martin 1977).

Neither the creek bottom nor agricultural types, with an average 5 percent of the mule deer observations, respectively (Table 9), exhibited a significant deviation from the numbers expected in any year.

Spring: The agricultural type seems to be the most important type during the spring season in most years. It exhibited positive significant preference in all years except 1974 and averaged 16 percent of the mule deer observations. Mule deer were seen feeding on creek bottom alfalfa fields in large groups at this time. These areas were the first to "green-up."

The greatest numbers were generally noted in the ponderosa pine type. In 1974, the 70 percent observed was significantly higher than expected but all other years were marked by lower than expected numbers observed. The overall average, 46 percent, was also significantly lower than expected.

The sagebrush/grassland types averaged 35 percent of the mule deer observations. Only in 1974 were any of the percentages significantly different from the expected and then significantly lower. The creek bottom type, average 3 percent, was at its lowest point of the year.

Climatological data (Table 1) shows the spring of 1974 to be the wettest of the study period. This, combined with above average temperatures, resulted in early general growth of forbs, especially within the ponderosa pine, sagebrush and grassland subtypes (Table 9), and accounts for the patterns of vegetation type usage exhibited in 1974. Obviously, when given a choice, mule deer prefer the sanctuary offered by the ponderosa pine type.

Summer: The agricultural type received significantly more use than expected in 2 of the 3 years in which observations were made and averaged 15 percent. Most of these observations (80 percent) were made in the creekbottom subtype. The importance of the creek bottom type is further shown as 13 percent of the mule deer, significantly more than expected, were observed in this type in 1976, and 8 percent during the course of the study.

The sagebrush/grassland types were selected against by mule deer as exhibited by the negative significant figures in Table 9. They averaged 22 and 5 percent, respectively.

While the ponderosa pine type supported the most observations, 50 percent, no significant preference was shown by mule deer for this vegetation type. The lowest percentage, 47 percent, was observed in 1976. This coincides with significant preference for the creek bottom type. Again the weather, this time hottest average temperature (Table 1), was the dominant influencing factor. As the uplands became increasingly dry, the deer were forced to the mesic creek and coulee bottoms (Martin 1976).

Fall: The shift of mule deer to the creek bottoms begun during the summer season is culminated during the fall when mule deer concentrations are the greatest of the year. An average of 26 percent of the mule deer were observed on only 2.5 percent (Table 3) of the land base. In 1975, when 21 percent of 693 deer observed were on creek bottoms, there would have been in excess of 11-13 deer per square mile. There were significantly more deer observed than expected on the creek bottom type in all four years of the study (Table 9). Its importance is further shown (Figure 12) as it was second only to the ponderosa pine type in total numbers observed.

Significant preference was noted in 3 of the 4 years in the agricultural vegetation type. The four year average, 21 percent, was also significantly higher than expected. The only year usage of the agricultural vegetation type was not significant, 1977, corresponded to the year the agricultural creek bottom subtype (Table 9) supported only a trace of the mule deer observed.

Ponderosa pine usage was at its lowest point of the year, 37 percent average. Use was significantly lower in all cases except the fall of 1977, when it was significantly higher than expected. General widespread rainfall caused the uplands to "green-up" relieving the pressure of mule deer on the creek bottoms. Early arrival of winter in 1977 also contributed to the dispersal of deer from the creek bottoms. Again mule deer chose the ponderosa pine type when it was available.

The sagebrush/grassland vegetation type received significantly less use than expected in all years and had a combined four year average of 17 percent of mule deer observations.

In summary, the ponderosa pine type received the most use throughout the study (Figure 12). It supported significantly more deer than expected during the winter months extending into spring and fall depending on weather conditions. Mule deer seemed to prefer this type, actively choosing it over other types whenever possible. During the dry fall season, deer use of the ponderosa pine type was at its lowest.

The sagebrush/grassland type was second to the ponderosa pine in terms of numbers observed. However, at no time were more deer observed than expected. During winter, summer and fall significantly less deer were observed than expected. Obviously these vegetation types are not preferred by mule deer in the Sarpy Creek study area.

The greatest densities of mule deer in the study were observed on the creek bottom type during the fall season. Use was also significantly greater than expected during the summer months. It appears that this smallest of the vegetation types is an important limiting factor of mule deer numbers in the study area, its importance rivaling critical winter ranges in the mountains of western Montana.

Use of the agricultural type was significantly higher than expected in all seasons except winter. That these areas are important to feeding deer is undeniable. The question is how much would they be used if the nearby protective cover of the creek bottom and ponderosa pine types were removed? Approximately 93 percent of the observations of mule deer on the agricultural type were on either the ponderosa pine or creek bottom subtypes.

Seasonal Activity

The number of deer observed standing and feeding was almost equal, 40 and 39 percent, respectively (Table 10). Since observation surveys were purposely planned to coincide with feeding times to maximize numbers observed, these activities should have been dominant. Numbers observed running and lying down were also equal at 10 percent.

Some interesting seasonal trends appear in Figure 13. The percentage of deer observed standing and lying down was highest during the winter season, 51 and 19 percent, respectively. Conversely, the number observed running was lowest (4 percent). The deer apparently were conserving energy.

During spring more deer were observed feeding (65%) than in any other activity at any season or year. They apparently were spending more time feeding, allowing higher numbers to be observed.

The numbers observed running increased from the winter low through spring to a high of 16 percent in both summer and fall.

Figure 13. Seasonal mule deer activity at time of observations, 1974-1977.

Table 10. Seasonal mule deer activity in the Sarpy Creek drainage 1975-77.

	Observed	Activity			
		Standing	Running	Lying	Feeding
Winter					
1974-75	312	58 ¹ / ₂	-	35	7
1975-76	341	45	9	9	37
1976-77	335	48	3	13	36
Total	988	51 ² / ₃	4	19	27
Spring					
1975	387	12	8	6	74
1976	424	33	8	6	54
1977	578	23	7	2	69
Total	1,389	23	8	5	65
Summer					
1975	75	29	20	8	43
1976	149	54	13	5	28
1977	215	51	14	9	27
Total	439	45	16	7	32
Fall					
1975	693	39	12	17	33
1976	503	40	17	8	35
1977	363	41	19	9	32
Total	1,559	40	16	11	33
Study Total	4,375	40 ³ / ₄	10	10	39
¹ / Percentage of years observations					
² / Average of yearly percentages					
³ / Average of seasonal percentages					

Seasonal Use of Topography

Usage of topographic features by mule deer is shown in Table 11. More deer were observed on hillsides than any other feature (41 percent). It was followed by creek bottoms (18 percent), plateaus (12 percent), coulee bottoms (10 percent) and valleys (9 percent).

Winter: Upland topographic features (hillsides, ridges, plateaus and coulee heads) accounted for 84 percent of the mule deer observations. The lowland types, coulee bottoms, valley floors and creek bottoms, had 7, 4 and 4 percent, respectively. This usage pattern is consistent with vegetation and distribution patterns reported earlier, i.e., mule deer are dispersed in the uplands during winter.

Spring: Usage of hillsides was at the highest level of the year (48 percent). An increase from 15 percent in winter to 34 percent in usage of the three lowland types was noted while usage of the ridge, plateau and coulee head features declined from 46 percent to 18 percent. The mule deer were feeding in the lowlands and traveling back to the uplands for cover. Consequently more observations were made on hillsides, a transitory feature, than either uplands or lowlands.

Summer: The pattern begun during summer was continued. Deer observed on the upland types decreased to 10 percent while those observed on the lowlands increased to 45 percent. The hillside category still supported the most observations, 44 percent. As the uplands dried out, more and more deer moved into the creek bottoms which had 22 percent of the mule deer observations.

Fall: Creek bottoms accounted for 27 percent of the mule deer observations and the lowlands had 47 percent, each seasonal high points. Usage of hillsides decreased to 38 percent and the uplands increased slightly to 16 percent. In 1975 and 1976, at the height of the dry spell, mule deer usage of the creek bottoms was 35 and 38 percent, respectively.

These data lend more support to the observation made earlier that mule deer congregate in the lowland creek bottoms during the dry summer and fall months and spread out over the upland types during winter.

Seasonal Use of Slope

The 4,847 mule deer classified were more or less equally divided between the four slope gradient categories (Table 12), each with approximately a quarter of the observations.

Table 11. Seasonal use of topography by mule deer in the Sarpy Creek Drainage 1974-77.

Season	Observed	Hill- side	Ridge	Plateau	Coulee Head	Coulee Bottom	Valley	Creek Bottom
Winter								
1974-75	312	47 ^{1/}	6	24	11	12	-	-
1975-76	341	25	21	19	16	1	10	8
1976-77	335	43	18	23	-	9	4	4
Total	988	38 ^{2/}	15	22	9	7	4	4
Spring								
1975	387	59	4	12	-	2	-	23
1976	424	40	1	18	-	13	19	8
1977	578	46	4	11	3	7	18	11
Total	1,389	48	3	14	1	8	12	14
Summer								
1975	75	48	8	1	-	8	17	17
1976	149	38	5	4	7	13	3	29
1977	215	45	1	5	-	18	10	21
Total	439	44	5	3	2	13	10	22
Fall								
1975	693	29	3	8	2	11	12	35
1976	503	36	6	5	4	5	5	38
1977	363	49	6	10	2	20	6	8
Total	1,559	38	5	8	3	12	8	27
Study Total	4,375	41 ^{3/}	7	12	4	10	9	18

^{1/} Percentage of years observations

^{2/} Average of yearly percentages

^{3/} Average of seasonal percentages

Table 12. Seasonal slope usage by mule deer in the Sarpy Creek drainage 1974-77.

Season	Observed	Slope Gradient			
		Flat	Gentle	Medium	Steep
Winter					
1973-74	116	41/	11	19	66
1974-75	312	1	41	21	37
1975-76	341	26	22	19	33
1976-77	335	20	27	13	40
Total	1,104	132/	25	18	44
Spring					
1974	141	4	29	33	34
1975	387	30	28	35	7
1976	424	22	38	32	9
1977	578	20	26	28	25
Total	1,530	19	30	32	19
Summer					
1974	-	-	-	-	-
1975	75	21	24	24	31
1976	149	33	11	52	3
1977	215	25	22	33	21
Total	439	26	19	36	18
Fall					
1974	215	68	22	4	6
1975	693	40	26	23	10
1976	503	55	13	21	11
1977	363	29	24	30	17
Total	1,774	48	21	20	11
Study Total	4,847	273/	25	27	21

1/ Percentage of years observations

2/ Average of yearly percentages

3/ Average of seasonal percentages

Winter: Flat land usage was at its lowest point (13 percent) but showed a range of 1 to 26 percent. Usage of steep gradients was 44 percent, the highest of the seasonal averages. It also exhibited a wide range, 33 to 67 percent. The two steeper gradients were marked by a 62 percent to 38 percent edge in numbers observed over the two flatter categories. The reason for this is that snow accumulations are less on the steeper slopes allowing the deer easier access to browse species.

Spring: This season shows a decrease in the usage of steep gradients and an increase in the other three. The two steep categories, medium and steep, had 51 percent of the observations, while the two flat categories, gentle and flat, had 49 percent. Again wide ranges were observed in the flat and steep categories between years.

Summer: Flat land observations increased to 26 percent but the two flat categories totaled only 45 percent, a slight decline from the spring season. The medium category reached its highest level of the year at 36 percent as the steeper categories were marked with 54 percent of the mule deer observations.

Fall: Mule deer usage of the flat category increased to 48 percent, the highest average of any category in any season. The two flat slope gradients together totaled 69 percent of the mule deer observed. The steep category, with 11 percent, was at its lowest point of the year. The two steeper gradient categories had 31 percent of the mule deer observations, also their lowest of the year. This pattern is reflective of the movement of mule deer into the mesic bottomlands.

Seasonal Use of Exposure

Mule deer utilized all exposures within the study area on a relatively equal basis. Percentages of deer observed ranged from a low of 5 percent on northwest slopes (Table 13) to a high of 13 percent on west exposures. Usage of northerly exposures over the four year period averaged 26 percent compared to 24 percent for the southerly exposures. Easterly and westerly exposures averaged 31 and 27 percent, respectively. Twenty-five percent of the mule deer were observed on flat lands. Creek bottom and plateau observations were included in the 'flat' category.

Winter: Use of southerly slopes was only slightly higher (35 percent) than use of northern exposures (32 percent). Only during the 1975-76 winter were there considerably more deer on the southerly slopes. That winter north and south exposures had 20 and 42 percent of the mule deer observations, respectively. Usage of the flat land category was also highest in '75-'76 when 26 percent of the mule deer were observed in that category. Winters were generally mild and open during the study period except for the winter of 1975-76 which had the highest recorded snowfall (Table 1).

Table 13. Seasonal use of exposure by mule deer in the Sarpy Creek drainage 1974-77.

Season	Observed	North	South	East	Exposure			NW	SE	SW	Flat
					West	NE					
Winter											
1973-74	116	14 ^{1/}	8	28	-	-		19	27	-	4
1974-75	312	5	4	4	13	25		12	15	21	1
1975-76	341	6	9	-	14	13		1	3	30	26
1976-77	335	12	10	2	26	17		4	3	14	13
Total	1,104	9 ^{2/}	7	9	13	14		9	12	16	11
Spring											
1974	141	8	8	14	37	-		-	26	4	4
1975	387	5	5	16	5	13		2	19	5	30
1976	424	14	15	20	6	6		4	9	4	22
1977	578	6	5	17	16	12		9	8	11	17
Total	1,530	8	8	17	16	8		4	15	6	18
Summer											
1974	-	-	-	-	-	-		-	-	-	-
1975	75	13	-	12	11	24		4	9	5	21
1976	149	10	10	8	17	10		2	5	5	33
1977	215	7	9	18	13	8		8	10	5	21
Total	439	10	6	13	14	14		5	8	5	25
Fall											
1974	215	-	4	2	6	7	tr ^{4/}	-	-	14	68
1975	693	11	5	8	11	12		3	7	3	40
1976	503	11	6	12	9	8		3	1	6	45
1977	363	10	12	8	19	13		8	3	9	19
Total	1,774	8	6	7	11	10		4	3	8	43
Study Total	4,847	9 ^{3/}	7	11	13	12		5	8	9	25

1/ Percentage of years observations

2/ Average of yearly percentages

3/ Average of seasonal percentages

4/ tr = trace; a percentage less than 0.5

Spring: Usage of southerly exposures decreased to 29 percent but still remained above the percentage of deer observed on northerly exposures (20 percent). The largest difference in usage between north and south slopes was observed in 1974 when they were marked by 8 and 38 percent, respectively. This year also had the most recorded spring precipitation (Table 1). Usage of flat lands increased to an average of 18 percent but only 4 percent of the deer observed in the spring of 1974 were in this category. The high precipitation resulted in a general "green-up" and the deer were able to find succulent forage throughout the study area.

Total use of east and west slopes increased from 22 percent in winter to 33 percent.

Summer: As the southern slopes began to dry out, mule deer moved to the mesic northern slopes and creek bottoms. Usage of northern slopes and flat lands increased to 29 and 25 percent respectively, while the percent of mule deer seen on southerly exposures declined to 19 percent. In 1975 considerably more deer were observed on northern (41 percent) than southern (14 percent) exposures. As might be expected, that summer had by far the lowest rainfall (Table 1).

Usage of east and west slopes was 27 percent.

Fall: More deer were observed on northerly slopes, average 22 percent, than on southern slopes, average 17 percent, in all years except 1974. The highest fall season precipitation was recorded in 1974 (Table 1). Use of flat lands was at its high point, averaging 43 percent for the four years of study. During this, the driest season of the year, 65 percent of the deer were observed in these most mesic sites, creek bottoms and northerly slopes.

Usage of east and west slopes declined to 18 percent.

Perhaps the most obvious fact pointed out by these data is the influence of precipitation on use of exposure. Each season when above average precipitation was recorded, mule deer shifted use to southerly exposures. During the dry months northerly slopes and flat lands, mostly creek bottoms, received the brunt of mule deer usage.

Pronghorn Antelope

Antelope are the second most abundant big game species in the Sarpy Creek area. Even though southeastern Montana is generally considered to be excellent antelope habitat, the Sarpy Creek area is marginal. A total of 2,852 antelope was observed during the four year study (Table 14). As with mule deer, fewer observations were made during the first year of study because less time and effort were expended. Only 307 antelope were observed during the winter season. This compares with 944 spring season observations.

Table 14. Antelope observations by season and year during the Sarpy Creek Study 1973-1977.

Year	Winter	SEASON			Total
		Spring	Summer	Fall	
1973-74	-	146	28	149	323
1974-75	67	183	197	284	731
1975-76	60	281	318	247	906
1976-77	180	334	197	181	892
Total	307	944	740	861	2,852

Distribution

Antelope observations show a major concentration area in the Horse Creek sub-unit (Figure 14) and two lesser concentrations, one each in the Bear Creek and Absaloka sub-units. Some movement seemed to occur between these areas and adjacent drainages. Amstrup (1976) reported movements of radioed female antelope of up to 30 airline miles between summer and winter ranges in the Decker area. Antelope were most concentrated during winter months and most dispersed in spring. Average group size ranged from over 50 in February and March to less than 7 in May and June in extreme southeastern Montana (Campbell 1970; Freeman 1971).

Winter: Very few winter observations were made during the four year study (Figure 14a). Only two winter ranges seem to be used by antelope in the Sarpy Creek area. One area is located in the northeast portion of the Bear Creek sub-unit. The other is in the Horse Creek sub-unit astride Sarpy Creek and extending west to the Sarpy-Tullock creek divide. These areas have primarily sagebrush/grassland vegetation (Figure 3).

No antelope observations were made in the Absaloka sub-unit. Apparently antelope migrate from this area onto Tullock Creek winter ranges. It is likely that antelope also leave their Horse Creek winter use areas during winters with deep snow accumulations. Low numbers observed (Table 14) during the winter months support this theory. The winter of 1976-77, in which observations were high, had average temperatures and below average precipitation (snow).

Spring: This season produced the highest number of group observations during the study period (Figure 14a). These observations occurred in all three sub-units. The Horse Creek sub-unit supported the most antelope. Antelope migrated from their wintering areas into upper Sarpy Creek and Sarpy Basin on East Fork Sarpy Creek. A concentration of observations was noted in the northeast portion of the Bear Creek sub-unit. A scattering of antelope were observed between the Horse Creek and Bear Creek concentration areas. The wide dispersal of antelope during the spring season is due to the fawning behavior of females. Kitchen (1974) reported parturient does leave the herd to fawn, reforming into nursery herds only when the young fawns were able to keep up with the herd.

Summer: The summer distribution pattern was similar to that observed in spring (Figure 14b). Most observations were made in the Horse Creek sub-unit. Distinct groupings were also observed in the northeast portion of the Bear Creek sub-unit and the Sarpy Basin area of the Absaloka sub-unit. A few scattered observations were still being made as the antelope were not formed into large herds as in winter.

Fall: The number of group observations outside the three major concentration areas decreased from that observed in summer continuing the trend from highest dispersal in spring. Again the antelope herd in the Horse Creek sub-unit was the largest. This is not surprising since the percentage of sagebrush/grassland vegetation is highest in the Horse Creek sub-unit at 57.6 percent (Table 3).

Population Characteristics

Local residents of the Sarpy Creek area reported antelope numbers were very low from the time of settlement until the 1940's (Martin 1975), with peak numbers occurring in the 1950-1960 decade. This closely parallels the numbers given by Compton et al. (1971). They reported antelope were abundant in Montana as late as 1896, dwindling during the period of agricultural development and increasing from approximately 11,000 in 1937 to 75,000 in 1965.

During the course of this study antelope numbers observed were highest in 1975-76, but were not greatly different over the final three years of the study ranging from 731 in 1974-75 to 906 the following year (Table 14). Antelope observations per hour of fixed-wing aerial observations were lowest during the 1976

season (Figure 5). Comparing the numbers observed per hour of flight during the fall season (Table 5) lends credence to the statement that the antelope population has remained quite stable throughout the study. The number observed per hour was 88.7 percent greater in the winter of 1976-77 than 1975-76. As stated earlier, the extremely mild nature of the 1976-77 winter probably accounted for this apparent difference in population level.

Summer and fall (pre-hunting season) antelope population characteristics for 1974 through 1977 are given in Table 15. Population structure and reproduction for the same period are illustrated in Figure 15. These data show the Sarpy Creek antelope herd to be quite stable. The percentage of fawns in the population fluctuated from a high of 30 percent in the summer of 1974 through a low of 15 percent in the fall of 1976 to average 23 and 21 percent for summer and fall, respectively. The number of fawns per 100 adults followed the same trend, higher in 1974 and 1977 with the low occurring in 1976. The decline in average from summer to fall (31 percent to 27 percent) is normal as the young antelope succumb to natural causes. The difference would have been greater except for 1975 when fall fawn:100 adult figures were higher than summer. This increase was probably caused by additional animals migrating into the study area from Tullock Creek. These stable production figures are considerably below historical figures for Fish and Game hunting districts 720 and 722 (Table 16). Wentland (1977) reports that antelope numbers in district 722 have declined below the levels experienced prior to the severe winter of 1964-65. He further states (Wentland 1976) that the fawn/100 female figures for 18 hunting districts for 1973, 1974 and 1975 were 93, 80 and 87, respectively. These figures are much greater than the comparable summer fawn:100 does figures observed in the Sarpy area (Table 15) of 59, 35 and 28 for the three years, respectively. Obviously production in the Sarpy Creek area is considerably below that in other portions of southeastern Montana. The percentage of does in the population has also remained stable, increasing slightly from 58 percent in the fall of 1974 to 60 percent in the fall of 1977, with an overall average of 61 percent (Table 15). The percentage of bucks has decreased slightly, from 20 in the fall of 1974 to 17 in the fall of 1977, and averaged 18 percent over the four years of study.

A compilation of 10 years of antelope harvest data is presented in Table 17. As with mule deer, the highest number of hunters in Region 7 was observed in the 1970-75 period (Figure 16). In the peak year, 1972, over 12,800 antelope hunters were active in southeastern Montana. Hunting districts 720 and 722 had 53 and 223 hunters afield in 1972, respectively. The number of hunters was severely limited in 1976 and 1977 in the two hunting districts at least partially because of the very low reproduction figures observed during the course of this study. The number of legal

Figure 15. Summer and fall antelope population structure (percent bucks, does, and fawns - bar graph) and production (fawns per 100 adults - line graph) in the Sarpy Creek drainage 1974-1977.

Figure 16. Antelope hunters in Fish and Game Region 7 and hunting districts 720 and 722, 1968-1977.

Table 15. Antelope population characteristics in the Sarpy Creek drainage during summer and fall 1974-77.

Season ^{1/}	Year	Bucks	Does	Fawns	Total	Fawns:100		Bucks:100	Population Structure(%)		
						Does	Adults	Does	Bucks	Does	Fawns
Summer	1974	10	29	17	56	59 ^{2/}	44	34	18	52	30
Fall	1974	30	86	33	149	38	28	35	20	58	22
Summer	1975	42	115	40	197	35	25	37	21	59	20
Fall	1975	47	168	69	284	41	32	28	17	59	24
Summer	1976	61	201	56	318	28	21	30	19	63	18
Fall	1976	48	161	38	247	24	18	30	19	65	15
Summer	1977	25	122	50	197	41	34	20	13	62	25
Fall	1977	30	109	42	181	39	30	28	17	60	23
Summer	Average					41	31	30	18	59	23
Fall	Average					36	27	30	18	61	21

^{1/} Summer - June, July and August
Fall - September, October and November

^{2/} All percentages rounded to nearest whole number

Table 16. Historical antelope population characteristics in the Sarpy Creek vicinity.^{1/}

Year	Fawns/100 Does		Fawns/100 Adults		Bucks/100 Does	
	720 ^{2/}	722	720	722	720	722
1963	75	103	60	75	25	38
1966	54	85	43	67	26	28
1969	79	86	56	65	39	32
1972	40	65	31	52	29	24
Average	62	85	48	65	30	31

^{1/} Taken from Wentland 1974.

^{2/} Fish and Game hunting districts.

antelope hunters do not reflect the increase of Rosebud County residents as the number of mule deer hunters did because antelope hunters are regulated by a permit system. However, the reproduction figures, already low because of the marginal nature of the habitat of the area, may have been further reduced because of increased human activity and/or poaching.

The number of antelope harvested reflected the number of hunters, again because of the permit system, and the percent of success remained fairly stable throughout the 10 year period (Figure 17). Percent success in Region 7 ranged from 72 to 83 percent with a median of 74 percent (Table 17). The comparatively small number of antelope harvested in the Sarpy Creek area is readily discernible as only one antelope was legally harvested in the area west of Sarpy Creek. Only 28 were harvested in all of districts 720 and 722 which are about three times the area of Sarpy Creek. Percent success was lower in both districts than in the entire region with 720 lower than 722.

Antelope hunter density in the Sarpy Creek area (Figure 18) is much lower than mule deer hunter density (Figure 9). The disparity between density of antelope hunters and kill is generally stable. This indicates antelope are not being over-harvested, either legally or illegally. If too many antelope were being taken by hunters, an increase in unit of effort (hunters per square mile) would result in less return (kill per square mile). In hunting districts 720 and 722, each increase or decrease

Figure 17. Antelope harvest and percent success in Fish and Game Region 7 and hunting districts 720 and 722, 1968-1977.

Figure 18. Antelope hunters and kill per square mile in Fish and Game Region 7 and hunting districts 720 and 722, 1968-1977.

Table 17. Antelope hunter and harvest parameters for Fish and Game Region 7 and hunting districts 720 and 722, 1968-1977.

Year	Hunters	Harvest	Percent Success	Hunter: Square Mile	Antelope Kill: Square Mile
<u>HD 720</u>					
1968	37	18	49	.06	.03
1969	36	22	61	.06	.03
1970	33	21	64	.05	.03
1971	41	12	29	.06	.02
1972	53	27	51	.08	.04
1973	13	6	46	.02	.01
1974	18	4	22	.03	.01
1975	23	11	48	.04	.02
1976	7	4	57	.01	.01
1977	1	1	100	.002	.002
<u>HD 722</u>					
1968	125	83	66	.10	.07
1969	162	111	69	.13	.09
1970	193	138	72	.16	.11
1971	164	112	69	.13	.09
1972	223	132	59	.18	.11
1973	144	94	65	.12	.08
1974	190	114	60	.15	.09
1975	175	92	53	.14	.08
1976	35	12	34	.03	.01
1977	42	27	64	.03	.02
<u>Region 7</u>					
1968	5,403	4,043	75	.19	.15
1969	8,379	6,238	74	.30	.22
1970	10,726	8,550	80	.39	.31
1971	11,299	8,160	72	.41	.29
1972	12,820	9,247	72	.46	.33
1973	11,079	8,047	73	.40	.29
1974	11,397	8,380	74	.41	.30
1975	10,572	7,852	74	.33	.25
1976	8,488	6,307	74	.27	.20
1977	9,334	7,737	83	.30	.24

in hunter density resulted in a corresponding increase or decrease in antelope kill per square mile.

The following statements can be made of the Sarpy Creek antelope population:

- (1) Antelope numbers have remained stable throughout the study but at levels below population peaks obtained in the early 1960's.
- (2) The population structure has remained stable with a composition of approximately 18 percent bucks, 60 percent does and 22 percent fawns during the summer and fall seasons.
- (3) Fawn production has decreased from about 89 fawns per 100 does in 1963 to average 41 fawns per 100 does during the four years of this study.
- (4) Fawn production is poor compared to other areas of southeastern Montana.
- (5) Numbers of antelope hunters and antelope killed are low compared to antelope hunters in other hunting districts of Fish and Game Region 7. They are also low compared to mule deer hunters and harvest in the Sarpy Creek area.
- (6) Hunters are not responsible for low antelope numbers and productivity within the study area.

Seasonal Use of Soil Associations

The most used soil type was the Bainville-Midway/Thedalund-Midway (B-M/T-M) association which supported 54 percent of the antelope observations (Table 18). Even so, it received significantly ($p=.05$) less use than expected. Two other associations, the Wayden-Regent (W-R) and Wibaux-Thedalund-Spearman (W-T-S), also were marked by the significant absence of antelope. Antelope preferred the Flasher-Bainville/Nelson-Alice (F-B/N-A), Wanetta-Hesper (W-H) and Pierre-Lismas (P-L) associations with the three types supporting 19, 15 and 10 percent of all antelope observations, respectively. All three percentages were significantly more than could be expected from a random distribution of antelope observations.

Distribution of chi-square values as explained previously is shown in figure 10. Like mule deer, antelope frequencies are distributed almost normally in the nonsignificant portion of the graph. A higher percentage of antelope seasonal soil type usage figures were significant than those of either mule deer or coyotes. This indicates that antelope are more sensitive to soil associations and their resultant effect on terrain and vegetation than the other two species.

Table 18. Seasonal use of soil associations by antelope in the Sarpy Creek drainage 1974-1977.

Soil Association	Winter					Spring					Summer					Fall					Study Total
	73-74	74-75	75-76	76-77	Total	74	75	76	77	Total	74	75	76	77	Total	74	75	76	77	Total	
	672/	60	180	307		140	183	281	334	938	56	197	318	197	768	149	284	247	181	861	2874
1. Wanetta-Hesper (T) ^{1/}	-	-	88+	47+	454/+	9	23+	4	4	10+	-	6	2	1	2	-	-	9	-	2	15 ^{5/}
2. Pierre-Lismas (T)	-	483/+	-	-*	16	4	10	7	3	6	34+	11	6	16+	17+	25+	8	21+	-*	14+	10+
3. Flasher-Bainville (T) /Nelson-Alice (B)	-	30+	-	-*	10	19+	15	13	18+	16+	36+	30+	19+	28+	28+	24+	32+	21+	29+	26+	19+
4. Bainville-Midway (T)/ Thedalund-Midway (B)	-	22*	12*	53*	29*	68	49*	76+	76+	67+	30*	46*	69	55*	50*	52*	59	41*	62	53*	54*
5. Wayden-Regent (B)	-	-	-	-*	-*	-	-	-	-	-*	-	-	-	-	-*	-	-	-	-	-*	-*
6. Wibaux-Thedalund-Spearman (B)	-	-	-	-*	-*	-*	-*	tr*	-*	tr ^{6/} *	-	7	4	-*	3*	-*	1*	8	8	4*	2*

^{1/} (T) - Treasure County; (B) - Bighorn County^{2/} Number observed^{3/} Percent of years observations^{4/} Average of yearly percentages^{5/} Average of seasonal percentages^{6/} tr = trace; a percentage less than 0.5

* - Negative usage significant at p=.05

+ - Positive usage significant at p=.05

Winter: Antelope were observed in all associations over the study period except the W-R and W-T-S. These associations (Figure 2) are found in the southern portions of the study area and have generally higher elevations and higher snowfall. Some sagebrush/grassland vegetation is found in the vicinity but ponderosa pine is the predominant vegetation type. These two factors, excessive snow depth and lack of sagebrush, explain why antelope avoid these areas in the winter.

Significantly fewer antelope were observed than expected in the B-M/T-M association (29 percent), the largest of the soil associations (Table 2).

Only the W-H association had more antelope than expected. It supported 45 percent of observations on only 3.7 percent of the land area. In the winter of 75-76, 88 percent of all antelope observed in the Sarpy area were found on the W-H soil association.

Spring: The B-M/T-M association received the most usage all four years of the study ranging from 49 percent to 76 percent. The F-B/N-A and W-H associations with 16 and 10 percent, respectively, exhibited positive preference by the antelope. Again the W-R and W-T-S associations received little or no use by antelope.

The W-H association, which exhibited high preference by antelope during the winter months, received significantly high use only in 1975 when temperatures were below average and precipitation was above average (Table 1). This association seems to be well suited to support antelope under adverse winter weather conditions. The F-B/N-A type had significantly more antelope than expected in the 1974 and 1977 spring seasons when both temperature and precipitation were above average.

Summer: The Flasher-Bainville/Nelson-Alice association, which comprises 9.2 percent (Table 2) of the area, accounted for 28 percent of the antelope observed during the summer months. It supported significantly more antelope than expected in all four years of the study, ranging from 19 to 36 percent. The Pierre-Lismas (P-L) association also received significantly more use than expected, averaging 17 percent of antelope observations.

The B-M/T-M association had significantly fewer antelope observations than expected all years except 1976. It averaged 50 percent, which although it was the highest percentage of any association during the summer months was significantly less than expected. The W-T-S association increased from a trace during spring to 3 percent in summer but also was marked by significantly fewer antelope observations than could be expected at the $p=.05$ level.

Fall: The pattern of fall usage was almost identical to that observed during the summer months. The B-M/T-M association had the most usage, 53 percent, but had significantly fewer antelope than expected. The F-B/N-A association again had significantly more observations in every year and averaged 26 percent, ranging from 21 to 29 percent. The dry summer and fall of 1976 saw the fewest antelope on the F-B/N-A association. That year antelope were displaced to the B-M/T-M association during summer, shifting to the P-L association in the fall. The P-L association sustained 14 percent of the antelope in the fall season, significantly more than expected. The W-T-S association which reached 8 percent in 1976 and 1977 and averaged 4 percent, the highest seasonal use of the year, still had significantly fewer antelope than expected under a random distribution pattern.

In summary, the Bainville-Midway/Thedalund-Midway association received the most use in every season except winter. It had significantly fewer antelope than expected in every season except spring when it had more than expected. This is in contrast to mule deer usage which was positively significant in every season except summer.

The Flasher-Bainville/Nelson-Alice association sustained the second highest number of antelope. It has significantly more than expected in every season except winter and one winter (1974-75) also showed significant preference by antelope. This differs from mule deer usage which was not significantly different than expected in any season.

The Pierre-Lismas association also received significantly more antelope use than expected, especially during the summer and fall seasons.

The Wanetta-Hesper association received the most usage of any soil type during the winter months. With 3.7 percent of the total area (Table 2), it sustained an average of 45 percent of the antelope observed. Clearly this association is a very important factor in winter survival. It received hardly any use (average 2 percent) during the summer and fall seasons.

The Wayden-Regent and Wibaux-Thedalund-Spearman received very little usage. No observations were made on the W-R during the study. No winter observations and only a trace during spring were recorded on the W-T-S association. Both associations had significantly fewer observations than expected at all times.

Antelope actively selected for or against various soil associations 45.5 percent of the time. That figure is 71 percent greater than that observed for mule deer. Apparently antelope are not as adaptable as are mule deer to the various soil associations. This phenomenon would partially explain why antelope are not as productive or abundant as mule deer in the study area.

Seasonal Use of Vegetation Types

A total of 2,852 antelope observations were included in analysis of vegetation type usage during the four year study. The sagebrush and grassland types, with 46 and 41 percent of all observations, respectively, were the most important types (Table 19). As the sagebrush/grassland type covered 39.6 percent of the study area (Table 3), it is easy to see why their combined 87 percent of observations was statistically significant. The agricultural type, 7 percent of observations, also, sported significantly higher numbers than expected. The largest vegetation type, ponderosa pine, had only 5 percent of the antelope observations, significantly fewer than could be expected on 52 percent of the land area. The creek bottom type received very little use, 1 percent, which was not significantly below the expected 2.5 percent.

The distribution of chi-square values by frequency of occurrence as explained in the mule deer section is shown in Figure 11. Antelope are very selective for vegetation types. They actively chose or avoided specific vegetation types in a significant manner 46.7 percent of the time. They were a little less selective than mule deer and more selective than coyotes. Comparing the vegetation usage graph (Figure 11) with the soil association usage graph (Figure 10) shows antelope to be equally influenced by vegetation and soil types in determination of their distribution.

Winter: The near total dependence of antelope on sagebrush during the winter season (Martinka 1967, Freeman 1971) is well known. The 100 percent occurrence of antelope within the sagebrush/grassland vegetation type (Figure 19) emphasizes that dependence.

Spring: The sagebrush/grassland types were again prominent, supporting 84 percent of the antelope observations. In each of the four years, there were significantly more antelope observed than expected. Antelope used all the vegetation types during the spring season. The agricultural type supported 8 percent of the antelope observations. Only in 1975, when 18 percent were observed in the sagebrush/grassland subtype were significantly more antelope than expected found to utilize the agricultural vegetation type. That same year, 1975, significantly more antelope than expected (13 percent) were seen in the creek bottom type. The four year average usage of the creek bottom type was 4 percent. The same percentage was observed in the ponderosa pine type. Antelope were observed in the ponderosa pine type only in 1976 and 1977. All four years of the study significantly fewer antelope than expected were observed in the ponderosa pine type.

Summer: Usage of sagebrush/grassland vegetation increased slightly over spring to 87 percent (Table 19). It received significantly more use than expected every year of the study.

Figure 19. Seasonal antelope vegetation type usage 1974-1977.

Table 19. Seasonal antelope vegetation type usage in the Sarpy Creek drainage 1974-1977.

Season	Observed	Ponderosa Pine						Sagebrush			Grassland		Creek Bottom			Agricultural					
		Pond- erosa Pine	Sage- Brush	Grass Land	Skunk Bush	Juniper	Snow- Berry	Total	Sage- Brush	Grass Land	Total	Grass- Land	Sage- Brush	Total	Cotton Wood	Shrub	Total	Pond- erosa Pine	Sagebrush/ Grassland	Creek Bottom	Total
Winter																					
1973-74	-	-	-	-	-	-	-	-*	-	-	-	-	-	-	-	-	-	-	-	-	
1974-75	67	-	-	-	-	-	-	-*	48	30	78+	22	-	22+	-	-	-	-	-	-	
1975-76	60	-	-	-	-	-	-	-*	-	-	65	35	100+	-	-	-	-	-	-	-	
1976-77	180	-	-	-	-	-	-	-*	100	-	100+	-	-	-	-	-	-	-	-	-	
Total	307	-	-	-	-	-	-	-*	49	10	59+	29	12	41+	-	-	-	-	-	-	
Spring																					
1974	146	-	-	-	-	-	-	-*	14	10	24+	56	13	69+	-	-	-	-	2	5	7
1975	183	-	-	-	-	-	-	-*	37	-	37+	30	3	33+	-	13	13+	-	18	-	18+
1976	281	tr ^{1/}	12 ^{2/}	7	2	-	-	10*	33	5	38+	45	5	49+	-	-	-	-	3	-	3
1977	334	-	1	4	2	tr	-	7*	41	7	47+	36	2	38+	2	tr	2	tr	4	1	5
Total	944	tr	13 ^{3/}	3	1	tr	-	4*	31	5	37+	42	5	47+	1	3	4	tr	7	2	8
Summer																					
1974	28	-	-	-	-	-	-	-*	-	54	54+	32	14	46+	-	-	-	-	-	-	-
1975	197	-	1	-	3	-	-	4*	39	6	45+	46	-	46+	-	-	-	-	5	-	5
1976	318	-	8	-	2	-	-	10*	37	3	40+	49	-	49+	-	-	-	-	1	-	1
1977	197	-	1	5	3	-	-	8*	21	9	30+	32	8	40+	-	-	-	-	6	16	22+
Total	740	-	2	1	2	-	-	5*	24	18	42+	40	6	45+	-	-	-	-	3	4	7
Fall																					
1974	149	-	-	-	5	-	-	5*	64	9	73+	5	-	5	-	-	-	-	16	-	16+
1975	284	-	2	1	-	-	-	3*	24	10	34+	46	10	56+	-	-	-	3	-	5	7
1976	247	-	3	4	-	-	-	7*	40	4	44+	39	-	39+	-	tr	tr	-	10	-	10
1977	181	-	-	-	18	-	-	18*	23	14	37+	9	14	23+	-	-	-	-	22	-	22+
Total	861	-	1	1	6	-	-	8*	38	9	47+	25	6	31+	-	tr	tr	1	12	1	14+
Study Total	2,852	tr	14 ^{4/}	1	2	tr	-	5*	36	11	46+	34	7	41+	tr	1	1	tr	5	2	7+

1/ tr = trace; a percentage less than 0.5

2/ Percentage of years observations

3/ Average of yearly percentages

4/ Average of seasonal percentages

+ - Positive usage significant at p=.05

* - Negative usage significant at p=.05

Agricultural type usage averaged 7 percent, ranging from no use in 1974 to 22 percent in 1977. The 1977 usage, bolstered by 16 percent in the creek bottom subtype, was significantly more than expected. No observations were made in the creek bottom vegetation type itself. The ponderosa pine type, which was marked by significantly fewer observations than expected in every year, averaged 5 percent.

Fall: While combined sagebrush/grassland usage was at its yearly low point, 78 percent, it was still significantly higher than expected. In the fall of 1974 only 5 percent of antelope observations were made on the grassland type. Otherwise significantly more antelope were observed on sagebrush/grassland types in every year of the study. Usage of the agricultural type was also significantly higher than expected, averaging 14 percent. Two years, 1974 and 1977, with 16 and 22 percent respectively, in the sagebrush/grassland subtype, accounted for this significance. The ponderosa pine type was marked with 8 percent of the antelope observations, the most it supported during the year. Nevertheless, significantly fewer antelope than expected were observed during every fall season within the ponderosa pine type. Only a trace of antelope (less than 0.5 percent) were observed in the creek bottom type.

In summary, the sagebrush and grassland types were the most important vegetation types to antelope in every season during the study. Usage varied from 100 percent in winter to 78 percent in fall. Sagebrush usage varied from 37 percent in spring to 59 percent in winter to 78 percent in fall. Sagebrush usage varied from 37 percent in spring to 59 percent in winter while grassland usage ranged from 31 percent in fall to 47 percent in spring.

The agricultural type, primarily the sagebrush/grassland subtype, was the second most important. It supported significantly more antelope than expected only during the fall season.

The creek bottom type received the most usage during the spring season when an average 4 percent were observed using it. The other seasons sported either no observations (winter and summer) or only a trace (fall).

The ponderosa pine type, which is the largest, had significantly fewer observations than expected in every season of every year. Fall, with 8 percent, was the season with the most usage.

Seasonal Activity

The percentage of antelope running at observation was 47 percent (Table 20). The relative openness of terrain and vegetative cover occupied by antelope and their inclination to run from danger (Kitchen 1974) explains this large percentage. The highest seasonal percentage running was winter, 75 percent,

Table 20. Seasonal antelope activity in the Sarpy Creek drainage 1975-77.

Season	Observed	Activity			
		Standing	Running	Lying	Feeding
Winter					
1974-75	67	-	78	-	22
1975-76	60	- ^{1/}	100	-	-
1976-77	180	52 ^{1/}	48	-	-
Total	307	17 ^{2/}	75	-	7
Spring					
1975	183	42	17	29	13
1976	281	49	15	7	30
1977	334	44	31	8	17
Total	798	45	21	14	20
Summer					
1975	197	52	37	7	5
1976	318	47	42	6	6
1977	197	37	42	-	21
Total	712	45	40	4	11
Fall					
1975	284	33	53	-	14
1976	247	54	36	5	4
1977	181	14	60	9	17
Total	712	34	50	5	12
Study Total	2,529	35 ^{3/}	47	6	12

^{1/} Percent of years observations

^{2/} Average of yearly percentages

^{3/} Average of seasonal percentages

and the lowest was spring, 21 percent. The small number of group observations resulting from the antelope congregating in large herds caused a large variability in winter activity percentages.

The second highest number of antelope were observed standing. This category was lowest during winter (17 percent) and highest in spring and summer, 45 percent each.

More antelope were observed feeding in the spring season (20 percent) than in the other seasons. The overall average was 12 percent.

Fewer antelope were observed lying down than in any other activity category. None were observed lying in winter while 14 percent were observed reclining during the spring season. The overall average was 6 percent.

Seasonal Use of Topography

Antelope usage of topographic features is presented in Table 21. Usage of the hillside category was the highest with 68 percent of all antelope observations. Plateaus and valley floors followed with 13 and 9 percent, respectively. The areas least used by antelope were coulee bottoms, coulee heads, creek bottoms and ridges.

Winter: Only three topographic features received any use during the winter months. Of these the hillside category, with 52 percent of antelope observations, was most important. Plateaus averaged 31 percent and valleys the remaining 18 percent of observations. These areas are the ones most likely to have available forage (sagebrush) during the winter months.

Spring: Usage of hillsides increased to 64 percent. Plateau and valley floor, with 13 and 12 percent of the observations respectively, usage declined from winter levels. Their usage was in the same low level as ridges and coulee bottoms except for 1975 on plateaus and 1977 on valley floors. Creek bottoms and coulee heads received little or no use during the three years data were gathered.

Summer: Usage of hillsides reached its highest average level during the summer season, 82 percent of antelope observations. The upland features (ridges, plateaus and coulee heads) received their least amount of usage, 3 percent. This is probably in response to the desiccation of forbs during the dry season. Usage of the lowland areas (coulee bottoms, creek bottoms and valley floors) did not increase as use of the uplands declined. The reason for that is antelope do not feel secure in the confines of those types. Their vision is at least partially obscured and escape routes are blocked by vegetation and topographic features such as bluffs, draws, and creeks.

Table 21. Seasonal use of topography by antelope in the Sarpy Creek drainage 1975-77.

Season	Observed	Topography				Coulee Head	Coulee Bottom	Creek Valley	Creek Bottom
		Hillside	Ridge	Plateau					
Winter									
1974-75	67	48 ^{1/}	-	22	-	-	-	30	-
1975-76	60	77	-	-	-	-	-	23	-
1976-77	180	30	-	70	-	-	-	-	-
Total	307	52 ^{2/}	-	31	-	-	-	18	-
Spring									
1975	183	48	4	29	-	15	4	-	-
1976	281	65	3	3	-	7	22	-	-
1977	334	78	1	9	-	3	9	tr	-
Total	798	64	3	13	-	9	12	tr	-
Summer									
1975	181	83	-	1	-	9	7	-	-
1976	318	79	10	tr ^{4/}	-	10	-	1	-
1977	197	82	-	-	-	-	2	16	-
Total	696	82	3	tr	-	6	3	6	-
Fall									
1975	284	76	2	9	-	3	6	5	-
1976	247	93	-	7	-	-	-	tr	-
1977	181	61	8	7	3	21	-	-	-
Total	712	77	3	8	1	8	2	2	-
Study Total	2,512	68 ^{3/}	2	13	tr	6	9	2	-

1/ Percentage of years observations

2/ Average of yearly percentages

3/ Average of seasonal percentages

4/ tr = trace; a percentage less than 0.5

Fall: Antelope were most evenly distributed during the fall season. Observations were made in every category and usage was evenly split between the upland and lowland features, 12 percent each. Usage of hillsides was quite high, 77 percent average, influenced by the extremely dry year, 1976, when 93 percent of all antelope were observed on hillsides.

Seasonal Use of Slope

Most of the antelope were observed on gentle or medium slopes, 40 percent each (Table 22). Antelope were least likely to be seen on flat lands, which included creek bottoms, and steep hillsides. The escape behavior pattern of running away, shown and discussed earlier, accounts for this usage pattern.

Winter: Usage of gentle and flat gradients were at their highest level of the year with 59 and 15 percent, respectively. Antelope were observed on a steep gradient only once during the four years of study, that in the winter of 1974-75, but it too was at its yearly high with an average of 12 percent. Obviously use of the medium slopes was at the low point of the year, 14 percent.

Spring: Usage of medium slopes increased to 51 percent. It was followed in importance by gentle slopes which supported 31 percent of the antelope observed. Use of steep and flat slopes were in direct opposition to each other although their average use was similar with 8 and 10 percent, respectively. In 1974 and 1977 use of flat gradients was low while use of steep gradients was high. In 1975 and 1976, the opposite situation occurred. Both 1974 and 1977 had above average temperature and precipitation. This may have been the causative factor as it influenced widespread early green-up.

Summer: Usage of medium gradient slopes reached its zenith during the summer season at 59 percent. It ranged from 89 percent in 1974 to 41 percent in 1977. Gentle slopes had the second highest percentage of antelope observations. Its 25 percent figure was the lowest of the year. Flat land usage was also at its low point of the year at 8 percent average and it ranged from 1 to 24 percent of summer antelope observations.

Fall: During the fall season antelope shifted use away from the medium and steep slopes to the flat and gentle gradients, establishing the trend which results in the winter extremes of usage. The gentle slopes were marked by 47 percent of the antelope observations while steep slopes supported only 3 percent.

Seasonal Use of Exposure

Over the four year study period antelope were observed on every aspect of exposure. The most were observed on north slopes, 16 percent, while the fewest numbers were seen on southwest slopes,

Table 22. Seasonal slope usage by antelope in the Sarpy Creek drainage 1974-77.

Season	Observed	Slope Gradient			
		Flat	Gentle	Medium	Steep
Winter					
1973-74	-	-	-	-	-
1974-75	312	11/	41	21	37
1975-76	60	23	57	20	-
1976-77	180	22	78	-	-
Total	552	15 ^{2/}	59	14	12
Spring					
1974	146	3	17	65	15
1975	183	10	47	43	-
1976	281	21	27	52	tr ^{4/}
1977	334	8	31	44	17
Total	944	10	31	51	8
Summer					
1974	28	4	7	89	-
1975	181	4	30	50	16
1976	318	1	41	54	4
1977	197	24	21	41	14
Total	724	8	25	59	8
Fall					
1974	149	-	70	30	-
1975	284	13	31	56	-
1976	247	7	40	49	5
1977	181	27	46	20	7
Total	861	12	47	39	3
Study Total	3,081	11 ^{3/}	40	40	8

1/ Percent of years observations

2/ Average of yearly percentages

3/ Average of seasonal percentages

4/ tr = trace; a percentage less than 0.5

5 percent (Table 23). Northerly exposures averaged 41 percent while southerly slopes supported 30 percent of the antelope observed. Easterly and westerly exposures had 48 and 30 percent of the antelope observed respectively while flat lands averaged 9 percent.

Winter: Use of northerly slopes (north, northeast and northwest) was the highest of the winter exposure usages at 46 percent. Southerly exposures (south, southeast and southwest) had 24 percent of the antelope observations. Flat lands were marked with their yearly high percentage of antelope observed, 15 percent. The westerly (west, northwest and southwest) exposures experienced their lowest usage level of the year at 7 percent.

Spring: Usage of southerly and easterly exposures, with 38 percent each, was the highest within the spring season. Antelope usage of northern exposures was 32 percent. This marked its lowest point of the year. Westerly exposure usage increased to 26 percent and flat land usage decreased to 10 percent.

Summer: Antelope, 49 percent of those observed, congregated on northerly slopes during the summer season. This compares to 30 percent observed on southerly slopes. Flat land usage was at its lowest point of the year, 6 percent.

Fall: Easterly exposures had the most usage, 48 percent of the antelope observed. Usage of northerly exposures decreased to 38 percent but was still 10 percentage points above southerly slope usage. Westerly slopes accounted for 30 percent of the antelope observations. Northerly and easterly exposures are generally more mesic than southerly and westerly exposures. This explains why the two former groupings of exposures received more antelope use in both fall and summer seasons. Antelope usage of the flat land category, which is primarily plateaus in this case, also was lowest during the dry seasons.

Table 23. Seasonal use of exposure by antelope in the Sarpy Creek drainage 1974-77.

Season	Observed	North	South	East	West	NE	NW	SE	SW	Flat
Winter 1973-74	-	-	-	-	-	-	-	-	-	-
1974-75	67	-	49	-	-	-	30	-	-	22
1975-76	60	77 ^{1/}	-	-	-	-	-	-	-	23
1976-77	180	30	23	22	25	-	-	-	-	-
Total	307	36 ^{2/}	24	7	8	-	10	-	-	15
Spring 1974	146	10	32	9	18	4	-	14	11	3
1975	183	-	12	20	7	11	26	15	-	10
1976	281	11	13	15	6	18	6	2	10	21
1977	334	7	18	6	2	28	7	13	12	7
Total	944	7	19	12	8	15	10	11	8	10
Summer 1974	28	25	11	-	-	21	25	14	-	4
1975	181	5	14	8	9	27	11	17	6	4
1976	318	13	8	19	3	13	14	20	9	1
1977	197	14	-	19	2	7	23	1	19	16
Total	724	14	8	12	3	17	18	13	9	6
Fall 1974	149	-	-	46	3	10	35	5	-	-
1975	284	18	6	6	10	11	7	30	-	13
1976	247	11	15	32	tr ^{4/}	10	10	6	10	7
1977	181	8	10	-	18	13	19	22	7	4
Total	861	9	8	21	8	11	18	16	4	6
Study Total	2,836	16 ^{3/}	15	13	7	11	14	10	5	9

1/ Percentage of years observations

2/ Average of yearly percentages

3/ Average of seasonal percentages

4/ tr = trace; a percentage less than 0.5

White-tailed Deer

White-tailed deer occur within the study area in relatively small numbers. For that reason, no detailed data analysis was included in this report.

White-tailed deer distribution is shown in Figure 4. Three separate small herds comprise the bulk of the observations. One of these is located at the northern end of the study area, one is located at the mouths of West Bear and Bear Creeks, and the third is located to the east of the Absaloka mine, south of East Fork Sarpy Creek.

Simpson (1977) described habitat utilization and population characteristics from 135 whitetail observations within Westmoreland's Tract III coal lease area. He stated that the ponderosa pine and upland drainageways were used for bedding, escape cover and possibly fawning. Most of his observations were made on agricultural types as the whitetails were feeding. Spring grains, alfalfa and "greening" winter wheat were the fields being used in spring, summer and fall, respectively. White-tailed deer in the Absaloka sub-unit had a production ratio of 75 fawns: 100 does in 1976 (Simpson 1977). This compares with 85 fawns: 100 does observed in Fish and Game Region 7 during the same year (Swenson 1978).

Coyotes

Coyote data gathering was intensified half-way through the study because of increased interest in this predator species generated by the ban on the use of the poison 1080 by Presidential decree and sharply higher prices for coyote pelts on the fur market. A total of 189 coyotes was observed during the two years of intensive coyote study. In both years, most coyotes were observed during the fall season.

Distribution

Seasonal coyote distribution is shown in Figure 20. Coyotes occurred throughout the study area. No areas were used on a continuous basis by the coyotes. There were more observations west of Sarpy Creek than east and slightly more observations in the Absaloka sub-unit than in the other two.

Population Characteristics

Coyote numbers in the Sarpy Creek area have remained fairly stable throughout the study period (Figure 5). Comparing numbers observed per hour of fixed-wing flight (Table 5) reveals 1.4, 1.5 and 1.2 coyotes/hour in 1975, 1976, and 1977, respectively. While summer observations increased from 0.4 to 0.8 to 1.6 for the 3 years respectively, numbers observed in winter and spring decreased from 1.8 and 1.2 coyotes/hour in each season during

Figure 20. Coyote distribution in the Sarpy Creek study area.

the 1977 surveys. Increased activity by fur trappers induced by very good prices for coyote pelts may have been responsible for the reduced numbers of coyotes observed. The reduced number is most likely a combination of fewer coyotes to observe and a learned avoidance of airplanes by the remaining coyotes.

Coyote numbers vis-a-vis mule deer numbers appear to have reached a peak in the 1976 season (Table 24) when there were 7.7 coyotes/100 mule deer. In all three years the summer ratio was highest and the spring ratio was lowest. The visibility of juvenile animals accounts for this shift as young coyotes are traveling earlier than mule deer fawns. The effects of winter harvest of coyote pelts also show up in the low spring ratio.

While more coyotes were seen in 1976 (Table 24), more survey hours resulted in only a slight rise in coyotes observed per hour. A large decline in mule deer observed per hour of flight during 1976 (Figure 5) was primarily responsible for the increase in the coyote:mule deer relationship. If mule deer numbers were greatly influenced by coyotes then 1977 should have seen mule deer numbers decline following the high of coyote numbers. In fact, mule deer numbers increased, as discussed earlier, and coyote numbers declined. Thus it seems that coyote numbers are fluctuating independently of mule deer numbers.

Table 24. Comparative coyote and mule deer observations in the Sarpy Creek drainage 1975-1977.

Season	Coyotes				Mule Deer				Coyotes/100 Mule Deer			
	1975	1976	1977	Average	1975	1976	1977	Average	1975	1976	1977	Average
Winter	16	27	15	19.3	312	341	335	329.3	5.1	7.9	4.5	5.9
Spring	15	16	19	16.7	387	424	578	463.0	3.8	3.8	3.3	3.6
Summer	4	17	18	13.0	75	149	215	146.3	5.3	11.4	8.4	8.9
Fall	31	49	28	36.0	693	503	363	519.3	4.4	9.7	7.7	6.9
Total	66	109	80	85.0	1,467	1,417	1,417	1,458.3	4.4	7.7	5.4	5.8

Seasonal Use of Soil Associations

During the course of the study none of the six soil associations averaged significantly more or less usage than expected (Table 25). In only three instances were there more coyotes found in a particular association than expected. The frequency percentage of chi-square values (Figure 10) is heavily weighted to the non-significant

Table 25. Seasonal use of soil types by coyotes in the Sarpy Creek drainage 1976-1977.

Soil Association	Winter			Spring			Summer			Fall			Study Total 189
	75-76 272/	76-77 15	Total 42	76 16	77 19	Total 35	76 17	77 18	Total 35	76 49	77 28	Total 77	
1. Wanetta-Hesper (T) ^{1/}	-	7	34/	-	-	-	-	-	-	-	-	-	15/
2. Pierre-Lismas (T)	43/	-	2	-	11	5	-	-	-	4	4	4	3
3. Flasher-Bainville (T) /Nelson-Alice (B)	11	13	12	6	5	6	6	39+	22	4	11	7	12
4. Bainville-Midway (T) /Thedalund-Midway (B)	74	47	64	81	58	70	71	61	66	59	75	67	66
5. Wayden-Regent (B)	7	33+	17	13	-	6	12	-	6	16+	4	10	11
6. Wibaux-Thedalund- Spearman (B)	4	-	2	-	26	13	12	-	6	16	7	12	8

^{1/} (T) - Treasure County; (B) - Bighorn County

^{2/} Number observed

^{3/} Percent of years observations

^{4/} Average of yearly percentages

^{5/} Average of seasonal percentages

+ - Positive usage significant at $p=.05$

95.8 percent, indicating that coyotes are not selecting for any soil association parameters. As they are very nearly randomly distributed over the entire study area, it follows that their primary food source is also widely dispersed throughout the study area.

The Bainville-Midway/Thedalund-Midway (B-M/T-M) association had the highest percentage of observations, 66 percent, while the Wanetta-Hesper association had the lowest, 1 percent.

Winter: Coyotes were observed on all six associations during the winter months. During the 1976-77 season, significantly more coyotes than expected were observed on the Wayden-Regent (W-R) association, 33 percent. This was a substantial increase over the 7 percent observed the previous year. The B-M/T-M association, which had the highest winter average at 64 percent, saw a large reduction in use from 1975-76 to 1976-77 with 74 and 47 percent for the two seasons, respectively. The reason for this switch is not clear at this time. This was the only season coyotes were observed on the Wanetta-Hesper association.

Spring: No significant deviations from the expected were observed during the spring season. This is related more to the low observation numbers than the lack of changes from one year to the next. The B-M/T-M association followed the same pattern observed during winter, i.e., high 1976 usage followed by a substantial decline in 1977. It was marked by the most observations, 70 percent, which was a slight increase over the winter average. Use of the Wibaux-Thedalund-Spearman (W-T-S) and Pierre-Lismas (P-L) associations was greatly increased in 1977, going from 0 percent to 26 and 11 percent, respectively. The W-R association exhibited the opposite patterns, decreasing from 13 percent in 1976 to 0 percent in 1977.

Summer: This season was noted for the least coyote dispersion. Only two associations, the B-M/T-M and Flasher-Bainville/Nelson-Alice, (F-B/N-A) received any use in 1977. The F-B/N-A, at 39 percent, received significantly more use than expected. The B-M/T-M, W-R and W-T-S associations each received about 10 percent less usage in 1977 than in 1976. The B-M/T-M association supported 70 percent of the summer coyote observations.

Fall: The B-M/T-M association again supported the highest numbers of coyotes, 67 percent, but was marked by a higher percentage in 1977 than in 1976. The W-R association had significantly more coyotes than expected in 1976. The fall season demonstrated the most consistent pattern of use by the coyotes. In both years, the same five soil associations sported coyote observations. This may indicate that the fall season weather is the most constant from year to year.

Looking at individual soil associations we see the B-M/T-M association had the most observations in every season during the two years. At no time was there a significant deviation from the expected number of observations. There was very little difference between seasons ranging from 64 percent in winter to 70 percent in spring. Summer and fall were practically equal with 66 and 67 percent of the seasonal observations, respectively.

The F-B/N-A received its highest use during summer (22 percent) and its least during spring and fall (5 and 7 percent, respectively). It also was used by coyotes each season both years.

The W-R association, which had 11 percent of the total number of coyotes observed, exhibited high numbers from spring 1976 through the winter of 1976-77. The last two seasons of that run were significantly higher than expected and were followed by two seasons of no observations. It seems likely that this area was heavily hunted during the winter of 1976-77. The hunting pressure would have forced some coyotes to leave, eliminated some and made the rest extremely wary of airplane traffic, explaining why observations dropped from significantly more than expected to zero. Zero was not less than expected because of the small area of the W-R soil association combined with the overall small number of coyotes observed during the spring and summer months.

The W-T-S association ranged from 2 percent in winter to 13 and 12 percent for spring and fall, respectively, of the coyotes observed. Its overall average was 8 percent.

The P-L and W-H associations with 3 and 1 percent of the coyote observations respectively, received the least use during the two years coyote data were compiled.

Seasonal Use of Vegetation Types

Only 189 coyotes were classified by vegetative type during the 1976 and 1977 seasons (Table 26). On a year-round basis coyote usage of vegetation types was fairly evenly split between the five types, ranging from 33 percent in the ponderosa pine type to 11 percent in the creek bottom type. Figure 11 shows that 35 percent of the seasonal vegetation type usage percentages had significant deviations from the expected levels. This is less than either mule deer or antelope displayed but much higher than the 4.2 percent figure calculated for coyote soil association usage (Figure 10). This indicates that coyotes are more dependent on vegetation types than soil association but not to the extent of mule deer and antelope.

Table 26. Seasonal coyote vegetation type usage in the Sarpy Creek drainage, 1976-1977.

	Winter 42 <u>1</u> /	Spring 35	Summer 35	Fall 77	Total 189
Ponderosa pine	33 <u>2</u> /	3	-	3	10 <u>3</u> /
Sagebrush	5	8	24	3	10
Grassland	17	-	-	13	7
Skunkbush	4	3	3	3	3
Juniper	3	-	-	-	1
Snowberry	-	-	6	4	2
Total Ponderosa pine	62	14*	32*	25*	33*
Sagebrush	6	31	36	32	26
Grassland	-	3	-	3	2
Total Sagebrush	6	34+	36	35	28
Grassland	23	21	6	4	13
Sagebrush	-	3	-	-	1
Total Grassland	23	24+	6	4	14
Cottonwood	-	6	-	2	2
Shrub	-	3	6	26	9
Total Creek bottom	-	9	6	28+	11+
Ponderosa pine	-	5	-	-	1
Sagebrush/grassland	-	3	-	5	2
Creek bottom	9	12	20	3	11
Total Agricultural	9	20	20	8	14

1/ Number observed during two years study (1976-1977)

2/ Average of yearly percentages

3/ Average of seasonal percentages

* = Negative usage significant at $p=.05$

+ = Positive usage significant at $p=.05$

Winter: There were no significant deviations from expected numbers of coyote observations during the winter season (Table 26). The ponderosa pine type received the most usage (62 percent). It supported a significantly high percentage in the 1976-77 winter, 80 percent (unpublished data). This was nearly double the usage recorded for the previous winter (Martin 1977). The combined sagebrush/grassland usage, which was equal to ponderosa pine in 1976-77, decreased from 44 percent to 13 percent and averaged 29 percent for the two years (Figure 21). The relatively harsh weather during the 1975-76 winter, may have forced the coyotes away from deep snow accumulations in the ponderosa pine type in search of prey.

Spring: Use of the grassland/sagebrush type increased to significantly high levels (58 percent) while observations within the ponderosa pine type dropped to 14 percent, the yearly low (Figure 21). Usage of agricultural types increased from 9 percent in winter to 20 percent (Table 26). Creek bottom observations also increased.

Summer: The sagebrush vegetation type had the highest percentage of coyote summer observations. Even though this was a slight increase over spring, it was not listed as being significantly high because sagebrush and grassland observations were treated statistically as occurring in the same type. Grassland usage declined to 6 percent (Table 26) and their combined percentage (42 percent) did not deviate from the expected number in a significant manner.

Usage of the ponderosa pine type increased to 32 percent but was still significantly low. No observations were made in the ponderosa pine type during the 1977 summer. Coyote usage of creek bottom and agricultural types continued to levels established during spring with 6 and 20 percent averages, respectively.

Fall: The fall season was marked by a substantial increase of coyote observations in the creek bottom vegetation type (Figure 21). An average 28 percent of coyotes observed (Table 25), a significantly high percentage, were in the creek bottom type. Usage of the sagebrush/grassland types was again highest, 39 percent, but not more than expected. Ponderosa pine usage, 25 percent, was less than expected. The number of coyotes utilizing the agricultural type decreased to 8 percent.

In summary, the sagebrush/grassland vegetation types supported the highest percentage of coyote observations in all seasons except winter (Figure 21) when ponderosa pine provided the most favorable conditions for coyote survival.

The agricultural type was important in spring and summer when crops were standing. Apparently rodents and other prey species vacated the fields after harvest in search of protective cover.

Figure 21. Seasonal coyote vegetation type usage 1976-1977.

Use of creek bottom vegetation during the dry fall season followed the same pattern established by mule deer. These increases must be related to the need of all species for water and further demonstrates the critical importance of the alluvial or riparian or creek bottom habitat, depending on which term is used to describe the same niche of nature.

Overall, the ponderosa pine type had more observations than any other single type. It was second to the combined sagebrush/grassland vegetation type usage. It was most used in winter and least used during the spring season.

Seasonal Activity

Nearly half of all coyotes were running at the moment of observation (Table 27). This is probably a result of their wary nature and a learned avoidance reaction to airplane hunters. The seasons with the highest percentage of running coyotes were winter and spring. These seasons either coincide with the time coyote pelts are prime or just after the hunting season. Seventy percent of coyotes observed in the spring season were running.

The second highest activity category was standing, 31 percent. This activity was most common in the summer time. Many young coyotes would sit and watch the airplane fly by while the adult would run, remembering the airplane hunters from the previous winter.

Relatively few coyotes were observed lying down or feeding, 12 and 10 percent respectively. The few coyotes observed feeding were family groups attending a livestock carcass. The fall season was marked by the highest percentages of coyotes observed lying down and feeding. Perhaps relative abundance of prey in the fall allowed coyotes to spend less time hunting and more time resting.

Seasonal Use of Topography

Usage of topographic features by coyotes is shown in Table 28. As with mule deer and antelope, most coyotes were placed in the hillside category (55 percent). Creek bottoms, with 21 percent of the observations, were the second most commonly used feature. The remaining features each received less than 10 percent of the observations.

Winter: The hillside category, with 70 percent, was at its highest level of the year. Plateaus, due to the 20 percent figure observed in 1977, were the second highest use category of 14 percent of the winter coyote observations. No observations were made in coulee heads or coulee bottoms.

Table 27. Seasonal coyote activity in the Sarpy Creek drainage, 1976-1977.

Season	Number Observed	Activity			
		Standing	Running	Laying	Feeding
Winter					
1975-76	27	30 ¹ / ₂	44	4	22
1976-77	15	20	73	7	-
Total	42	25 ² / ₂	59	5	11
Spring					
1976	16	31	56	13	-
1977	19	16	84	-	-
Total	35	24	70	6	-
Summer					
1976	17	47	41	6	6
1977	18	78	17	6	-
Total	35	62	29	6	3
Fall					
1976	49	10	22	18	49
1977	28	18	43	39	-
Total	77	14	33	29	25
Study Total	189	31 ³ / ₂	48	12	10

¹/ Percentage of years observations

²/ Average of yearly percentages

³/ Average of seasonal percentages

Table 28. Seasonal use of topography by coyotes in the Sarpy Creek drainage 1976-1977.

Season	Number Observed	Hill- Side	Ridge	Plateau	Coulee Head	Coulee Bottom	Valley	Creek Bottom
Winter								
1975-76	27	67 ^{1/}	7	7	-	-	7	11
1976-77	15	73	-	20	-	-	-	7
Total	42	70 ^{2/}	4	14	-	-	4	9
Spring								
1976	16	38	6	6	-	13	6	31
1977	19	53	5	21	-	11	5	5
Total	35	45	6	14	-	12	6	18
Summer								
1976	17	47	12	-	6	6	-	29
1977	18	67	6	-	-	-	-	28
Total	35	57	9	-	3	3	-	29
Fall								
1976	49	63	2	6	4	2	-	22
1977	28	36	4	14	-	14	-	32
Total	77	50	3	10	2	8	-	27
Study Total	189	55 ^{3/}	5	9	1	6	2	21

^{1/} Percentage of years observations

^{2/} Average of yearly percentages

^{3/} Average of seasonal percentages

Spring: The percentage of coyotes observed on hillsides remained the highest of the categories but declined to its low point of the year, 45 percent. The shift was made up in the coulee bottom and creek bottom categories. They increased from a combined total of 9 percent in winter to 30 percent. There was a large variation in creek bottom usage between 1976 and 1977 with 31 and 5 percent, respectively. Ridge, plateau and valley floor usage (6, 14 and 6 percent, respectively) remained nearly the same as observed in the winter season. Once again no observations were made in coulee heads.

Summer: Usage of hillsides and creek bottoms increased over spring levels. They supported 57 and 29 percent of the coyote observations, respectively. The number of coyotes using plateaus declined from the 14 percent levels observed in winter and spring to zero. This pattern may reflect movement to more mesic environs.

Fall: Coyotes remained on the hillsides and creek bottoms during the fall season, 50 and 27 percent, respectively. Plateau's replaced ridges as the next most common topographic feature used by the coyotes, 10 percent. Basically, the fall usage pattern is similar to that established during summer.

Seasonal Use of Slope

Coyotes were observed on all slopes in fairly even percentages (Table 29). The less steep gradients sported 56 percent of the coyote observations, slightly more than the 44 percent observed in the medium and steep slope categories.

Winter: The medium and steep slopes, with 47 and 12 percent of the coyote observations respectively, received their highest usage of the year. Coyotes may have been avoiding deeper snow on the more level terrain. During the 1976-77 winter only 27 percent of the observations were made on the flat and gentle gradients.

Spring: Flat land usage increased to 35 percent and gentle slope usage increased to 28 percent. Medium slope usage decreased to 24 percent of the coyote observations. The percent of coyotes observed on steep slopes ranged from zero in 1976 to 26 percent in 1977. The 1977 spring was warmer and wetter than the 1976 spring.

Summer: Coyotes shifted back to the steeper slopes but not to the extent observed during the winter season. Usage of steep slopes was at its annual high, 20 percent, while gentle slopes were marked by their lowest percentage of the year, 11 percent.

Fall: Coyotes followed the other wildlife species into the mesic bottom lands during the dry fall season. An average of 77 percent of the coyotes were seen on flat and gentle slopes, both of which registered annual highs. The steep slopes were marked by annual low percentages.

Table 29. Seasonal slope usage by coyotes in the Sarpy Creek drainage 1976-1977.

Season	Number Observed	Slope Gradient			
		Flat	Gentle	Medium	Steep
Winter					
1975-76	27	26 ^{1/}	30	33	11
1976-77	15	20	7	60	13
Total	42	23 ^{2/}	18	47	12
Spring					
1976	16	44	25	31	-
1977	19	26	32	16	26
Total	35	35	28	24	13
Summer					
1976	17	29	6	29	35
1977	18	33	17	44	6
Total	35	31	11	37	20
Fall					
1976	49	33	43	10	14
1977	28	54	25	18	4
Total	77	43	34	14	9
Study Total	189	33 ^{3/}	23	30	14

^{1/} Percent of years observations

^{2/} Average of yearly percentages

^{3/} Average of seasonal percentages

Seasonal Use of Exposure

During the course of the study coyotes were observed on every exposure in relatively equal numbers (Table 30). Southerly aspects, 29 percent of coyote observations, had slightly more usage than northerly slopes, 26 percent. Westerly slopes supported more observations than easterly slopes, 29 percent and 23 percent, respectively. The highest single category was flat land at 31 percent. This usage pattern is a reflection of the mobility of coyotes and their ability to utilize the entire study area in their search for food.

Winter: Like other species, coyotes congregate on the relatively warm and snow-free southerly (S, SE & SW) exposures during the winter months. Forty-nine percent of coyote winter observations were made on southerly slopes. The opposite aspects (N, NE & NW) were marked by only 20 percent of the coyote observations. Usage of flat lands was at its lowest point of the year, 24 and 15 percent, respectively.

Spring: Northerly and southerly exposures each supported 26 percent of the coyote observations. Usage of flat lands increased to 32 percent. The importance of easterly slopes was indicated by a two-fold increase over winter levels to 30 percent. With westerly slope usage at 22 percent, the spring usage pattern was the most balanced with the four aspects ranging from 22 to 30 percent and flat land usage at 32 percent. Perhaps the spring season has the least amount of stress and environmental hinderance for the coyote population.

Summer: Coyotes shifted usage to the mesic northerly slopes as 40 percent of coyote observations were made on those three exposures. Southerly slope usage remained constant at 27 percent of the coyote observations. Use of easterly slopes declined to the level observed during the winter season, 15 percent. The westerly slopes, bolstered by a hefty 31 percent figure for the northwest exposure, supported 52 percent of the coyotes observed. Flat land usage was constant at 31 percent.

Fall: Flat land, creek bottoms primarily, accounted for 37 percent of the fall coyote observations. Easterly slopes had 36 percent and northerly slopes, 20 percent. The more xeric westerly and southerly slope received 19 and 17 percent of the coyote observations, respectively.

Table 30. Seasonal use of exposure by coyotes in the Sarpy Creek drainage 1976-1977.

Season	Number Observed	North	South	Exposure East	West	NE	NW	SE	SW	Flat
Winter										
1975-76	27	11 ¹ / ₇	26	4	-	15	-	4	15	26
1976-77	15	7	33	-	13	7	-	-	20	20
Total	42	9 ² / ₇	30	2	7	11	-	2	17	23
Spring										
1976	16	-	13	6	6	-	25	-	6	44
1977	19	16	5	21	-	11	-	21	5	21
Total	35	8	9	14	3	5	13	11	6	32
Summer										
1976	17	-	6	-	-	18	6	6	35	29
1977	18	-	-	-	6	-	56	6	-	33
Total	35	-	3	-	3	9	31	6	18	31
Fall										
1976	49	4	4	35	4	10	-	4	8	31
1977	28	11	-	14	-	7	7	-	18	43
Total	77	7	2	25	2	9	4	2	13	37
Study Total	189	6 ³ / ₇	11	10	4	8	12	5	13	31

¹/ Percent of years observations²/ Average of yearly percentages³/ Average of seasonal percentages

Prairie Grouse

Sharp-tailed grouse are the most abundant game bird species found in the study area. Some sage grouse also are located in the Sarpy Creek drainage. A total of 422 sharp-tailed grouse (Table 31) was observed on 40 active grounds in 1977. Twenty-four sage grouse were observed on 3 strutting grounds. Banding projects in the Colstrip and Absaloka mine areas were continued in cooperation with employees of Ecological Consulting Service and Westmoreland Resources. Some telemetry work was conducted by these two companies.

Distribution

The 46 sharptail dancing grounds are shown in Figure 22. During the 1977 season, the Absaloka sub-unit had the highest number of active dancing grounds with 15 of 16 known grounds supporting birds. The Horse Creek sub-unit had displaying male birds on 14 of 19 arenas (dancing grounds) while there were birds on all 11 known grounds in the Bear Creek sub-unit (Table 31). In 1977, there were approximately 0.09 dancing grounds per square mile in the Sarpy Creek drainage. Sisson (1976) reported a range of .06 to .77 sharptail display grounds/square mile on three small areas in Nebraska. Schwarzkoph (1980) identified 19 active dancing grounds (0.12 per square mile) in the Colstrip vicinity.

While additional dancing grounds were discovered every year of the study (16, 16, 4 and 10 for 1974, 1975, 1976 and 1977, respectively) not all of the known arenas were used every year (Appendix Table 3). Two to six previously used grounds were vacant in each of the three latter years of study. This abandonment of certain locations is related to several factors including climate, land use patterns, available nearby cover and general population levels (Amman 1957, Pepper 1972, Sisson 1976).

There were four sage grouse strutting grounds found within the study area (Figure 22). Displaying birds have not been observed on ground #2 since the first year of the study (Appendix Table 3). While this arena may have been a satellite ground, it is unlikely since the ground is over 4 airline miles from the nearest active ground. Wallestad (1975) found radio-equipped cocks in central Montana ventured a maximum of 1.1 miles from their strutting grounds.

Population Characteristics

The number of male sharp-tailed grouse utilizing dancing grounds on a year-to-year basis has commonly been used to estimate spring population levels and establish population trend data. The number of males per active ground indicates the population high during this study occurred in 1975 (Figure 23) when there were 13.8 males/ground (Table 31). This is confirmed by Eng (1977), who found 13.7 and 9.5 male sharptail grouse per active

Figure 22. Prairie grouse breeding grounds, pheasant crow count routes and turkey observations (1974-1977) in the Sarpy Creek study area.

Figure 23. Male sharp-tailed grouse per active dancing ground in the Sarpy Creek area, 1974-1977.

Table 31. Prairie grouse breeding ground data, 1974-1977.

No. of Active Grounds					Male Birds Attend.				Average Male Birds/ Active Ground					Estimated Spring Population Density (Birds/sq. mi.)				
Sub-unit	74	75	76	77	74	75	76	77	74	75	76	77	Study Average	74	75	76	77	Study Average
<u>SHARP-TAILED GROUSE</u>																		
Bear Cr	2	4	6	11	26	49	71	94	13.0	12.3	11.8	8.5	11.4	0.5	0.9	1.3	1.7	1.1
Horse Cr	8	14	11	14	108	208	124	172	13.5	14.9	11.3	12.3	13.0	2.6	5.0	3.0	4.2	3.7
Absaloka	6	12	13	15	69	156	114	156	11.5	13.0	8.8	10.4	10.9	1.2	2.7	2.0	2.7	2.2
Total	16	30	30	40	203	413	309	422	12.7	13.8	10.3	10.6	11.9	1.3	2.7	2.0	2.7	2.2
<u>SAGE GROUSE</u>																		
Bear Cr	0	1	1	1	0	5	2	3	0.0	5.0	2.0	3.0	2.5	-	.06	.02	.03	.03
Horse Cr	3	2	2	2	35	37	37	21	11.7	18.5	18.5	10.5	14.8	.56	.60	.60	.52	.52
Total	3	3	3	3	35	42	39	24	11.7	14.0	13.0	8.0	11.7	.15	.18	.17	.15	.15

ground in 1975 and 1976, respectively on the Amax coal lease study area which is located in the Horse Creek sub-unit of the Sarpy study area, and Sullivan (1979), who reported 9.5, 9.8, 8.6 and 9.0 male sharptail grouse per ground for 1974, 1975, 1976 and 1977, respectively. Sullivan's study was conducted on Westmoreland Resources, Inc. Tract III coal lease area which is located within the Absaloka sub-unit of the Sarpy study area.

An estimation of population levels based on an assumed 1:1 sex ratio and the existence of non-territorial males present in the population (Ripplin and Boag 1974) at a minimum ratio of 1.5:1 (Knapp 1977), shows 1975 and 1977 to have nearly equal densities (Figure 24). This is the result of birds being observed on more grounds in 1977 than in 1975. Econ, Inc. (1978) reported the highest population levels of sharp-tailed grouse in the Colstrip area during 1975. The number of active dancing grounds within the Colstrip study area has increased by 10.5 percent since 1975 compared to a 25 percent increase in the Sarpy study area. Since the Colstrip area is about half the size of the Sarpy study area, it seems logical to assume a higher percentage of existing arenas were located during the first years of the Colstrip study than were found in the Sarpy study area. While some of the 14 new dancing grounds observed since the 1975 season were undoubtedly active previously, most of them were located in areas where the birds would have been observed had they been active. Hence, the increased number of active grounds in 1977 is probably a response to a generally higher population level. Unless all dancing grounds in an area are known and monitored on an annual basis, making statements about population levels and trends would be quite risky.

The number of male sage grouse attending the three major strutting grounds fluctuated from a high of 14.0 per ground in 1975 to a low of 8.0 per active ground in 1977. Absolute numbers observed followed this same pattern (Table 31). The Horse Creek sub-unit, which had the highest amount of sagebrush/grassland (Table 3), supported the highest densities of sage grouse within the study area, 0.52 per square mile (Table 31).

Use of Soil Associations

The Flasher-Bainville/Nelson-Alice soil association supported the highest number of male sharptails/dancing ground, 12.8, followed closely by the Wibaux-Thedalund-Spearman association in 1977 (Table 32). The Pierre-Lismas association, which had the highest number of male birds per ground in 1976 (Martin 1977), had the lowest number in 1977. By far the most dancing grounds were located in the Bainville-Midway-Thedalund-Midway association

Figure 24. Sharptail grouse population density in the Sarpy Creek area, 1974-1977.

Table 32. Sharptail dancing ground distribution by soil association in 1977.

Soil Association	All Grounds	Active Grounds	Male Birds	Male Birds/ Active Ground
1. Wanetta-Hesper (T)	-	-	-	-
2. Pierre-Lismas (T)	3	3	25	8.3
3. Flasher-Bainville (T) /Nelson-Alice (B)	9	5	64	12.8
4. Bainville-Midway (T) /Thedalund-Midway (B)	27	25	249	10.0
5. Wayden-Regent (B)	-	-	-	-
6. Wibaux-Thedalund- Spearman (B)	7	7	84	12.0
	46	40	422	10.0

This is somewhat less than might have been expected in the largest soil association (Table 2). No grounds were located on the Wanetta-Hesper or Wayden-Regent associations during the four years of study.

All of the sage grouse strutting grounds were located in the Bainville-Midway/Thedalund-Midway association.

Sharptail Banding and Telemetry Studies

In the spring of 1975 a sharptail banding study was initiated in cooperation with personnel of Westmoreland Resources, Inc., Ecological Consulting Service and the Montana Department of Fish, Wildlife, and Parks. This study was continued through the 1977 spring breeding season and beyond the termination of the Sarpy Basin Wildlife Ecology Study. Radio telemetry was initiated in 1977.

The main objectives of the banding and telemetry studies were to determine: annual mortality of sharptail grouse in this area, normal movement patterns, and what habitat types these specific birds were utilizing during different seasons of the year.

The study was conducted in two areas, near Colstrip and around Westmoreland's Absaloka mine on Sarpy Creek. William F. Schwarzkoph, ECON, Inc., was the project leader in the Colstrip vicinity. Raymond R. Austin, ECON Inc., followed by William

Sullivan, Westmoreland Resources, Inc., were project leaders in the Sarpy Creek area. Robert Greene of the Montana Department of Fish, Wildlife, and Parks provided cannon nets and assisted during the trapping phases of this study. Detailed results of these studies can be found in the following publications: ECON Inc., 1975a, 1975b, 1976, 1977, and 1978 and Sullivan 1979.

Annual mortality: An annual mortality rate of banded birds in Nebraska was calculated to be 69.4 percent (Sisson 1976). Robel et al. (1972) estimated annual mortality at 79.5 and 70.6 percent respectively on two study areas in South Dakota. Hillman and Jackson (1973) reported 71.5 and 70.4 percent annual mortality rates respectively on two study areas also in South Dakota. These rates do not include the mortality of juveniles from hatching to approximately eight months of age.

The annual mortality rates of banded birds in the Colstrip and Absaloka studies averaged 87.6 and 76.9 percent, respectively (Table 33). These higher than previously reported mortality rates can be attributed to the predominant use of the cannon net capture method, which causes more physical damage to individual birds than a walk-in trap; to the use of full poncho markers, with black numbers, which makes the birds more visible and vulnerable to avian predators; and to the use of radios. Although the harness systems did not seem to interfere with the sharp-tailed grouse's flight, it definitely made them more vulnerable to predation. Sullivan (1979) reported the overall mortality rate of grouse fitted only with a poncho marker to be 53 percent. Of 18 radioed birds, 11 were found in or near avian predator nests. None of the five birds fitted with radio transmitters on the Colstrip study area in 1978 lived more than ten days. Four of these were known to have been killed by predators.

The continued trapping of specific dancing grounds appears to be detrimental to the viability of those particular populations. All six arenas in the Colstrip vicinity which were trapped for two consecutive years experienced reduced numbers (Table 34). Two of the grounds were abandoned completely. One ground in the Absaloka study area was also abandoned. The lone exception was a dancing ground in the Absaloka study area at which attendance increased annually despite four continuous years of trapping.

Movement: The use of radios and poncho marked birds has confirmed the central position of the dancing ground in the lives of sharp-tailed grouse. During the courtship season, male sharptails remained within .5 miles of their dancing ground (Sullivan 1979). Dominant male grouse were observed to return to their same arenas in subsequent years. All nest sites located were within one mile of a dancing ground (Schwarzkoeph 1980). Pepper (1972) found no nest during his study more than one mile from a dancing ground. Hens radioed on nests stayed within one-quarter mile of their nest sites during the first two weeks after the young hatched (ECON, Inc., 1978).

Table 33. Annual mortality of sharp-tailed grouse in the Colstrip 10x20 and Absaloka study area.

Dancing Grounds	B ¹ / '75	R ² / '76	M ³ / '76	B '76	R '77	M	B '77	R '78	M	Average
Colstrip ⁴ /	3	-	-	8	0	100.0	15	3	80.0	90.0
	4	-	-	5	1	80.0	19	1	95.0*	87.5
	7	15	3	4	1	85.7*	-	-	100.0	88.6
	8	9	0	6	0	100.0	-	-	-	100.0
	16	10	1	3	2	50.0*	-	1	50.0*	63.3
	19	17	1	9	2	80.0*	-	-	100.0*	91.4
Total	51	5	90.2	35	6	85.0*	34	5	87.5*	87.6
Absaloka ⁵ /	3(8) ⁶ /	11	2	3	2	60.0*	7	0	100.0*	80.6
	4(25)	7	1	6	3	57.1*	12	4	73.3*	72.0
	5(10)	13	3	-	-	100.0*	-	-	-	88.5
Total	31	6	80.6	9		66.7*	19	4	83.3*	76.9

1/ B = number banded

2/ R = number survived over winter

3/ M = Percent mortality = $B-R/B$

4/ Taken from ECON, Inc. 1976, 1977 and 1978

5/ Taken from Sullivan 1979

* Percent mortality = $(B+R') - R/B+R'$ where R' = number of banded birds surviving from previous year.

6/ Number in () corresponds to identification in Figure 22.

Table 34. Numbers of male sharp-tailed grouse on dancing grounds before and after banding on the Colstrip 10x20 and Absaloka study areas.

Dancing Ground		1974	1975	1976	1977	1978
Colstrip	3	21	27	22*	26*	21
	4	14	10	17*	17*	13
	7	13	20*	11*	0	0
	8	15	11*	8*	2	6
	16	8	15*	6*	6	9
	19	12	17*	14*	6	0
Average		13.8	16.7	13.0	9.5	8.2
Absaloka	3(8)	12	14*	12*	9*	12
	4(25)	-	9*	10*	15*	17*
	5(10)	7	15*	12	0	0
Average		9.5	12.7	11.3	8.0	9.7

* Year trapping was conducted.

The farthest movement by a marked bird, approximately 12 miles, occurred on the Colstrip study area in 1975. This bird may have been a female or a sub-dominant male (ECON, Inc. 1976). Several birds were observed to move 3-5 miles from the dancing grounds on which they were marked. These birds were probably sub-dominant males.

Few summer, fall or winter observations were made either because of radio failure, predation of radioed birds or the difficulty of spotting marked birds in the generally good cover of those seasons. The observations made corroborate the findings of Pepper (1972) that males remain within one mile of their dancing ground in the summer. Hillman and Jackson (1973) indicated sharp-tailed grouse stayed within 3 miles of wintering sites.

Habitat usage: The best sharp-tailed grouse habitat is characterized by grassland-shrub associations in which mid-and tall grasses provide substantial residual cover (Pepper 1972, Sisson 1976).

During winter, grassland, agricultural and big sagebrush-grassland types were most often used in the Colstrip area (ECON Inc. 1978). Grouse in the Sarpy area moved to lowland habitat types where they were observed in riparian vegetation, on haystacks, in farm yard shelter belts, in stands of ponderosa pine and on snow free southern exposures (Sullivan 1979).

In spring, silver sagebrush-grassland, grassland and skunkbush-grassland habitat type usage was most prevalent as the birds congregated around their dancing grounds (ECON, Inc., 1978). Sullivan (1978) reported sharp-tailed grouse feed in grassland associations and resort to the sagebrush, juniper, skunkbush and riparian vegetation types for cover. Sharptail grouse nests are usually located on the ground in dense vegetation. They prefer native grasslands and shrubs but will nest in cultivated stubble and hay lands (Pepper 1972). He further stated that foliar density is more important than height. Of the three nests located in the Sarpy and Colstrip vicinities, two were found on a Western Energy Company reclamation area and one was located in a stand of big sagebrush (ECON, Inc. 1978; Sullivan 1979). All three sites had very dense foliar cover.

Alfalfa fields and hay meadows were heavily used by sharp-tails in the Sarpy area during the summer months (Sullivan 1979). North slope shrub associations were used for loafing and cover. ECON, Inc. (1978) reported skunkbush-grassland, silver sage-grassland and grassland types to be the most heavily utilized during summer.

Ponderosa pine-grassland, silver sagebrush-grassland and skunkbush-grassland habitat types were most commonly used during the fall season as the sharptails became concentrated in the shrub associations (ECON, Inc. 1978).

Sullivan (1979) reported large amounts of chokecherries, rosehips, and hawthorn berries in the crops of hunter harvested birds indicating use of shrubby thickets for feeding.

Ring-necked Pheasants

Pheasant crow count routes are shown in Figure 22. Four years of data gathering are summarized in Table 35. The number of cocks heard per stop increased steadily from 13.3 in 1974 to 18.3 in 1977 in the Sarpy drainage. The greatest change was in the upper portion which increased from 7.9 to 21.5 calls per stop, a gain of 172 percent from 1974 to 1977. All of the Sarpy routes registered increases except the lower Sarpy route. The lower Sarpy route had the highest density of cock pheasants, averaging 25.5 calls per stop over the four years of study. This route had the highest number of calls per stop in Fish, Wildlife and Parks Region 7 from 1974 through 1977 (Knapp 1979).

Five broods were counted in the summer of 1977. Thirty-three juvenile birds, average 6.6 per brood, were observed. This is somewhat less than the 8.7 and 8.4 young per brood observed in 1975 and 1976, respectively (Martin 1977).

Table 35. Ring-necked pheasant crowing count survey data in the Sarpy Creek and surrounding drainages.

Route	Length ^{1/}	Average Calls Per Mile			
		1974	1975	1976	1977
*Lower Sarpy Cr	16	27.7	24.7	25.6	24.1
*Upper Sarpy Cr	16	7.9	11.8	21.0	21.5
Lower Tullock Cr	15	4.7	11.7	16.7	11.8
Upper Tullock Cr	15	10.6	17.6	-	-
*North Fork Beaver Cr	6	1.8	8.0	7.2	7.8
*East Bear Creek	9	9.8	14.2	9.4	14.3
Armell's Cr	21	2.7	-	-	-
Yellowstone River	23	3.8	-	6.9	-
Reservation Cr	10	4.7	-	-	-
East Fork Sarpy Cr	7	3.4	11.5	11.4	13.0
Sarpy Study Area		13.3	16.7	17.0	18.3
Surrounding Area		4.9	14.6	10.8	11.8
Total		8.1	15.9	14.9	16.8

^{1/} Number of stops each one mile apart

* - Routes within the Sarpy Study area

Merriam's Turkey

Turkey observations from 1974 through 1977 are shown in Figure 22. The turkeys are concentrated in the Absaloka unit between east Fork Sarpy Creek and the Tullock-Sarpy Creek divide. The largest single group observed was 66 feeding in a grain field just north of the Westmoreland mine during the 1977 winter season (Sullivan 1978).

These turkeys are yearlong residents of the Sarpy Basin. Some movement to the Little Wolf Mountains may occur during the summer and fall seasons.

Nongame Species

There have been 129 bird species (including game birds) observed within the Sarpy Creek study area (Eng 1977, Sullivan 1978). These are listed in Appendix Table 4. Of these, twelve are listed as species of special interest or concern in Montana (Flath 1978). They are: goshawk (*Accipiter gentilis*), sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*Accipiter cooperii*), ferruginous hawk (*Buteo regalis*), golden eagle (*Aquila chysaetos*), bald eagle (*Haliaeetus leucocephalus*), marsh hawk (*Circus cyaneus*), prairie falcon (*Falco mexicanus*), peregrine falcon (*Falco peregrinus*), merlin (*Falco columbarius*), screech owl (*Otus asio*) and long-eared owl (*Asio otus*).

Thirty-nine nongame mammal species have been observed (Moore 1977, Sullivan 1978). Of these, six are listed as species of special interest or concern in Montana (Flath 1978). They are Merriam's shrew (*Sorex merriami*), Preble's shrew (*Sorex prebei*), long-legged bat (*Myotis volans*), spotted bat (*Euderma maculatum*), western big-eared bat (*Plecotus townsendii*) and lynx (*Lynx canadensis*). All nongame mammals are listed in Appendix Table 5.

Eleven amphibian and reptile species have been identified in the Absaloka sub-unit of the Sarpy study area (Appendix Table 6). Of these, the snapping turtle (*Chelydra serpentina*) and plains hognose snake (*Thomnophis radix*) are listed as species of special interest or concern (Flath 1978).

SUMMARY

Mule Deer

Mule deer, the most abundant big game species, are non-migratory in the Sarpy Creek area. They exhibit distinct seasonal preferences for vegetative and topographic types. Greatest concentrations were observed during the dry summer and early fall months along major creek bottoms and coulee bottoms. The deer were widely dispersed during fall and spring seasons with only slight winter concentrations in a few areas being observed.

With relatively stable deer numbers prior to 1970, the area was subjected to severe hunting pressure, both legal and illegal, peaking in the early 1970's. The heavy harvest resulted in fewer total numbers, increasing percentages of does and lower productivity in the herd. Hunter success ratios bottomed out in 1976. Following drastic reductions in the number of hunters and suspension of harvesting does, the Sarpy Creek herd showed signs of recovery in 1977.

Mule deer were observed in all six soil associations. They actively selected for or against certain associations 26.6 percent of the time. The Bainville-Midway/The dalund-Midway association was the most important, exhibiting significant ($p=.05$) positive usage in all seasons except summer.

Mule deer were more influenced by vegetation type than soil association. The ponderosa pine type received the most usage and seemed to be the preferred type. The creek bottom types were very important in the summer and fall dry seasons. Agricultural types were important food sources except during the winter season.

The influence of precipitation was demonstrated throughout the study but was particularly conspicuous as it affected usage of exposure. In seasons with above average moisture, usage of southerly slopes increased. During dry seasons, usage was concentrated on the northerly slopes and creek bottom flat lands.

Antelope

Most antelope were observed in the central portion of the study area in the Horse Creek sub-unit. Some movement between drainages was apparent as antelope left the Absaloka sub-unit during winter months. Antelope were most widely dispersed during the spring season and most concentrated in the winter.

The population levels appear to be stable with low production (41 fawns per 100 does average) and low hunter harvest.

Antelope were 71 percent more selective for soil association than were mule deer. The Flasher-Bainville/Nelson-Alice association supported significantly ($p=.05$) more antelope than expected every season except winter. The Wanetta-Hesper association was very important to antelope during the winter months, supporting 45 percent of the antelope observed on 3.7 percent of the study area.

The sagebrush/grassland vegetation types were the most important to antelope during every season of the study. The creek bottom type had the least usage while significantly ($p=.05$) less antelope were observed than expected in every season utilizing the ponderosa pine type.

That antelope prefer open terrain and little vegetative cover was shown by their avoidance of coulee bottoms, creek bottoms and pine covered ridges. Most antelope were observed in open hilly country on medium to gentle slopes. They were more often observed on northerly and easterly exposures than southerly or westerly, respectively.

Coyotes

Coyotes were observed throughout the study area in all seasons.

Population numbers seem to be relatively stable and independent of mule deer population fluctuations.

Seasonal observations of coyotes did not deviate significantly from the numbers expected on any of the soil associations. Coyote distribution was more related to vegetation type than soil association but not to the extent of either mule deer or antelope. Overall the sagebrush/grassland type supported more coyotes than any single vegetation type. Ponderosa pine was most important in winter and creek bottoms were most important in the dry fall season.

Coyotes were most often observed on hillsides and creek bottoms. They were nearly equally distributed between steep to flat slopes and on all exposures.

The lack of selection for or against any of the categories studied shows the ability of the coyote to utilize every portion of its range.

Sharp-tailed Grouse

Sharp-tailed grouse were the most abundant game bird. They were observed on 46 dancing grounds, 40 of which were active during the 1977 breeding season. A population peak may have occurred in 1975 based on the average number of male birds per

known active ground. However, a higher number of birds were observed in 1977 as more active grounds were located. It is possible that as the population increased more grounds became active and artificially lowered the number of males per active ground.

The Bainville-Midway/Thedalund-Midway soil association had by far the most dancing grounds and birds observed.

Sharptail telemetry studies revealed relatively high mortality rates in the Colstrip and Absaloka Mine vicinities. At least part of this loss is due to the method used in trapping and the telemetry equipment. Avian predators were the primary instrument of destruction. Continued trapping of individual grounds appears to be detrimental to those particular populations. The dancing ground was found to be the yearlong center of activity for sharptail grouse. Grouse were observed to be heavily dependent on shrub associations for food and cover in all seasons. Grasslands were also important.

Others

White-tailed deer, sage grouse, ring-necked pheasants and Merriam's turkey are other game species present and short discussions are given in this report. Hungarian partridge and various waterfowl species were observed but no data were gathered for them. Non-game bird, mammal, amphibian and reptile species observed on the study area were listed but not discussed.

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Appendix Table 1. Climatological data from the Hysham 25 SSE weather station during the fourth year of study (1977).

Season	Month	Year	Temperature <u>1/</u>			Number of Days Max.		Precipitation	
			Average	High	Low	Below 32	Over 90	Total	Snow
Winter	Dec.	1976	25.6	51	-9	6	0	.23	7.0
	Jan.	1977	11.9	47	-25	16	0	.99	24.3
	Feb.	1977	32.3	62	5	0	0	.30	1.7
Spring	Mar.	1977	34.5	71	10	3	0	1.68	31.0
	Apr.	1977	45.4	83	7	0	0	.28	3.0
	May	1977	56.2	85	32	0	0	3.32	tr ^{3/}
Summer	June	1977	66.0	96	36	0	6	.94	.0
	July	1977	69.8	102	39	0	13	1.91	.0
	Aug.	1977	63.6	101	35	0	2	1.80	.0
Fall	Sept.	1977	56.6	90	30	0	1	1.30	.0
	Oct.	1977	46.4	78	20	0	0	1.65	.0
	Nov.	1977	28.3	65	-29	7	0	.92	10.7

1/ Temperature in degrees fahrenheit

2/ Precipitation in inches received

3/ tr = trace

Appendix Table 2. A brief description of the soils series found in the Sarpy Creek drainage.

Series	County ^{1/}	Topography	Surface Drainage	Vegetation ^{2/}
Wanetta	Treasure	Level to sloping terraces	Good	Short & mid grasses
Hesper	Treasure	Rolling, eroded uplands	Good	Ag sp; Ag sm; Ar tr
Pierre	Treasure	Rolling, eroded uplands	Good	Ag sp; Ag sm; Ar tr
Lismas	Treasure	Rolling to hilly or strongly dissected uplands	Excessive	Ag sm; St vi; Bo gr; Ar tr; Sa ve
Flasher	Treasure	Rolling to strongly rolling or hilly, eroded uplands	Excessive	Ca lo; St vi; Or hy
Bainville	Treasure	Crests of ridges and hills	Excessive	Brush & trees; short, mid & tall grasses
Thedalund	Big Horn	Undulating to very steep hills	Medium	Ag sm; St vi; Bo cu; Ar tr
Midway	Big Horn-Treasure	Rolling to steep, broken, eroded uplands	Excessive	Ag sp; Ag sm; Bo gr; Ar ca4; Ar tr; Rh tr; Gu sa; Bo cu
Nelson	Big Horn	Undulating and rolling hills and ridges	Medium	Ca lo; Ag sp; Ar ca4; Yu gl
Alice	Big Horn	Moderately steep and rolling valleys	Slow	Ca lo; Bo cu; Bo gr; An sc; Eriog; Ambro
Wayden	Big Horn	Sloping or rolling to very steep hills and ridges	Medium	Ag sp; Ag sm; Gu sa; Ps ar
Regent	Big Horn	Gently undulating to hilly ridges and plains	Slow	Ag sm; Ag tr; Da in; Fe id; Ch na
Wibaux	Big Horn	Undulating to very steep uplands	Rapid	Ag sp; St vi; Ar fr; Gu sa; Ch na
Spearman	Big Horn	Undulating and rolling plains	Medium	St vi; Ag sm; Ar tr; Gu sa

1/ Source of information by county: Treasure - Moshier, R.L. and A.G. Fielder. 1967. Soil Survey of Treasure County, Montana. 173 pp.

Big Horn - Meshnick, J.D. et al. 1972. Unpubl. Soil Survey of Big Horn County, Montana. 1086 pp.

2/ Plant abbreviations from Anon. 1969. Coded plant list for the state of Montana. Montana Fish and Game Dept. 93 pp.

Appendix Table 3. Location of prairie grouse breeding grounds and male birds attending in 1974, 1975, 1976 and 1977.

Species	Ground Number	Location			Date Located	Hunting District	Method ¹ / ₂	Male Birds Attending			
		T	R	S				1974	1975	1976	1977
Sage Grouse	1	2N	36E	12	4- 9-74	720	A	16	23	19	
	2	3N	37E	8	4- 9-74	720	A	3	-	-	
	3	3N	37E	27	3-24-74	722	V	16	14	18	
	4	4N	36E	22	4-23-75	720	A	-	5	2	
Sharp-tailed Grouse	1	1N	36E	24	4-16-74	720	A	6	7	7	14
	2	1N	36E	36	4-16-74	720	A	20	9	14	20
	3	2N	36E	3	4-23-74	720	V	6	8	1	0
	4	2N	36E	10	4-23-74	720	V	15	17	15	16
	5	2N	37E	30	3-29-74	720	V	16	13	5	5
	6	3N	36E	10	4- 1-74	720	V	14	11	9	0
	7	3N	37E	7	4- 9-74	720	A	16	20	-	0
	8	1N	37E	25	3-26-74	722	V	12	14	9	6
	9	1N	38E	27	3-26-74	722	F	9	15	7	13
	10	1N	38E	31	3-26-74	722	V	7	15	4	0
	11	1N	38E	36	3-26-74	722	V	15	20	17	17
	12	2N	37E	14	3-27-74	722	A	13	26	32	15
	13	2N	38E	30	3-27-74	722	A	12	9	13	13
	14	3N	37E	1	3-27-74	722	A	16	20	-	14
	15	4N	38E	30	3-27-74	722	A	10	-	6	5
	16	5N	37E	27	3-31-74	722	A	16	-	-	6
	17	2N	38E	17	3-31-74	722	A	-	12	7	16
	18	2N	38E	22	3-31-74	722	A	-	8	-	0
	19	3N	37E	25	3-31-74	722	A	-	16	10	13
	20	3N	38E	22	3-31-74	722	A	-	12	2	5
	21	3N	37E	23	4- 3-75	722	A	-	18	-	9
	22	1N	38E	23	4-10-75	722	V	-	8	3	1
	23	3N	36E	14	4-15-74	720	V	-	18	-	0
	24	1N	37E	13	4-12-75	722	A	-	9	2	5
	25	1N	37E	27	4-12-75	722	A	-	9	8	13

Appendix Table 3 continued.

Species	Ground Number	Location T R S			Date Located	Hunting District	Method ^{1/}	1974	1975	1976	1977
Sharp-tailed Grouse	26	1N	38E	34	4-12-75	722	A	30	30	15	16
	27	1S	37E	9	4-12-75	720	A	8	8	6	12
	28	4N	37E	31	4-23-75	720	A	10	10	9	5
	29	4N	36E	12	4-23-75	720	A	10	10	10	12
	30	5N	37E	18	4-23-75	720	A	16	16	14	9
	31	6N	36E	25	4-23-75	720	A	13	13	18	11
	32	1N	36E	13	5- 5-75	720	F	12	12	15	24
	33	1S	37E	11	4- 7-76	720	A	-	-	7	3
	34	3N	37E	35	4- 7-76	722	A	-	-	20	21
	35	3N	37E	14	4- 8-76	722	A	-	-	10	12
	36	4N	37E	13	4- 8-76	722	A	-	-	14	16
	37	2N	38E	28	4-24-77	722	V				12
	38	3N	36E	23	4-13-77	720	A				9
	39	4N	36E	26	4-13-77	720	A				4
	40	1N	38E	20	4-13-77	722	A				6
	41	1N	38E	21	4-13-77	722	A				4
	42	5N	37E	18	4-15-77	720	V				5
	43	1N	37E	4	4-16-77	720	V				2
	44	4N	37E	3	5- 3-77	722	F				9
	45	4N	38E	26	5- 9-77	722	V				5
	46	2N	37E	27	4-12-77	722	A				12

^{1/} A = Airplane; V = Vehicle; F = Foot

Appendix Table 4. Bird species observed on the Sarpy Study area.

Name		Absaloka ^{1/}	Horse Creek ^{2/}
Horned grebe	(<i>Podiceps auritus</i>)	x	x
Eared grebe	(<i>Podiceps nigricollis</i>)	x	
Western grebe	(<i>Aechmophorus occidentalis</i>)		x
Great blue heron	(<i>Ardea herodias</i>)	x	x
American bittern	(<i>Botaurus lentiginosus</i>)	x	
Canada goose	(<i>Branta canadensis</i>)	x	
Snow goose	(<i>Chen caerulescens</i>)	x	
Northern shoveler	(<i>Anas clypeata</i>)		x
Pintail	(<i>Anas acuta</i>)	x	x
Mallard	(<i>Anas platyrhynchos</i>)	x	x
Gadwall	(<i>Anas strepera</i>)	x	x
Green-winged teal	(<i>Anas crecca</i>)	x	x
Blue-winged teal	(<i>Anas discors</i>)	x	x
American widgeon	(<i>Anas americana</i>)	x	x
Redhead	(<i>Aythya americana</i>)		x
Ring-necked duck	(<i>Aythya collaris</i>)	x	x
Lesser scaup	(<i>Aythya affinis</i>)		x
Goshawk	(<i>Accipiter gentilis</i>)	x	x
Sharp-shinned hawk	(<i>Accipiter striatus</i>)	x	x
Cooper's hawk	(<i>Accipiter cooperii</i>)	x	x
Red-tailed hawk	(<i>Buteo jamaicensis</i>)	x	x
Swainson's hawk	(<i>Buteo swainsoni</i>)	x	x
Rough-legged hawk	(<i>Buteo lagopus</i>)	x	
Ferruginous hawk	(<i>Buteo regalis</i>)	x	x
Golden eagle	(<i>Aquila chrysaetos</i>)	x	x
Bald eagle	(<i>Haliaeetus leucocephalus</i>)	x	
Turkey vulture	(<i>Cathartes aura</i>)	x	
Marsh hawk	(<i>Circus cyaneus</i>)	x	x
Prairie falcon	(<i>Falco mexicanus</i>)	x	x
Peregrine falcon	(<i>Falco peregrinus</i>)	x	
Merlin	(<i>Falco columbarius</i>)	x	
American kestrel	(<i>Falco sparverius</i>)	x	x
Sharp-tailed grouse	(<i>Pediacetes phasianellus</i>)	x	x
Sage grouse	(<i>Centrocercus urophasianus</i>)		x
Ring-necked pheasant	(<i>Phasianus colchicus</i>)	x	x
Gray partridge	(<i>Perdix perdix</i>)	x	x
Turkey	(<i>Meleagris gallopavo</i>)	x	x
American coot	(<i>Fulica americana</i>)	x	x
Killdeer	(<i>Charadrius vociferus</i>)	x	x
Common snipe	(<i>Capella gallinago</i>)	x	x
Upland sandpiper	(<i>Bartramia longicauda</i>)	x	x
Spotted sandpiper	(<i>Actitis macularia</i>)	x	x
Willet	(<i>Catoptrophorus semipalmatus</i>)		x
Lesser yellowlegs	(<i>Tringa flavipes</i>)		x
American avocet	(<i>Recurvirostra americana</i>)	x	x
California gull	(<i>Larus californicus</i>)	x	x
Rock dove	(<i>Columba livia</i>)	x	x
Mourning dove	(<i>Zenaida macroura</i>)	x	x

Appendix Table 4 continued.

Name		Absaloka ^{1/}	Horse Creek ^{2/}
Black-billed cuckoo	(<i>Coccyzus erythrophthalmus</i>)	x	x
Screech owl	(<i>Otus asio</i>)	x	x
Great horned owl	(<i>Bubo virginianus</i>)	x	x
Long-eared owl	(<i>Asio otus</i>)		x
Short-eared owl	(<i>Asio flammeus</i>)	x	
Common nighthawk	(<i>Chordeiles minor</i>)	x	x
Poorwill	(<i>Phalaenoptilus nuttallii</i>)	x	x
Belted kingfisher	(<i>Megasceryle alcyon</i>)	x	x
Common flicker	(<i>Colaptes auratus</i>)	x	x
Red-headed woodpecker	(<i>Melanerpes erythrocephalus</i>)	x	x
Hairy woodpecker	(<i>Picoides villosus</i>)	x	x
Downy woodpecker	(<i>Picoides pubescens</i>)	x	x
Eastern kingbird	(<i>Tyrannus tyrannus</i>)	x	x
Western kingbird	(<i>Tyrannus verticalis</i>)	x	x
Say's phoebe	(<i>Sayornis saya</i>)	x	x
Western wood pewee	(<i>Contopus sordidulus</i>)	x	x
Horned lark	(<i>Eremophila alpestris</i>)	x	x
Violet-green swallow	(<i>Tachycineta thalassina</i>)	x	
Bank swallow	(<i>Riparia riparia</i>)	x	x
Barn swallow	(<i>Hirundo rustica</i>)	x	x
Tree swallow	(<i>Iridoprocne bicolor</i>)		x
Cliff swallow	(<i>Petrochelidon pyrrhonota</i>)	x	x
Gray jay	(<i>Perisoreus canadensis</i>)	x	
Black-billed magpie	(<i>Pica pica</i>)	x	x
Common crow	(<i>Corvus brachyrhynchos</i>)	x	x
Pinyon jay	(<i>Gymnorhinus cyanocephalus</i>)	x	x
Black-capped chickadee	(<i>Parus atricapillus</i>)	x	x
White-breasted nuthatch	(<i>Sitta carolinensis</i>)	x	x
Red-breasted nuthatch	(<i>Sitta canadensis</i>)	x	x
House wren	(<i>Troglodytes aedon</i>)	x	x
Rock wren	(<i>Salpinctes obsoletus</i>)	x	x
Gray catbird	(<i>Dumetella carolinensis</i>)	x	x
Brown thrasher	(<i>Toxostoma rufum</i>)	x	x
American robin	(<i>Turdus migratorius</i>)	x	x
Swainson's thrush	(<i>Catharus ustulatus</i>)		x
Veery	(<i>Catharus fuscescens</i>)	x	
Mountain bluebird	(<i>Sialia currucoides</i>)	x	x
Ruby-crowned kinglet	(<i>Regulus calendula</i>)	x	
Bohemian waxwing	(<i>Bombycilla garrulus</i>)	x	
Cedar waxwing	(<i>Bombycilla cedrorum</i>)	x	x
Loggerhead shrike	(<i>Lanius ludovicianus</i>)	x	x
Starling	(<i>Sturnus vulgaris</i>)	x	x
Solitary vireo	(<i>Vireo solitarius</i>)	x	x
Yellow warbler	(<i>Dendroica petechia</i>)	x	x
Yellow-rumped warbler	(<i>Dendroica coronata</i>)	x	x
Blackpoll warbler	(<i>Dendroica striata</i>)	x	

Appendix Table 4 continued.

Name		Absaloka ^{1/}	Horse Creek ^{2/}
Common yellowthroat	(<i>Geothlypis trichas</i>)	x	x
Yellow-breasted chat	(<i>Icteria virens</i>)	x	x
Wilson's warbler	(<i>Wilsonia pusilla</i>)	x	x
American redstart	(<i>Setophaga ruticilla</i>)	x	x
House sparrow	(<i>Passer domesticus</i>)	x	x
Western meadowlark	(<i>Sturnella neglecta</i>)	x	x
Yellow-headed blackbird	(<i>Xanthocephalus xanthocephalus</i>)	x	x
Red-winged blackbird	(<i>Agelaius phoeniceus</i>)	x	x
Northern oriole	(<i>Icterus galbula</i>)	x	x
Brewer's blackbird	(<i>Euphaga cyanocephalus</i>)	x	x
Common grackle	(<i>Quiscalus quiscula</i>)	x	
Brown-headed cowbird	(<i>Molothrus ater</i>)	x	x
Western tanager	(<i>Piranga ludoviciana</i>)	x	x
Black-headed grosbeak	(<i>Pheucticus melanocephalus</i>)	x	x
Indigo bunting	(<i>Passerina cyanea</i>)		x
Lazuli bunting	(<i>Passerina amoena</i>)	x	x
Evening grosbeak	(<i>Hesperiphona vespertina</i>)	x	x
Pine grosbeak	(<i>Pinicola enucleator</i>)	x	x
Gray-crowned rosy finch	(<i>Leucosticte tephrocotis</i>)	x	
Common redpoll	(<i>Carduelis flammea</i>)	x	
Pine siskin	(<i>Carduelis pinus</i>)	x	x
American gold finch	(<i>Carduelis tristis</i>)	x	x
Red crossbill	(<i>Loxia curvirostra</i>)	x	x
Rufous-sided towhee	(<i>Pipilo erythrophthalmus</i>)	x	x
Lark bunting	(<i>Calamospiza melanocorys</i>)	x	x
Savannah sparrow	(<i>Passerculus sandwichensis</i>)	x	x
Vesper sparrow	(<i>Poocetes gramineus</i>)	x	x
Lark sparrow	(<i>Chondestes grammacus</i>)	x	x
Dark-eyed junco	(<i>Junco hyemalis</i>)	x	x
Tree sparrow	(<i>Spizella arborea</i>)	x	
Chipping sparrow	(<i>Spizella passerina</i>)	x	
Clay-colored sparrow	(<i>Spizella pallida</i>)		x
Brewer's sparrow	(<i>Spizella breweri</i>)	x	x
White-crowned sparrow	(<i>Zonotrichia leucophrys</i>)	x	
Song sparrow	(<i>Melospiza melodia</i>)	x	

129 species

^{1/} From Sullivan 1978^{2/} From Eng 1977

Appendix Table 5. Non-game mammal species observed on the Sarpy study area.

Name		Absaloka	Horse Cr
Common shrew	(<i>Sorex cinereus</i>)		x
Merriam's shrew	(<i>Sorex merriami</i>)		x
Preble's shrew	(<i>Sorex preblei</i>)		x
Long-eared bat	(<i>Myotis evotis</i>)		x
Least bat	(<i>Myotis leibii</i>)		x
Little brown bat	(<i>Myotis lucifugus</i>)		x
Long-legged bat	(<i>Myotis volans</i>)		x
Silver-haired bat	(<i>Lasionycteris noctivagans</i>)		x
Big brown bat	(<i>Eptesicus fuscus</i>)		x
Hoary bat	(<i>Lasiurus cinereus</i>)		x
Spotted bat	(<i>Euderma maculatum</i>)		x
Western big-eared bat	(<i>Plecotus townsendii</i>)		x
White-tailed jack rabbit	(<i>Lepus townsendii</i>)	x	x
Mountain cottontail	(<i>Sylvilagus nuttallii</i>)		x
Desert cottontail	(<i>Sylvilagus audubonii</i>)		x
Porcupine	(<i>Erethizon dorsatum</i>)	x	x
Beaver	(<i>Castor canadensis</i>)	x	x
Northern pocket gopher	(<i>Thomomys talpoides</i>)		x
Wyoming pocket mouse	(<i>Perognathus fasciatus</i>)		x
Ord's kangaroo rat	(<i>Dipodomys ordii</i>)		x
Least chipmunk	(<i>Eutamias minimus</i>)	x	x
Thirteen-lined ground squirrel	(<i>Spermophilus tridecemlineatus</i>)	x	x
Red squirrel	(<i>Tamiasciurus hudsonicus</i>)		x
House mouse	(<i>Mus musculus</i>)		x
Western harvest mouse	(<i>Reithrodontomys megalotis</i>)	x	x
Northern grasshopper mouse	(<i>Onychomys leucogaster</i>)	x	x
Deer mouse	(<i>Peromyscus maniculatus</i>)	x	x
Muskrat	(<i>Ondatra zibethicus</i>)	x	x
Sagebrush vole	(<i>Lagurus curtatus</i>)		x
Prairie vole	(<i>Microtus ochrogaster</i>)	x	x
Meadow vole	(<i>Microtus pennsylvanicus</i>)	x	x
Long-tailed vole	(<i>Microtus longicaudus</i>)		x
Bobcat	(<i>Lynx rufus</i>)	x	x
Lynx	(<i>Lynx canadensis</i>)		x
Red fox	(<i>Vulpes vulpes</i>)	x	x
Coyote	(<i>Canis latrans</i>)	x	x
Striped skunk	(<i>Mephitis mephitis</i>)	x	x
Badger	(<i>Taxidea taxus</i>)	x	x
Long-tailed weasel	(<i>Mustela frenata</i>)	x	x

39 species

1/ Sullivan 1978

2/ Moore 1977

Appendix Table 6. Amphibians and reptiles observed on the Sarpy study area.

Name <u>1</u> /	
<hr/>	
Amphibians	
Tiger salamander	(<i>Ambystoma tigrinum</i>)
Spade foot toad	(<i>Scaphiopus bombifrons</i>)
Western toad	(<i>Bufo boreas</i>)
Leopard frog	(<i>Rana pipiens</i>)
Reptiles	
Snapping turtle	(<i>Chelydra serpentina</i>)
Painted turtle	(<i>Chrysemys picta</i>)
Western hognose snake	(<i>Heterodon nasicus</i>)
Racer	(<i>Coluber constrictor</i>)
Gopher snake	(<i>Pituophis melano leucus</i>)
Plains garter snake	(<i>Thamnophis radix</i>)
Prairie rattlesnake	(<i>Crotalus viridis viridis</i>)

1/ From Sullivan 1978