A survey of big game animals on a proposed strip mining site at Sarpy Creek in southeastern Montana by John Matthew Edwards

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Fish and Wildlife Management
Montana State University

Abstract:
Field studies were conducted on a proposed strip mining site in 1975 and 1976 to obtain baseline information. The study area lies astride the western foothills of the Little Wolf Mountains. Vegetation in the region is mostly a ponderosa pine savannah with sagebrush flats to the west and north. A bottomland type occurs along Sarpy Creek and its two major tributaries: Horse Creek and East Fork Sarpy Creek. Due to the more mesic properties of these drainages, they have been put under intensive cultivation. Mule deer usage of these bottomlands increased during the summer months of the study. Two female mule deer were tagged with radio collars in late spring of 1976. Return data indicates a small sized home range during the summer. Fawn/doe counts were 75 and 59/100 does in 1975 and 1976, respectively. Antelope usage was almost exclusively in the sagebrush or field types. Antelope fawn/doe counts were 69/100 in 1975 and 39/100 in 1976. Patterns of usage indicate that any change in the water drainage systems will have a major impact on wildlife. The topography of the reclaimed land will be important in the distribution and abundance of wildlife in the area.

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A SURVEY OF BIG GAME ANIMALS ON A PROPOSED STRIP MINING SITE AT SARPY CREEK IN SOUTHEASTERN MONTANA

by

John Matthew Edwards

A thesis submitted in partial fulfillment
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Approved:

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Head, Major Department

Graduate Dean

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ABSTRACT

Field studies were conducted on a proposed strip mining site in 1975 and 1976 to obtain baseline information. The study area lies astride the western foothills of the Little Wolf Mountains. Vegetation in the region is mostly a ponderosa pine savannah with sagebrush flats to the west and north. A bottomland type occurs along Sarpy Creek and its two major tributaries: Horse Creek and East Fork Sarpy Creek. Due to the more mesic properties of these drainages, they have been put under intensive cultivation. Mule deer usage of these bottomlands increased during the summer months of the study. Two female mule deer were tagged with radio collars in late spring of 1976. Return data indicates a small sized home range during the summer. Fawn/doe counts were 75 and 59/100 does in 1975 and 1976, respectively. Antelope usage was almost exclusively in the sagebrush or field types. Antelope fawn/doe counts were 69/100 in 1975 and 39/100 in 1976. Patterns of usage indicate that any change in the water drainage systems will have a major impact on wildlife. The topography of the reclaimed land will be important in the distribution and abundance of wildlife in the area.

INTRODUCTION

Portions of eastern Montana lie astride the Fort Union Formation. This geologic formation extends through four states and contains one of the largest coal reserves in the United States. This coal is usually located at a shallow depth and is easily extracted by strip mining. The recent "energy crisis" coupled with rising power demands and stricter air pollution laws has resulted in an increase in mining activities. The Westmoreland Corporation has been mining in the Sarpy Creek basin for three years and a mine at Colstrip has been open for a number of years. Additional mines have been proposed that would start operation in the near future.

This increase in mining activity has caused a considerable controversy. The primary objections raised against strip mining have centered upon the reclamation phase. One result of this controversy has been the passage of stricter reclamation laws. In 1973 the Montana legislature passed the "Strip Mining and Reclamation Act". Among other provisions the law states that: "...after the land has been backfilled, topsoiled and approved, the contractor shall prepare the soil and plant such legumes, grasses, shrubs and trees on the land affected as are necessary to provide a suitable permanent diverse vegetation cover capable of feeding and withstanding grazing pressure from a *quantity and mixture of wildlife and livestock*

(emphasis added) at least comparable to that which the land could have supported prior to the operation". This has been considered a landmark legislation for many reasons, one of which is the inclusion of wildlife in reclamation considerations. In order to fulfill these requirements it is imperative that accurate baseline information be obtained prior to the first mining cut.

In accordance with these requirements, field work was carried out in a portion of the Sarpy Creek basin that the Amax Mining Corporation has proposed to mine and has initiated purchase of leases. The study was conducted primarily during the spring of 1975 and the summers of 1975 and 1976 with additional investigations during the winter and spring of 1976. The specific objectives of the study were: 1) to characterize the vegetation present, 2) to gather quantitative data on the distribution, abundance and land use patterns of medium and large sized mammals, 3) to evaluate the data in order to identify any special characteristics that would be of importance in reclamation to insure the re-establishment and maintenance of wildlife at pre-mining levels.

DESCRIPTION OF THE STUDY AREA

The Sarpy Creek study area is located in southeastern Montana approximately 30 miles (48 km) south of the town of Hysham (Fig. 1). It encompasses 36,493 acres (14,769 hectares) and is bounded on the west by Sarpy Creek, on the south by the East Fork Sarpy Creek, on the east by the Sarpy Creek-Armells Creek divide and on the north by the county road to Wilsons ranch. Elevations range from 3,080 feet (939 meters) in the northwestern portion to 3,600 feet (1,097 meters) in the southeast. The topography is characterized by rolling, sagebrush-covered hills in the lower areas which grade into the steep tree-covered hills and draws of the higher regions. With the exception of one state-owned section, the entire area is privately owned.

The major drainage system consists of Sarpy Creek and its two major tributaries, East Fork Sarpy Creek and Horse Creek. During the summers of 1975 and 1976, East Fork Sarpy Creek was the only creek that was not intermittent. In addition to these drainages and other natural springs and seepages, a minimum of 13 stockponds and 14 wells have been developed in the study area.

Climatological data were obtained from the United States Department of Commerce Weather Station Hysham 25 SSE located near the mouth of Horse Creek in the center of the study area. Average monthly and

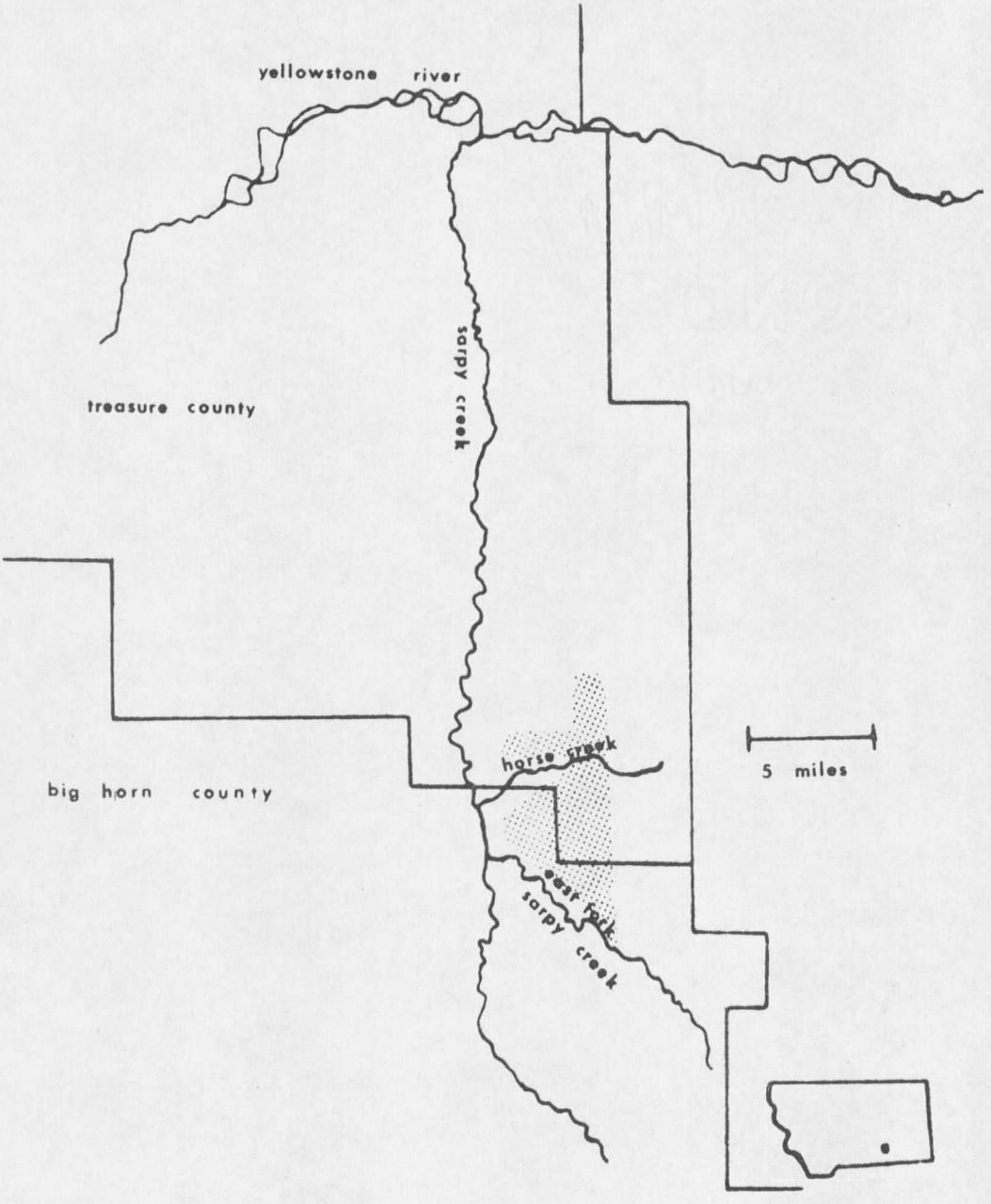

Figure 1. Map of the Study Area Showing Major Features.

yearly temperatures and precipitation amounts for the two years of the study are shown in Table 1.

The climate for this region is considered semi-arid with hot, dry summers and moderately cold, dry winters (Jackson 1971). Precipitation averaged 15 inches annually at Hysham 19 SSE from 1961 to 1970. February is the driest month (0.4 inches ave.) and June the wettest (2.6 inches ave.) month (Moshier and Fielder 1967).

The Fort Union Formation (Tongue River Member) is the principal geologic feature of this region. It was deposited in the Tertiary Paleocene Epoch and has a lithologic character of massive sandstones, light-colored clays, and thick coal beds (Thom 1935). The soils that have developed in the study area from this parent material are of two major associations: Flashier-Bainville and Bainville-Midway. The Flashier-Bainville association is moderately deep, dark-colored, sandy soils and moderately deep to shallow, light-colored loamy soils on strongly rolling to hilly uplands. The Bainville-Midway association is moderately deep to shallow, light-colored loams and clay loams on rolling to rough, broken land. Soils of these associations have low to moderate water storage capabilities (Moshier and Fielder 1967).

TABLE 1. THE CLIMATOLOGICAL DATA FROM THE HYSHAM 25 SSE WEATHER STATION FOR THE YEARS 1975 AND 1976.

Month	Average Temperature	Highest	Lowest	# Days Above 90°F	# Days Below 32°F	Precipitation in Inches Total	Precipitation in Inches Snow and Sleet
1975							
January	22.1	50	-23	0	30	1.69	10.3
February	14.0	47	-24	0	28	0.56	7.9
March	28.8	58	- 4	0	30	0.84	10.8
April	36.0	72	4	0	23	2.16	18.3
May	50.0	86	27	0	5	2.58	T[1]
June	58.5	88	34	0	0	2.05	0.0
July	71.9	104	38	16	0	1.10	0.0
August	66.0	97	37	7	0	0.24	0.0
September	55.2	88	22	0	10	0.33	0.0
October	45.1	88	17	0	20	2.07	6.0
November	29.2	77	-20	0	29	1.63	19.4
December	23.0	56	-21	0	31	1.17	25.8
					TOTALS	16.42	98.1
1976							
January	20.3	50	-28	0	31	0.67	15.7
February	32.1	61	- 8	0	28	0.91	5.8
March	30.5	65	-22	0	28	0.41	5.0
April	46.3	80	17	0	13	1.29	4.0
May	55.0	86	23	0	5	1.93	0.0
June	61.0	90	36	1	0	4.14	0.0
July	71.8	106	39	18	0	0.27	0.0
August	69.3	103	36	15	0	0.96	0.0
September	58.9	96	20	0	6	0.92	0.0
October	42.2	85	8	0	21	1.52	0.0
November	30.5	67	-24	0	29	0.77	12.5
December	25.6	51	- 9	0	M[2]	0.23	7.0
					TOTALS	14.02	50.0

[1]Reading was only a trace
[2]Data was missing

Ranching is the major industry although the bottomlands have been cultivated extensively. Alfalfa and barley are the principal crops with some winter wheat being grown. During the study period logging existed on a very small scale in the extreme southeast portion of the area.

METHODS

Vegetation

Daubenmire (1959) defined the term "Habitat Type" as the vegetative community that would occur in an area if the land was not disturbed. This classification was based upon analysis of the vegetation in pristine areas or at least those areas where disturbance had been minimal. Because the Sarpy Creek basin has had a long history of land disturbance, few pristine or relatively undisturbed areas remain. This limitation excludes the use of the term "Habitat Type" in the classification of the vegetation in the region. Instead, the term "Vegetation Type" (V.T.) was used and is defined as the vegetational community that existed at the time of the study.

The vegetative classification followed the general approach of Pfister *et al.* (1974) and Mueggler and Handl (1974). The vegetation was classified into six vegetation types: Ponderosa Pine Mosaic, Sagebrush, Rhus-Yucca, Bottomland, Field and Cultivation. With the exception of the Cultivation type, all were quantitatively evaluated to determine their vegetative composition. All groups except the Bottomland type were analyzed by a modification of the canopy-coverage method of Daubenmire (1959). Six 20 M transects were established in each of the four types. Twenty 2x5 dm plots were placed at one meter intervals along each line. An effort was made to locate

the transects in relatively homogeneous portions of each representative type. The Bottomland type was evaluated by a modification of the point-quadrant method of Cottam (Cottam and Curtis 1956). Plant nomenclature follows Booth (1950, 1972) and Booth and Wright (1959).

Wildlife

Distribution and abundance of wildlife was determined by observations of antelope, mule deer, whitetail deer and coyotes along several vehicle routes throughout the study area. Routes were covered randomly during mornings and evenings. Observations were recorded as to species, group size, activity, vegetation type and location. Sex and age class of antelope, mule deer and whitetail deer were recorded when possible. Eleven aerial surveys were made during the summer of 1975 and the spring and summer of 1976. An additional flight was made in December of 1975. Foot surveys were made during the same time periods.

In May 1976 two female mule deer were collared with radio transmitters. Subsequent relocations from ground and air aided in establishing daily movements and summer ranges.

HISTORY OF LAND USE

Prior to the early 1800s, the land use patterns of the early inhabitants probably had only a minor impact on the area. Following the Lewis and Clark expedition, the patterns of land usage started to change. The trappers who travelled through the region in the early and mid-nineteenth century had a major impact on the supply of fur-bearing animals. The fur trade along the Missouri River basin was estimated at one-half million dollars per year in 1831 (Chittenden 1902). However, these trappers had little permanent effect upon the native vegetation.

The entire Sarpy Creek drainage was included in the original Crow Indian Reservation of 38 million acres established by the first Fort Laramie Treaty of 1851. Despite reduction in size of the original reservation, the Sarpy Creek basin was retained as part of the tribal land. During this time little disturbance occurred to native vegetation.

The first trail herd of cattle entered the Yellowstone basin in 1833, but it wasn't until the 1880s that large numbers of cattle occurred. Rancher-historian Granville Stuart estimated the number of range cattle in the Yellowstone basin to be 600,000 in 1883 (Stuart 1925). Many of these large cattle and sheep companies had grazing permits on the Crow Indian Reservation. These large herds

probably had a substantial impact on the vegetation of the region. The severe winter of 1886-1887 effectively, if temporarily, reduced these large numbers of cattle.

In 1904 the Crow Indian tribe ceded 1.1 million acres of land to the U.S. Government. The Sarpy Creek basin was included in this packet. The land was opened up to homesteading under various amendments to the Homestead Act of 1862. Under the provisions of this legislation, the population in the region slowly increased. More and more claims were established both along the creek bottoms and in the upland hills. With every new homesite, additional acreage was put to the plow. In this era prior to mechanization, various crops were planted both for sale and for livestock feed. As the decade of the 1920s progressed, corn became the dominant crop (Reddig, pers. comm.).

The intense drought and economic problems of the 1920s and 1930s ended the homesteading era in Sarpy Creek. Many small ranches folded and the plowed lands were abandoned. A series of successional vegetative stages began which have not as yet resulted in a climax community.

Concurrent with the economic and climatic recovery of the 1940s, many of these abandoned ranches were acquired by those ranchers who had been able to survive the depression. By congressional act in

1959, all vacant and undispensed ceded land and reserved coal rights were returned to tribal ownership.

In the 1960s and 1970s use of the land intensified. Using refined techniques, acres of sagebrush were removed to provide additional grazing for cattle. Other areas were plowed and seeded to specialized grasses, notably Crested Wheatgrass (*Agropyron cristatum*). Additional acreage has been put into cultivation, principally alfalfa, barley and winter wheat. Most of the cultivated areas were along the river bottoms. Many wells were drilled and stockponds built to provide water in the uplands for cattle.

VEGETATION

Few quantitative vegetational studies have been reported for eastern Montana. Mackie (1970) reported on the vegetation of the Missouri River breaks. Jonas (1964) described the vegetation in the Long Pines region of southeastern Montana. Martin (1976) described a qualitative categorization of the cover in the Sarpy Creek basin. Herbert (1977) has described the vegetation on limited portions of the study area. None of these studies can be applied directly to a quantitative analysis of the vegetation in the entire Sarpy Creek study area.

Mueggler and Handl (1974) provided a key to the grassland communities, but their primary concern was with the mountain grassland types. Their reference sites extended out onto the prairies but none was further east than the city of Billings, Montana. Pfister *et al.* (1974) classified the vegetation under a ponderosa pine (*Pinus ponderosa*) canopy. Their categories were based upon a discrete community characterized by a dominant grass or shrub. In the Sarpy Creek study area, four of the six categories that they described exist. They occur as a mosaic pattern rather than as discrete communities. Because of these problems, the vegetation was classified as modifications of the categories described by either Mueggler or Pfister *et al.* (Fig. 2).

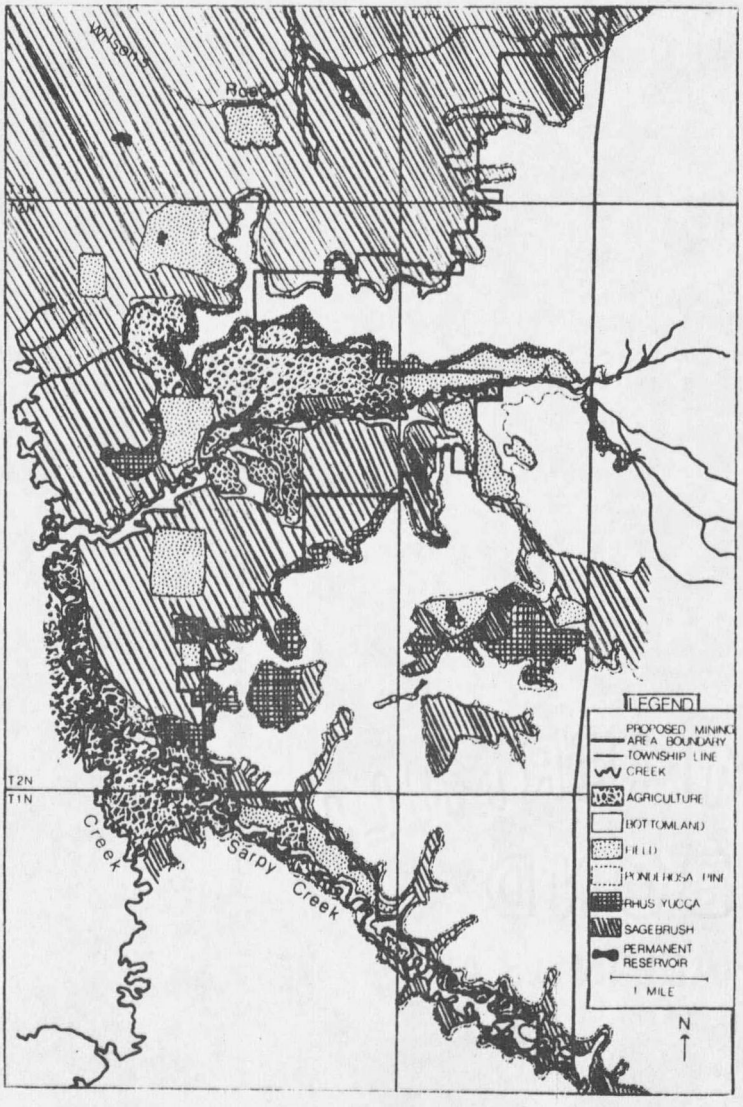

Figure 2. Map of the Study Area Showing the Location of the Vegetation Types.

VEGETATION TYPES

The two major vegetation types in the study area, based upon the amount of land covered were: Ponderosa Pine Mosaic V.T. (Fig. 3) and Sagebrush V.T. (Fig. 4). The Ponderosa Pine Mosaic V.T. occurs in the more broken hills and slopes of the Little Wolf Mountains to the south and east. It is composed of mature stands of ponderosa pine with varying amounts of understory growth.

The Sagebrush V.T. is dominated by Big Sagebrush (*Artemisia tridentata*) and is found on the more level terrain along the north and west portions of the area. It also occurs sporadically throughout the region in the more hilly areas. Portions of this type have been disturbed to provide additional grazing for cattle. The land thus disturbed was placed into a separate classification: Field Vegetation Type. A sub-division of the Sagebrush V.T. exists along the creek bottoms. It is characterized by the presence of Silver Sage (*Artemisia cana*) as the dominant plant. Because of the more mesic nature of this sub-type, large portions of it have been put into cultivation. All lands thus disturbed have been placed into the Cultivation Vegetation Type.

Two other vegetation types occur less extensively in the Sarpy Creek study area. A Rhus-Yucca V.T. exists throughout the region in relatively small patches. It is found on hilltops that are devoid

Figure 3. Ponderosa Pine Mosaic Vegetation Type.

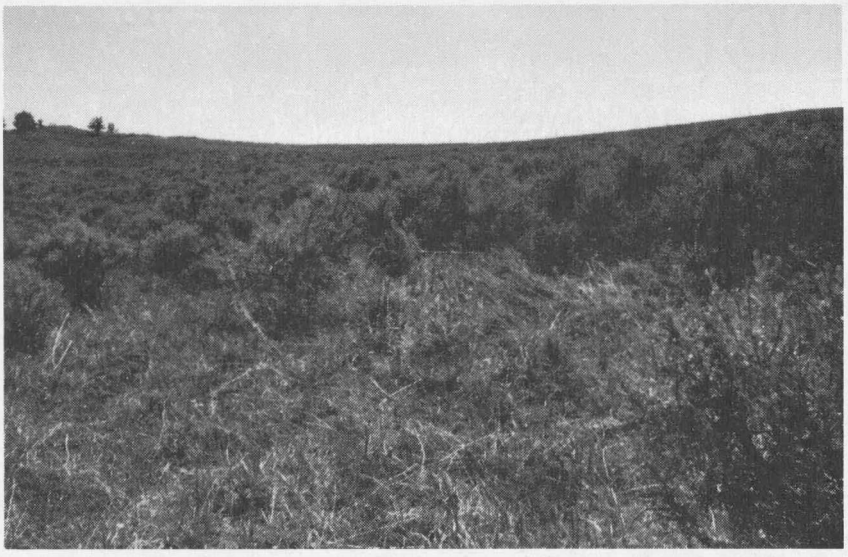

Figure 4. Sagebrush Vegetation Type.

of ponderosa pine (Fig. 5). It also occurs as an apron along the lower edge of ponderosa pine stands and above the Sagebrush V.T. It is an open community with grasses encountered most often.

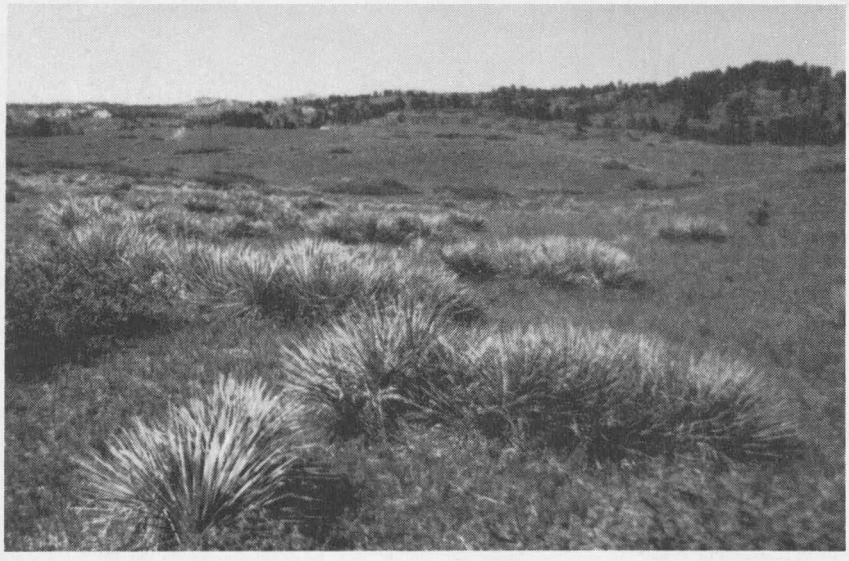

Figure 5. Rhus-Yucca Vegetation Type.

The Bottomland V.T. occurs along the Sarpy Creek, East Fork Sarpy Creek and Horse Creek drainages. It is composed of the more mesic plants that occur immediately adjacent to the stream beds. This type also occurs along the smaller side drainages (Fig. 6).

All those lands that were once plowed and then abandoned, and those areas that were severely disturbed to provide additional grazing for cattle were placed in the Field V.T. This type occurs intermittently throughout the area (Fig. 7).

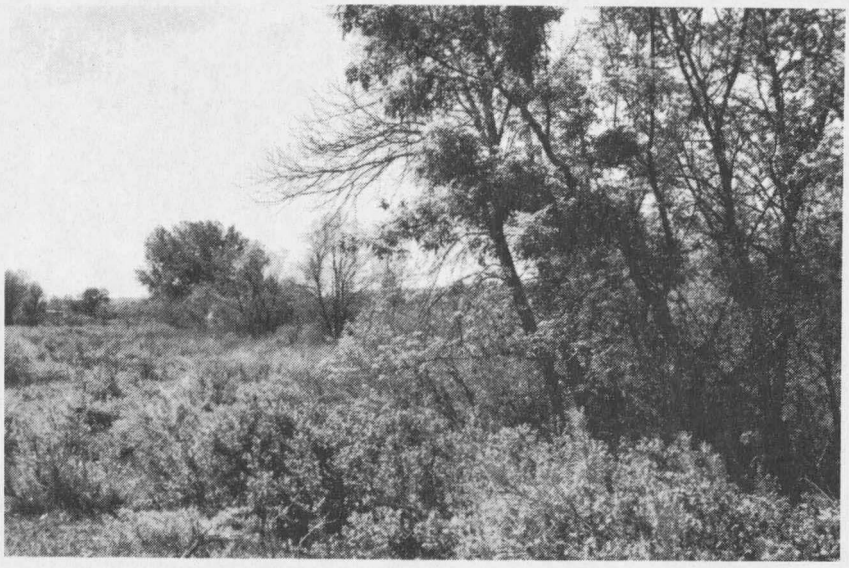

Figure 6. Bottomland Vegetation Type.

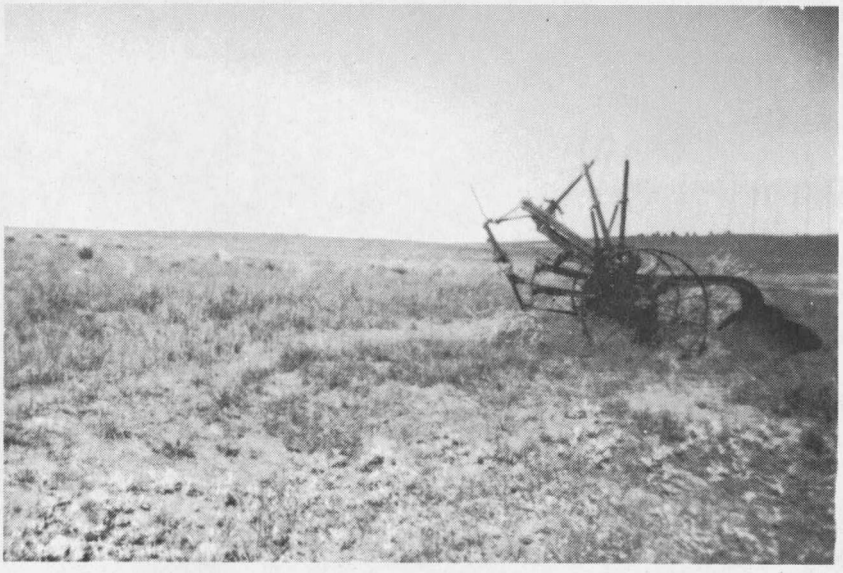

Figure 7. Field Vegetation Type.

Ponderosa Pine Mosaic V.T.

This type is characterized by mature stands with only local areas showing mixed-age groupings to any large extent. Reproduction as indicated by the presence of saplings is sparce under the canopy of mature trees, but is greater along the edges of the stands. Fire plays an important part in the reproduction of this species and fire has been controlled since the settlement of the region. Dry summers and lightning provide the potential for periodic fires, but any fire started is quickly extinguished by the local ranchers. Pfister *et al.* (1974) reported that overstories of ponderosa pine are typically even-aged with a sparsity of smaller size classes in old growth stands. This may reflect the traditional role of fire in elimination of younger trees and subsequent near-complete occupancy of the site by "old veterans". In younger stands protected from wildfire, a mixed-age stand occurs. In the Sarpy Creek area the 40 years of fire elimination has resulted in some areas showing a mixed-age composition.

Four of the six categories described by Pfister *et al.* (1974) occur in the area (Table 2).

Pinus ponderosa/Symphoricarpos albus. In the Sarpy Creek area both species of snowberry (*Symphoricarpos albus* and *S. occidentalis*) occur. This type exists in the more mesic sites throughout the area.

TABLE 2. THE CANOPY COVERAGE AND FREQUENCY OF OCCURRENCE OF PLANT SPECIES IN THE UNDERSTORY OF THE PONDEROSA PINE MOSAIC VEGETATION TYPE.

Taxa[1]	Lines					
	I	II	III	IV	V	VI
Graminoids						
Agropyron smithii	4.0/40[2]	+[3]/15	2.1/15			
Agropyron spicatum	8.3/20	5.8/80	11.9/80	19.8/70	21.5/85	4.1/65
Andropagon hallii	+/5					
Andropagon scoparius				7.9/25	3.3/10	12.9/45
Aristida longiseta	6.8/30				1.9/5	4.6/20
Bouteloua curtipendula	11.9/70	7.4/50	+/5		7.4/30	1.4/30
Bouteloua gracilis			6.1/30	3.8/30		1/15
Bromus japonicus		1.5/35	1.9/50	+/35	+/35	1.3/25
Bromus tectorum			+/5			
Carex spp.		2.3/40	+/15	+/25		+/35
Festuca idahoensis	1.4/30					
Poa spp.	+/20	+/5			+/5	
Stipa	1.9/5	+/15	1.6/15	3.3/35	1.5/10	+/5
Forbs						
Achillea millefolium	+/10				+/5	+/5
Ambrosia psilostachya		11.1/75	1.5/35			
Artemisia frigida					+/5	
Artemisia ludoviciana	2.4/15	4.3/25		4.6/30	1.6/15	5/75
Cerastium arvense	+/10	3.0/25	1.9/25	2.6/10		+/5
Collomia linearis	+/5					
Echinaceae pallida		+/10				+/1
Linum perenne		+/5				
Phlox hoodii					+/5	1.0/15
Plantago purshii					+/15	
Solidago rigida	+/5			+/5	+/20	
Ratibida columnifera	+/5	+/15		+/5		+/10
Shrubs						
Gutierrezia sarothrae		+/5				
Rhus trilobata			6.6/25	+/5	+/10	
Rosa spp.		+/5		+/5	+/10	
Symphoricarpos spp.			+/10			

1 Includes those taxa with a canopy coverage of 1 percent or greater.
2 Canopy coverage/number of plots in which plant occurred (120/line).
3 + a value of less than 1 percent.

Snowberry is commonly the only plant species in the shrub story at the highest part of the drainage. In the lower regions it is commonly associated with Horse Mint (*Monarda fistulosa*) and Rose (*Rosa* spp.).

Pinus ponderosa/Prunus virginiana. This type occurs lower down the drainage than the Snowberry type but is a continuum with it. On steep sided drainages this type abounds and provides a dense tangle of underbrush used by deer as security areas.

Pinus ponderosa/Andropogon spp. This type occurs characteristically along the sandstone outcrops. It is the least abundant type in terms of area covered but where it does occur, the stands are very dense.

Pinus ponderosa/Agropyron spicatum. Most of the understory is of this type. This grass species is often less abundant than Sideoats Grama (*Bouteloua curtipendula*) in the Sarpy Creek area, especially in wet years. However, in the relatively level openings in the ponderosa pine savannah this species occurs frequently.

Sagebrush V.T.

The second of the two largest vegetation types is commonly found at the lower elevations on rolling foothills and flats. Big sagebrush is the most abundant shrub often occupying extensive areas (Fig. 4). Few other shrubby species were encountered in this type. The most notable ones that did occur were: False-tarragon Sagewort (*Artemisia*

dracunculus), Greasewood (*Sarcobatus vermiculatus*), and occasionally Prairie Rose (*Rosa arkansana*) was encountered (Table 3). Mueggler and Handl (1974) described a similar Habitat Type - *Artemisia tridentata/ Agropyron spicatum*. The primary difference between the Habitat Type that they described and the Vegetation Type in Sarpy Creek is in the amount of coverage of Bluebunch Wheatgrass (*Agropyron spicatum*). In their studies this species averaged 38% coverage while in the Sarpy Creek study area it averaged only 6%. The most commonly encountered grass was Japanese Chess (*Bromus japonicus*). Western Wheatgrass (*Agropyron smithii*) occurs in the area with an average coverage of 8%. Blue Grama (*Bouteloua gracilis*), Needle-And-Thread (*Stipa comata*), and Green Needlegrass (*Stipa viridula*) occurred locally.

Forbs were of relatively low abundance. The three most commonly encountered were: Field Chickweed (*Cerastium arvense*), Hoods Phlox (*Phlox hoodii*) and Common Salsify (*Tragopogon dubius*). Wild Onion (*Allium textile*) was abundant in the spring but was generally gone by the time the vegetation was analyzed. Crested Wheatgrass has been introduced throughout the area and is a common escape. Yellow Sweet-clover (*Melilotus officinalis*) which has been planted as a companion crop with Crested Wheatgrass is occasionally encountered. Areas that were planted to these two crops are included in the Field V.T. described later.

TABLE 3. THE CANOPY COVERAGE AND FREQUENCY OF OCCURRENCE OF PLANT SPECIES IN THE SAGEBRUSH VEGETATION TYPE.

Taxa[1]	Lines					
	I	II	III	IV	V	VI
Graminoids						
Agropyron smithii	5.6/80[2]	13.3/55	6/70	1.6/40	4.1/65	+[3]/5
Agropyron spicatum				3.5/65	2.4/20	+/5
Aristida longiseta			+/15			
Bouteloua gracilis				5.8/35		
Bromus japonicus	2.4/45	7.3/65	2.6/30	2.0/55	2.1/60	3.9/80
Bromus tectorum	1.5/30	+/5	+/10	+/30		1.1/20
Calamovilfa longifolia					+/5	
Carex spp.	1.1/45	9.8/75	+/20	+/30		2.6/30
Distichlis stricta					4.9/70	
Koeleria cristata	1.0/40		1.8/45		+/10	2/60
Poa sandbergii		4.5/15			+/20	
Poa spp.		+/20			+/5	2.5/50
Forbs						
Achillea millefolium	+/10		+/15			
Ambrosia psilostachya			+/10			
Antennaria parvifolia		+/5				
Artemisia frigida		+/5	2.6/10		+/5	
Cerastium arvense	10.6/85		6.1/70			
Grindelia squarrosa			+/5			
Linum perenne					+5	
Phlox hoodii	+/5	3.9/25	+/20	2.3/40	1.4/30	1.4/30
Plantago purshii	+/10		1.1/20			
Tragopogon dubius		+/30		1.4/55		+/5
Shrubs						
Artemisia dracunculus			3.1/25			
Artemisia tridentata	22.6/80	14.0/40	31.4/90	17/80	16.4/55	33.5/85
Gutierrezia sarothrae	+/5	+/5	+/5	2.6/55		
Opuntia polycantha	+/5	2.4/15			+/10	
Sarcobatus vermiculatus		4.3/25				

1 Includes those taxa with a canopy coverage of 1 percent or greater.
2 Canopy coverage/number of plots in which plant occurred (120/line).
3 + a value of less than 1 percent.

Rhus-Yucca V.T.

This type does not occupy extensive areas. It occurs on those sandstone hills that are devoid of ponderosa pine (Fig. 5). It is also found as an interim between the forested hills and the sagebrush covered flats. This type is characterized by an open overstory, abundant grasses and few shrubby species (Table 4).

Mueggler and Handl (1974) reported on a similar Habitat Type that they called *Rhus trilobata/Agropyron spicatum*. Soap Weed (*Yucca glauca*) was not encountered in any of their plots. They did notice a high occurrence of Bluebunch Wheatgrass which was found in 100% of their study plots. This grass was not encountered in the Rhus-Yucca V.T.

The two most often encountered grasses in this type were Japanese Chess and Blue Grama. Sedges (*Carex* spp.) were very abundant. Western Ragweed (*Ambrosia psilostachya*) was the most frequently encountered forb. All of these species are considered as either indicators of disturbance or increasers under heavy grazing pressure. Their occurrence at these levels in this vegetation type is a reflection of the amount of past disturbance. Since this vegetation type has large amounts of naturally occurring grasses, it has been heavily grazed and was often put into cultivation by the first homesteaders. Extensively disturbed areas have been placed into the Field V.T.

TABLE 4. THE CANOPY COVERAGE AND FREQUENCY OF OCCURRENCE OF PLANT SPECIES IN THE RHUS YUCCA VEGETATION TYPE

Taxa[1]	Lines					
	I	II	III	IV	V	IV
Graminoids						
Agropyron cristatum	2.63/2[2]			7.1/12	4.5/16	+[3]/1
Agropyron dasystachyum	+/3					
Agropyron spicatum	+/1					
Andropogon spp.			3.83/2			
Bouteloua curtipendula			5.5 /6			
Bouteloua gracilis		8.6/7	20.9 /15	+/2		
Bromus japonicus	24.7 /19	10.6/17	9.6 /15	23.3/15	12.3/16	2.4/13
Bromus tectorum			+/3	5.9/8	2.0/6	
Calamovilfa longifolia		15.5/14	+/1			
Carex spp.		+/1		+/1	+/1	+/1
Koeleria cristata	+/1		2.4 /5			
Poa spp.				6.1/6		+/2
Sporobolus cryptandrus	+/1					+/5
Stipa comata	12.3 /19	3.5/13	4.4 /15		2/2/4	
Vulpia octoflora	2.8 /7	+/2		+/4		2.1/12
Forbs						
Achillia millifolium				1.5/12	+/2	3.3/6
Artemisia frigida	1.5 /7			+/2		+/2
Artemisia ludoviciana	2.5 /1	4.0/4		7.0/8		
Ambrosia psilostachya		1.8/9		6.3/15	8.8/17	+/3
Cirsium vulgare	1.9 /1					+/1
Erigonum annum	+/1					4.3/10
Plantago purshii				+/3		+/6
Ratibida columnifera				+/1		1/3
Sphaeralcea coccinea						+/2
Taraxicum officinale						+/6
Thlaspi arvense				+/1		
Tragopogon dubius				+/1		
Shrubs						
Artemisia dracunculus		+/2		4.3/5	+/1	2.1/12
Gutierrezia sarothrae					1.5/2	
Opuntia polycantha					+/1	

1 Includes those taxa with a canopy coverage of 1 percent or greater.
2 Canopy coverage/number of plots in which plant occurred (120/line).
3 + a value of less than 1 percent.

Bottomland V.T.

This vegetation type occurs along the three major drainage systems and is often a continuum with the vegetation found along the minor drainage systems that were described under the Ponderosa Pine Mosaic V.T. The Bottomland V.T. is characterized by vegetation reflective of the more mesic properties associated with a drainage locale (Tables 5, 6 and 7). These waterways have the only trees in the area that were not ponderosa pine. Plains Cottonwood (*Populus deltoides*), Green Ash (*Fraxinus pennsylvanica*), and Box Elder (*Acer negundo*) were the most conspicuous. Under the trees were thickets of Fleshy Hawthorn (*Crategus succlenta*), Buffaloberry (*Shepherdia canadensis*), Chokecherry, Snowberry and dense tangles of Rose (Fig. 6).

The dry nature of the region along with its sandy soils results in a rather sharp line of demarcation between the more mesic Bottomland V.T. and the more xeric Sagebrush V.T. Tables 5, 6 and 7 show this sharp line of demarcation by the presence of more xeric plants along one side of the line and the occurrence of the more mesic plants on the side closer to the streambed. Along certain portions of the area these two plant types overlap slightly.

Field V.T.

This type included areas that were once homesteaded and since abandoned, those areas that have been seeded to specialized grasses

TABLE 5. THE BOTTOMLAND VEGETATION OF HORSE CREEK AS ANALYZED BY A POINT-QUADRANT METHOD.

Point	Quadrant	Species	Distance To Nearest Bush	Diameter 1	Diameter 2
0 Meters	1	*Populus deltoides*	2 M 60 cm	5 M 20 cm	6 M 43 cm
	2	*Rhus trilobata*	11 M 50 cm	3 M 10 cm	2 M 70 cm
	3	*Rosa* spp.	0 M 85 cm	0 M 30 cm	0 M 28 cm
	4	*Rosa* spp.	1 M 80 cm	2 M 10 cm	3 M 20 cm
10 Meters	1	*Symphoricarpos alba*	1 M 30 cm	0 M 40 cm	0 M 20 cm
	2	*Artemisia cana*	2 M 0 cm	1 M 10 cm	1 M 20 cm
	3	*Artemisia cana*	0 M 70 cm	0 M 78 cm	0 M 50 cm
	4	*Rosa* spp.	2 M 30 cm	1 M 10 cm	0 M 90 cm
20 Meters	1	*Rosa* spp.	0 M 20 cm	0 M 10 cm	0 M 0 cm
	2	*Rosa* spp.	0 M 30 cm	0 M 10 cm	0 M 20 cm
	3	*Rosa* spp.	0 M 80 cm	0 M 32 cm	0 M 23 cm
	4	*Rosa* spp.	0 M 63 cm	0 M 45 cm	0 M 35 cm
30 Meters	1	*Rosa* spp.	0 M 78 cm	0 M 30 cm	0 M 10 cm
	2	*Rosa* spp.	0 M 72 cm	0 M 48 cm	0 M 45 cm
	3	*Rosa* spp.	1 M 10 cm	1 M 50 cm	1 M 20 cm
	4	*Rosa* spp.	3 M 50 cm	0 M 80 cm	0 M 30 cm
40 Meters	1	*Symphoricarpos alba*	1 M 10 cm	0 M 80 cm	0 M 40 cm
	2	*Rosa* spp.	0 M 45 cm	0 M 20 cm	0 M 15 cm
	3	*Symphoricarpos/Rosa**	0 M 90 cm	0 M 50 cm	0 M 85 cm
	4	*Symphoricarpos/Rosa**	3 M 96 cm	0 M 80 cm	0 M 60 cm

* The two bushes were too entwined to separate. The bush was evaluated as if it consisted of but one species.

TABLE 5. (Continued)

Point	Quadrant	Species	Distance To Nearest Bush	Diameter 1	Diameter 2
50 Meters	1	*Artemisia cana*	1 M 20 cm	0 M 10 cm	0 M 10 cm
	2	*Artemisia cana*	3 M 0 cm	0 M 85 cm	0 M 53 cm
	3	*Symphoricarpos alba*	9 M 20 cm	1 M 0 cm	0 M 60 cm
	4	*Symphoricarpos alba*	3 M 10 cm	0 M 35 cm	0 M 60 cm
60 Meters	1	*Artemisia cana*	10 M 35 cm	1 M 0 cm	0 M 80 cm
	2	*Artemisia cana*	6 M 5 cm	1 M 0 cm	0 M 50 cm
	3	*Fraxinus pennsylvanica*	1 M 70 cm	2 M 80 cm	3 M 60 cm
	4	*Fraxinus pennsylvanica*	3 M 90 cm	2 M 0 cm	3 M 10 cm
70 Meters	1	*Artemisia cana*	2 M 20 cm	0 M 90 cm	1 M 20 cm
	2	*Rhus trilobata*	1 M 80 cm	1 M 0 cm	0 M 55 cm
	3	*Fraxinus pennsylvanica*	2 M 60 cm	3 M 20 cm	5 M 10 cm
	4	*Fraxinus pennsylvanica*	1 M 8 cm	1 M 60 cm	2 M 0 cm
80 Meters	1	*Artemisia cana*	16 M 45 cm	0 M 45 cm	0 M 35 cm
	2	*Artemisia cana*	14 M 30 cm	0 M 40 cm	0 M 35 cm
	3	*Prunus virginiana*	1 M 40 cm	0 M 80 cm	0 M 67 cm
	4	*Prunus virginiana*	2 M 70 cm	5 M 50 cm	4 M 60 cm
90 Meters	1	*Artemisia cana*	9 M 0 cm	0 M 60 cm	0 M 45 cm
	2	*Artemisia cana*	10 M 10 cm	0 M 50 cm	0 M 60 cm
	3	*Crataegus succlenta*	1 M 40 cm	1 M 10 cm	0 M 80 cm
	4	*Crataegus succlenta*	2 M 50 cm	4 M 10 cm	3 M 80 cm

TABLE 6. THE BOTTOMLAND VEGETATION OF SARPY CREEK AS ANALYZED BY A POINT-QUADRANT METHOD.

Point	Quadrant	Species	Distance To Nearest Bush	Diameter 1	Diameter 2
0 Meters	1	*Artemisia cana*	2 M 10 cm	0 M 50 cm	0 M 75 cm
	2	*Symphoricarpos alba*	0 M 5 cm	0 M 30 cm	0 M 75 cm
	3	*Symphoricarpos alba*	1 M 20 cm	0 M 20 cm	0 M 30 cm
	4	*Artemisia cana*	0 M 70 cm	0 M 30 cm	0 M 20 cm
10 Meters	1	*Artemisia cana*	2 M 50 cm	3 M 0 cm	0 M 90 cm
	2	*Symphoricarpos alba*	0 M 40 cm	0 M 80 cm	0 M 70 cm
	3	*Symphoricarpos alba*	1 M 10 cm	0 M 30 cm	0 M 20 cm
	4	*Artemisia cana*	2 M 10 cm	4 M 90 cm	1 M 50 cm
20 Meters	1	*Symphoricarpos alba*	1 M 30 cm	0 M 20 cm	0 M 20 cm
	2	*Acer negundo*	2 M 10 cm	2 M 40 cm	3 M 10 cm
	3	*Symphoricarpos alba*	1 M 50 cm	0 M 75 cm	1 M 5 cm
	4	*Symphoricarpos alba*	1 M 60 cm	0 M 60 cm	0 M 50 cm
30 Meters	1	*Symphoricarpos alba*	1 M 10 cm	0 M 10 cm	0 M 10 cm
	2	*Ribes aureum*	0 M 60 cm	1 M 10 cm	1 M 50 cm
	3	*Symphoricarpos alba*	1 M 0 cm	0 M 70 cm	0 M 60 cm
	4	*Symphoricarpos alba*	0 M 90 cm	1 M 10 cm	0 M 90 cm
40 Meters	1	*Artemisia cana*	9 M 10 cm	0 M 30 cm	0 M 20 cm
	2	*Ribes aureum*	1 M 20 cm	2 M 10 cm	0 M 90 cm
	3	*Ribes aureum*	1 M 0 cm	2 M 0 cm	0 M 70 cm
	4	*Artemisia cana*	28 M 30 cm	0 M 70 cm	0 M 30 cm

TABLE 6. (Continued)

Point	Quadrant	Species	Distance To Nearest Bush	Diameter 1	Diameter 2
50 Meters	1	*Rosa* spp.	0 M 20 cm	0 M 60 cm	0 M 30 cm
	2	*Acer negundo*	3 M 10 cm	4 M 70 cm	10 M 20 cm
	3	*Artemisia cana*	24 M 80 cm	0 M 90 cm	0 M 30 cm
	4	*Artemisia cana*	25 M 0 cm	1 M 10 cm	1 M 20 cm
60 Meters	1	*Artemisia cana*	20 M 30 cm	0 M 70 cm	0 M 40 cm
	2	*Populus tremuloides*	2 M 10 cm	10 M 10 cm	8 M 90 cm
	3	*Ribes aureum*	2 M 80 cm	1 M 10 cm	0 M 70 cm
	4	*Artemisia cana*	12 M 50 cm	1 M 30 cm	1 M 0 cm
70 Meters	1	*Artemisia cana*	6 M 10 cm	0 M 30 cm	0 M 20 cm
	2	*Ribes aureum*	0 M 60 cm	1 M 10 cm	0 M 80 cm
	3	*Rosa* spp.	1 M 10 cm	0 M 80 cm	0 M 40 cm
	4	*Artemisia cana*	8 M 10 cm	0 M 80 cm	0 M 60 cm
80 Meters	1	*Artemisia cana*	0 M 10 cm	1 M 20 cm	0 M 70 cm
	2	*Rosa* spp.	1 M 20 cm	0 M 40 cm	0 M 60 cm
	3	*Symphoricarpos alba*	0 M 90 cm	0 M 80 cm	0 M 50 cm
	4	*Rosa* spp.	0 M 10 cm	0 M 60 cm	0 M 50 cm
90 Meters	1	*Ribes aureum*	0 M 50 cm	1 M 0 cm	0 M 90 cm
	2	*Symphoricarpos alba*	0 M 30 cm	0 M 60 cm	0 M 40 cm
	3	*Rosa* spp.	1 M 30 cm	0 M 40 cm	0 M 60 cm
	4	*Ribes aureum*	1 M 0 cm	0 M 20 cm	0 M 40 cm

TABLE 7. THE BOTTOMLAND VEGETATION OF EAST FORK SARPY CREEK AS ANALYZED BY A POINT-QUADRANT METHOD.

Point	Quadrant	Species	Distance To Nearest Bush	Diameter 1	Diameter 2
0 Meters	1	*Symphoricarpos alba*	2 M 0 cm	0 M 20 cm	0 M 20 cm
	2	*Rosa* spp.	1 M 0 cm	7 M 0 cm	8 M 0 cm
	3	*Artemisia cana*	0 M 30 cm	0 M 70 cm	0 M 90 cm
	4	*Artemisia cana*	0 M 30 cm	0 M 60 cm	0 M 70 cm
10 Meters	1	*Artemisia cana*	0 M 10 cm	0 M 30 cm	0 M 60 cm
	2	*Artemisia tridentata*	0 M 10 cm	0 M 10 cm	0 M 20 cm
	3	*Artemisia cana*	0 M 10 cm	0 M 10 cm	0 M 20 cm
	4	*Artemisia cana*	0 M 20 cm	0 M 90 cm	1 M 90 cm
20 Meters	1	*Rosa* spp.	0 M 5 cm	TANGLE*	
	2	*Rosa* spp.	0 M 5 cm	TANGLE	
	3	*Rosa* spp.	0 M 5 cm	TANGLE	
	4	*Rosa* spp.	0 M 5 cm	TANGLE	
30 Meters	1	*Artemisia cana*	0 M 20 cm	0 M 60 cm	0 M 50 cm
	2	*Artemisia cana*	0 M 30 cm	0 M 30 cm	0 M 50 cm
	3	*Rosa* spp.	0 M 10 cm	0 M 20 cm	0 M 30 cm
	4	*Artemisia cana*	0 M 20 cm	0 M 20 cm	0 M 20 cm
40 Meters	1	*Rosa* spp.	0 M 10 cm	TANGLE	
	2	*Rosa* spp.	0 M 10 cm	TANGLE	
	3	*Artemisia cana*	0 M 10 cm	1 M 20 cm	1 M 60 cm
	4	*Artemisia cana*	0 M 30 cm	0 M 10 cm	0 M 10 cm

* All four quadrants were covered by the same bush.

TABLE 7. (Continued)

Point	Quadrant	Species	Distance To Nearest Bush	Diameter 1	Diameter 2
50 Meters	1	*Rosa* spp.	1 M 0 cm	TANGLE	
	2	*Rosa* spp.	0 M 90 cm	TANGLE	
	3	*Artemisia cana*	2 M 10 cm	0 M 80 cm	0 M 50 cm
	4	*Artemisia cana*	2 M 40 cm	0 M 20 cm	0 M 30 cm
60 Meters	1	*Rosa* spp.	1 M 0 cm	TANGLE	
	2	*Rosa* spp.	1 M 0 cm	TANGLE	
	3	*Artemisia cana*	0 M 20 cm	0 M 20 cm	0 M 80 cm
	4	*Artemisia cana*	0 M 20 cm	0 M 70 cm	0 M 50 cm
70 Meters	1	*			
	2	*			
	3	*Artemisia cana*	0 M 20 cm	0 M 20 cm	0 M 20 cm
	4	*Artemisia cana*	2 M 0 cm	0 M 10 cm	0 M 10 cm
80 Meters	1	*			
	2	*			
	3	*Artemisia cana*	0 M 20 cm	0 M 20 cm	0 M 40 cm
	4	*Artemisia cana*	0 M 10 cm	0 M 30 cm	0 M 30 cm
90 Meters	1	*Rosa* spp.	1 M 0 cm	0 M 20 cm	0 M 20 cm
	2	*Rosa* spp.	1 M 0 cm	0 M 40 cm	0 M 40 cm
	3	*Artemisia cana*	2 M 0 cm	3 M 0 cm	2 M 0 cm
	4	*Artemisia cana*	2 M 0 cm	0 M 60 cm	0 M 80 cm

* Only grasses and sedges were present between point and creek.

for additional grazing, and those portions of the Sagebrush V.T. that have been severely disturbed to remove sagebrush. Crested Wheatgrass was the most commonly seeded specialized grass and was frequently encountered in the analysis. The most often encountered grass was Japanese Chess. In the entire study area this species was more often encountered than Cheat Grass (*Bromus tectorum*) but both were widely distributed. Needle-And-Thread occurred often. In their publication, Mueggler and Handl (1974) reported that Bull Thistle (*Cirsium vulgare*), Common Dandelion (*Taraxicum officinale*) and Common Salsify (*Tragopogon dubius*) were invader species in their *Agropyron spicatum* series. These species occurred in the plots located in the disturbed portions of the sagebrush locales in the Sarpy Creek study area. Booth and Wright (1966) listed Western Ragweed as occurring along roadsides and in waste places. This species was the most often encountered forb in this vegetation type (Table 8).

Cultivation V.T.

This type is agricultural land with winter wheat and alfalfa as the principal crops (Fig. 8). I believe that the vegetation type that was removed to provide these cultivated areas was a Silver Sage type, plus a small portion of the Sagebrush V.T. that borders the more mesic areas.

TABLE 8. THE CANOPY COVERAGE AND FREQUENCY OF OCCURRENCE OF PLANT SPECIES IN THE FIELD VEGETATION TYPE.

Taxa[1]	Lines					
	I	II	III	IV	V	VI
Graminoids						
Agropyron smithii						+/10
Andropogon gerardii	+/20[2]	+[3]/10				
Andropogon scoparius			5.1/15			22.9/70
Aristida longiseta	+/5	+/5				
Bouteloua gracilis	6.7/15	1.1/45	16.6/70	7.9/50	6.4/40	6.6/70
Bromus japonicus	3.3/35	3.9/35	2.5/50	2.4/45	8.8/50	
Bromus tectorum		+/25		6.0/45	4.0/40	
Calamovilfa longifolia	+/10	+/5		+/5	12.6/70	
Carex spp.	19.9/80	30.3/75	4.3/35		14.0/60	20.8/75
Koeleria cristata	3.9/30	2.9/20	7.3/70	2.8/35	2.0/30	+/15
Poa	2.0/55	1.4/30	+/5	+/25	1.4/30	
Stipa spp.	2.5/30					
Forbs						
Ambrosia psilostachya	1.8/8	+/7	3.6/14	2.8/12		+/7
Artemisia frigida						1.9/1
Artemisia ludoviciana	7.9/6			2.1/7		
Chrysopsis villosa						+/1
Cirsium undulatum		+/1				
Cerastium arvense		+/1		+/1		
Eriogonum annuum			1.8/4	5.3/12		
Haplopappus spinulosus						+/1
Liatris punctata				4.0/3	+/2.5	2.0/2
Phlox hoodii						1.1/4
Plantago purshii		1.6/8	+/2.5	+/2.5		
Solidago rigida						+/2
Shrubs						
Artemisia dracunculus	3.6/5		2.8/3		8.6/7	
Gutierrezia sarothrae		+/1				
Opuntia polycantha				+/3		
Rhus trilobata	30.1/9	14.0/3			5.3/8	3.1/1
Rosa arkansana		2.1/3				
Yucca glauca	11.0/3	14.6/3	3.3/2	4.9/1	3.8/2	6.1/2

1 Includes those taxa with a canopy coverage of 1 percent or greater.
2 Canopy coverage/number of plots in which plant occurred (120/line).
3 + a value of less than 1 percent.

Figure 8. Cultivation Vegetation Type.

MULE DEER

Population Characteristics

A total of 456 observations of mule deer were recorded in the study area. Of these, 136 were classified in 1975 and 85 in 1976. Ten relocations of two radio-collared deer were made in 1976.

As the summer progressed the increasing tendency for fawns to accompany their mothers resulted in an increased visibility to an observer. This was reflected in an increase in the fawns per 100 does ratio from July when the first fawns were observed through September when the last counts were made (Table 9). I believe the September counts were the most reliable. These data indicate a decrease in fawn production from 75/100 in 1975 to 50/100 in 1976. Eustace (1974) reported 70 and 43 fawns per 100 does for hunting districts 720 and 722, respectively. Sarpy Creek is the boundary between these two districts. Martin (1976) reported counts of 86, 77 and 71 fawns per 100 does in 1973, 1974 and 1975, respectively, for the entire Sarpy Creek drainage.

Eustace (1974) rated fawn production as poor if the count per 100 does ranged from 40 to 59, fair if the range is 60 to 79 and good if the range is 80 to 99. Since 1973 the fawn production in the Sarpy Creek area has decreased from good to marginally fair. During the study period there were six probable cases of twinning identified.

TABLE 9. A CLASSIFICATION OF MULE DEER OBSERVATIONS.

Time	Males	Females	Fawns	Unclassified	Fawns/ 100 Does	Males/ 100 Does
1975						
April	1	58	0	0	0.0	1.7
May	2	50	0	0	0.0	4.0
June	4	41	0	2	0.0	9.8
July	4	15	3	0	20.0	27.0
August	9	74	29	4	39.2	12.0
September	2	32	24	3	75.0	9.4
1976						
March	1	27	0	0	0.0	3.7
May	2	20	0	0	0.0	10.0
June	0	9	0	0	0.0	0.0
July	2	12	1	0	8.3	16.7
August	2	44	11	0	25.0	4.5
September	1	17	10	0	59.0	5.9

Robinette *et al.* (1955) reported that twins were the most common litter size for mule deer on good quality range in Utah.

Sex Ratios

The number of males observed per 100 does was very low. There were indications that the males leave the study area and move into the Little Wolf Mountains in the summer and do not return until the onset of the rut. During the 1976 hunting season more males were taken than were seen during the summer, thus the ratios indicated for the summer months must be considered as an absolute minimum (Table 9). Martin (1975) reports antlered male ratios of 19/100 does for the fall of 1975 for the entire Sarpy Creek drainage.

Average Group Size

Average mule deer group sizes by month for 1975 and 1976 are shown in Table 10. The average group size was largest in winter and early spring when the deer were concentrated on the wintering areas. The average group size decreased from mid-spring through early summer as the animals dispersed to utilize the new vegetative growth. Knowles (1975) related smaller group sizes to better forage conditions on his study area in the Missouri breaks of Montana. From mid-summer through September the average group size increased as the land dried out and the deer moved to the more mesic bottomlands.

TABLE 10. THE AVERAGE GROUP SIZE OF MULE DEER OBSERVED IN THE STUDY AREA BY MONTH FOR 1975 AND 1976.

Time	Average Group Size	Number of Groups Observed
1975		
April	9.8	6
May	3.0	14
June	1.4	27
July	1.5	17
August	2.3	47
September	3.8	17
1976		
March	9.3	3
May	1.7	14
June	1.8	5
July	1.4	10
August	2.7	16
September	2.5	22

Pac (1975) reported an increase of only 0.2 in average group size during the summer for mule deer in the Bridger Mountains of Montana. The much larger increase reported here is probably related to the more xeric climate of southeastern Montana.

Distribution and Movements

The mule deer moved off of the winter range with the onset of new vegetative growth. Figure 9 indicates the widespread distribution of deer in late spring and early summer. As the uplands dried out, the deer moved into the more mesic bottomlands and higher

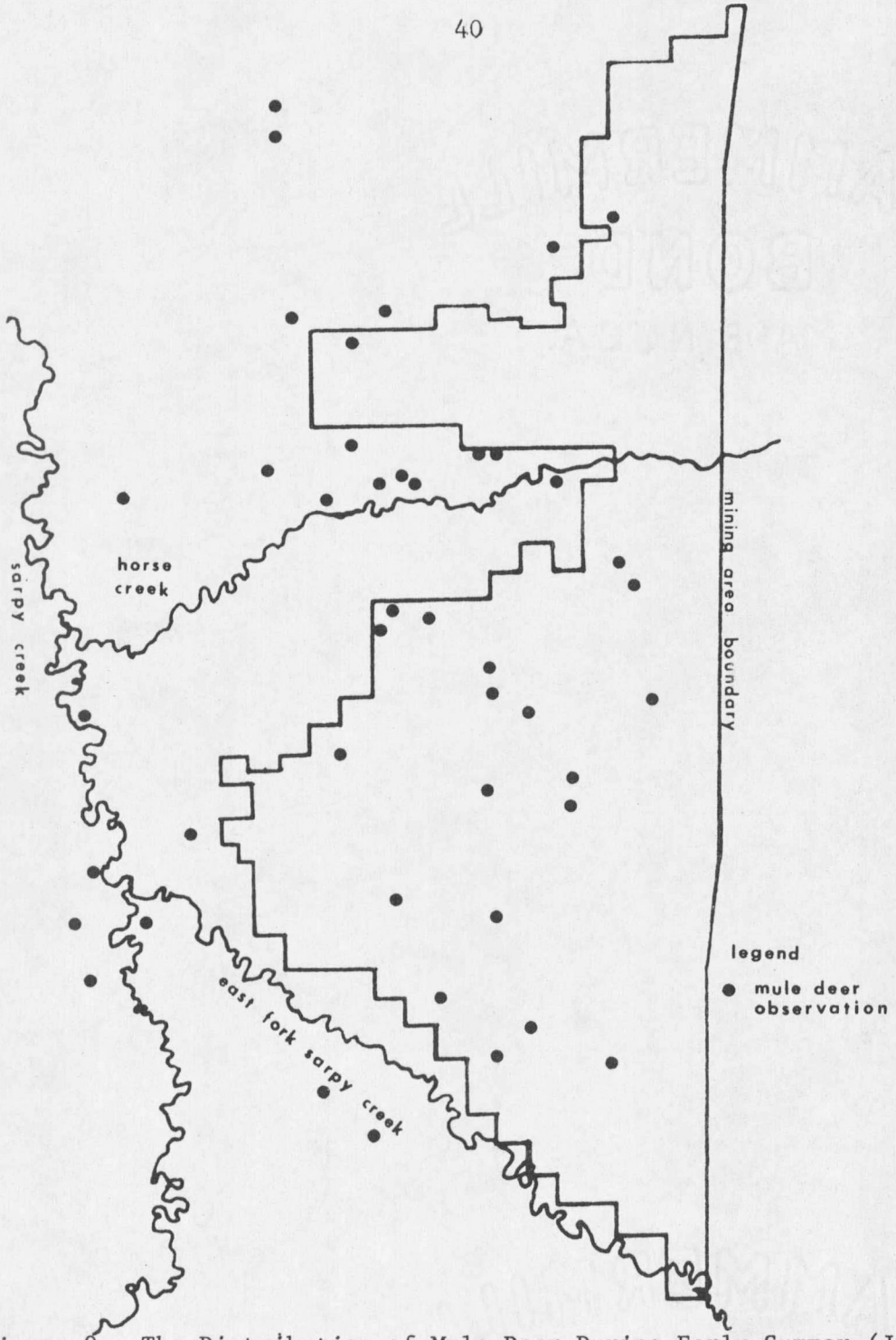

Figure 9. The Distribution of Mule Deer During Early Summer (June, July) of 1975.

concentrations resulted (Fig. 10). They remained in association with these bottomlands until fall. Snow depth in late fall and early winter forced the deer onto the winter ranges (Fig. 11). These winter ranges were characterized by steep relief where the top plateaus were windswept and in close proximity to bottomlands or brushy draws.

Two deer were collared with radio transmitters on the 28th of May, 1976. Figure 12 shows the ten relocations of these deer. The transmitter on deer number 2 was intermittent and the number of relocations of this animal was low. Both deer had already established a seasonal range in the Bottomland V.T. prior to being collared. Relocations indicate that once the deer move into the bottomlands, daily movements are minimal. After each deer was relocated, neither was observed more than 300 Meters from the site of the first relocation.

Use of Vegetation Types

Spring (March, April and May). The usage of the Sagebrush V.T. in March and April varied from 83% of the deer observed in 1975 to none in 1976. The heavy snowfall in April of 1975 kept the deer confined to the wintering areas which were partially within the Sagebrush V.T. The lack of snowcover in the spring of 1976 allowed the deer to move throughout the area (Table 11). In May the deer

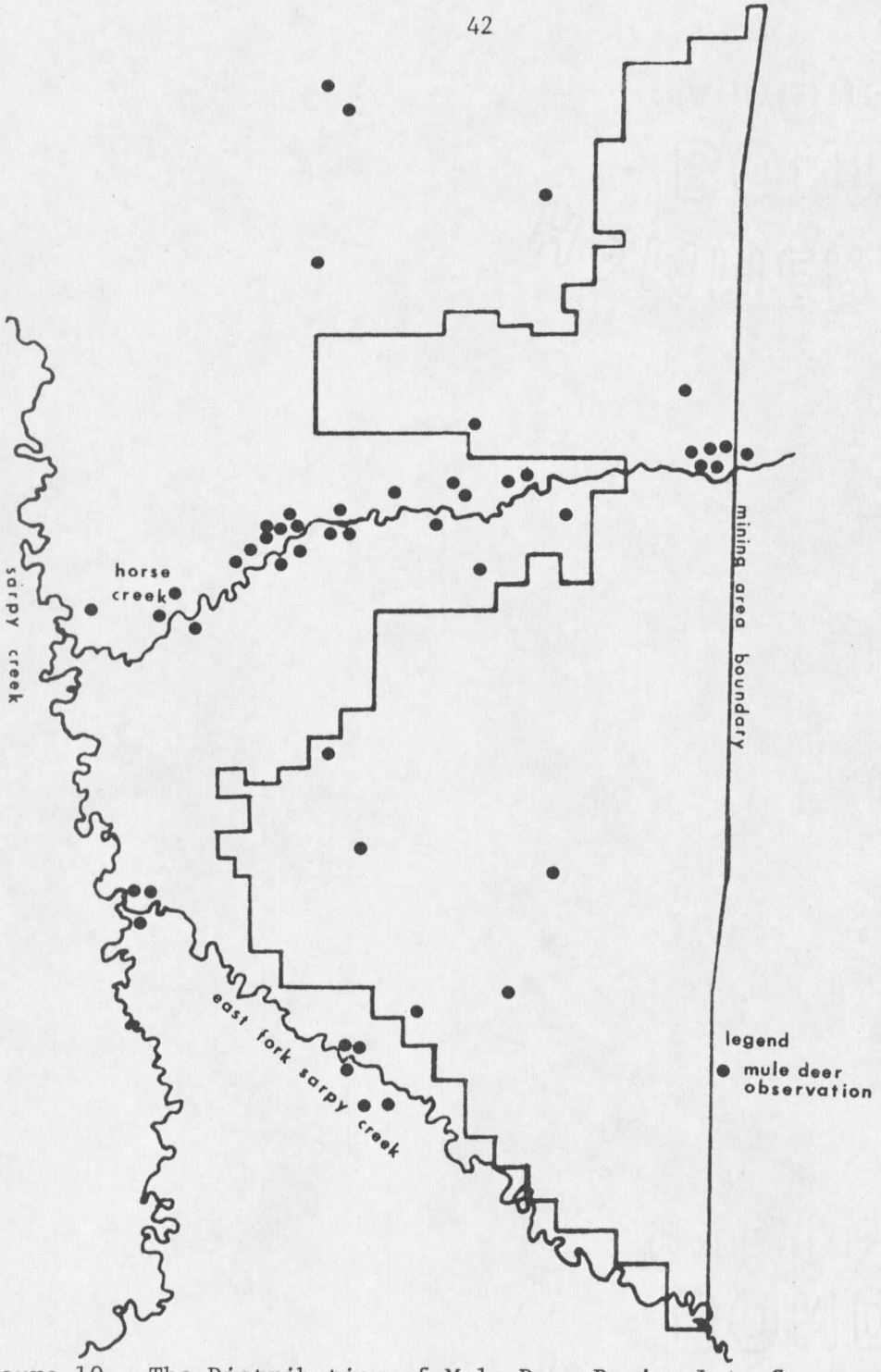

Figure 10. The Distribution of Mule Deer During Late Summer (August, September) of 1975.

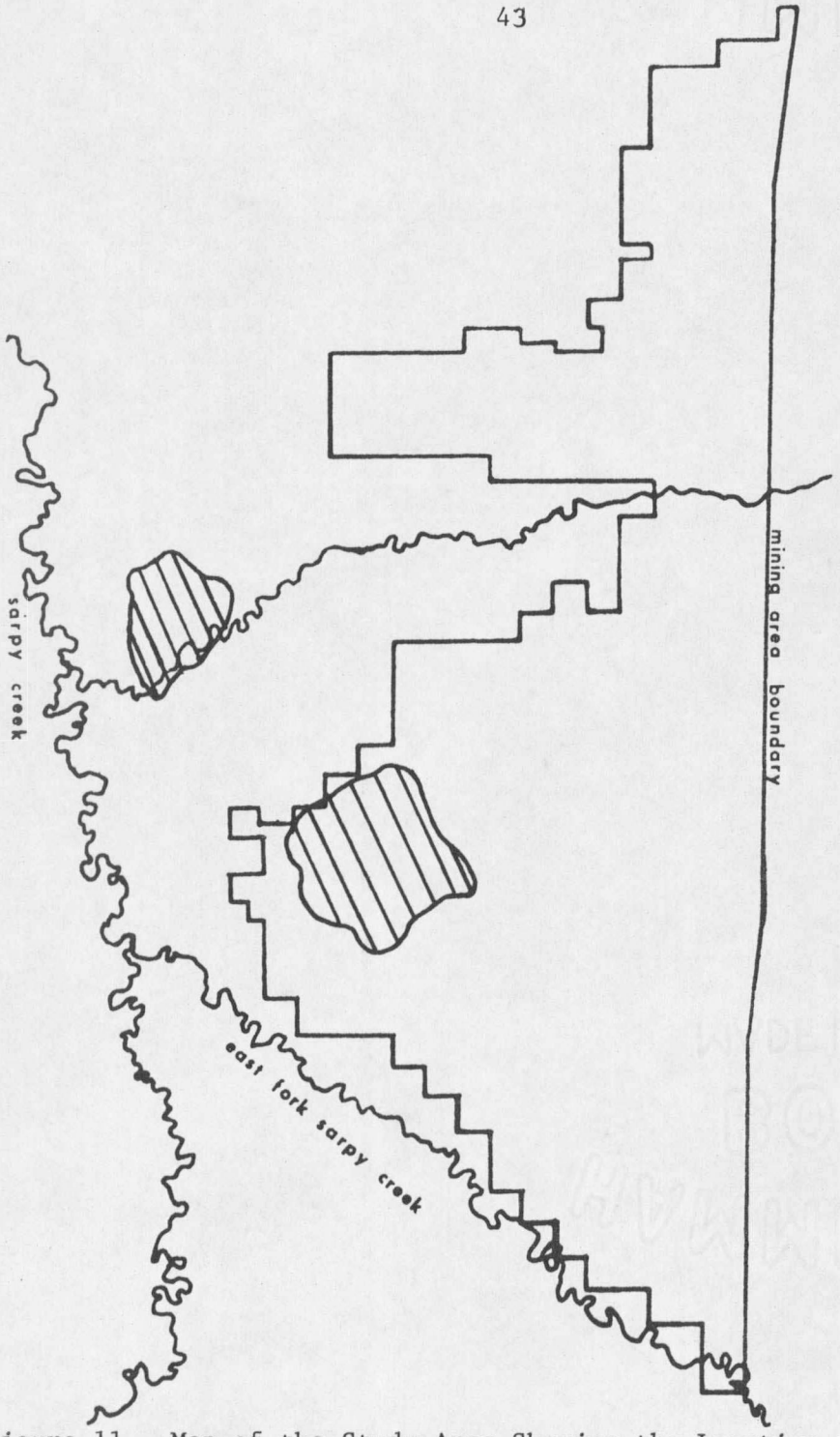

Figure 11. Map of the Study Area Showing the Location of the Two Wintering Ranges.

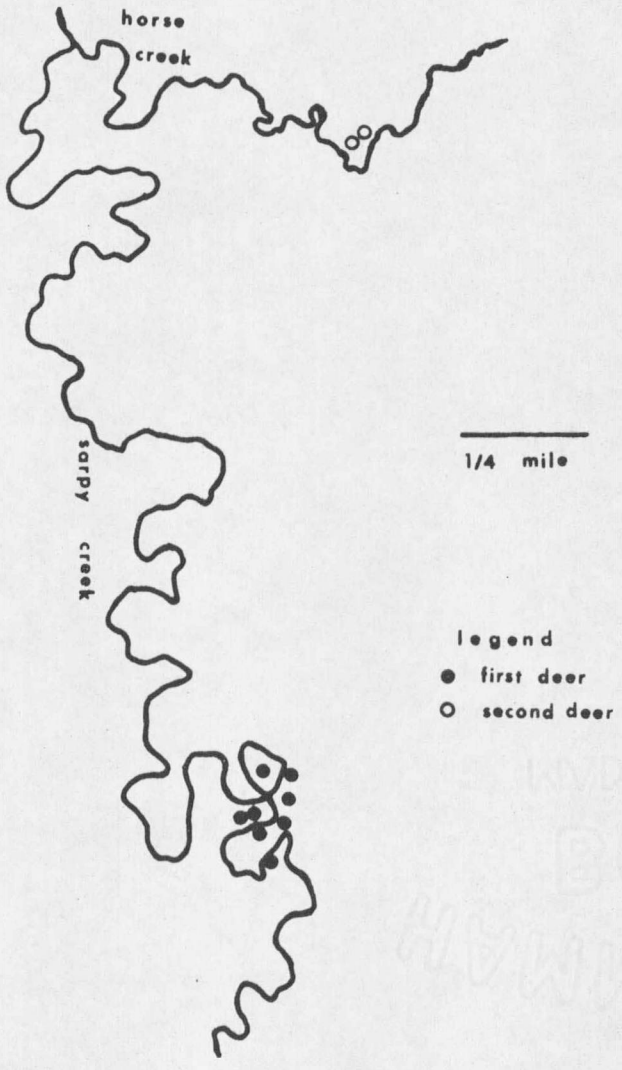

Figure 12. Map of the Study Area Showing the Ten Relocations of Two Radio-collared Deer.

TABLE 11. MULE DEER USAGE OF VEGETATION TYPES BY MONTH AS OBSERVED IN THE STUDY AREA DURING 1975 AND 1976.

Time	Total[1]	Sagebrush[2]	Cultivation[2]	Bottomland[2]	P. Pine[2] Mosaic	Rhus-[2] Yucca	Field[2]
1975							
April	59	83.1	0.0	15.3	1.7	0.0	0.0
May	52	5.8	9.6	13.5	53.8	11.5	5.8
June	47	19.1	31.9	12.8	23.4	12.8	0.0
July	22	18.2	45.5	13.6	13.6	9.1	0.0
August	118	16.1	12.3	57.7	12.3	1.8	0.0
September	3	6.0	0.0	86.6	6.6	0.0	0.0
December	18	20.0	0.0	20.0	60.0	0.0	0.0
1976							
March	28	0.0	0.0	46.4	39.2	14.3	0.0
May	22	31.8	9.1	54.6	4.5	0.0	0.0
June	9	22.2	0.0	44.4	33.3	0.0	0.0
July	15	33.3	0.0	33.3	13.3	20.0	0.0
August	44	23.0	13.6	75.0	9.1	0.0	0.0
September	28	17.9	0.0	71.4	10.7	0.0	0.0

[1]Total number of deer observed.
[2]Percentage of observations/month.

were widely distributed throughout the area with observations recorded in all vegetation types in 1975. During this time period deer were observed in the Field V.T. This was the only incidence of deer usage of this vegetation type during the study period. The Ponderosa Pine Mosaic V.T. accounted for most observations in late spring.

Early Summer (June, July). June is one of the wettest months with 2.05 and 4.14 inches of rainfall in 1975 and 1976, respectively (Table 1). This amount of rainfall kept the soil relatively moist through the start of the dry month of July. As the uplands dried out, the number of observations in these areas declined. Usage of the Bottomland V.T. increased in 1975 but decreased slightly in 1976. The decline may have been due to the large amount of rainfall in June of 1976.

Late Summer (August, September). During these two dry months the pattern of deer usage shifted to the more mesic bottomlands. Observations in the Bottomland V.T. more than doubled from July to August. During this period, Horse Creek and Sarpy Creek became intermittent. Pockets of standing water remained but flowage ceased. There was a slight increase in the number of observations in the Ponderosa Pine Mosaic V.T. in late summer. Usage of all other vegetation types declined.

Winter (December). The number of observations during this period was small. Aerial and ground surveys along with deer tracks were used to indicate areas of heavy usage. The deer were consistently observed along the edge between two vegetation types. While most observations were in the Ponderosa Pine Mosaic V.T., the animals were never observed more than 15 meters from an area of the Sagebrush V.T.

Use of Slope

Table 12 shows usage of slope by mule deer for the two years of the study. More mule deer were observed on gentle slopes than on the other two categories. This occurred because of the high usage of the Bottomland V.T. in late summer. This type is characteristically

TABLE 12. A CLASSIFICATION OF MULE DEER OBSERVATIONS BY SLOPE.

Year	Gentle[1]	Medium	Steep
1975	49[2]	40	20[3]
1976	40	11	11
TOTALS	89	51	31

[1]Categories: Gentle = 0.0° - 1.7° rise
Medium = 1.7° - 5.1° rise
Steep = Above 5.1° rise

[2]Numbers represent counts of observations, not individuals.

[3]Six of the mule deer observed on steep slopes were on slopes of 17.9° rise or greater. These deer were the ones observed in cattle-free areas.

located on level or nearly level grounds. The Steep category accounted for only 12% of the total observations, yet the usage of these steep slopes was more important than the percentage suggests. The two wintering ranges were associated with steep slopes and most of the observations in the Steep category were made during winter and early spring. However, during the summer months there were six instances of mule deer usage of very steep slopes having a gradient of 17.9° or more. The vegetation on these extremely steep slopes was invariably a dense tangle of brush that was not used by cattle.

ANTELOPE

Population Characteristics

A total of 101 observations of 629 antelope was recorded on the study area during 1975 and 1976 of which 227 antelope were classified in 1975 and 92 in 1976.

Fawn production in 1975 was high for Montana with a count of 69 fawns per 100 does being observed (Table 13). Martin (1976) reported a ratio of 41 per 100 does for the entire Sarpy Creek drainage during 1975. While antelope can be found occasionally along the entire Sarpy Creek drainage, the only extensive area of

TABLE 13. THE SEX AND AGE RATIOS OF ANTELOPE OBSERVED IN THE STUDY AREA DURING SPRING AND SUMMER OF 1975 AND 1976.

Year	Number of Observations	Fawn/Doe	Males/Females
1975	227	69/100	34/100
1976	92	32/100	39/100

sagebrush-covered land occurs in and around the study area. The occurrence of this habitat is reflected in the higher fawn production reported here. Dusek and McCann (1975) reported counts of 17 fawns per 100 adults in the Bull Mountains. Coop and Simmons reported counts of 58 and 53 fawns per 100 does for hunting district 570,

located in south-central Montana. Fawn production in 1976 dropped to 32 per 100 does. This level of production is comparable with the above listed reports. Since fawn production for any one year is for a large part a reflection of conditions during the previous year, the reasons for the large fawn production of 1975 is unknown.

Sex Ratios

The number of males observed per 100 does was relatively constant for the two years of the study (Table 13). Martin (1976) reported 28 bucks per 100 does for the entire Sarpy Creek drainage. There were four territories identified on the study area. These territories were established by early July in both years. Two bachelor herds of six and four males, respectively, were observed in 1975 and 1976.

Average Group Size

Average group sizes by month for 1975 and 1976 are shown in Table 14. Average group size was the smallest in spring as the animals moved onto the study area from the winter ranges. The largest average group size was recorded in July, coinciding with the appearance of fawns in the population. The average group size declined slightly throughout the summer.

TABLE 14. THE AVERAGE GROUP SIZE OF ANTELOPE OBSERVED IN THE STUDY AREA BY MONTH FOR 1975 AND 1976.

Time	Average Group Size	Number of Groups Observed
1975		
April	5.1	7
May	6.0	7
June	4.5	20
July	6.8	18
August	6.5	18
September	6.2	5
1976		
May	1.7	7
July	6.2	5
August	8.4	8
September	7.8	6

Distribution and Movements

No antelope were observed during the winter on the study area. Extensive areas of sagebrush-covered rangeland exists to the west of Sarpy Creek, and it is probable that the antelope move out onto these flats during the winter months. Apparently snowdepth triggers these movements, for local ranchers report seeing antelope in the study area during those winters with light snowfall.

Use of Vegetation Types

The Sagebrush V.T. and the Field V.T. accounted for the most observations during the study period. During 1975 antelope were

TABLE 15. ANTELOPE USAGE OF VEGETATION TYPES BY MONTH AS OBSERVED IN THE STUDY AREA DURING 1975 AND 1976.

Time	Sagebrush	Cultivation	Bottomland	P. Pine Mosaic	Rhus-Yucca	Field
1975						
April	24	0	0	3	0	9
May	29	8	0	0	0	6
June	43	2	0	1	7	34
July	60	17	0	3	4	38
August	51	19	0	0	2	36
September	42	0	0	0	0	0
TOTALS	249	46	0	7	13	123
%	55.8	10.3	0.0	1.6	2.9	27.8
1976						
March	4	0	0	0	0	0
May	11	0	0	6	1	1
July	22	0	0	0	0	2
August	60	0	0	0	0	23
September	34	0	0	0	0	20
TOTALS	131	0	0	6	1	46
%	71.2	0.0	0.0	3.3	0.5	25.0

observed using the Cultivation V.T. while none were observed using this vegetation type in 1976. In both years antelope were observed using the Ponderosa Pine Mosaic V.T. but most observations were of does. While there were no observations of fawns with the does on this type, most doe observations were recorded during or just prior to fawning time (Table 15).

Use of Slope

The Gentle and Medium slope categories accounted for 95.5% of all antelope observations (Table 16). There were only four instances of usage of the Steep category with all occurring within the Ponderosa Pine Mosaic V.T. One male was observed under a ponderosa pine canopy more than one kilometer from the nearest opening of more than 20 acres.

TABLE 16. A CLASSIFICATION OF ANTELOPE OBSERVATIONS BY SLOPE.

Year	Gentle[1]	Medium	Steep
1975	16[2]	47	2[3]
1976	8	13	2
TOTALS	24	60	4

[1]Categories: Gentle = 0.0° - 1.7° rise
Medium = 1.7° - 5.1° rise
Steep = Above 5.1° rise

[2]Numbers represent counts of observations, not individuals.

[3]Three of the four observations on steep slopes were of females using the Ponderosa Pine Mosaic Vegetation Type.

WHITETAIL DEER

There were four observations of whitetail deer during the study period. Two does were seen both years along the Sarpy Creek drainage. Neither doe was ever seen with a fawn at her side. Whitetail deer are commonly observed a few miles to the south of East Fork Sarpy Creek and along the Yellowstone River bottomlands 30 miles (48 km) to the north. Residents of the study area reported that whitetail deer are not commonly observed, but that sightings have increased in recent years.

COYOTES

The Sarpy Creek study area has an established population of coyotes. In 1975 there were 7 coyotes observed per 100 deer and 8 per 100 in 1976. These animals are hunted and trapped extensively particularly during the winter when the prime pelts provide an additional source of income.

DISCUSSION

The importance of winter range in the life history of mule deer in the northern Rocky Mountains has been well documented (Robinette *et al.* 1952, Donan and Rasmussen 1944). These and other studies were concerned with mule deer populations in mountainous terrain. The authors conclusions assumed that the summer range was at least adequate in comparison with the winter range. Few studies have concerned themselves with the summer range condition of those deer herds that exist in the semi-arid rain shadow of the northern Rocky Mountains. Deer occurring in these regions have a second critical period: the extremely dry late summer months.

During August and September rainfall in the Sarpy Creek study area totaled 0.54 inches in 1975 and 1.88 in 1976 (Table 1). Both years were at or above the average annual rainfall of 14 inches. In July and August of 1975 there were 23 days when the temperature exceeded 90°F and 33 days in 1976. The combination of long periods without significant rainfall and hot daytime temperatures results in a rapid dessication of forbs, particularly in the more xeric uplands. In response to this drying out of the vegetation, the mule deer in the Sarpy Creek area moved into the creek bottoms where the alluvial character of these areas provided moisture for a longer period of the summer. These movements into the bottomlands

corresponded roughly with the time flowage ceased in the creeks. While pockets of standing water remained, deer concentrations in the bottomland were not located in the regions of the streambed where the pockets of water existed. In the uplands, where reservoirs provided quantities of standing water, fewer deer were seen during the dry months. It appears that the primary factor causing deer migrations to the bottomlands and which localized concentrations therein was the sub-irrigation along the alluvium bottoms. This sub-irrigation provided a longer period of succulence for vegetation.

In very dry summers and in periods of prolonged drought, the period of time that succulence is provided by this sub-irrigation would be considerably reduced. During these periods the deer would be forced to utilize the less nutritious browse. Anthony (1976) reported that during drought periods mule deer in southeastern Arizona utilized evergreen and drought-resistant species. The hot, dry season appeared to be the most critical period of the year for those deer herds.

With the notable exception of a severe drought, it is unlikely that any significant die-off would occur during the late summer months. However, the utilization of less nutritious browse would result in a reduced weight gain and a lowered probability of surviving through the winter. Those does whose fawns survive may be affected

to a greater degree since the added demand of lactation places the doe under greater stress. Verme (1969) stated that "Unless lush summer range is available to maintain the mother in good condition, her productivity in the ensuing rut may be appreciably lowered". The removal of these alluvium bottomlands would result in a reduced productivity and greater mortality among the mule deer herds in Sarpy Creek.

The two wintering areas identified in the study area were characterized by steep relief with security areas in close proximity. The steep relief provided windswept regions where snowfall was blown away before any appreciable accumulations could occur. These areas were covered with sagebrush which provided easily obtained browse during those periods of winter when snow depth in the bottomlands would hinder deer movements. Security was provided in one of these wintering areas by a dense growth of ponderosa pine on the steep lee slope. On the other wintering area security was apparently provided by large unrestricted views. Both areas were located near brushy draws or bottomlands which provided additional browse in the winter months.

During the study period, deer used some of the extremely steep slopes for security during the summer months. Those slopes that were too steep and brushy for cattle were occasionally used by deer as security areas. Similar areas containing cattle trails were not

utilized by deer. Avoidance of cattle use areas has been reported by McMahn (1960), Firebaugh (1969), Dusek (1971) and Komberec (1976). In both years of the study, deer were observed in one pasture in early spring. The introduction of cattle into this pasture coincided with movement out by deer. In both years deer were not observed in this pasture after the cattle were introduced.

The fawn/doe rates observed during the study period compare favorably with rates reported from other areas of Montana. Mackie (1977) stated that fawn/doe rates for the Bridger Mountains in fall of 1975 was approximately 20 fawns per 100 does. Dusek and McCann (1975) reported 36 fawns per 100 does in the Bull Mountains during the fall of 1974. Knapp (1975) reported 55, 62, 58 and 52 fawns per 100 does in four coal leases within the Decker-Birney study area of southeastern Montana during the fall of 1974. Using fawn/doe counts from this study, a population projection was made using the POPELK computer program (Picton 1976). A ten year projection suggested that the herd structure is that of a non-stationary, increasing population. In this projection the deer herd increased from initial population of 50 animals to a final figure of 65 deer. The detailed herd structure appears to be realistic. A second ten year projection incorporating greater fluctuations of the fawn/doe ratios gave a smaller increase. This run also gave realistic herd structure projections and thus the

fawn crop may be actually fluctuating more widely than was observed during the two years of the study.

Antelope usage of vegetation types indicated the importance of the Field V.T. to these animals. The vegetation in this type is characterized by a dysclimax community. It is possible if native vegetation were established on reclamation soils that additional habitat for antelope may be created which increase in its value to antelope until a climax community became established.

RECLAMATION CONSIDERATIONS

1. The present vegetation in the study area reflects the history of land use practices and is probably producing less than maximum forage. Any reclamation consideration that uses the present level as the target figure would result in a loss of potential production.

2. The alluvial bottomlands provide additional succulent forage during the critical late summer months. Removal of these sub-irrigated creek bottoms would result in a reduced carrying capacity of the area. Replacement of water with reservoirs would not alleviate this reduction.

3. Steep relief is a critical factor in wintering areas. Lack of relief and the vegetation characteristic of it would increase the probability of a high mortality rate during those winters with heavy snowfall.

LITERATURE CITED

Anthony, R. G. 1976. Influence of drought on diets and numbers of desert deer. J. Wildl. Mgt. 40(1): 141-144.

Booth, W. E. 1950. Flora of Montana, Part 1, Conifers and Monocots. Res. Found. Mont. St. Coll., Bozeman. 232 pp.

_____. 1972. Grasses of Montana. Mont. St. Univ., Bozeman. 64 pp.

_____ and J. C. Wright. 1966. Flora of Montana, Part 2, Dicotyledons. Mont. St. Coll., Bozeman. 230 pp.

Chittenden, H. M. 1902. History of the American fur trade of the far west. Harper Publishing Co. 3 Vols.

Coop, K. J. and C. A. Simmons. 1975. Big game surveys and inventories. Job Prog. Rpt., Region 5. Mont. Dept. Fish and Game. Unpb.

Cottam, G. and J. T. Curtis. 1956. The use of distance measures in phytosociological sampling. Ecology 37: 451-460.

Daubenmire, R. 1959. A canopy-coverage method of vegetational analysis. Northwest Sci. 33: 43-64.

_____. 1968. Plant Communities; a textbook of plant synecology. Harper and Row, N.Y. 300 pp.

Doman, E. R. and D. I. Rasmussen. 1944. Supplemental feeding of mule deer in winter in northern Utah. J. Wildl. Mgt. 8(4): 317-388.

Dusek, G. L. 1971. Range relationships of mule deer in the prairie habitat, northcentral Mont. M.S. Thesis, Mont. St. Univ., Bozeman. 63 pp.

_____ and S. A. McCann. 1975. Bull mountains coal field study. Mont. Dept. Fish and Game and the Consolidation Coal Co., Prog. Rpt. 76 pp.

Eustace, C. D. 1974. Big game survey and inventory. Job Prog. Rpt. Mont. Dept. Fish and Game. Unpb. 11 pp.

Firebaugh, J. E. 1969. Relationship of mule deer to livestock on summer range in the Pryor Mountains, Montana. M.S. Thesis, Mont. St. Univ., Bozeman. 55 pp.

Herbert, J. T. 1977. An inventory of the bird populations within the Sarpy Creek drainage, southeastern Montana. M.S. Thesis, Mont. St. Univ., Bozeman. 81 pp.

Jackson, P. V. 1971. Montana rangeland resource program. Coop. Ext. Service, Mont. St. Univ., Bozeman. 56 pp.

Jonas, R. J. 1964. Ecology and management of Merriams turkey in the Long Pines, southeastern Montana. Ph.D. Thesis, Mont. St. Coll., Bozeman. 118 pp.

Knapp, S. J. 1975. Birney-Decker wildlife study. Prog. Rpt. #1(2). Mont. Dept. Fish and Game and Bureau of Land Mgt. 46(71) pp.

Knowles, C. J. 1975. Range relationships of mule deer, elk and cattle in a rest rotation grazing system during summer and fall. M.S. Thesis, Mont. St. Univ., Bozeman. 111 pp.

Mackie, R. J. 1970. Range ecology and relations of mule deer, elk and cattle in the Missouri River breaks. Wildl. Monograph #20. 77 pp.

Martin, P. R. 1975. Sarpy basin wildlife ecology study. Mont. Dept. Fish and Game. 58 pp.

_____. 1976. Sarpy basin wildlife ecology study. Mont. Dept. Fish and Game. 62 pp.

McMahan, C. A. 1966. Suitability of grazing enclosures for deer and livestock research on the Kerr Wildlife Management Area, Tex. J. Wildl. Mgt. 30(1): 151-162.

Moshier, R. L. and A. G. Fielder. 1967. Soil Survey Treasure County, Mont. U.S. Dept. Agric. S.S.C. in coop. with Mont. Agric. Exp. Sta. 173 pp.

Mueggler, W. F. and W. P. Handl. 1974. Mountain grassland and shrubland of western Montana (interim report). U.S.D.A. Forest Serv. Intermountain Forest and Range Experiment Station and Region 1. 230 pp.

Pac, D. F. 1976. Distribution, movement and habitat use during spring, summer and fall by mule deer associated with the Armstrong winter range, Bridger Mountains, Montana. M.S. Thesis, Mont. St. Univ., Bozeman.

Pfister, R. D., B. L. Kovalchik, S. F. Arno and R. C. Presby. 1974. Forest habitat types of Montana. Intermountain Forest and Range Experiment Station and northern region, U.S. Forest Serv., Missoula, Mont. 213 pp.

Picton, H. D. 1976. POPELK computer program. Institute of Applied Research, Mont. St. Univ., Bozeman.

Robinette, W. L., O. Julander, J. S. Gashwiler and J. G. Smith. 1952. Winter mortality of mule deer in Utah in relation to range conditions. J. Wildl. Mgt. 16(3): 289-299.

Stuart, G. 1925. Forty years on the frontier as seen in the journals and reminiscences of Granville Stuart. Paul Phillips, ed. Cleveland. 2 Vols.

Thom, W. T. 1935. Geology of Big Horn County and the Crow Indian Reservation, Mont. Geol. Surv. Bull. 856. 200 pp.

Verme, L. J. 1969. Reproductive patterns of whitetail deer related to nutritional plane. J. Wildl. Mgt. 33(4): 881-887.

Edwards, John M
A surveyof big game animals on a proposed strip mining site at Sarpy Creek ...