



Food habits, range use and home range of Pronghorn Antelope in central Montana during winter
by Stephen Roy Bayless

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE in Fish and Wildlife Management

Montana State University

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Abstract:

A study of the food habits, range use, and home range of pronghorn antelope with emphasis on the winter period was conducted in 1966-67 on a 171,712 acre area in north-central Montana. The physiography and vegetation of the area was described. The vegetation consisted of eight types: sagebrush-grassland, grassland, shale slope, greasewood, greasewood-sage-brush, cropland, abandoned meadow, and woodland. Quantitative measurements of canopy coverage and densities of taxa were made for five of the eight types. Characteristics of the antelope population were evaluated from results of five aerial censuses in summer. There were 309 females per 100 males and 74 fawns per 100 females. Distribution of antelope and use of vegetation types was evaluated. The sagebrush-grassland type received most of the use, both in summer and winter. Most of the antelope observations in winter were in vegetation types where sagebrush was common. The average group size for antelope in winter was 23.5, with groups being largest when snow covered the ground. The average group size in summer was 9.4. Winter food habits were determined from the examination of 28 feeding sites and analysis of the contents of each of 18 rumen samples. The winter diet of antelope, determined by examination of feeding sites, consisted of 93 percent shrubs, 6 percent forbs, and a minor amount of grass. The diet determined by analysis of rumen contents consisted of 78 percent shrubs, 19 percent forbs, and a small amount of grass. Big sagebrush (*Artemisia tridentata*) provided the bulk of the antelope food. A statistical analysis was conducted to determine the relationship between abundance of available plant species and their significance in the diet of antelope. Big sagebrush was the only plant which was present in significantly higher proportions in the diet than in the plant community. Three dead fawns were found on the study area. The apparent cause of death was malnutrition. Their rumen contents did not vary significantly from those of other antelope collected during the winter. Poor body condition of antelope and fawn mortality was possibly related to quality of sagebrush in the diet. Winter home range size was determined for each of 16 individually marked antelope. Each of three was equipped with a radio transmitter. Marked antelope were located daily when possible. A total of 579 individual observations of marked antelope was recorded from December 10 through March 23. Eight of the marked antelope "shifted" their home range at least once in winter. A yearling female had a home range size of 5574.4 acres and a yearling male, 4160.0 acres. Six adult females had an average home range size of 2841.4 acres; three fawn females, 2417.1 acres; and five fawn males, 1579.5 acres. Fawn females had the most variable home range size. Adult females used a larger area on the sagebrush-grassland vegetation type than on the grease-wood-sagebrush type* Both fawn males and females showed the opposite.

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ANTELOPE IN CENTRAL MONTANA DURING WINTER

by

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ABSTRACT

A study of the food habits, range use, and home range of pronghorn antelope with emphasis on the winter period was conducted in 1966-67 on a 171,712 acre area in north-central Montana. The physiography and vegetation of the area was described. The vegetation consisted of eight types: sagebrush-grassland, grassland, shale slope, greasewood, greasewood-sagebrush, cropland, abandoned meadow, and woodland. Quantitative measurements of canopy coverage and densities of taxa were made for five of the eight types. Characteristics of the antelope population were evaluated from results of five aerial censuses in summer. There were 309 females per 100 males and 74 fawns per 100 females. Distribution of antelope and use of vegetation types was evaluated. The sagebrush-grassland type received most of the use, both in summer and winter. Most of the antelope observations in winter were in vegetation types where sagebrush was common. The average group size for antelope in winter was 23.5, with groups being largest when snow covered the ground. The average group size in summer was 9.4. Winter food habits were determined from the examination of 28 feeding sites and analysis of the contents of each of 18 rumen samples. The winter diet of antelope, determined by examination of feeding sites, consisted of 93 percent shrubs, 6 percent forbs, and a minor amount of grass. The diet determined by analysis of rumen contents consisted of 78 percent shrubs, 19 percent forbs, and a small amount of grass. Big sagebrush (*Artemisia tridentata*) provided the bulk of the antelope food. A statistical analysis was conducted to determine the relationship between abundance of available plant species and their significance in the diet of antelope. Big sagebrush was the only plant which was present in significantly higher proportions in the diet than in the plant community. Three dead fawns were found on the study area. The apparent cause of death was malnutrition. Their rumen contents did not vary significantly from those of other antelope collected during the winter. Poor body condition of antelope and fawn mortality was possibly related to quality of sagebrush in the diet. Winter home range size was determined for each of 16 individually marked antelope. Each of three was equipped with a radio transmitter. Marked antelope were located daily when possible. A total of 579 individual observations of marked antelope was recorded from December 10 through March 23. Eight of the marked antelope "shifted" their home range at least once in winter. A yearling female had a home range size of 5574.4 acres and a yearling male, 4160.0 acres. Six adult females had an average home range size of 2841.4 acres; three fawn females, 2417.1 acres; and five fawn males, 1579.5 acres. Fawn females had the most variable home range size. Adult females used a larger area on the sagebrush-grassland vegetation type than on the greasewood-sagebrush type. Both fawn males and females showed the opposite.

INTRODUCTION

Information on the winter food and range use habits of pronghorn antelope (Antilocapra americana) in Montana is somewhat limited. Cole (1956) reported the results of a comprehensive study of food and range use habits with special reference to alfalfa, but data for winter were less comprehensive than for other seasons. Cole and Wilkins (1958) studied food and range use in reference to the effects on production of winter wheat. Martinka (1967) reported on mortality and food habits of pronghorns during a severe winter. Prominent among reports for other states are the publications of Einarsen (1948) and Buechner (1950) who give information for Oregon and Texas, respectively.

The principal objectives of the present study, conducted during the summer of 1966 and winter of 1966-67, were to obtain quantitative data on winter food and range use habits of pronghorns to help evaluate current management practices. The summer period was largely devoted to studies of the vegetation of the study area. The use of radio tracking equipment greatly aided the study of habitat relationships and behavior. The study gained importance due to a research project within the study area concerned with the effects on wildlife of sagebrush removal.

DESCRIPTION OF THE STUDY AREA

The study area, located in central Montana approximately 40 miles east of Lewistown, covered about 171,712 acres. It was bounded on the west by U.S. Highway 87, on the north by State Highway 20, on the east by State Highway 244, and on the south by the Flatwillow Creek Road (Fig. 1). The principal economy of the area is stock raising, integrated with grain, alfalfa and forage production. Privately owned lands constitute 67.3 percent (115,640 acres) of the area; publicly owned lands, 32.7 percent (56,080 acres). Land ownership is shown on Appendix Fig. 21. Public lands are administered by the Bureau of Land Management, Charles M. Russell Game Range, and the State of Montana.

The characteristic physiographic features of the area are sharply rolling upland plains, shale slopes and bottomlands (Cole, 1956). The latter two occur where erosion has dissected the upland plain. McDonald, Elk, Yellow Water, Spring, and Pike Creeks flow through the area. Many stock water ponds, in addition to the larger Yellow Water Storage Reservoir, are found on the area.

The soils have developed over cretaceous shales of the Colorado formation (Andrews et al., 1944). Upland soils range from heavy clays to shaly clay loams. Shale slopes have soils ranging from fine shale loams to coarse shale gravels. Bottomlands have soils with thin loamy surface horizons, barren spots of salt impregnated soils, and clay soils with dense saline-alkaline subsoils.

Gieseke et al. (op. cit.) describes the climate for the area as semiarid, "...characterized by moderately low rainfall, great extremes

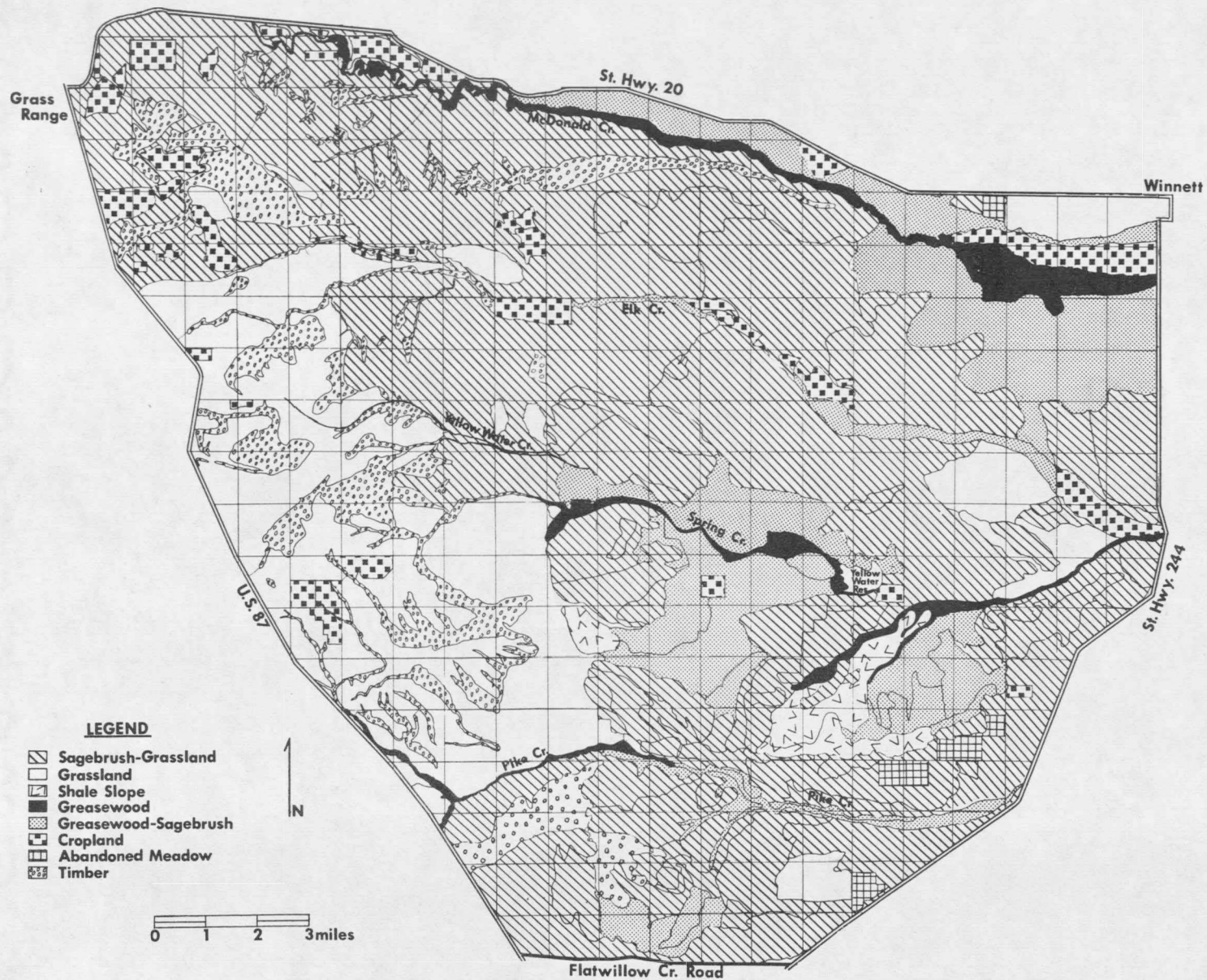


Figure 1. The Yellow Water Triangle Study Area Showing Vegetation Types.

in summer and winter temperatures, many sunny days and relatively low humidity." The average annual precipitation at Flat Willow (United States Department of Commerce weather station), on the east edge of the study area, is 12.57 inches. The mean average annual temperature is 45.4°F. Temperature extremes during the study period were 105°F. in July, 1966, and -13°F. in March, 1967.

Major influent wild mammals of the area, in addition to antelope, included white-tailed deer (Odocoileus virginianus) and mule deer (Odocoileus hemionus).

VEGETATION

The vegetation of the study area is included in the Temperate Grassland Biome (Odum, 1959) and the Mixed Grass Prairie Association (Oosting, 1948). Although studies of the vegetation of this area are few, Mackie (1965) described the vegetation of the Missouri River Breaks, and Cole (1956) described vegetation types in the same general area as that of the present study. The present analysis, with slight modification, follows Cole's vegetation description of the area, but makes use of quantitative measurements for five of the eight vegetation types recognized. Nomenclature is that of Booth (1950) and Booth and Wright (1959).

The method of vegetation analysis was a modification of the method of Daubenmire (1959), whereby 2x5 dm plots were systematically placed within a relatively homogenous and undisturbed portion of each vegetation stand (Fig. 2). The percent canopy-cover of each taxon, and percentages of bare ground, rock, and lichens, were recorded for each plot. Classes were: Class 1 = 0-5%; Class 2 = 5-25%; Class 3 = 25-50%; Class 4 = 50-75%; Class 5 = 75-95%; and Class 6 = 95-100%. The midpoint of each class was the value used in data tabulations. Taxa occurring within each vegetation stand but not in any of the plots were also recorded.

Twenty 2x5 dm plots within each of thirty-nine 20x50 ft. sample units on the various vegetation types were evaluated in summer. Thirty sample units with each located at an antelope feeding site and consisting of ten 2x5 dm plots along a 100 ft. line were evaluated in winter. Although a pronounced difference occurred in composition and coverage of forbs between summer and winter, composition of shrubs and grasses between the seasons

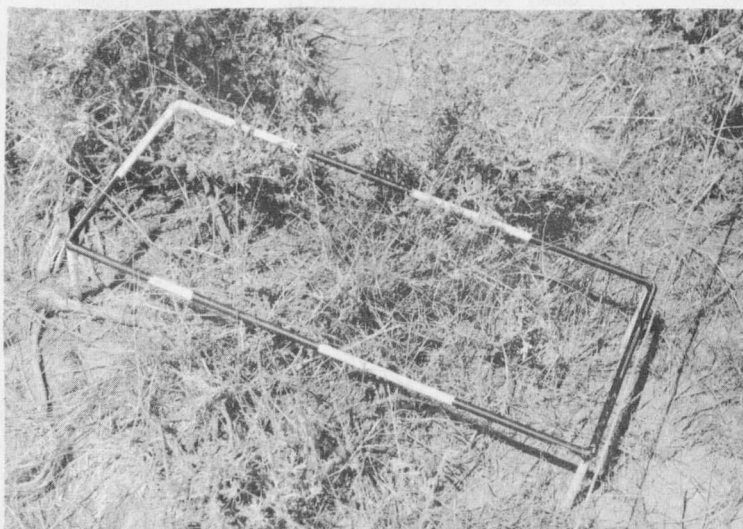


Figure 2. A 2x5 Dm. Plot Frame Used During Measurements Of Vegetation.

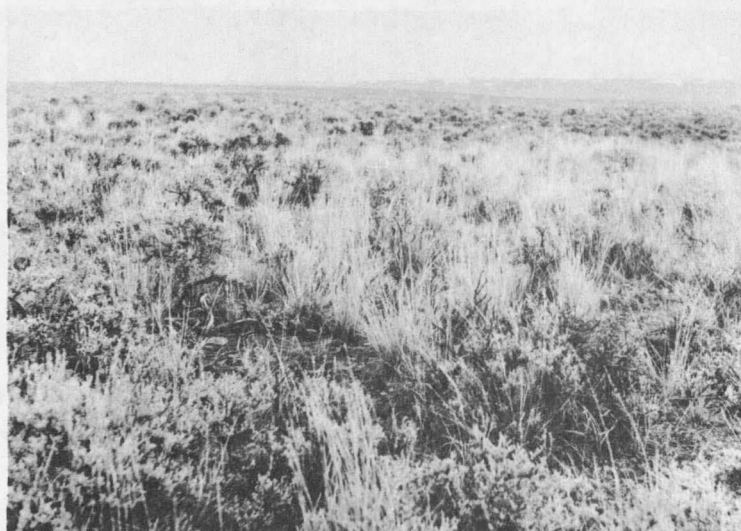


Figure 3. Sagebrush-Grassland Vegetation Type.

remained comparable. Combined data for both seasons are given in Table I.

Ground cover was further evaluated by recording the point intercept of each of the four sharply pointed legs of the plot frame on bare ground, rock, litter, or living vegetation (Table II).

To measure sagebrush density on the sagebrush-grassland type, I measured the canopy intercept of all sagebrush plants encountered along transect lines. Each of the twenty-seven 200 foot transects measured in summer was composed of four 50 foot lines equidistant across the greatest length of a 20x50 foot sample unit. Several sagebrush plants were measured in each one-third of the sample unit to obtain the average maximum height and average height for the stand. In winter, the canopy coverage and height of all sagebrush plants occurring along each of sixteen 100 foot transects were measured. Table III is a summary of these measurements.

Occurrence and distribution of vegetation types are shown on Fig. 1.

Sagebrush-Grassland Vegetation Type:

This type (Fig. 3) occupied the major portion of the study area, 51.3% or 85,696 acres. Various degrees of association and dominance occurred between big sagebrush (Artemisia tridentata), grasses, and forbs. These appeared to characterize differences in topography, soils, and/or intensity of livestock grazing. Various sagebrush measurements for this type are given in Table III.

Western wheatgrass (Agropyron smithii), bluebunch wheatgrass (Agropyron spicatum), blue grama (Bouteloua gracilis), and desert saltgrass (Distichlis stricta) were the dominant native grasses. Dominant forbs included fringed

TABLE I. CONSTANCY, CANOPY COVERAGE, AND FREQUENCY OF TAXA FOR FIVE VEGETATION TYPES IN THE YELLOW WATER TRIANGLE STUDY AREA AS DETERMINED BY MEASUREMENTS WITHIN 2X5 DECIMETER PLOTS.

Taxa	Vegetation Type				
	Sagebrush-	Grassland	Shale Slope	Greasewood	Greasewood-
	Grassland	Grassland	Slope		Sagebrush
	43 Stands 2160 Plots-Summer 640 Plots-Winter	5 Stands 320 Plots-Summer 40 Plots-Winter	7 Stands 240 Plots-Summer 160 Plots-Winter	2 Stands 160 Plots-Summer Summer	12 Stands 60 Plots-Summer 90 Plots-Winter
	Cy/Cv/Fr 1/	Cy/Cv/Fr	Cy/Cv/Fr	Cy/Cv/Fr	Cy/Cv/Fr
SHRUBS					
<u>Artemisia cana</u>	2/ +/10				8/34/90
<u>Artemisia</u>					
<u>tridentata</u>	98/14/49	X	71/20/57	100/ 1/5	92/6/ 28
<u>Atriplex</u>					
<u>nuttallii</u>	2/ +/ 5		14/ 4/10		50/ 2/20
<u>Chrysothamnus</u>					
<u>nauseosus</u>			100/ 7/29		
<u>Eurotia lanata</u>	2/ 2/10				
<u>Gutierrezia</u>					
<u>sarcocolla</u>	44/ 2/21	40/ 1/15	86/ 3/23	50/ +/5	25/ 2/20
<u>Potentilla</u>					
<u>fruticosa</u>	2/ +/ 5				
<u>Rosa arkansana</u>			71/ 1/24		8/ +/10
<u>Sarcobatus</u>					
<u>vermiculatus</u>	X 2/			100/ 2/13	75/ 4/18
<u>Symphoricarpos</u>					
<u>occidentalis</u>	X				
FORBS					
<u>Achillea</u>					
<u>millefolium</u>	7/ +/7	20/ +/ 5	29/ +/10		X
<u>Allium textile</u>					8/ +/10
<u>Androsace</u>					
<u>septentrionalis</u>	33/ +/15	80/ 1/49	14/ 2/60	50/ 2/80	25/ 1/45
<u>Antennaria</u>					
<u>dimorpha</u>					8/ +/20

TABLE I. (Continued)

Taxa	Vegetation Type				
	Sagebrush- Grassland	Grassland	Shale Slope	Greasewood	Greasewood- Sagebrush
	43 Stands	5 Stands	7 Stands	2 Stands	12 Stands
	2160 Plots-Summer 640 Plots-Winter	320 Plots-Summer 40 Plots-Winter	240 Plots-Summer 160 Plots-Winter	160 Plots-Summer Summer	60 Plots-Summer 90 Plots-Winter
	Cy/Cv/Fr	Cy/Cv/Fr	Cy/Cv/Fr	Cy/Cv/Fr	Cy/Cv/Fr
<u>Antennaria rosea</u>	2/4/60				
<u>Arenaria hookeri</u>	53/ 2/36	20/ +/ 5	29/ +/20		8/ +/ 5
<u>Artemisia</u>					
<u>frigida</u>	81/ 5/47	80/14/83	14/ +/30	100/ 3/45	50/ 2/27
<u>Artemisia</u>					
<u>longifolia</u>	2/ +/10		43/ 5/37		
<u>Artemisia</u>					
<u>ludoviciana</u>	2/ +/ 5		14/ +/10		
<u>Aster canescens</u>	5/ +/25				33/ 5/31
<u>Astragalus</u>					
<u>agrestis</u>	2/ +/5		14/ +/ 5		
<u>Astragalus</u>					
<u>bisulcatus</u>	7/ +/ 8		14/ +/ 5		
<u>Astragalus</u>					
<u>gilviflorus</u>	9/ +/13				
<u>Astragalus</u>					
<u>missouriensis</u>	2/ 1/10				
<u>Camelina</u>					
<u>microcarpa</u>	2/ +/ 5				8/ +/15
<u>Chrysopsis</u>					
<u>villosa</u>	2/ +/ 5				
<u>Cirsium flodmani</u>	5/ +/ 5				8/ +/10
<u>Collomia linearis</u>	19/ +/14	60/ +/ 7	14/ +/ 5	50/ +/15	8/ +/ 5
<u>Draba verna</u>	12/ +/ 9		29/ +/13	50/ +/20	25/ +/17
<u>Ellisia nyctelea</u>	2/ +/ 5				
<u>Erigeron</u>					
<u>ochroleucus</u>	X	X			
<u>Erigeron pumilus</u>	37/ +/16	40/ +/10			25/ +/ 7

TABLE I. (Continued)

Taxa	Vegetation Types				
	Sagebrush-	Grassland	Shale Slope	Greasewood	Greasewood-
	Grassland	Grassland	Shale Slope	Greasewood	Sagebrush
	43 Stands 2160 Plots-Summer 640 Plots-Winter	5 Stands 320 Plots-Summer 40 Plots-Winter	7 Stands 240 Plots-Summer 160 Plots-Winter	2 Stands 160 Plots-Summer Summer	12 Stands 60 Plots-Summer 90 Plots-Winter
	Cy/Cv/Fr	Cy/Cv/Fr	Cy/Cv/Fr	Cy/Cv/Fr	Cy/Cv/Fr
<u>Eriogonum flavum</u>	5/ +/15				
<u>Gaura coccinea</u>	23/ +/10	40/ +/20	14/ +/10	50/ +/ 5	
<u>Geum triflorum</u>	2/ +/ 5				
<u>Grindelia</u>					
<u>squarrosae</u>	5/ +/ 5				8/ +/35
<u>Haplopappus</u>					
<u>nuttallii</u>		X			8/ +/ 5
<u>Hymenoxys</u>					
<u>acaulis</u>	5/ +/33				
<u>Lactuca spp.</u>				50/ +/ 5	
<u>Lepidium</u>					
<u>densiflorum</u>	19/ +/ 7				17/ +/ 18
<u>Melilotus</u>					
<u>officinalis</u>	2/ +/30			50/ +/10	8/ +/ 5
<u>Opuntia polycantha</u>	65/ 1/17	40/ +/13	43/ +/10	50/ 2/15	25/ 5/38
<u>Oxytropis sericea</u>		20/ +/ 5	14/ +/ 5		
<u>Penstemon nitidus</u>	2/ +/10		14/ +/15		
<u>Petalostemum</u>					
<u>purpureum</u>		20/ +/10			
<u>Phlox hoodii</u>	16/ +/17	20/ +/20	29/ 1/18		
<u>Plantago purshii</u>	26/ +/31	20/ +/30	14/ 2/65	50/ +/15	8/ +/ 5
<u>Plantago spinulosa</u>	40/ +/32	60/ +/20		50/ 2/70	25/ +/33
<u>Psoralea</u>					
<u>argophylla</u>	7/ 1/28		14/ +/ 5		
<u>Psoralea</u>					
<u>tenuiflora</u>	19/ 1/13	20/ 4/45	43/ 3/33		17/ 1/15
<u>Ratibida</u>					
<u>columnifera</u>	X				

TABLE I. (Continued)

Taxa	Vegetation Type				
	Sagebrush-	Grassland	Shale Slope	Greasewood	Greasewood-
	Grassland	Grassland	Slope	Grassland	Sagebrush
	43 Stands 2160 Plots-Summer 640 Plots-Winter	5 Stands 320 Plots-Summer 40 Plots-Winter	7 Stands 240 Plots-Summer 160 Plots-Winter	2 Stands 160 Plots-Summer Summer	12 Stands 60 Plots-Summer 90 Plots-Winter
	Cy/Cv/Fr	Cy/Cv/Fr	Cy/Cv/Fr	Cy/Cv/Fr	Cy/Cv/Fr
<u>Selaginella densa</u>	40/12/39	40/ 7/40	14/ 4/10	100/16/65	33/ 4/16
<u>Sisymbrium loeselii</u>	+/ +		14/ +/15		
<u>Sphaeralcea</u>					
<u>coccinea</u>	53/ +/23	60/ +/30			25/ +/15
<u>Taraxacum</u>					
<u>officinale</u>	2/ +/35	X	14/ +/15		17/ +/20
<u>Thelaspisma</u>					
<u>marginatum</u>	2/ +/5				
<u>Thermopsis</u>					
<u>rhombifolia</u>			43/ 4/60		
<u>Tragopogon dubius</u>	9/ +/15	X			X
<u>Vicia americana</u>	5/ +/32	80/ +/25	14/ +/35	50/ +/ 5	25/ 1/27
GRASSES AND GRASS- LIKE PLANTS					
<u>Agropyron</u>					
<u>crispatum</u>	9/25/61				
<u>Agropyron</u>					
<u>dasystachyum</u>	49/ 6/55	60/ 5/38	29/ 2/15	50/ 3/55	42/19/77
<u>Agropyron smithii</u>	84/18/61	40/ 3/48	43/19/87	100/ 2/38	58/20/81
<u>Agropyron spicatum</u>	51/12/61	60/ 7/50	71/21/76	100/ 7/63	42/ 9/56
<u>Bouteloua</u>					
<u>gracilis</u>	79/11/46	60/18/78	29/ 4/30	100/ 9/40	33/14/40
<u>Bromus japonicus</u>	2/ +/15				8/ 3/30
<u>Bromus tectorum</u>	21/ 3/21	20/ 1/45		50/ 3/35	17/ 1/45
<u>Calamovilfa</u>					
<u>longifolia</u>			14/ 4/75		
<u>Carex brevior</u>	65/ +/28	60/ +/23	14/ +/20		33/ 1/30

TABLE I. (Continued)

Taxa	Vegetation Type				
	Sagebrush-	Grassland	Shale Slope	Greasewood	Greasewood-
	Grassland	Grassland	Shale Slope	Greasewood	Sagebrush
	43 Stands 2160 Plots-Summer 640 Plots-Winter	5 Stands 320 Plots-Summer 40 Plots-Winter	7 Stands 240 Plots-Summer 160 Plots-Winter	2 Stands 160 Plots-Summer Summer	12 Stands 60 Plots-Summer 90 Plots-Winter
	Cy/Cv/Fr	Cy/Cv/Fr	Cy/Cv/Fr	Cy/Cv/Fr	Cy/Cv/Fr
<u>Danthonia</u>					
<u>unispicata</u>	26/ +/10			50/ 1/15	
<u>Distichlis stricta</u>	2/14/70			100/39/83	17/10/53
<u>Festuca octoflora</u>	35/ +/18		14/ +/15	100/ +/15	8/ +/10
<u>Hordeum jubatum</u>				X	
<u>Koeleria cristata</u>	88/ 4/51	80/ 3/39	29/ 1/30	50/ +/5	42/ 3/30
<u>Poa canbyi</u>	16/ 2/24	20/ 1/30	14/14/100	100/ 5/38	33/ 4/23
<u>Poa compressa</u>	9/ 1/18		29/ +/18	50/ 5/35	25/ 3/43
<u>Poa pratensis</u>	2/ +/ 5				8/ 1/25
<u>Poa secunda</u>	93/ 2/52	60/ 3/47	57/ 2/28	100/ 1/40	67/ 5/49
<u>Schedonnardus</u>					
<u>paniculatus</u>	49/ 2/26	40/ +/28	14/ 1/30		50/ +/19
<u>Stipa comata</u>	53/ 7/48	100/13/69			
<u>Stipa viridula</u>	23/ 4/29	40/ 5/48	14/ +/10		8/ 3/25
ROCK	16/ +/25	20/+/ 5	14/ 1/20		
LICHENS	84/ 3/70	80/ 1/45	71/ 4/80	100/ 2/60	75/ 1/45
BARE GROUND	100/71/100	100/69/100	100/76/100	100/60/100	100/80/100

1/ Constancy (percent occurrence among stands)/ Canopy Coverage (percent of area covered by foliage)/ Average Frequency (percent occurrence among plots). + indicates canopy-coverage or frequency values less than one percent.

2/ X indicates taxon did not average one percent coverage or frequency.

TABLE II. GROUND-COVER CHARACTERISTICS FOR FIVE VEGETATION TYPES. DATA ARE FREQUENCIES OF OCCURRENCE OF BARE GROUND, ROCK, LITTER, AND LIVING VEGETATION AMONG 4,320 POINTS.

Vegetation Type	Number of Points	Bare Ground	Rock	Litter	Living Vegetation
		Pct.	Pct.	Pct.	Pct.
Sagebrush-Grassland	2800	39.5	0.5	28.9	31.1
Grassland	360	35.6	0.3	33.1	31.1
Shale Slope	400	51.8	1.3	22.8	24.3
Greasewood	160	26.3	-	35.6	38.1
Greasewood-Sagebrush	600	57.8	1.5	22.3	18.3

sagewort (Artemisia frigida) and Selaginella (Selaginella densa).

Grassland Vegetation Type:

This type (Fig. 4) occupied 16.6% or 27,700 acres of the study area. For the entire type, needle-and-thread (Stipa comata) and blue grama were the most important grasses, but various degrees of association and dominance occurred among the grasses. Important forbs included fringed sagewort and Selaginella.

Shale Slope Vegetation Type:

A small portion of the study area, 1.6% or 2,675 acres, was occupied by this type (Fig. 5). It was confined to slopes below shale ridges. Longleaf sagebrush (Artemisia longifolia), big sagebrush, rubber rabbit-brush (Chrysothamnus nauseosus), broom snakeweed (Gutierrezia sarothrae), Arkansas rose (Rosa arkansana), western wheatgrass, prairie sand reedgrass (Calamovilfa longifolia), canby bluegrass (Poa canbyi), saltbush (Atriplex

TABLE III. SAGEBRUSH CHARACTERISTICS AS DETERMINED BY MEASUREMENTS IN INCHES ALONG LINE TRANSECTS IN EACH OF 43 STANDS IN THE SAGEBRUSH-GRASSLAND VEGETATION TYPE. 1/

Density 2/	1 Rare	2 Scattered	3 Common	4 Dense	Average
No. Transects (Stands)	5	9	15	14	-
Av. No. of Plants/Transects	5.6	16.1	32.4	54.9	27.3
Av. Max. Plant Ht.	14.7	19.2	19.0	19.4	18.1
Av. Plant Ht.	10.3	11.6	11.8	10.5	11.1
Av. Canopy Intercept/Plant	10.2	10.7	11.4	8.5	10.2

1/ Each of the 27 transects for summer was 200 feet. Each of the 16 transects for winter was 100 feet, but the data are expanded to represent 200 foot transects.

2/ Densities were assigned to the sagebrush in each stand on the basis of the number of plants intercepted/200 feet of line as follows:

0 - 8	Plants = 1 Rare
9 - 20	" = 2 Scattered
21 - 40	" = 3 Common
41 +	" = 4 Dense

nuttallii), slimflower scurfpea (Psoralea tenuiflora), Selaginella, and prairie thermopsis (Thermopsis rhombifolia) were characteristic.

Greasewood Vegetation Type:

This type (Fig. 6) was confined to stream bottoms. It occupied 2.8% or 4,672 acres of the study area. Greasewood (Sarcobatus vermiculatus) was dominant, but big sagebrush was also present. Desert saltgrass was the most common of grasses. Common forbs included fringed sagewort and Selaginella.



Figure 4. Grassland Vegetation Type.



Figure 5. Shale Slope Vegetation Type.

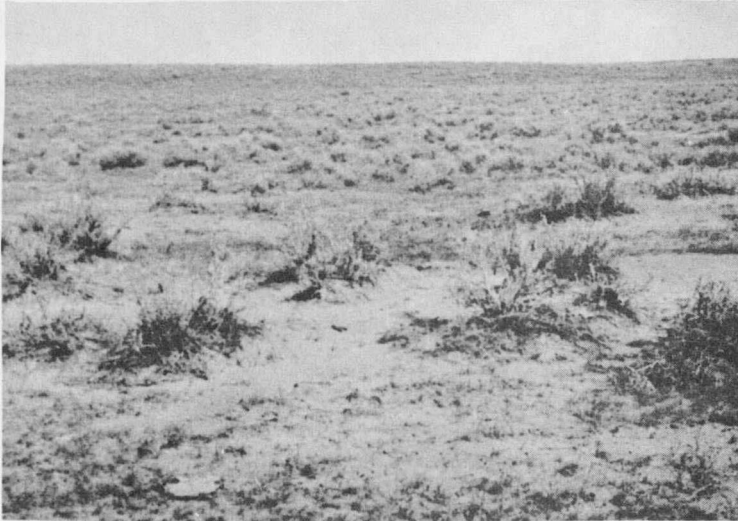


Figure 6. Greasewood Vegetation Type In Foreground Along Creek Bottom--
Greasewood-Sagebrush Type In Center Of Picture.



Figure 7. Cropland Vegetation Type.

Greasewood-Sagebrush Vegetation Type:

This type (Fig. 6), occupying 14.2% or 23,776 acres, was the second most extensive type. It was confined to bottomland flats and adjacent gentle slopes between the sagebrush-grassland and greasewood vegetation type. Greasewood, big sagebrush, and in places, silver sagebrush (Artemisia cana), were dominant shrubs. Dominant grasses included thick-spike wheatgrass (Agropyron dasystachyum), western wheatgrass, blue grama, and desert saltgrass. Among forbs, hoary aster (Aster canescens), plains prickley pear (Opuntia polycantha), and Selaginella were important.

Other Vegetation Types:

Vegetation types of little importance to antelope, but occurring on the study area, were the Cropland type (Fig. 7), covering 4.2% or 7,040 acres; the Abandoned Meadow type (Fig. 8), occupying 0.7% or 1,107 acres; and the Woodland type (Fig. 9), which covered 8.6% or 14,355 acres.

The cropland type included alfalfa, native hay, and wheat fields. The abandoned meadow type was abandoned agricultural land which had been reseeded, either naturally with native vegetation or artificially with crested wheatgrass (Agropyron cristatum). The woodland type of ponderosa pine (Pinus ponderosa) was restricted to the more mesic western portion of the study area where its distribution was broken and scattered.



Figure 8. Abandoned Meadow Vegetation Type.



Figure 9. Woodland Vegetation Type.

PRONGHORN POPULATION CHARACTERISTICS

Six aerial censuses were conducted (Table IV). Each flight across the study area during a census period permitted the coverage of a one-mile strip. Starting at the northwest corner, antelope were classified in each north-south strip until the entire area had been covered. All flights started shortly after sunrise, and were undertaken only on calm and clear days.

During the first four censuses, 1925 antelope were classified. Data from the September and February flights were not reliable for sex and age class composition. Does and fawns were difficult to distinguish from the air after August. There were 309 females per 100 males, and 74 fawns per 100 females. The fawn-female figure includes yearling females. Some workers, including Einarsen (1948), have reported that antelope females do not breed until their second year. Others have reported breeding of fawns (Buechner, 1950 and Wright et.al., 1962).

In 1962 an aerial census of the study area conducted by personnel of the Montana Department of Fish and Game disclosed 1171 antelope with a fawn/female ratio of 90/100. In 1963, during a similar census, 502 antelope were counted with a fawn/female ratio of 90/100.

During the winter, seven female antelope were collected. They were aged according to changes in mandibular dentition (Wright, 1962). No yearlings were collected. Except for one with a single fetus, all females were carrying twins (Appendix, Table XV).

TABLE IV. RESULTS OF SIX AERIAL CENSUSES MADE ON THE YELLOW WATER TRIANGLE STUDY AREA DURING THE SUMMER OF 1966 AND WINTER OF 1966-67.

Pronghorns Classified								
Dates	Aircraft	No. Obser- vers ^{1/}	Adults		Fawns	Total	♀♀/	Fawns/
			♀♀ ♂♂	♀♀ or ♂♂			100♂♂	100♀♀
6/27, 28/66	Super Cub	2	207 54	32	135	428	383	65
7/11/66	Cessna 180	3	246 89	13	181	529	276	74
8/3,4/66	Super Cub	2	227 78	9	210	524	291	93
8/12/66	Cessna 180	3	209 67	37	131	444	312	63
9/9/66	Super Cub	2	- -	-	-	380	-	-
2/9/67	Cessna 180	3	- -	-	-	441	-	-

^{1/} The figure for number of observers always includes the pilot.

ANTELOPE DISTRIBUTION AND USE OF VEGETATION TYPES

Winter (December, January, February, March):

The relation between the occurrence of antelope and vegetation types was evaluated by recording the type where the animal was first observed for each of 9345 observations (Table V). A total of 8904 observations of individual antelope was recorded with the aid of a 15-60x spotting scope and 7x35 mm. binoculars during 75 observation days from December 9 through March 23 while traversing the area in a vehicle over essentially the same routes. Observability of antelope was poor when snow covered the ground, and especially so when it persisted in scattered patches and the sky was cloudy. During an aerial census on February 9, 441 individual antelope observations were tallied.

The sagebrush-grassland vegetation type received most of the antelope use regardless of month (Table V) or weather conditions (Appendix, Tables XVI. and XVII). During each month, 62 percent or more of the observations were in this type, and for the entire winter, 71 percent. The sagebrush-grassland and greasewood-sagebrush types combined provided 80 percent or more of the observations in each month and 89 percent for winter. The grassland, greasewood, and cropland types received minor use, and no use was recorded for the shale slope, timber, or abandoned meadow types. There was some evidence from individually marked antelope of movement from grassland to sagebrush types during periods when snow covered the ground.

The density of sagebrush at each observation site recorded from the ground was determined (Table VI). Density values were assigned on an ocular estimate basis resulting from experience gained while cover mapping

TABLE V. PERCENTAGE DISTRIBUTION BY MONTH OF 9345 OBSERVATIONS OF INDIVIDUAL ANTELOPE ON THE YELLOW WATER TRIANGLE STUDY AREA ON FIVE VEGETATION TYPES IN WINTER, 1966-67.

Month	Sagebrush- grassland	Grassland	Greasewood	Greasewood- sagebrush	Cropland	No. Observ.		
						Singles	Groups	Total Antelope
December	67(20.6) ^{1/}	4(15.4)	10(46.3)	13(38.0)	6(51.0)	5	76	1810
January	86(30.1)	4(50.5)	5(49.7)	3(45.0)	2(49.0)	7	84	2682
February ^{2/}	62(18.6)	6(11.8)	-	31(27.0)	-	9	161	3204
March	70(21.7)	7(14.8)	-	23(27.2)	-	1	75	1649
Average Total	71(22.8)	5(23.1)	4(48.0)	18(34.3)	2(50.0)	22	396	9345

^{1/} Percentage of total antelope observed for the month. Average group size in parenthesis excluding singles.

^{2/} Data from an aerial census on February 9 are combined with data from ground observations.

TABLE VI. PERCENTAGE DISTRIBUTION BY MONTH OF 8904 OBSERVATIONS OF INDIVIDUAL ANTELOPE IN RELATION TO SAGEBRUSH DENSITY IN WINTER, 1966-67.

Month	Sagebrush Density				Total No. Observations
	1 Rare	2 Scattered	3 Common	4 Dense	
December	9 ^{1/}	29	50	12	1810
January	7	28	53	12	2682
February	7	38	45	10	2763
March	7	17	48	28	1649
Average	7.5	28.0	49.0	15.5	
Total					8904

^{1/} Percentages are based on 100 percent for each month.

(Table III). Most of the antelope observations were in vegetation types where sagebrush density was estimated as "common"; i.e., 21 to 40 plants intercepted per 200 feet of line transect.

Vegetation characteristics at antelope bedding sites in winter are given in Appendix Tables XVIII and XIX.

Three hundred and ninety-six groups each consisting of two or more and together comprising 9323 antelope, were observed from December 10 through March 22 (Table V). The average group size was 23.5. The three groups observed in December and January on the cropland vegetation type were largest, followed by those on the greasewood and greasewood-sagebrush types, respectively. Dirschl (1963) believed that the extent and quality

of the winter range was the factor determining group size for antelope.

Group size increased steadily from approximately 20 when the ground was dry to about 31 when snow covered the ground (Appendix Table XX). No correlation between group sizes of antelope and temperatures was established, except groups were slightly larger with warmer temperatures (Appendix Table XXI).

Summer (June, July, August, September):

Use of vegetation types in summer was evaluated from 2305 observations of antelope during five aerial censuses (Table VII). The sagebrush-grassland type received more use than did any other type during June, July, August, and for the entire summer, but intensities of use during this period were significantly less than for the winter months (Table V). Use of this type steadily decreased through the summer. In September, the grassland and cropland types each received greater use than sagebrush-grassland. Cole (1956) found that sagebrush-grassland was used more than other vegetation types by antelope prior to midsummer, but after this time, use of this type decreased and use of greasewood and shale slope types increased. He also indicated that use of alfalfa fields sharply increased after mid-August, reaching a maximum in late September.

A total of 2249 antelope in 238 groups averaging 9.4 was observed during the five aerial censuses in summer. Groups were largest on the cropland vegetation type, but only eight percent of the total groups were seen here (Table VII). Most of the groups observed were in sagebrush-grassland, where the average group size was 8.2. Female-fawn groups, bachelor herds,

TABLE VII. PERCENTAGE DISTRIBUTION BY MONTH OF 2305 OBSERVATIONS OF INDIVIDUAL ANTELOPE ON SEVEN VEGETATION TYPES IN SUMMER, 1966, AS DETERMINED BY FIVE AERIAL CENSUSES.

Vegetation Type	Month				Average	Total
	June	July	August ^{1/}	September		
Sagebrush-grassland	53(7.0) ^{2/}	50(7.2)	44(10.8)	16(7.9)	41(8.2)	
Grassland	24(7.7)	24(11.5)	31(11.4)	45(12.8)	31(10.9)	
Shale slope	2(8.0)	-	-	-	tr(8.0)	
Greasewood	5(6.7)	2(6.0)	1(10.0)	1(2.0)	2(6.2)	
Greasewood-sagebrush	9(4.5)	6(5.0)	16(12.6)	17(7.9)	12(7.5)	
Cropland	6(5.5)	17(18.0)	8(11.1)	22(20.8)	13(13.9)	
Abandoned meadow	2(9.0)	-	-	-	tr(9.0)	
	101	99	100	101		
Tot. No. singles	24	11	11	10		56
Tot. No. groups	60	60	85	33		238
Tot. No. Antelope	428	529	968	380		2305

^{1/} Data for this month are the result of two aerial censuses, one on August 3 and the other on August 9.

^{2/} Percentage of total antelope observed for the month. Average group size in parenthesis excluding singles.

and territorial males, as described by Cole (1956) were observed. Data are summarized in Appendix Table XXII.

WINTER HOME RANGE

Nineteen antelope, including seven adult females, one yearling female, four fawn females, one yearling male, and six fawn males, were trapped on December 9, 1966. They were driven with the aid of a helicopter a maximum distance of seven miles into a 40x100 foot oval shaped trap (Fig. 11) with one-quarter mile wings (McLucas, 1956). They were individually marked and released the following day.

A neckband constructed of plastic impregnated nylon ("Saflag") backed with nylon webbing, similar to bands used by Knight (1966) for elk, was stapled around the neck of each of 16 antelope (Fig. 12). Generally, two fingers of space was allowed between the neck band and an animal's neck. One fawn was never seen again and another was seen for only three days after release. Possibly the neck bands were lost by slipping over the fawns' heads. Various symbols and color combinations for individual bands facilitated recognition. Depending on light conditions, individual bands were identifiable at distances of one-half to three-quarters of a mile, with some patterns being more easily recognizable than others (Appendix Table XXIII).

Each of three antelope was equipped with a two-stage crystal controlled transmitter mounted on a one-eighth inch thick leather collar (Fig. 13) rivetted around the animal's neck (Fig. 14). Transmitters operated in the 151 Mc. range. Two emitted steady signals, and the third, a pulsating signal. The transmitters with steady signals were more easily heard than was the one with a pulsating signal when high winds caused noise in the earphones of the receiver. Theoretical transmitter life was estimated at 180 days, but collection of the "radioed antelope" at the end of the study

TABLE VIII. WINTER FOOD HABITS OF ANTELOPE BY MONTH AS INDICATED BY 13,758 INSTANCES OF PLANT USE AT 28 FEEDING SITES ON THE YELLOW WATER TRIANGLE STUDY AREA.

Taxa ^{1/}	January 9 Feeding sites					February 12 Feeding Sites					March 7 Feeding Sites					
	% of Veg. avail- able					% of Veg. avail- able					% of Veg. avail- able					
	No. In- stan- ces	50- 2x5 dm. Plots	50- 2x5 dm. Plots	50- 2x5 dm. Plots	50- 2x5 dm. Plots	No. In- stan- ces	50- 2x5 dm. Plots	50- 2x5 dm. Plots	50- 2x5 dm. Plots	50- 2x5 dm. Plots	No. In- stan- ces	50- 2x5 dm. Plots	50- 2x5 dm. Plots	50- 2x5 dm. Plots		
	of Use	of Diet	of Tran- sects	t value	of Use	of Diet	of Tran- sects	t value	of Use	of Diet	of Tran- sects	t value	of Use	of Diet	of Tran- sects	t value
SHRUBS																
<u>Artemisia</u> <u>cana</u>	910	19	7 ^{2/}	+3.07	257	4	tr	-	367	11	3	-				
<u>Artemisia</u> <u>tridentata</u>	4309	76	13	+5.64s ^{3/}	3378	79	13	+7.66s	3096	78	13	+9.69s				
<u>Chrysothamnus</u> <u>nauseosus</u>	-	-	-	-	129	3	tr	-	254	5	1	-				
<u>Symphoricarpos</u> <u>occidentalis</u>	-	-	-	-	-	-	-	-	95	3	1	-				
Total Shrubs	5266	96	-	-	3795	87	-	-	3852	97	-	-				
FORBS																
<u>Artemisia</u> <u>frigida</u>	7	tr	tr	-	332	11	6	+0.71	94	3	tr	-				
<u>Aster</u> <u>canescens</u>	214	2	2	+0.41	-	-	-	-	-	-	-	-				
Total Forbs	289	3	-	-	339	11	-	-	94	3	-	-				
GRASSES																
<u>Poa</u> <u>compressa</u>	-	-	-	-	80	2	tr	-	-	-	-	-				
Total Grasses	43	tr	-	-	80	2	-	-	-	-	-	-				

TABLE VIII. (continued)

- 1/ Only those species which comprised one percent or more of the diet for at least one month are included. Others occurring were: Agropyron spicatum (J), Artemisia longifolia (M), Atriplex spp. (J,F), Eurotia lanata (F), Grindelia squarrose (J), Opuntia polycantha (J,F), Phlox hoodii (F), and Poa secunda (J).
- 2/ As determined by canopy coverage.
- 3/ S indicates a significant positive t-value.

TABLE IX. FREQUENCY OF OCCURRENCE AND VOLUME PERCENTAGES OF PLANT TAXA AND FORAGE CLASSES AMONG 18 ANTELOPE RUMEN SAMPLES COLLECTED OVER A FIVE-MONTH PERIOD IN WINTER, 1966-67.

Taxa ^{1/}	Month						Unknown ^{2/}
	December (3) 3/	January (2)	February (3)	March (6)	April (1)		(3)
SHRUBS							
<u>Artemisia cana</u>	33/3 ^{4/}	50/T		17/T			
<u>Artemisia tridentata</u>	100/50	100/57	100/47	100/38	100/22		100/54
<u>Atriplex</u> spp.	67/T	100/3	33/T	17/T			33/T
<u>Chrysothamnus nauseosus</u>	67/7	50/21	33/9	67/3	100/9		
Unidentified shrubs	100/12	100/10	100/15	100/23	100/47		100/33
Total Shrubs	100/73	100/92	100/71	100/64	100/78		100/87
FORBS							
<u>Artemisia frigida</u>	67/14	50/T	67/15	83/5			67/1
<u>Aster canescens</u>		50/3					
<u>Leptodactylon pungens</u>	67/4			17/T			67/4
<u>Opuntia polycantha</u>	100/5	100/3	67/7	100/19			100/T
<u>Oxytropis</u> spp.							33/1
Unidentified forbs	100/4	100/T	100/6	100/8			100/4
Total Forbs	100/27	100/7	100/28	100/33			100/11
GRASS AND GRASS- LIKE PLANTS	100/1	100/1	67/T	100/2	100/22		67/1

1/ Only those taxa which comprised one percent or more of the volume for at least one month are included. Others occurring were: Antennaria rosea (December, February, March, and Unknown), Artemisia longifolia (Unknown), Allium textile (March), Juniperus spp. (March), and Lichens (March).

2/ Includes three rumen samples from fawns found dead on the study area in February or March.

3/ Number of rumen samples in parenthesis.

4/ Percent frequency/aggregate percent of total volume. T indicates values less than one percent.

individual species and its abundance in the plant community (expressed as percent canopy coverage).

Shrubs were the most important forage class in the antelope diet during winter, averaging 93 percent of the total use at feeding sites and 78 percent by volume of the total identifiable material in rumen samples. Among shrubs, big sagebrush was the most important, both at feeding sites, where it averaged 78 percent of the total instances of use, and in rumens, where it averaged 45 percent by volume of the total identifiable material. It was the only plant which yielded a significant positive t-value, indicating significantly higher proportions in the diet than in the plant community. Cole (1956), working in the same area, found that browse species, including big sagebrush and silver sagebrush, formed the major portion of rumen samples in December, January, and February. Many authors have indicated the importance of browse in winter antelope diets (Ferrel et al., 1952; Yoakum, 1958; and Dirschl, 1963).

Forbs were the next most important forage class, both in rumens and at feeding sites. They averaged six percent of the diet on feeding sites and 19 percent by volume of the total identifiable material in rumens. Fringed sagewort was the most important forb at feeding sites. Fringed sagewort and prickley pear cactus were the important forbs in rumens. Antelope were observed to paw prickley pear cactus several times, apparently for the purpose of breaking off the upper, spiny portion of the plant in order to eat the base.

Grass was unimportant, both at feeding sites and in rumens, but was

eaten by antelope during green-up periods in warm weather. In the April rumen sample, grass, a large part of which was green, formed 22 percent by volume of the total identifiable material.

During the winter, two dead fawn antelope were found in February and one in March. The gelatinous condition of the marrow in the femur bones indicated malnutrition (Cheatum, 1949). Little or no subcutaneous fat was visible on females and fawns collected for rumen samples. The amount of fat inside the respective body cavities was observed to grow progressively less with each collection through the winter.

The rumen contents of the antelope which apparently died of malnutrition did not vary significantly from those of other rumens. Thirteen and three-tenths percent of 511 sagebrush plants measured on feeding sites were decadent (25 percent or more of the crown was dead). On many feeding sites, big sagebrush plants were severely hedged (Fig. 10). Characteristics for sagebrush plants at feeding sites and permanent browse transect sites are given in Tables X and XI.

Martinka (1967), reporting on mortality of Montana pronghorns in a severe winter, suggested that malnutrition may have been related to a lack of sufficient quantities of shrubby sagebrush in the diet. The poor body condition and fawn mortality noted in this study possibly was related to quality of sagebrush in the diet. The relatively low fawn-female ratios (Table IV) may also be indicative.

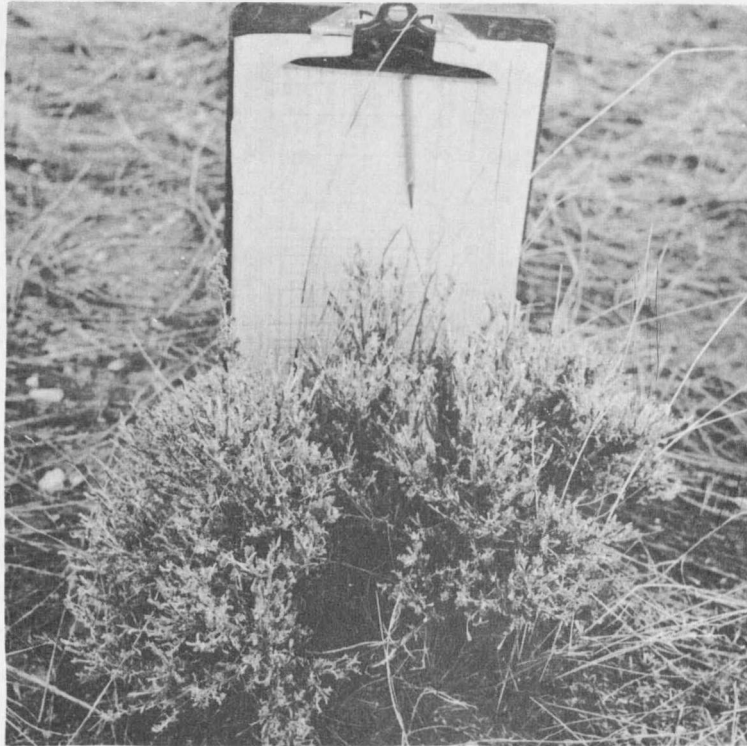


Figure 10. A Severely Hedged Big Sagebrush Plant.

TABLE X. SAGEBRUSH CHARACTERISTICS AT 28 ANTELOPE FEEDING SITES AS DETERMINED BY MEASUREMENTS IN INCHES ALONG A 100 FOOT LINE TRANSECT AT EACH SITE.

	January	February	March	All Feeding Sites
Av. Ht./Site	10.2	9.9	12.6	10.7
Av. % Of Plants Decadent/Site ^{1/}	15.9	12.8	10.9	13.3
Av. Canopy Intercept/Site	9.9	8.5	12.3	9.9
Av. Sagebrush Density ^{2/}	Dense	Common	Common	Common

^{1/} Plants were classed as "decadent" if 25 percent or more of the crown area was dead.

^{2/} See Table III.

TABLE XI. PERCENTAGE DISTRIBUTION OF SAGEBRUSH CHARACTERISTICS AS DETERMINED BY OCULAR ESTIMATION OF 25 PLANTS ALONG A TRANSECT LINE AT EACH OF SEVEN PERMANENT SITES.

Little or no clumping	Moderately clumped	Severely clumped	Mature	Decadent	Young
31	35	34	72	26	2

WINTER FOOD HABITS

The contents of a one-quart rumen sample from each of 18 antelope collected on the study area were analyzed according to the method of Cole (1956), and others. Recognizable items were volumetrically measured and expressed as percentages. Feeding site examinations, conducted immediately after the feeding site had been vacated by feeding antelope, supplemented rumen content analyses in determining food preferences. Each "bite" from a plant was recorded as one instance of use on a feeding site, as described by Knowlton (1960). The percent of the diet constituted by each plant used was computed for each rumen and feeding site. These percentages were totaled and averaged using the aggregate percent method (Martin et al., 1946). Results are shown in Tables VIII and IX.

Ten 2x5 decimeter plots placed along a 100 foot line were examined at each feeding site not covered with snow to determine the percent canopy coverage of each plant species. On feeding sites with snow cover, the canopy coverage of shrubs was recorded along a 100 foot line transect. During periods when snow covered the ground, antelope were observed to eat plants which extended above the snow.

The difference between the percent of diet and percent canopy coverage for each species used was determined at each feeding site. The average of the differences between the percent of the diet and the percent canopy coverage for each plant species was tested statistically where sample sizes permitted with a two-tailed t-test at the five percent level of significance (Li, 1965). The hypothesis tested was: there is no significant difference between the percent of the diet constituted by an



Figure 11. Antelope Inside Trap.



Figure 12. Fawn Female (4008) Being Fitted With Neck Band.

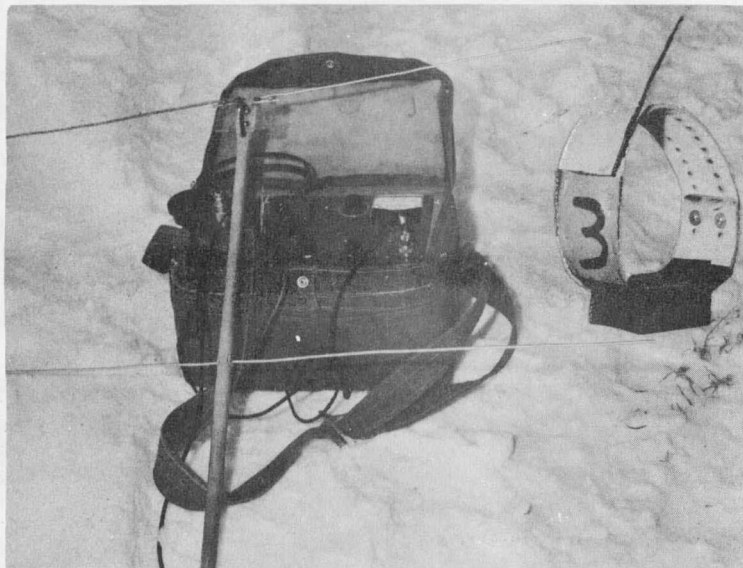


Figure 13. Transmitter Attached To Leather Collar (Left) And Receiver (Right).



Figure 14. Yearling Male Antelope (1372) Showing Leather Neck Collar With Transmitter Package On Right And Antenna On Left.

prevented their continued operation until battery depletion.

Receivers were the double conversion crystal-controlled superheterodyne type, with sensitivity better than one-tenth microvolt (Fig. 13). Radio equipment was supplied by Markusen Electronic Specialties, 92 West Harney Road, Esko, Minnesota.

Banded and "radioed" antelope were located daily when possible. A high point near the center of the study area was selected as a listening post. All three transmitter signals could be heard from this location early in the study period. Signals were heard from as far away as seven miles from this point under optimum conditions. Depressions or ridges hindered reception. A total of 579 locations of individually marked antelope was recorded with the aid of the receiver and ocular aids (15-60x spotting scope and 7x35 mm. binoculars), from December 9 through March 23.

When released, all 18 successfully marked antelope returned to the same general area from which they were originally driven. Eight, including one with a radio, remained in this area (Yellow Water Area) through the winter study period; five, including one with a radio, moved approximately seven miles north to the Teigen Area after remaining in the Yellow Water Area for only three days; one "radioed yearling male" moved three miles south to the Pike Creek Area after spending three days in the Yellow Water Area; and two banded antelope shifted their home range to the Teigen Area after spending approximately one month in the Yellow Water Area (Fig. 15). Data for two antelope were too incomplete for further conclusions.

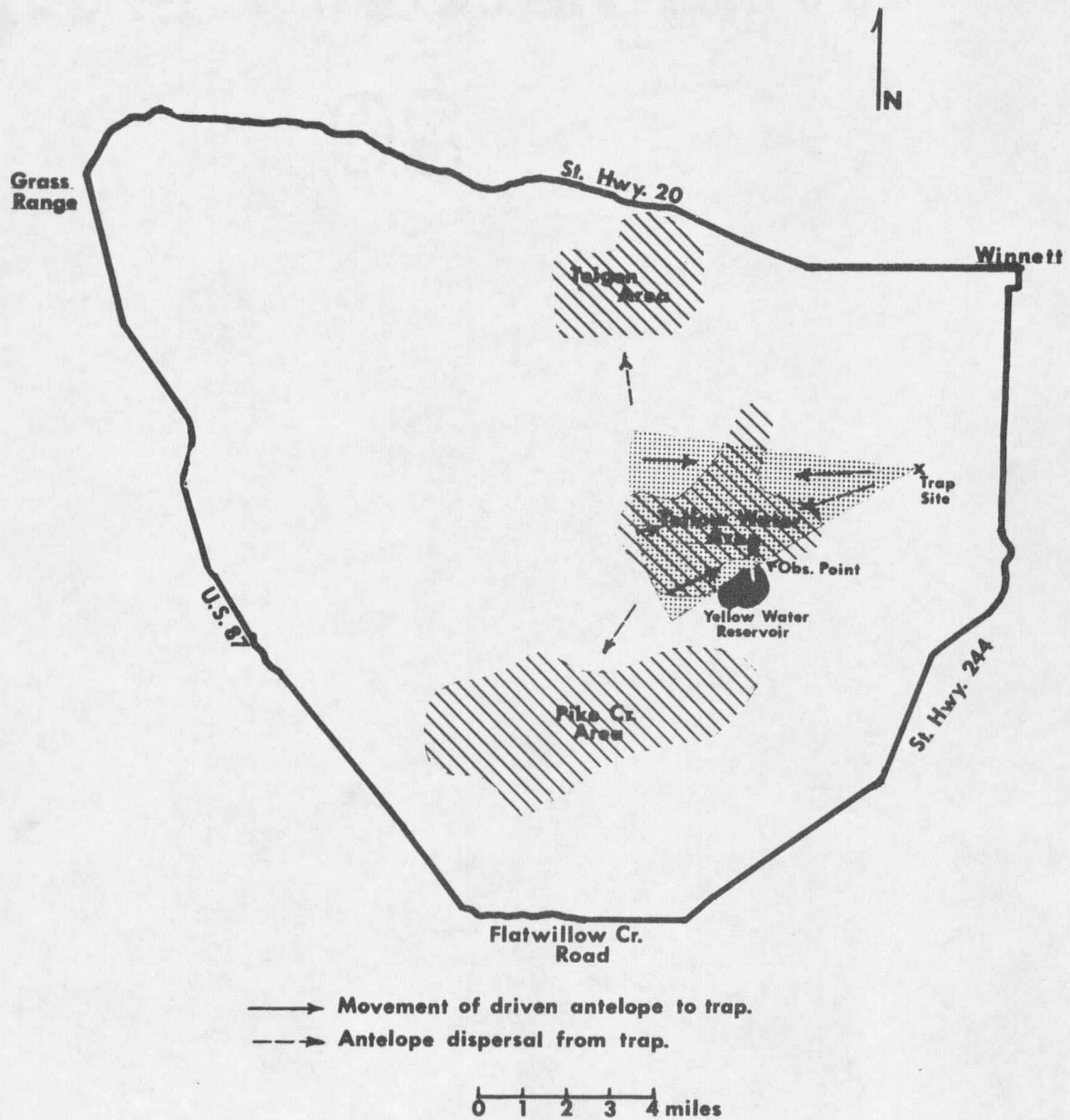


Figure 15. Yellow Water Triangle Study Area Showing Antelope Trapping Pattern and Winter Concentration Areas of Marked Antelope.

Locations of individual antelope were recorded in one-tenth of a mile intervals by day and month on a one-half inch scale map. Locations of representatives of each of the various sex and age groups are shown on Figures 16 through 20. The locations for the remaining animals are shown on Appendix Figures 22 through 25. To estimate home range size, a line was drawn around the outside points of observation for each individual antelope. The area enclosed was calculated with the aid of a Polar Planimeter (Table XII). One antelope (S4013) was deleted from home range calculations because only five observations were recorded. Eight of the 16 for which home ranges were calculated each "shifted" their home range; seven once and one twice. A home range "shift" was defined as a movement from one area of activity to another with no subsequent return.

The yearling female had the largest home range of all sex and age groups, followed by the yearling male, adult females, fawn females, and fawn males, respectively (Table XIII). For those groups where more than one animal was available, home range sizes were tested with a standard analysis of variance, one-way classification, at the 5 percent level of significance. The hypothesis tested was: there was no significant difference between the mean home range size of adult females, fawn females, and fawn males. Whether the assumptions were satisfied in this test was questionable, but the resulting F-value of 1.4898 with 2 and 11 degrees of freedom led to acceptance of the hypothesis. A t-test applied to the three group means also led to acceptance of the hypothesis that no significant difference existed (11 degrees of freedom at the 5 percent level of

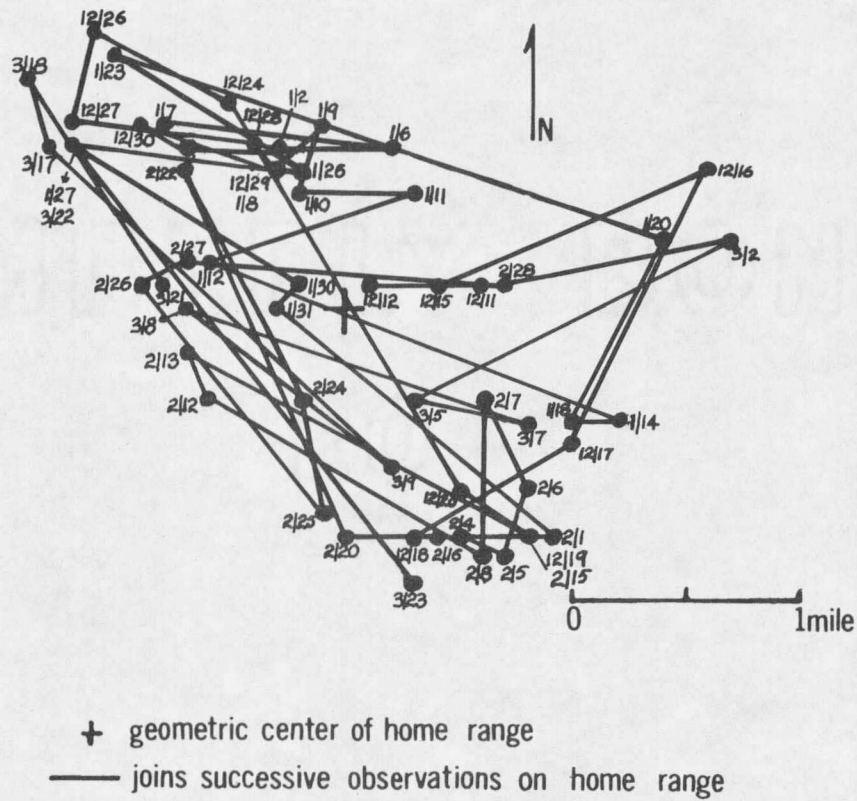


Figure 16. Individual Locations Of An Adult Female (1301) By Day And Month In The Yellow Water Area With No Home Range Shifts.

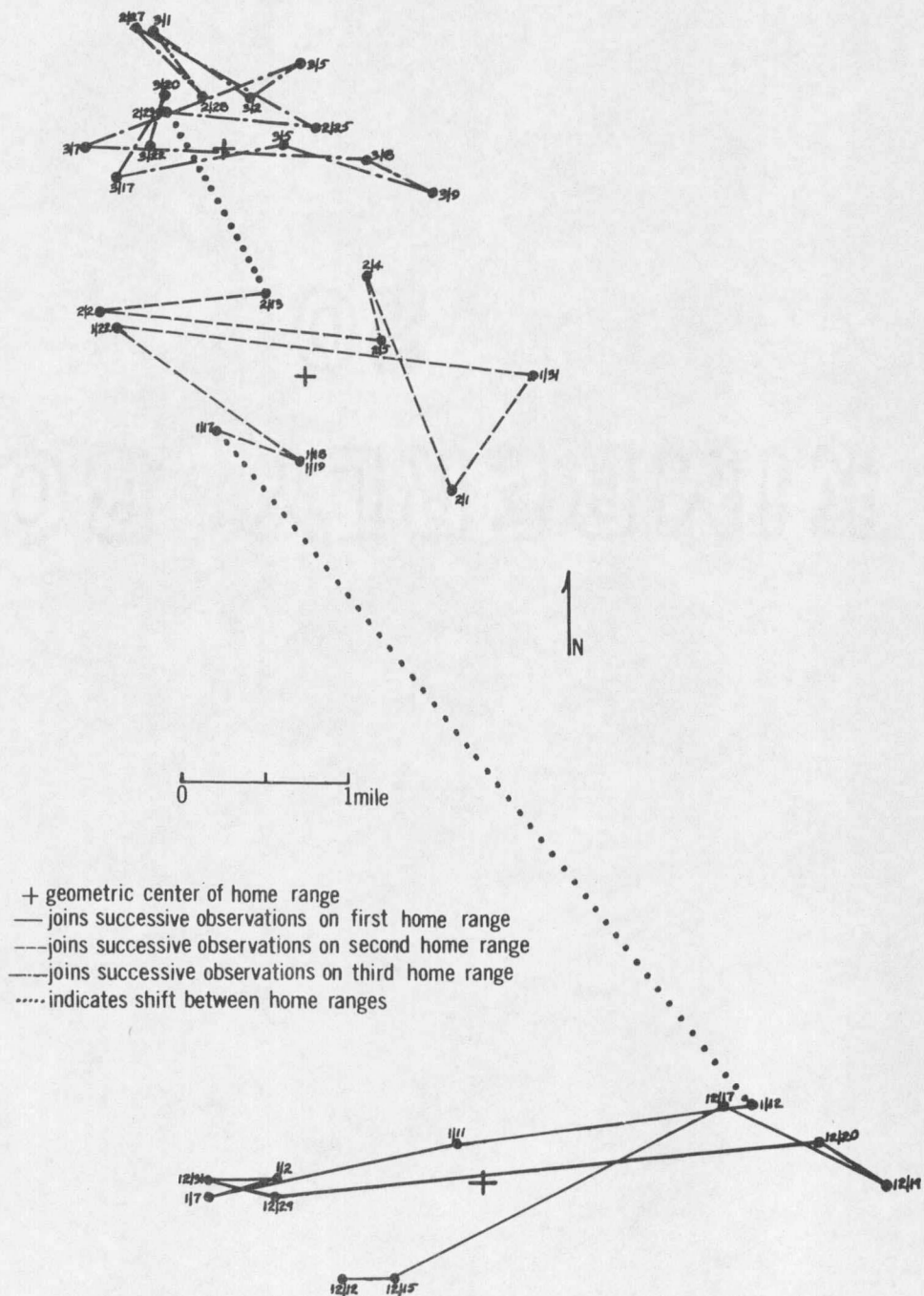
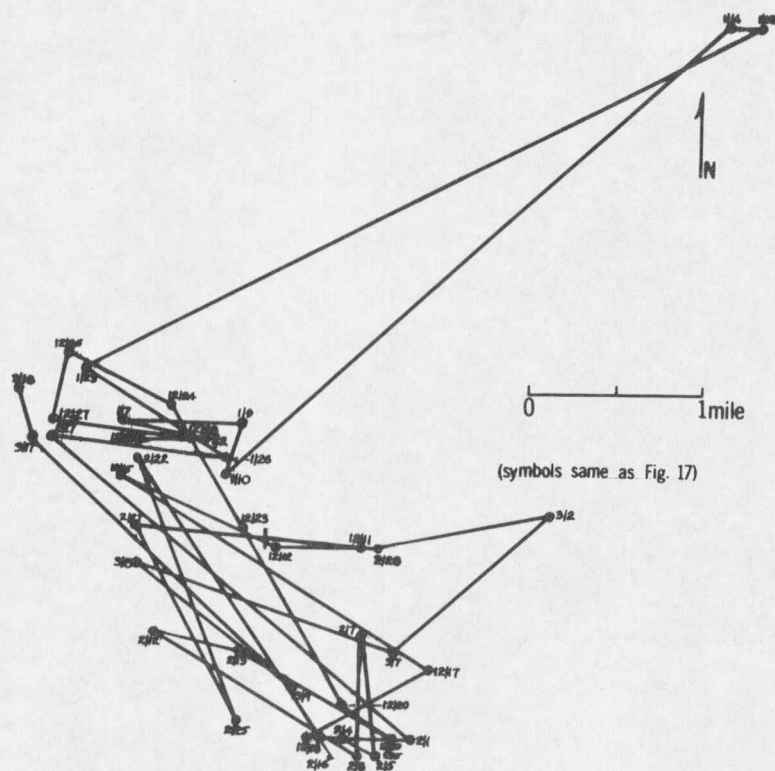


Figure 17. Individual Locations Of An Adult Female (4002) By Day And Month Showing Two Home Range Shifts. The First Home Range Was In The Yellow Water Area; The Second And Third In The Teigen Area.

A. Yearling Female (4003) In Yellow Water Area With No Home Range Shift.



B. Yearling Male (1372) In Pike Creek Area Showing One Home Range Shift.

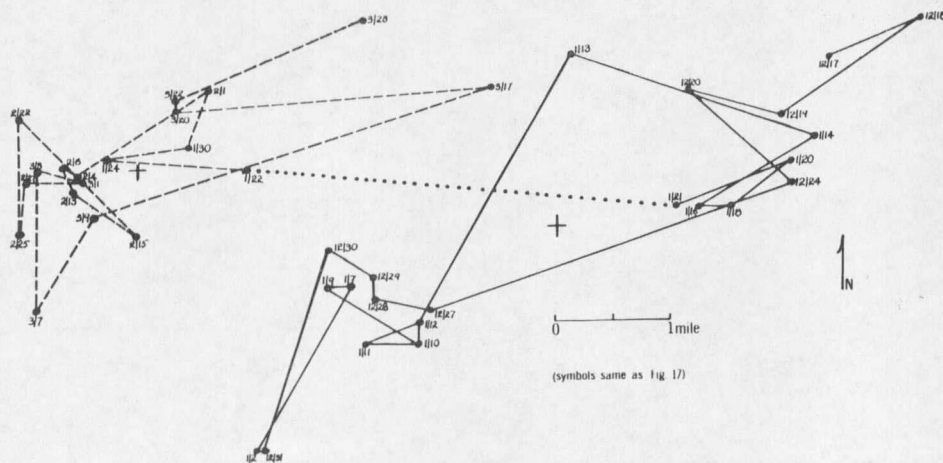
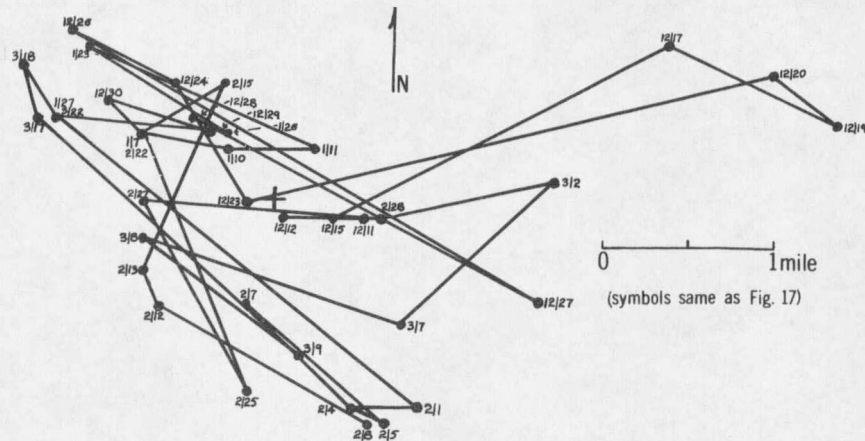


Figure 18. Individual Locations Of A Yearling Male And A Yearling Female By Day And Month.

A. Fawn Female (4010) In Yellow Water Area Showing No Home Range Shift.



B. Fawn Female (4008) In Teigen Area Showing One Home Range Shift.

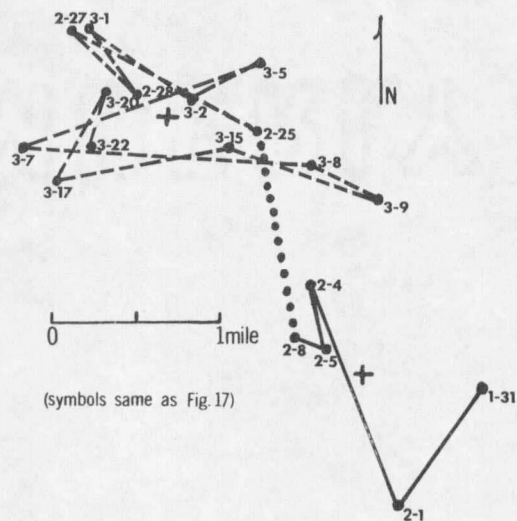
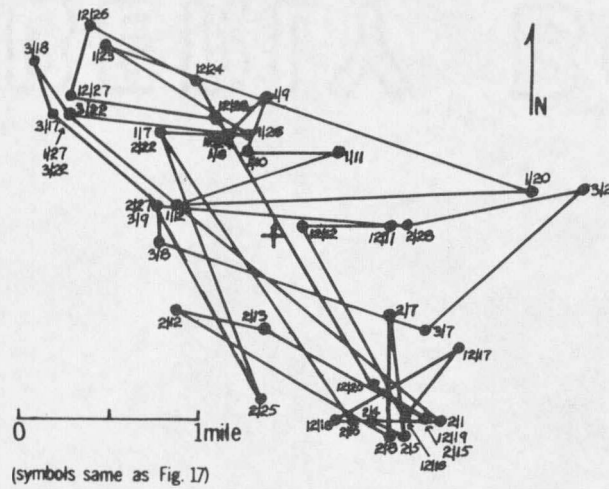


Figure 19. Individual Locations Of Fawn Females By Day And Month.

A. Fawn Male (4015) In Yellow Water Area With No Shift In Home Range.



B. Fawn Male (4007) In Teigen Area Showing One Home Range Shift.

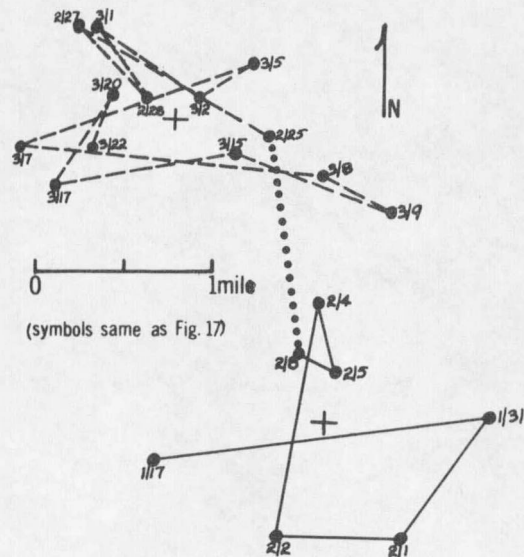


Figure 20. Individual Locations Of Fawn Males By Day And Month.

TABLE XII. SUMMARY OF MOVEMENT DATA FOR 16 INDIVIDUALLY MARKED ANTELOPE ON THE TRIANGLE STUDY AREA IN WINTER, 1966-67.

Antelope	Dates of Observation	No. of Observ.	Shift (miles) Between Home Ranges ^{1/}	Distance (miles)			Estimated Home Range (acres)
				Maximum Between Observ.	First to Last Observ.	From Center of Range ^{2/} Mean Max.	
Adult ♀ (4002)	12/12-1/12	11		4.08	2.66	1.41 2.42	1510.4
	1/17-2/13	10	4.97	2.62	0.88	0.83 1.36	1369.6
	2/23-3/22	14	1.47	2.05	0.23	0.65 1.28	870.4
Adult ♀ (4004)	12/12-3/18	39	-	3.17	1.76	1.00 1.75	2924.8
Adult ♀ (4005)	12/12-3/18	39	-	3.96	1.76	1.08 2.78	3776.0
Adult ♀ (4014)	12/11-3/22	39	-	3.96	1.91	1.09 2.70	3840.0
Adult ♀ (1301)	12/11-3/23	58	-	3.16	1.35	0.98 1.74	2835.2
Adult ♀ (1374)	12/14-2/13	35		4.27	2.54	1.29 2.85	3929.6
	2/23-3/22	14	1.56	2.12	0.20	0.60 1.35	915.2
Yearling ♀ (4003)	12/11-3/18	41	-	5.02	2.20	1.16 4.10	5574.4
Fawn ♀ (4008)	1/31-2/8	5		1.40	1.13	0.59 0.80	409.6
	2/25-3/22	13	1.90	2.11	1.00	0.63 1.32	915.2
Fawn ♀ (4009)	12/12-1/11	14		4.27	0.45	1.22 2.85	1644.8
	1/17-1/20	4	4.82	1.60	1.15	0.58 0.52	134.4
Fawn ♀ (4010)	12/11-3/22	38	-	4.80	1.90	1.12 3.32	4691.2
Yearling ♂ (1372)	12/17-1/21	22		6.82	1.85	1.98 3.64	5209.6
	1/22-3/23	19	3.64	4.37	1.64	0.97 3.13	3110.4
Fawn ♂ (4006)	12/18-3/18	37	-	3.18	2.64	1.04 2.30	2560.0
Fawn ♂ (4007)	1/17-2/8	7		1.90	1.00	0.68 0.98	1011.2
	2/25-3/22	13	1.90	2.10	1.00	0.62 1.31	960.0
Fawn ♂ (4011)	1/31-2/8	5		1.40	1.13	0.56 0.80	428.8
	2/25-3/22	13	1.89	2.10	1.00	0.63 1.33	960.0
Fawn ♂ (4012)	1/31-2/8	5		1.40	1.13	0.56 0.80	428.8
	2/25-3/22	12	1.99	1.70	1.00	0.55 1.00	723.2
Fawn ♂ (4015)	12/11-3/22	42	-	1.17	1.90	1.01 1.75	2668.8

^{1/} Center to center distance.

^{2/} Central point of the area within which the animal was observed, calculated geometrically (Hayne, 1949).

TABLE XIII. AVERAGE WINTER HOME RANGE SIZE FOR EACH OF FIVE SEX AND AGE GROUPS OF INDIVIDUALLY MARKED ANTELOPE ON THE YELLOW WATER TRIANGLE STUDY AREA IN WINTER, 1966-67.

Age and Sex Group	No. of Antelope	Av. Home Range Size (acres) ^{1/}	Range
Adult ♀	6	2841.4	1250.1-3840.0
Yearling ♀	1	5574.4	-
Fawn ♀	3	2417.1	915.2-4691.2
Yearling ♂	1	4160.0	-
Fawn ♂	5	1579.5	723.2-2668.8

^{1/} Eight antelope had home range "shifts". The average of the home ranges for each of these antelope was used in calculating average home range size, except for four where the number of observations for one of the home ranges was less than six. For these four the home range resulting from six or more observations was used.

TABLE XIV. AVERAGE AREA USED BY EACH OF THREE SEX AND AGE GROUPS OF INDIVIDUALLY MARKED ANTELOPE IN RELATION TO VEGETATION TYPES IN WINTER, 1966-67.

Vegetation Type	Average Area Used (acres)		
	Adult ♀	Fawn ♀	Fawn ♂
Greasewood-sagebrush	2977.3(5) ^{1/}	3168.0(2)	2614.4(2)
Sagebrush-grassland	3542.4(2)	729.6(2)	1504.0(3)

^{1/} The number of antelope used in calculations in parenthesis.

significance).

Fawn females had the most variable home range sizes, followed by adult females and fawn males, respectively. Since home range data were available for only one yearling female and one yearling male, no conclusion could be made about the variability of the home ranges for these sex and age groups.

Adult females used a larger area on the sagebrush-grassland vegetation type than on the greasewood-sagebrush type. Both fawn males and females showed the opposite (Table XIV).

APPENDIX

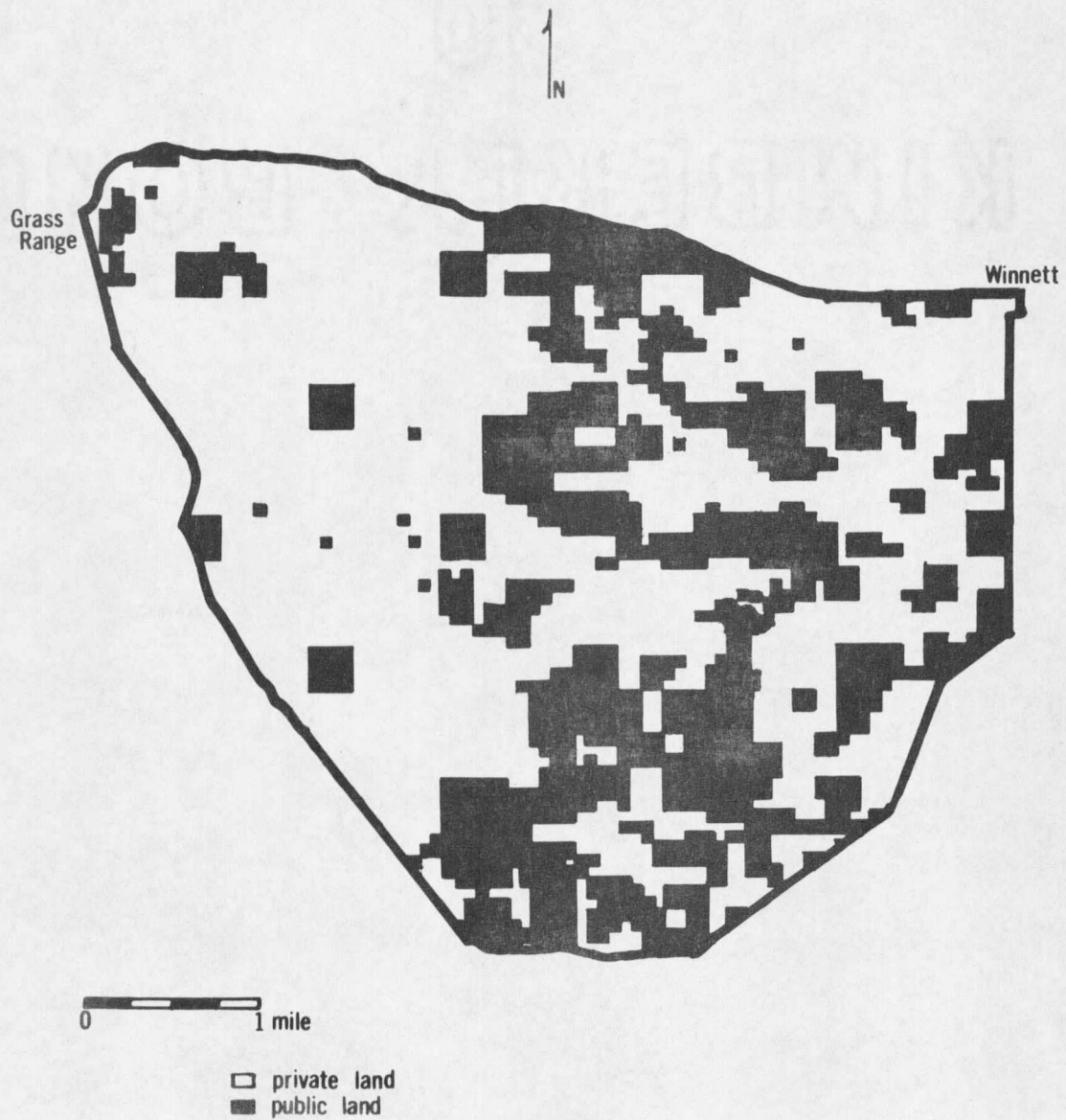


Figure 21. Yellow Water Triangle Study Area Showing Land Ownership.

TABLE XV. MEASUREMENT OF FETUSES FROM SEVEN FEMALE ANTELOPE COLLECTED ON THE YELLOW WATER TRIANGLE STUDY AREA DURING THE WINTER OF 1966-67

Date Collected	Age of Female	Number of Fetuses	Sex	Weight	Crown-Rump Length
12/23/66	3yrs-7mos	2	♀	2 ozs.	112 mm.
			♂	3 ozs.	113 mm.
1/21/67	5yrs-8mos	2	♀	5 ozs.	152 mm.
			♂	6 ozs.	156 mm.
2/1/67	7yrs-9mos	2	♀	8 ozs.	170 mm.
			♂	7 ozs.	165 mm.
3/22/67	8yrs-10mos	2	♀	21 ozs.	245 mm.
			♂	18 ozs.	213 mm.
3/23/67	5yrs-10mos	2	♀	30 ozs.	281 mm.
			♂	24 ozs.	256 mm.
3/23/67	2yrs-10mos	1	♀	22 ozs.	257 mm.
3/23/67	5yrs-10mos	2	♂	26 ozs.	276 mm.
			♂	28 ozs.	279 mm.
4/21/67	2yrs-11mos	2	♀	61 ozs.	345 mm.
			♂	60 ozs.	340 mm.

TABLE XVI. PERCENTAGE DISTRIBUTION OF 8708 OBSERVATIONS OF INDIVIDUAL ANTELOPE IN RELATION TO GROUND CONDITION IN WINTER, 1966-67.

Ground Condition	Vegetation Type					Total No. Observations
	Sagebrush-Grassland	Grassland	Greasewood	Greasewood-Sagebrush	Cropland	
Dry	67 ^{1/}	5	-	28	-	1716
Damp	65	13	-	22	-	477
Wet, Muddy	77	8	2	13	-	2353
Scattered Snow	70	6	8	17	-	1388
Snow 1-6"	74	1	6	13	5	2774

^{1/} Percentages are based on 100 percent for each ground condition category.

TABLE XVII. PERCENTAGE DISTRIBUTION OF 8573 OBSERVATIONS OF INDIVIDUAL ANTELOPE IN RELATION TO TEMPERATURE IN WINTER, 1966-67.

Temperature	Vegetation Type					Total No. Observations
	Sagebrush-Grassland	Grassland	Greasewood	Greasewood-Sagebrush	Cropland	
Minus 0°F.	78 ^{1/}	8	-	14	-	296
0-32°F.	72	3	4	19	2	4909
32-40°F.	77	8	-	14	2	2438
40-60°F.	69	6	10	16	-	930

^{1/} Percentages are based on 100 percent for each temperature category.

TABLE XVIII. PERCENT CONSTANCY, CANOPY COVERAGE, AND FREQUENCY OF OCCURRENCE OF VEGETATION AT 12 ANTELOPE WINTER BEDDING SITES AS DETERMINED BY MEASUREMENTS WITHIN 2x5 DECIMETER PLOTS.

Taxa	Constancy	Coverage	Frequency
SHRUBS			
<u>Artemisia tridentata</u>	100	16	43
<u>Atriplex</u> spp.	25	2	23
<u>Chrysothamnus nauseosus</u>	8	2	20
<u>Gutierrezia sarothrae</u>	33	1	18
<u>Rosa arkansana</u>	8	2	10
<u>Sarcobatus vermiculatus</u>	25	9	27
FORBS			
<u>Arenaria hookeri</u>	42	2	46
<u>Artemisia frigida</u>	58	9	51
<u>Aster canescens</u>	8	5	20
<u>Cirsium flodmani</u>	8	tr	10
<u>Erigeron pumilus</u>	8	tr	10
<u>Opuntia polycantha</u>	42	4	30
<u>Plantago spinulosa</u>	25	tr	17
<u>Psoralea tenuiflora</u>	25	tr	13
<u>Selaginella densa</u>	17	tr	15
<u>Taraxacum officinale</u>	8	tr	10
GRASSES AND GRASS-LIKE PLANTS			
<u>Agropyron dasystachyum</u>	8	28	80
<u>Agropyron smithii</u>	83	34	92
<u>Agropyron spicatum</u>	25	10	50
<u>Bouteloua gracilis</u>	50	10	40
<u>Bromus japonicus</u>	8	3	30
<u>Carex brevior</u>	25	tr	30
<u>Koeleria cristata</u>	50	4	45
<u>Poa canbyi</u>	17	3	25
<u>Poa compressa</u>	8	2	30
<u>Poa secunda</u>	92	2	46
<u>Schedonardus paniculatus</u>	17	tr	25
LICHENS	83	3	59
BARE GROUND	100	81	100

TABLE XIX. GROUND COVER CHARACTERISTICS AT 12 ANTELOPE WINTER BEDDING SITES. DATA ARE FREQUENCIES OF OCCURRENCE OF BARE GROUND, ROCK, LITTER, AND LIVING VEGETATION AMONG 480 POINTS.

Bare Ground	Rock	Litter	Living Vegetation
61	-	19	20

TABLE XX. AVERAGE GROUP SIZE OF ANTELOPE BY MONTH IN RELATION TO GROUND CONDITIONS ON THE YELLOW WATER TRIANGLE STUDY AREA IN WINTER, 1966-67.

Ground Condition	Month				No. Observ.	No. Groups	Av. Group Size
	December	January	February	March			
Dry	-	37.2/9/5	18.6/43/64	19.8/14/17	1712	86	19.9
Damp	-	-	-	19.8/29/24	476	24	19.8
Wet, muddy	23.8/14/13 ^{1/}	25.9/17/19	22.7/38/53	24.6/21/14	2349	99	23.7
Scattered Snow	18.6/21/14	28.3/22/23	24.4/10/11	22.9/14/9	1386	57	24.3
Snow 1-6"	28.8/64/36	36.4/52/37	19.4/9/5	25.9/21/11	2765	89	31.1

^{1/} Average group size (two or more antelope represented a group) /percent of observation days in month with that particular ground condition/ number of groups.

TABLE XXI. AVERAGE GROUP SIZE OF ANTELOPE BY MONTH IN RELATION TO TEMPERATURE ON THE YELLOW WATER TRIANGLE STUDY AREA IN WINTER, 1966-67.

Temperature	Month				No. Observ.	No. Groups	Av. Group Size
	December	January	February	March			
Minus 0°F.	-	28.3/9/6	-	20.8/7/6	295	12	24.6
0 to 32°F.	31.3/57/31 ^{1/}	34.3/54/39	18.8/52/78	21.9/64/51	4894	199	24.6
32 to 40°F.	20.0/43/32	28.8/27/18	23.4/33/37	22.6/29/18	2427	105	23.1
40 to 60°F.	-	30.1/9/17	23.2/14/18	-	929	35	26.5

^{1/} Average group size (two or more antelope represented a group)/percent of observation days in month with that particular temperature condition/number of groups.

TABLE XXII. SUMMER GROUPING CHARACTERISTICS OF ANTELOPE BY MONTH DETERMINED FROM RESULTS OF FIVE AERIAL CENSUSES IN THE YELLOW WATER TRIANGLE STUDY AREA, 1966.

Month	No. Observ.	Av. Group Size	Female-Fawn Groups			Bachelor Herds		No. Territorial ♂'s
			No. Observ.	Av. Group Size	% of Groups w/ Territorial ♂	No. Observ.	Av. Group Size	
June	404(60) ^{1/}	6.7	349(47) ^{1/}	7.4	26	36(6) ^{1/}	6.0	18
July	518(60)	8.6	446(44)	10.1	48	64(13)	4.9	28
August ^{2/}	957(85)	11.3	885(73)	12.1	71	39(7)	5.6	29
Sept.	370(33)	11.2	327(22)	14.9	86	27(6)	4.5	28
Total	2249(238)							

^{1/} Two or more antelope were considered to represent a group. Number in parenthesis is number of groups.

^{2/} Data for this month was the result of two aerial censuses. They were averaged to obtain the data for bachelor herds and territorial males.

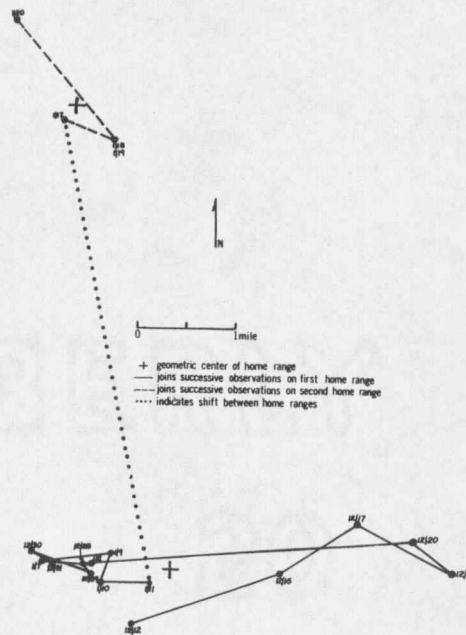
TABLE XXIII. CHARACTERISTICS OF INDIVIDUAL NECK BANDS AND COLLARS USED ON EACH OF 19 ANTELOPE TRAPPED ON THE YELLOW WATER TRIANGLE STUDY AREA ON DECEMBER 9, 1966.

Ear Tag Numbers	Band and Collar Characteristics			Radio Channel	Antelope	
	Color	Pattern Color and Description	Observ- ability		Age and Sex	Weight (lbs.)
S4001, S4501	Black	White	1/		Fawn ♀	64
		"S"				
S4002, S4502	Black	White	2/		Adult ♀	97
		Dots				
S4003, S4503	Black	White	3/		Yearling ♀	91
		Squares				
S4004, S4504	Black	White	Medium		Adult ♀	103
		Arrows				
S4005, S4505	Black	White	Good		Adult ♀	111
		Candy Stripe				
S4006, S4506	Black	White	Medium		Fawn ♂	74
		Chevrons				
S4007, S4507	Black	White	3/		Fawn ♂	76
		Diamonds				
S4008, S4508	Black	White	Poor		Fawn ♀	64
		Checkerboard				
S4009, S4509	Orange	Black	Medium		Fawn ♀	67
		"T"				
S4010, S4510	Orange	Black	Medium		Fawn ♀	64
		Triangle				
S4011, S4511	Orange	Black	Poor		Fawn ♂	72
		"X"				
S4012, S4512	Orange	Black	Good		Fawn ♂	70
		Circles				
S4013, S4513	Orange	Black	Poor		Fawn ♂	71
		Hourglass				
S4014, S4514	Orange	Black	Good		Adult ♀	91
		"Z"				
S4015, S4515	Orange	Black	Good		Fawn ♂	71
		Crescent				
S4016, S4516	Orange	Black	1/		Adult ♀	102
		Lines				
S1301, S1302	Leather	Blue	Poor	9	Adult ♀	104
		"7"				
S1372, S1373	Leather	Red	Poor	7	Yearling ♂	100
		"3"				
S1374, S1375	Leather	Yellow	Poor	5	Adult ♀	89
		Squares				

TABLE XXIII. (Continued)

- 1/ S4001 was never seen again after release; S4016 was seen for only three days after release.
- 2/ Observability was based on the following categories:
 - Good - recognizable at 1/2 to 3/4 mile under both good and poor light conditions.
 - Medium - recognizable at 1/2 to 3/4 mile with good light conditions only.
 - Poor - recognizable only at short distances with good light conditions.
- 3/ Bands of S4003 and S4007 were easily observed, but difficult to distinguish from each other.

A. Fawn Female (4009) In Yellow Water Area Showing Home Range Shift to Teigen Area.



B. Fawn Male (4006) In Yellow Water Area With No Home Range Shift.

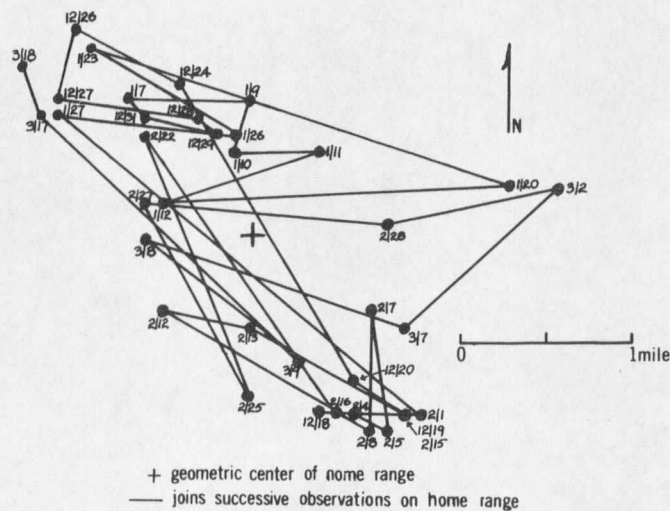
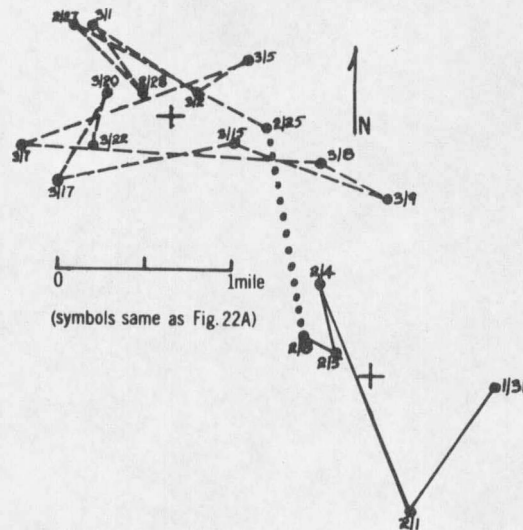


Figure 22. Individual Locations Of A Fawn Male And A Fawn Female By Day And Month.

A. Fawn Male (4011) In Teigen Area Showing One Home Range Shift.



B. Fawn Male (4012) In Teigen Area Showing One Home Range Shift.

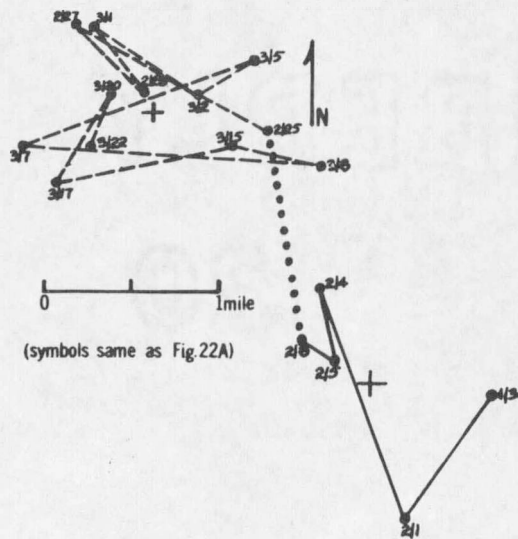
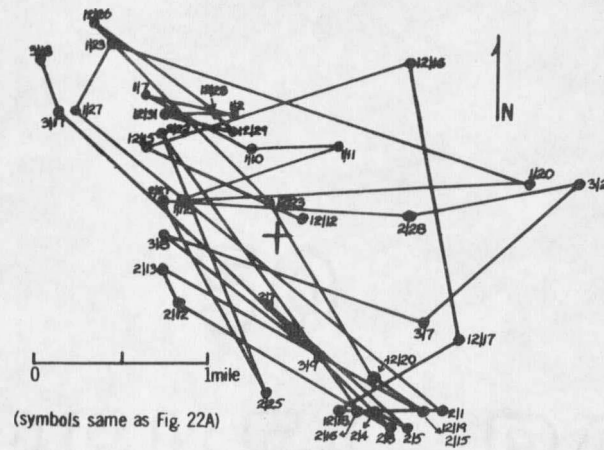


Figure 23. Individual Locations Of Fawn Males By Day And Month.

A. Adult Female (4004) In Yellow Water Area
Showing No Home Range Shift.



B. Adult Female (4005) In Yellow Water Area
Showing No Home Range Shift.

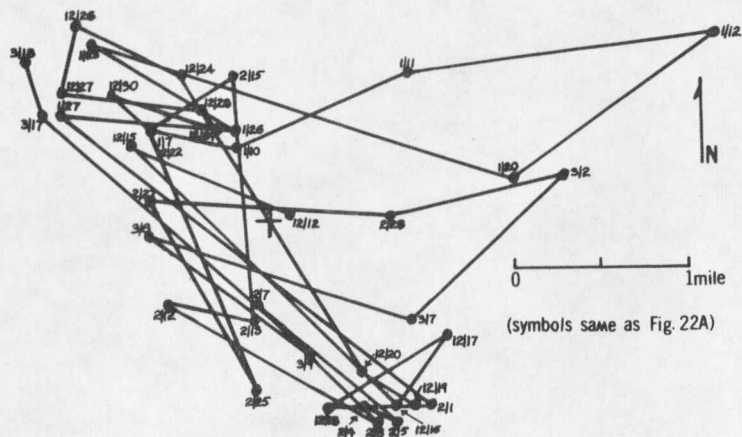


Figure 24. Individual Locations Of Adult Females By Day And Month.

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