



Yearlong movements and habitat use of mule deer associated with the Willow Creek winter range in southeastern Idaho
by Terry Ross Thomas

A thesis submitted 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 was conducted from May 1984 to November 1986 using radio telemetry to determine the yearlong distribution, movements, migration patterns and habitat use of Rocky Mountain Mule Deer (*Odocoileus hemionus hemionus*) wintering in the Willow Creek drainage of Eastern Idaho. Deer summered 15-115 kilometers (km) from winter ranges with 63 percent summering in excess of 40 km from their winter home ranges. Mean minimum home range size for females was 5.3 square kilometers (km²). Males had significantly larger home ranges than females and females in the eastern half of the study area had significantly larger home ranges than those in the western half. Fidelity to seasonal home ranges was high during the study with only 1 male changing summer home ranges and 1 male and 1 female changing winter ranges. With few exceptions, deer were on summer ranges at the beginning of hunting season. Distance between summer and hunting season geographic activity centers averaged 1.2 km. Livestock operations appeared to cause shifts in habitat use but a single instance of logging on a home range did not. Migration was generally direct and followed bold topographic features oriented toward the alternate seasonal ranges. Deer used the same migration corridors and transition ranges in spring and fall. Deer preferred closed canopy cover types on summer ranges, open canopy cover types during migration, closed canopy cover types early winter and grain fields in late winter. One winter-summer population unit was identified. There was little mixing of deer from different winter range subunits and female home range size for the winter of 1985-86 averaged 1.8 km². Helicopter disturbance during trend counts was shown to not cause shifts in distribution but some apparent shifting occurred in relation to crop rotation patterns. Trend counts indicated a stable population on the winter range 1984-86. Male:female:fawn ratios for early winter 1985-86 were 29:100:89. There was no significant difference between percent fawns in early and late winter (43 and 42 percent, respectively). Discrepancies between trend count indices and population characteristics are discussed.

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ASSOCIATED WITH THE WILLOW CREEK WINTER
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A thesis submitted in partial fulfillment
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Master of Science

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Fish and Wildlife Management

MONTANA STATE UNIVERSITY
Bozeman, Montana

August 1987

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APPROVAL

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Terry Ross Thomas

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style and consistency, and is ready for submission to the College of Graduate Studies.

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ACKNOWLEDGMENTS

I wish to express my sincere appreciation to the following people for their vital contributions to this study: Dr. Lynn Irby, Montana State University (MSU), who directed this study, for field assistance, guidance in preparation of this manuscript and for his hospitality, Dr. Richard Mackie , Dr. Harold Picton , Dr. Clayton Marlow and Dr. Robert White, MSU, Dr. Jack Connelly and Cecil Brown, Idaho Department of Fish and Game (IDFG) for reviewing this manuscript and providing valuable information, Steve Haynes, IDFG, for financial support, time, information and use of equipment, Tracey Trent and Justin Naderman, IDFG, for direction and use of equipment, Richard Winstead, IDFG, for assistance with the computer, Fred and Linda Reed, Western Air Research, for splendid services in aerial relocations, Dan Duggan, IDFG, for field assistance, Dr. Dalton Burkhalter, MSU, for assistance with relocation data analysis, Gary Ball, for permission to sample in his fields, employees of IDFG, U.S. Forest Service and Bureau of Land Management as well as private citizens, who aided in capturing deer for the study. I especially acknowledge the constant love, support, patience and assistance of my wife, Cathleen, to whom I dedicate this work.

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ABSTRACT

A study was conducted from May 1984 to November 1986 using radio telemetry to determine the yearlong distribution, movements, migration patterns and habitat use of Rocky Mountain Mule Deer (Odocoileus hemionus hemionus) wintering in the Willow Creek drainage of Eastern Idaho. Deer summered 15-115 kilometers (km) from winter ranges with 63 percent summering in excess of 40 km from their winter home ranges. Mean minimum home range size for females was 5.3 square kilometers (km²). Males had significantly larger home ranges than females and females in the eastern half of the study area had significantly larger home ranges than those in the western half. Fidelity to seasonal home ranges was high during the study with only 1 male changing summer home ranges and 1 male and 1 female changing winter ranges. With few exceptions, deer were on summer ranges at the beginning of hunting season. Distance between summer and hunting season geographic activity centers averaged 1.2 km. Livestock operations appeared to cause shifts in habitat use but a single instance of logging on a home range did not. Migration was generally direct and followed bold topographic features oriented toward the alternate seasonal ranges. Deer used the same migration corridors and transition ranges in spring and fall. Deer preferred closed canopy cover types on summer ranges, open canopy cover types during migration, closed canopy cover types early winter and grain fields in late winter. One winter-summer population unit was identified. There was little mixing of deer from different winter range subunits and female home range size for the winter of 1985-86 averaged 1.8 km². Helicopter disturbance during trend counts was shown to not cause shifts in distribution but some apparent shifting occurred in relation to crop rotation patterns. Trend counts indicated a stable population on the winter range 1984-86. Male:female:fawn ratios for early winter 1985-86 were 29:100:89. There was no significant difference between percent fawns in early and late winter (43 and 42 percent, respectively). Discrepancies between trend count indices and population characteristics are discussed.

INTRODUCTION

Long distance migration by Rocky Mountain mule deer (Odocoileus hemionus hemionus) between seasonal ranges can create management problems for the responsible agencies. Groups of deer with markedly different age and sex structures, movement patterns, and vulnerability to harvest may winter on a common ground. Overharvest or underharvest of specific segments may not be detected when deer hunted under varying administrative regulations and philosophies winter together. Kasworm (1981) and Ishle (1982) found that long distance migrating populations of mule deer were subjected to prolonged hunting seasons. Deer were hunted on summer ranges in early fall and on transition ranges later when they crossed an administrative boundary. Ishle (1982) concluded that recovery from overharvest could be slow because long distances and behavioral constraints would limit recolonization rates. Bertram and Rempel (1977) reported increased harvest when deer concentrated on transition ranges easily accessible to hunters.

The first step in determining the extent of this problem involves identification of migration routes,

seasonal ranges and timing of movements between seasonal ranges. Mackie et al. (1980) indicated that this knowledge is crucial in establishing seasons and harvest quotas.

In the Willow Creek drainage (Bonneville County) of southeastern Idaho, preliminary data (Trent, personal communication [pers. comm.]) indicated that some deer migrated long distances to the winter range. The current study (1984-86) was initiated to determine the yearlong distribution of deer using the Willow Creek winter range and to identify factors that might influence population characteristics and harvest/management practices.

Specific objectives were:

1. Determine summer distribution of marked animals
2. Determine hunting season distribution
3. Identify migration corridors
4. Identify discrete winter range
subpopulations and population characteristics
5. Determine habitat use during winter, migration
and hunting seasons.

Supplementary data were gathered on deer from the adjacent Wolverine Winter Range as they were suspected of sharing a common summer range with Willow Creek deer.

STUDY AREA

The principal Willow Creek Winter Range (WCWR) (Figure 1) extends 23 kilometers (km) from Kepps Crossing north to Ririe Dam. Willow Creek is a deep canyon complex 44 km long with 71 km of tributary canyons. Wintering areas currently of minor importance extend 11 km south. Ririe Reservoir occupies 20 kilometers of canyon bottoms in the northern portion of the winter range. Elevations on WCWR vary from 1550 meters (m) to 1950 m.

Climate is cold and dry (Appendix Table 21). The 25-year mean annual precipitation is 42.6 centimeters (cm) and the 25-year mean annual temperature is 5.1 degrees Centigrade (C). The winters of 1983-84, 1984-85 and 1985-86 were severe, average, and mild, respectively (Figure 2).

Plateaus above the canyons were intensively cultivated to winter wheat (Triticum aestivum). Eight hundred hectares (ha) of agricultural fields have been returned to permanent perennial forb cover in the past 10 years on winter and transition ranges. Native vegetation on WCWR was dominated by stands of sagebrush/grassland (Artemesia tridentata and A. tripartita and Agropyron

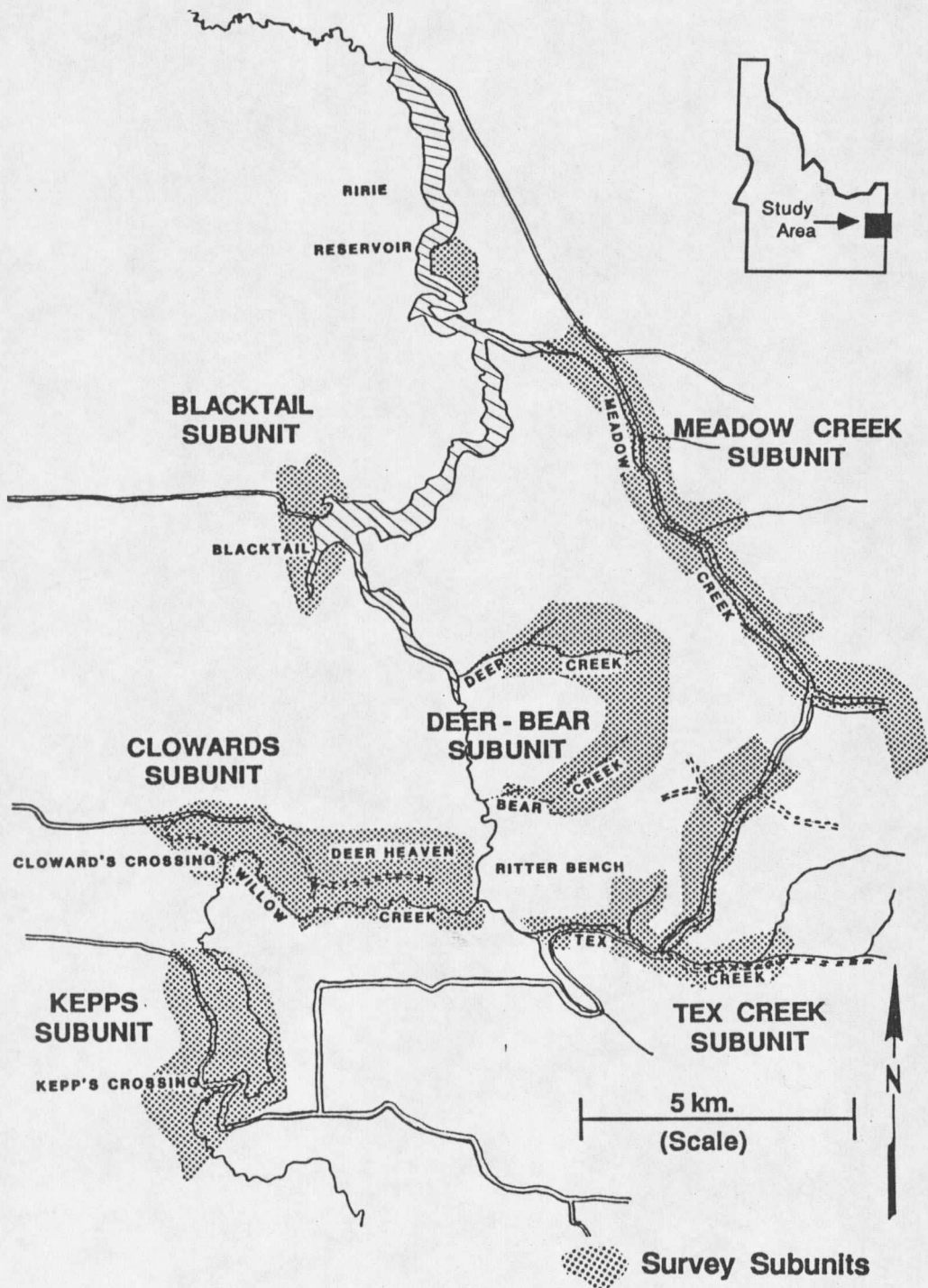


Figure 1. Principal Willow Creek Winter Range.

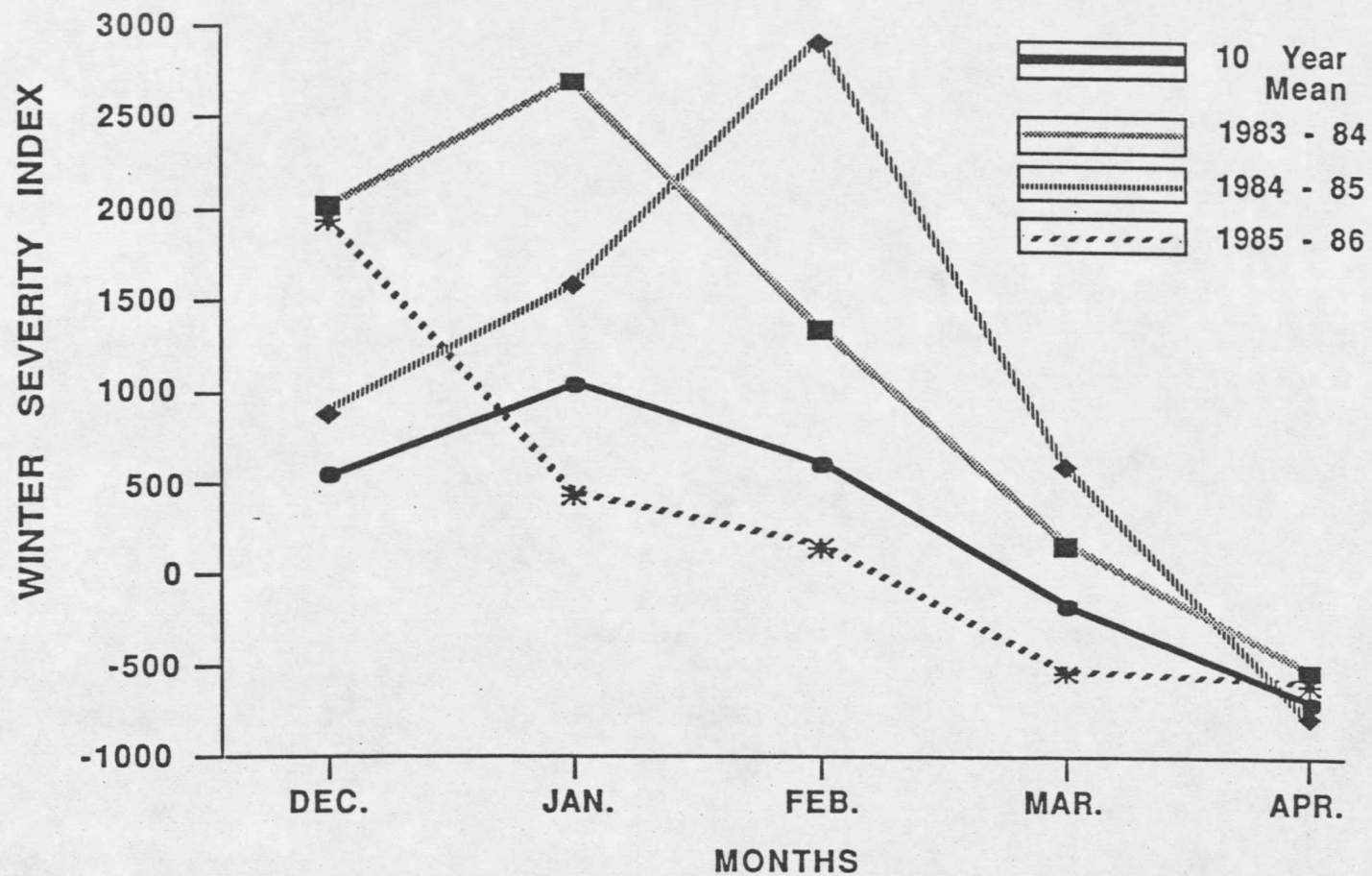


Figure 2. Winter severity indices (Picton and Knight 1971) 1983-86, for Idaho Falls airport, Bonneville County, Idaho.

spicatum, Stipa commata and Poa species). Stands of juniper (Juniperus osteosperma and J. scopulorum) occurred on all exposures but occupied only 3 percent of the area of the WCWR (Appendix Table 24). Aspen (Populus tremuloides) occurred mainly on north and east exposures and other areas where snowdrifts tended to accumulate.

Elk (Cervus elaphus) and moose (Alces alces) were the only other large herbivores on the WCWR during winter. The 2,000 elk tended to use the upper reaches of the winter range but occasionally wandered onto the lower portions, where they remained in high numbers during severe winters. About 50 moose were scattered in deciduous vegetation and riparian zones throughout the WCWR.

The summer range of the Willow Creek deer herd encompassed approximately 5,000 km² south and east of the winter range (Figure 3). It extended from the Bonneville County line on the north to Stump Creek and the Blackfoot River on the south and from the foothills east of Idaho Falls on the west to the Snake River Mountains and Salt River Mountains on the east. The Willow Creek summer range overlapped summer range of deer from the Wolverine winter range in the southern portion of the area.

Summer range elevations varied from 1,550 m to 2,988 m with an overall mean of 2,009 m. The western portion of the summer range was primarily rolling terrain bisected by the deep canyons of Willow Creek and Gray's Lake Outlet. The mean elevation was 1,953 m. Sagebrush and aspen stands were intermixed with agricultural lands, primarily winter wheat and pasture. The eastern portion of the summer range was mountainous with the exception of the Snake River and Lane Creek valleys and had a mean elevation of 2,065 m. The eastern region had substantially more area in forested cover types than the western region (Appendix Table 25), and the terrain was more complex (Table 1). Habitat types and community types present on the National Forest lands in the eastern region are presented in Appendix Table 21.

The WCWR encompassed approximately 15,500 ha in a mosaic of ownership. Cultivated lands were largely privately owned. State and federal lands accounted for 10,800 ha including most of the canyon complexes, eastern limits of the winter range and transition range.

The western portion of the summer range was largely privately owned but state managed lands accounted for 19 percent and Bureau of Land Management (BLM) controlled lands accounted for 2 percent. Approximately 90 percent of the eastern portion of the summer range was controlled

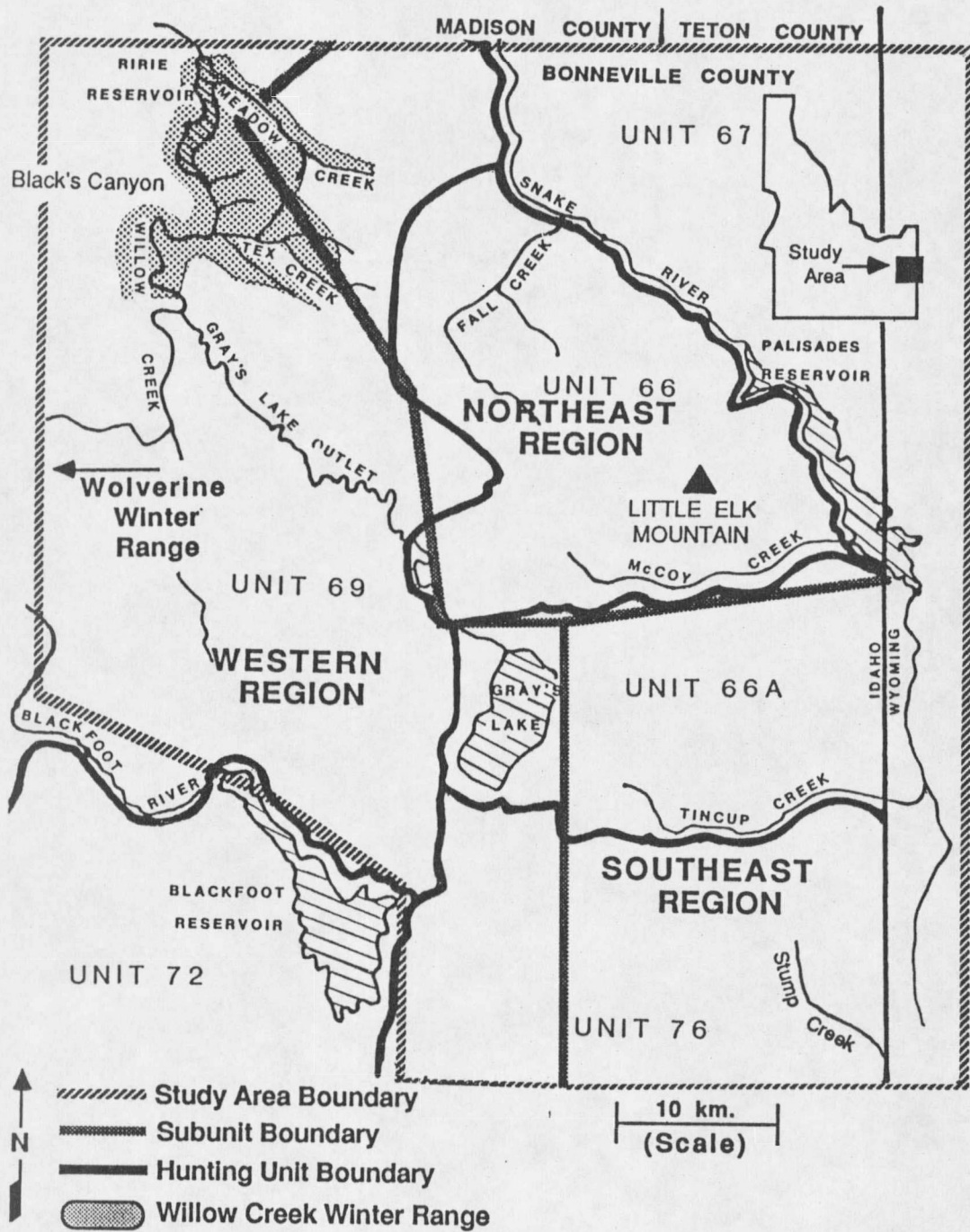


Figure 3. Willow Creek study area and subunits.

Table 1. Comparison of topographical variables of Willow Creek study area regions indicating the lower complexity of the western region (W=western, SE=southeastern and NE=northeastern regions).

Region	$\bar{X}$ Elev. ² (m)	$\bar{X}$ Slope (Percent)	Percent Forest	Percent Flatland ¹	Improved/ Road/km ²	Unimproved/ Road/km ²	Intermittent/ Streams/km ²	Permanent/ Streams/km ²
W n=36 ³	1939	13	10	41	0.4	0.3	0.5	0.5
SE n=30	2081	30	57	8	0.1	0.2	0.4	0.7
NE n=34	2081	42	68	15	0.2	0.2	0.8	0.5

¹ Less than 6 percent slope.

² Elev.=Elevation.

³ n=number of 4 km² areas analyzed.

by the United States Forest Service (USFS). The remainder, primarily bottomlands, was largely in private ownership.

The dominant land uses on the WCWR were agriculture and deer and elk winter range. Cultivated fields were in an alternate year summer fallow rotation. Approximately 50 percent of the winter/transition range was under the management of the Idaho Department of Fish and Game (IDFG) Tex Creek Wildlife Management Area (TCWMA). Management practices included return of previously tilled lands to permanent forb cover, hay production and hunting season/winter vehicle closures.

Land use on the Willow Creek study area summer range was principally agriculture. Cultivated lands extended throughout the western region but were generally restricted to valleys and plateaus adjacent to the Snake River in the eastern regions. Grazing occurred on all portions of the study area. Large bands of sheep used National Forest lands, while cattle were predominant on private and state lands. Other land uses included Grays Lake Wildlife Refuge, surface mining and a small amount of logging.

METHODS

Deer Trapping

Eighty-eight mule deer were captured in five areas on the winter range (Figure 1) between December, 1983 and March, 1986; 66 were captured on the Wolverine Winter Range in March 1985. Eighty-six were captured using a helicopter and collapsable drivenets (Beasom et al. 1980), 66 by drop-net (Ramsey 1968) and 2 by clover trap (Clover 1954). Thirty of these deer were fitted with radio collars (Telonics Inc., Mesa, AZ), 51 with urethane marking collars (Ritchey Manufacturing, Brighton, CO) and 15 with standard colored livestock eartags. All were eartagged with numbered metal tags.

Distribution and Movements

Radiocollared deer were relocated at approximately 10-14 day intervals during most of the study. More intensive monitoring occurred during Spring 1985 (7 day intervals) and during the hunting seasons of 1985 and 1986 (3-4 day intervals). Relocations employed a Maule fixed-wing aircraft equipped with 2 "H" and 1 3-element yagi antennas. Individual deer locations were recorded

to 0.01 minutes of latitude and longitude using Loran C navigational receivers interfaced to an onboard custom computer (Fred Reed, Western Air Research, Driggs, ID). Coordinates were plotted on 7.5 minute (7.5') United States Geological Survey (USGS) topographical maps. Small scale corrections were made as necessary when the pilot's description of the sighting did not agree with the Loran location.

Home range and movement analyses employed the computer program TELNEW (Lonner and Burkhalter 1986). The minimum convex polygon method (Mohr 1947) was used to calculate seasonal home ranges. Areas of highest use were identified by calculating home range size after eliminating 10 percent of the relocations furthest from the GAC (Harestad 1981) and was referred to as 90 percent home range.

Thirty-seven night relocations were made on selected deer in autumn to monitor nocturnal movements. All relocations were made using the fixed-wing aircraft and Loran navigational system and occurred on nights of full or near full moon and between 2030 and 0100 hours.

Migration routes were plotted using relocations of radiocollared deer during spring and autumn migrations. Direct line (summer GAC to winter GAC) and minimum actual movement distances (summed distance between all migration

relocations) were calculated and compared. The migration period for individual radiomarked animals was defined as the first relocation greater than 3 km off a seasonal home range (without a return movement) until the first relocation on the alternate seasonal home range.

Winter distribution was based on radio relocations, ground surveys, 4 fixed-wing aircraft surveys and 3 helicopter surveys. Interchange between winter range subunits by radiomarked deer was determined by measuring the minimum distance between home range polygons.

Habitat Availability on the Summer Range

Availability of vegetative cover types on the summer range was determined using 300 35 millimeter (mm) color slides. These were taken every 2.5' longitude and 2.5' latitude from an altitude of 4,880 m and provided coverage of 620 km² (approximately 10 percent of the study area). Proportions of cover types in each slide were calculated by projection on a dot grid containing 80 randomly selected points. Summed results of counts on all slides were considered to be an index to the proportion of various cover types in the study area.

Topographical availability was sampled on 7.5' maps using 100 points randomly selected from the 300 photo

points. A 4 km² area was sampled at each selected map point for aspect (80 points/4 km²) and elevation (40 points/4 km²). The number of permanent and intermittent streams and the number of major and minor roads were noted and lengths were estimated.

Habitat Use on the Summer Range

Habitat use on the summer range was based on aerial relocations of radiocollared deer. Each relocation site was categorized (inflight and by map analysis) by terrain (elevation, aspect and slope) and cover type (conifer, aspen, open, riparian and agricultural) and documented with a 35 mm color slide. Slides were projected on an 80-dot grid and used to determine proportions of cover types in the vicinity (100-500 m depending on aircraft altitude when photo was taken) of the relocation.

Each relocation was plotted on a 7.5' USGS map. Exposure, slope, elevation, distance (km) to the nearest road (regardless of status) and distance (km) to the nearest improved road (accessible in fair weather to a passenger car) were identified from the map.

Vegetation on the summer range was surveyed with 94 100-square-meter (100 m²) circular plots using a modification of the technique of Pfister et al. (1977). Plots were described only within the home ranges of

radiomarked deer. I sampled the dominant cover types that appeared in each home range.

Use of abundant plant species by ungulates was recorded while walking a single transect bisecting the home range. Overall utilization was noted by class: no obvious use, less than 10 percent, 10-50 percent, 50-75 percent and 75-100 percent of the standing crop.

Habitat Availability on the Winter Range

Cover type availability was determined using United States Agricultural Stabilization and Conservation Service (ASCS) black and white aerial photographs at a scale of 1/660. Each subunit was sampled with a dot grid of 80 points/2.57 km². A minimum of 315 points/subunit was sampled.

Topographical availability was determined using 7.5' USGS maps. Each subunit was sampled with 80 points/2.56 km² for elevation and aspect.

Habitat Use on the Winter Range

Habitat use of winter range was assessed using 3 approaches: relocation of radiocollared deer, fixed-wing aerial surveys and ground transects. Radio relocations on WCWR were analyzed using the approach described for summer range.

Six ground survey routes were established in areas where deer had been marked. Survey routes were run 2-5 times from December 1985 to March 1986. At each deer location, group size, sex, age (adult or fawn for antlerless deer and adult or yearling for males based on antler form), cover type, snow depth, activity and time of day were noted.

Deer use of the winter wheat fields on the WCWR canyon rim was observed during 4 fixed-wing aircraft flights in April 1985 and January, February and March, 1986. All 4 flights were flown using the same grid pattern with the aid of the Loran navigational system.

Habitat Selection

Selection for vegetation and aspect by radiocollared deer was determined on all ranges using the method described by Neu et al. (1974). Use of elevation and slope were tested against availability using Student's t-test (Steele and Torrie 1982:95). Preference was defined as greater than expected use and avoidance as less than expected use at $P < 0.05$. Habitat use during the hunting season (first week of October until mid November) was compared with habitat use from time of arrival on the summer range until the beginning of the elk season (approximately the first week of October).

Population Parameters on the Winter Range

Helicopter trend counts were available for 1973-86 (IDFG files, Idaho Falls, ID). Age and sex ratios were determined from 1,887 deer classified during survey route runs. Sex classifications ceased by the end of January; thereafter only adult:fawn ratios were calculated. Age structure of the harvested animals was determined from IDFG harvest records.

RESULTS

Distribution on Summer Range

Radiomarked deer used winter and summer home ranges separated by 11-115 km. Two neckbanded females and 1 male were observed during the summer within 3 km of the principal WCWR boundary. Summer GACs of radiomarked deer and locations of all reports of neckbanded and eartagged animals marked since 1983 are presented in Figure 4. Sixty-six percent of all deer radiomarked on the WCWR summered in Hunting Units (HU) 66A and 76 (Table 2). Range overlap between deer from the Willow Creek and Wolverine winter ranges was limited to the southern portion of HU 69 and HU 76 and possibly HU 66A.

Deer marked on the Clowards subunit and on Ritter Bench (Figure 1) were most closely associated with each other on summer range (Table 3). These deer split into 2 segments, 5 (33 percent) remained in the northern portions of HU 69 and HU 66 (and in Wyoming) and the remaining 10 (66 percent) went into HU 66A and HU 76.

Movements on Summer Range

The mean arrival date on summer home ranges for 1984-86 was May 29 (span May 20-June 14) (Figure 5).

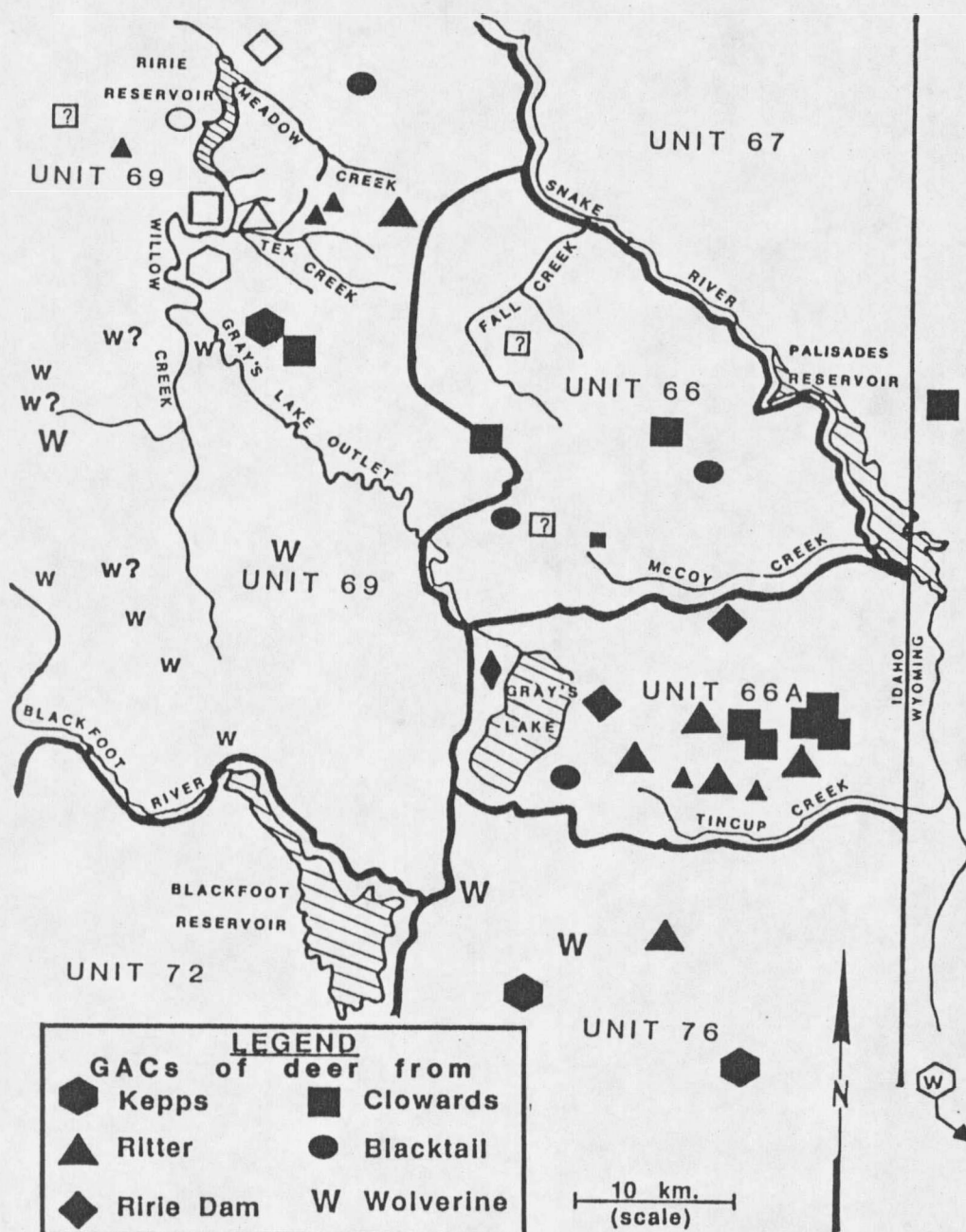


Figure 4. Summer distribution of deer marked on Willow Creek and Wolverine winter ranges, 1983-86. Empty symbols=capture sites, solid symbols=summer home ranges, small symbols=sightings and returns of marking collars, ?=site of capture uncertain (best guess indicated).

Table 2. Summer distribution by hunting unit of all deer radiomarked on Willow Creek and Wolverine Canyon winter ranges, 1983-86.

Winter Range	Summer Unit	Percent	Number of Deer
Willow Creek	66	12.5	3
Willow Creek	66A	50.0	12
Willow Creek	69	16.5	4
Wolverine	69	50.0	2
Willow Creek	76	12.5	3
Wolverine	76	50.0	2
Willow Creek ¹	Wyoming	8.5	2

¹ Both males, one of which now winters in Wolverine

Table 3. Distance (km) between individual GACs on summer range of female deer marked on different subunits on Willow Creek winter range as an indication of degree of association of marked animals on summer range.

Capture Site	Number of Deer	Mean Distance (km)	Range (km)
Kepps	2	23.0	
Clowards	6	17.9 (2.9) ¹	0.5-48.5
Blacktail	3	20.8	13.5-26.0
Ririe Dam	2	12.5	
Ritter Bench	6	26.0 (11.5) ¹	4.3-57.3
<u>Comparison²</u>			
Kepps vs. Clowards		33.8	24.5-67.0
Kepps vs. Blacktail		35.4	15.5-48.0
Kepps vs. Dam		29.2	20.4-35.5
Clowards vs. Blacktail		25.6	15.5-41.5
Clowards vs. Dam		16.9	11.5-39.5
Clowards vs. Ritter		24.6	1.0-54.3
Blacktail vs. Dam		16.1	6.5-21.5

¹ Value when one female is excluded.

² Mean of three equal-sized subsets.

Several females had extended movements during late June which were probably related to fawning.

Males had significantly larger home ranges than females (males mean=8.7 km², females mean=4.8 km², $t=2.90$). However, there were also significant differences among females in different subunits of the summer range (Tables 4 and 5). Females in the western region (Figure 3) had significantly smaller home ranges (or a size difference that approached significance [$p<0.05$]) than females in the northeastern or southeastern regions ($t=4.78$, $t=1.60$). Home range size was not significantly different between years but yearly home ranges were significantly smaller than cumulative (i.e. the total area used over all years) home ranges (Table 5).

Fidelity of radiomarked deer to summer home ranges was high. Only one deer, a male marked as a yearling, established a new home range (defined by no overlapping points between years). He shifted 5.0 km east from an area of dryland farms to a more forested area where the only agricultural use was pasture. The remainder of the deer averaged 0.7 km between successive summer GACs.

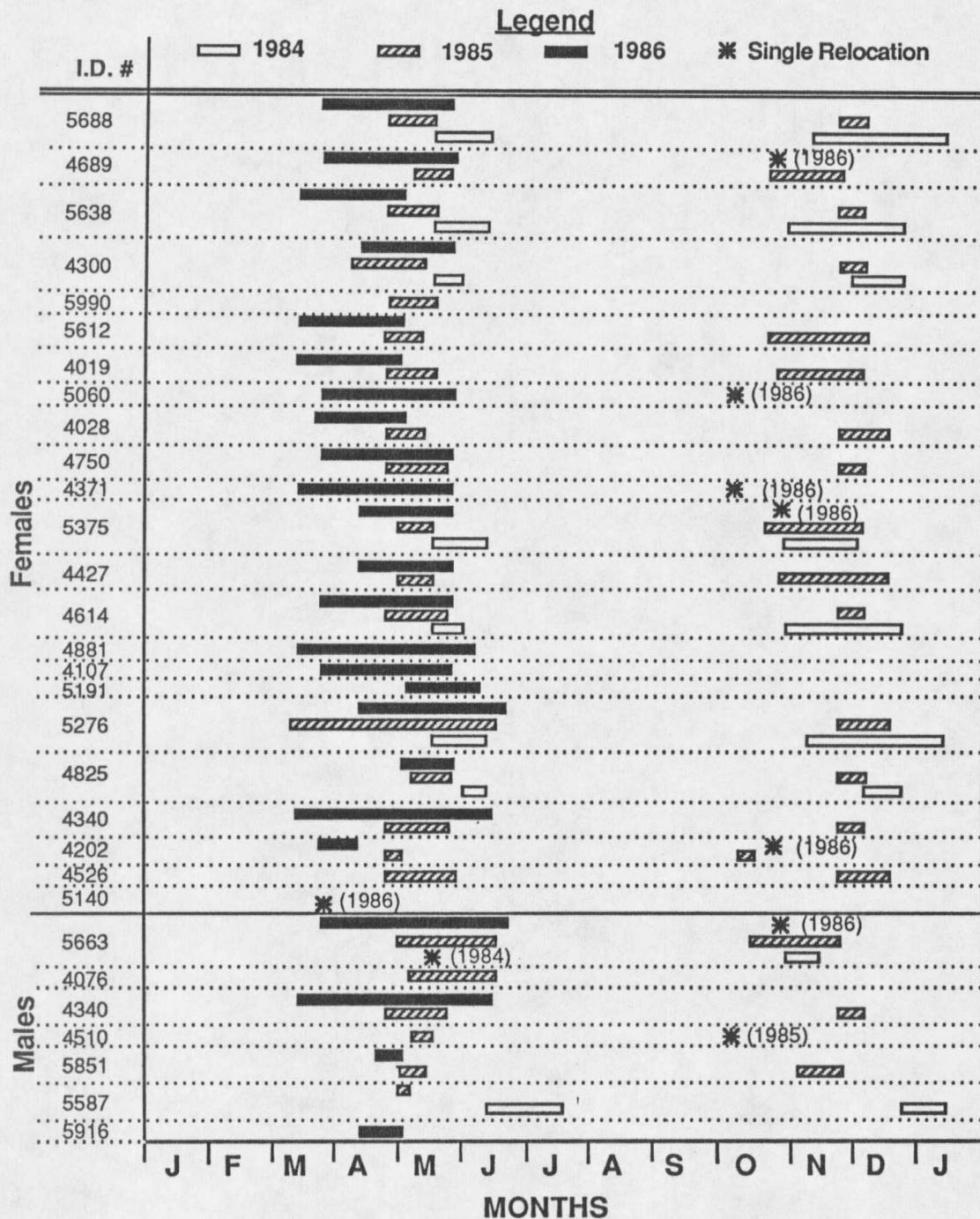


Figure 5. Spring/fall chronology of migration of deer marked on Willow Creek and Wolverine winter ranges, 1984-86. Identification numbers are arranged by distance between winter and summer GACs in ascending order.

Table 4. Minimum convex polygon summer home range size (km²) and 90 percent () (Harestad 1981) home range size for deer marked on Willow Creek and on Wolverine Canyon winter ranges (n=number of relocations.)

ID	Region	1984	n	1985	n	1986	n	Cumulative ²	n
4202 ⁴	W			3.7 (3.2)	19	2.6 (1.6)	19	4.8 (3.6)	38
4427 ^{1,4}	W			5.8 (0.8)	19	1.8 (0.5)	19	12.7 (0.8)	38
4526 ¹	W			7.3 (4.4)	21				
5375 ⁴	W	0.6 (0.6)	10	4.2 (0.6)	19	1.1 (0.6)	19	5.9 (2.0)	48
5638 ⁴	W	0.7 (0.6)	10	1.4 (1.2)	21	2.5 (1.2)	20	3.8 (2.0)	51
Average		0.7 (0.6)		4.5 (2.0)		2.0 (1.0)		6.8 (2.1)	
4019	SE			8.0 (3.9)	17	7.7 (6.2)	18	13.7 (9.0)	37
4028	SE			2.2 (1.3)	21	5.7 (2.4)	18	6.5 (2.8)	39
4107	SE					4.4 (2.5)	18		
4300 ⁴	SE	1.8 (1.4)	14	2.1 (1.6)	23		3	3.2 (2.6)	40
4371	SE					1.7 (1.1)	12		
4614	SE	3.2 (2.1)	11	5.1 (4.2)	20	1.2 (0.8)	19	7.7 (4.8)	50
4689 ¹	SE			7.4 (2.1)	17	4.0 (1.0)	17	9.6 (2.5)	34
4750	SE			3.9 (2.2)	19	2.3 (2.1)	19	5.1 (3.1)	38
4881	SE					2.8 (1.9)	17		
5060 ⁴	SE					1.0 (0.8)	12		
5191	SE					1.2 (1.0)	18		
5612	SE			12.1 (6.0)	17	8.9 (7.4)	19	15.5 (9.9)	36
5688	SE	1.7 (1.7)	11	5.4 (4.3)	19	3.0 (2.9)	18	6.9 (5.2)	48
5990	SE			9.2 (3.2)	19	6.5 (5.5)	16	10.4 (8.7)	35
Average		2.2 (1.7)		6.2 (3.2)		3.9 (2.8)		8.7 (5.4)	
4825 ⁴	NE	9.7 (4.9)	15	9.7 (9.2)	20	9.1 (8.3)	18	18.8 (14.2)	
5140	NE					3.2 (2.4)	21		
5276	NE	14.7 (6.5)	11	7.9 (1.9)	16	9.1 (8.0)	16	22.0 (15.9)	43
Average		12.2 (9.0)		8.8 (7.2)		7.1 (6.2)		20.4 (15.1)	
Males									
4510 ^{1,4}	W			7.8 (5.5)	13				
5916 ⁴	W					4.0 (2.4)	16		
4076	NE			1.7 (1.4)	13				
4340	NE			11.8 (5.9)	19	3.3 (1.9)	16	15.3 (6.2)	35
5587 ^{3,4}	NE	9.8 (4.1)	12	21.4 (5.2)	16				
5851	NE			12.6 (5.5)	24	9.8 (4.2)	19	19.5 (7.1)	43
5663	SE			10.5 (2.3)	10	3.4 (1.8)	11	18.5 (5.3)	21
Average		9.8 (4.1)		11.0 (4.1)		5.1 (2.6)		17.8 (6.2)	

¹ Deer marked on Wolverine Canyon winter range.

² For deer with two or more years of data.

³ Changed home ranges.

⁴ Deer of aspen habitats.

Table 5. Differences in summer minimum convex polygon home range size as indicated by Student's t-test values (n=number of deer in each comparison).

Comparison	t value
1985 vs. 1984 n=7 n=7	-.21
1986 vs. 1985 n=14 n=14	-1.22
1986 vs. cumulative n=14 n=14	-3.24*1
SE vs. W region n=25 n=11	1.60*
NE vs. W region n=7 n=11	4.78*
Males vs. females n=11 n=43	2.90*

1* = significant difference, - = mean of first group is lower than mean of second group.

Data indicated a high degree of home range overlap for 3 marked females that summered in HU 66A. They had an association value (mean distance between simultaneous relocations [Lonner and Burkhalter 1986]) of 1.7 km. Each deer's cumulative 2-year GAC averaged 0.3 km from their common 2-year GAC. Two or all of these deer were relocated several times together on summer range, during migration, and on winter range.

One male and 2 females had split home ranges. One female spent a period early each summer (1984-86) on presumably her fawning area, 6.0 km from her late summer GAC. The other 2 had early/late summer GACs separated by a distance of 5.5 and 6.5 km, respectively.

Factors Influencing Movements on the Summer Range

Long movements were noted for several deer. One male moved 8 km to the Snake River on 12 November 1984, apparently related to rutting activities. However, in late September 1985 he made a similar movement to the same area and stayed for approximately 2 weeks. A female, summering in HU 76 in essentially an island situation, moved 5.5 km east across an agricultural valley to foothills on the other side in August 1985 for one relocation. During the same period in 1986, she moved 4 km to the south for one relocation. A female summering in HU 66A, moved nearly 5 km west near the marshes of Gray's Lake for one relocation on October 8, 1985.

Deer within 2.8 km of agricultural areas had a longer mean nightly movement ($t=1.805$) than deer greater than 3 km from agricultural lands. On at least 5 occasions these movements were into agricultural fields and were more than 1.5 km from a previous or subsequent relocation within a 20-hour period (Table 6).

Livestock grazing appeared to influence the movements of radiomarked deer on 3 occasions, and in one case a female shifted her GAC 5.0 km from open habitat to dense conifers when cattle grazed her early summer range.

Two males shifted activity patterns in an apparent attempt to avoid areas grazed by sheep. Herbaceous vegetation on areas grazed by livestock was utilized 60-100 percent by late summer/early fall.

Table 6. Summer night movements of radiomarked deer from agricultural and mountain habitats (n = number of relocations).

Habitat Class	n	$\bar{X}$ Movement ¹ (km)	Range (km)	Standard Deviation
Agriculture ²	22	0.7	0.2-1.8	0.55
Mountain	15	0.5	0-0.8	0.30

¹ Distance moved between a night relocation and a relocation within 20 hours before or after the night relocation.

² Deer with home ranges within 2.8 km of agricultural fields.

Little logging occurred on the Willow Creek study area. An active logging operation on one female's home range did not discernibly change her home range habits once logging was initiated in 1985 (distance between 1984 GAC and 1985 GAC < 0.7 km).

Three deer made movements greater than 4.0 km during the archery season (late August to late September) and then returned to their pre-archery ranges by late

September. Two of these deer repeated the movements during the general hunting season. Ten deer moved over 2 km from summer core areas at the beginning of elk hunting season in October.

For those deer monitored more than 1 year, movements in October were usually toward winter range and similar in pattern between years. By late October, deer returned to their summer ranges. The mean distance between hunting season and summer range GACs (Table 7) for all radiomarked animals was 1.2 km.

Females in the southeast and northeast regions significantly increased their distance from all roads (Table 8) during hunting season but western region females and the males did not. In the western region, opportunity to move away from roads was frequently limited because of higher road densities.

Habitat Use on Summer Range

A cover type-area curve (Oosting 1956), constructed for the least common cover type discernible on 35-mm slides, indicated that a sample size of 65 slides would be sufficient to delineate availability of cover types. This allowed partitioning of the summer range into 3

Table 7. Distance (km) and bearing (degrees) between summer/hunt GACs for deer marked on Willow Creek and Wolverine winter ranges.

ID	Region	1984		1985		1986	
		Distance	Bearing	Distance	Bearing	Distance	Bearing
4202	W					0.6	205
4427	W			0.7	310	0.2	0
4526	W			2.4	50		
5375	W	0.4	270	0.8	280	0.1	10
5638	W	0.5	290	0.4	140	0.2	280
Average		0.5		1.1		0.3	
4019	SE			3.0	270	2.4	305
4028	SE			0.4	315	0.6	260
4107	SE					0.2	0
4300	SE	0.2	355	0.6	220		
4614	SE	2.5	225	1.8	200	0.3	170
4689	SE			3.7	320	1.4	305
4750	SE			0.9	355	1.4	340
4881	SE					0.6	23
5191	SE					0.5	158
5612	SE			3.5	280	2.7	280
5688	SE	0.5	70	0.6	270	0.5	250
5990	SE			1.3	130	1.4	130
Average		1.1		1.8		1.1	
4825	NE	2.8	40	2.2	0	3.0	0
5140	NE					0.6	13
5276	NE	1.0	220	1.0	250	1.5	320
Average		1.4		1.7		1.2	
5916	Male W					0.4	352
4340	Male NE			2.1	330	0.8	0
5587	Male NE	1.4	240				
5851	Male NE			0.4	335	1.5	110
5663	Male SE			0.6	300	0.6	260
Average				1.0		0.8	

Table 8. Differences between observed deer use during summer and hunting season and availability for 3 topographical variables as indicated by Student's t-test¹ values.

Region	Difference-Summer and Hunt Distance to Major Road	Summer		Hunt ²	
		Elevation (m)	Slope (Percent)	Elevation (m)	Slope (Percent)
Western	-2.18 * ³	5.00 *	3.35 *	1.39	-3.17 *
Southeast	7.00 *	-2.29 *	-2.83 *	13.90 *	0.60
Northeast	2.50 *	1.10	-2.29 *	3.40 *	0.27
Males	-0.87	7.40 *	0.76	-1.27	2.18 *

¹ *= significant difference.

² Comparison between summer use and hunt use.

³ -=mean of use is lower than that of available.

regions, each having a minimum of 65 availability slides. Availability was calculated independently for sets of deer within each region.

Radiomarked deer were relocated at all times of the day (Figure 6) and generally preferred forested cover types (Table 9). Night relocations indicated that use of open and/or agricultural cover types may have been underestimated, especially for deer using aspen cover types. Deer in the western region selected closed aspen cover types in greater proportions than available but deer in the southeastern region selected open conifer types. Four of 7 males selected closed conifer cover types while 3 selected closed aspen types.

Most females preferred north and northeast aspects (Table 10). The limited number of females in the northeast region preferred southwest and west aspects.

Females in the western region avoided the flat lowlands prevalent in that region (Tables 8 and 10). Females in the northeast and southeast regions either selected lower elevation and gentler slope than the average available or used these features in proportion to availability. Males selected significantly higher elevations.

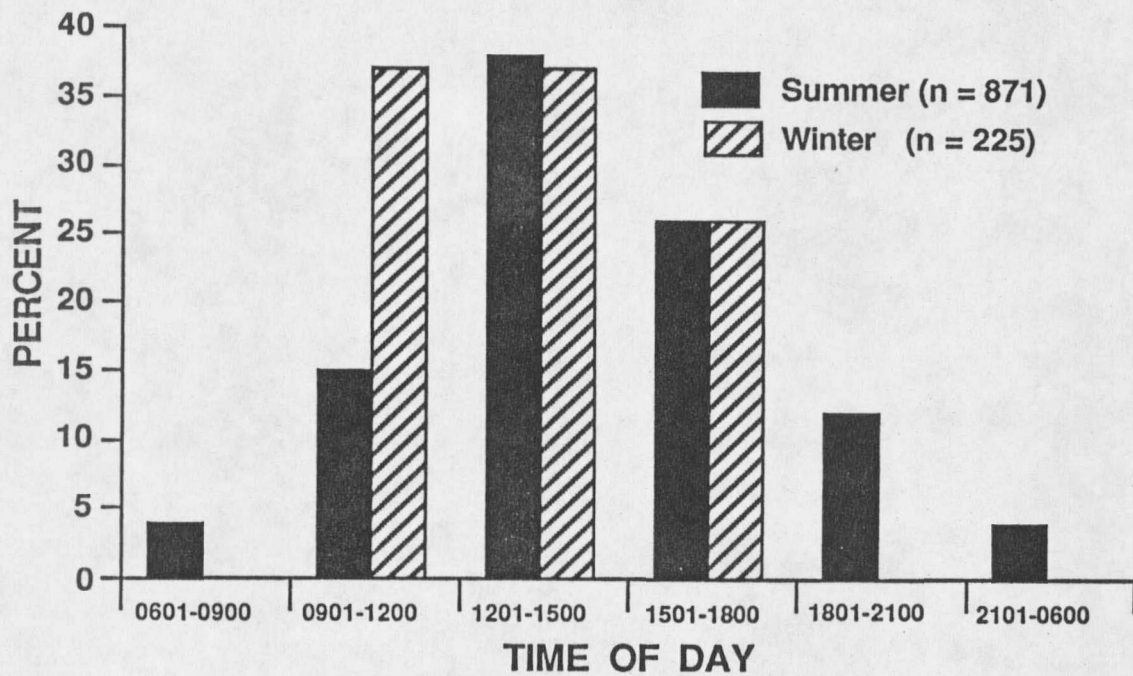


Figure 6. Distribution of relocations of mule deer by time for summer and winter ranges on the Willow Creek study area, 1984-86.

Table 9. Chi-square analysis¹ of observed deer use versus (vs.) availability for cover types on Willow Creek study area summer range.

Region/ID Number	Closed Conifer	Open Conifer	Closed Aspen	Open Aspen	Open ²	Agri.	Riparian	Other
<u>W</u>								
4202	N	N	+	+	-	-	N	N
4427 ³	N	-	+	0	-	N	0	N
4526 ³	+	+	+	N	-	N	N	N
5375	N	N	+	N	-	-	N	N
5638	N	N	+	+	-	-	N	N
<u>SE</u>								
4019	+	+	N	+	-	-	N	N
4028	+	+	-	+	-	N	N	+
4300	-	+	+	N	-	N	-	N
4614	-	+	+	-	+	N	N	N
4689 ³	+	+	N	+	-	N	N	N
4750	+	+	-	+	-	N	N	+
5612	+	+	N	N	-	-	N	N
5688	+	+	N	+	-	-	N	+
5990	+	+	-	N	-	N	N	+
<u>NE</u>								
4825	-	N	+	+	-	N	N	N
5276	+	-	-	N	+	+	N	N
<u>Males</u>								
4076, NE	+	N	N	N	N	+	N	N
4340, NE	N	+	-	N	-	N	N	N
4510, W	+	N	+	N	-	N	N	N
5587, NE	-	N	+	N	-	N	-	N
5663, SE	+	+	-	N	-	N	N	N
5851, NE	+	N	N	+	N	-	N	N

¹ +/- = significant positive /negative occurrence.

N = no significant difference from expected.

² Mountain brush, sagebrush and grass cover types combined.

³ Deer marked on Wolverine winter range.

Habitat Use During the Hunting Season

There was no apparent overall difference in use of cover types use between summer and hunting season (1984 and 1985 hunting seasons combined) (Figure 7). Use of north and northwest aspects by deer increased during hunting season (Figure 8).

Table 10. Chi-square analysis¹ of observed female deer use versus availability for aspect on summer range.

<u>Region</u>	<u>Aspect</u>									
	<u>N</u>	<u>NE</u>	<u>E</u>	<u>SE</u>	<u>S</u>	<u>SW</u>	<u>W</u>	<u>NW</u>	<u>Ridge</u>	<u>Flat</u>
W	+	N	-	N ²	-	N	N	N	N ²	-
SE	N	+	-	N	N ²	+	-	N ²	N ²	-
NE	-	-	N	-	N	+	+	N		-

¹ +/- = significant positive/negative occurrence.

N = no significant difference from expected.

² Data pooled within the region for analysis.

Mean elevation of relocations significantly increased during hunting season in the southeastern and northeastern regions (Table 8). There was no significant increase in elevations used by females in the western region but this was expected because they were already using elevations significantly higher than the average available elevation in the region. Males used lower than average elevations at this time but differences were not significant.

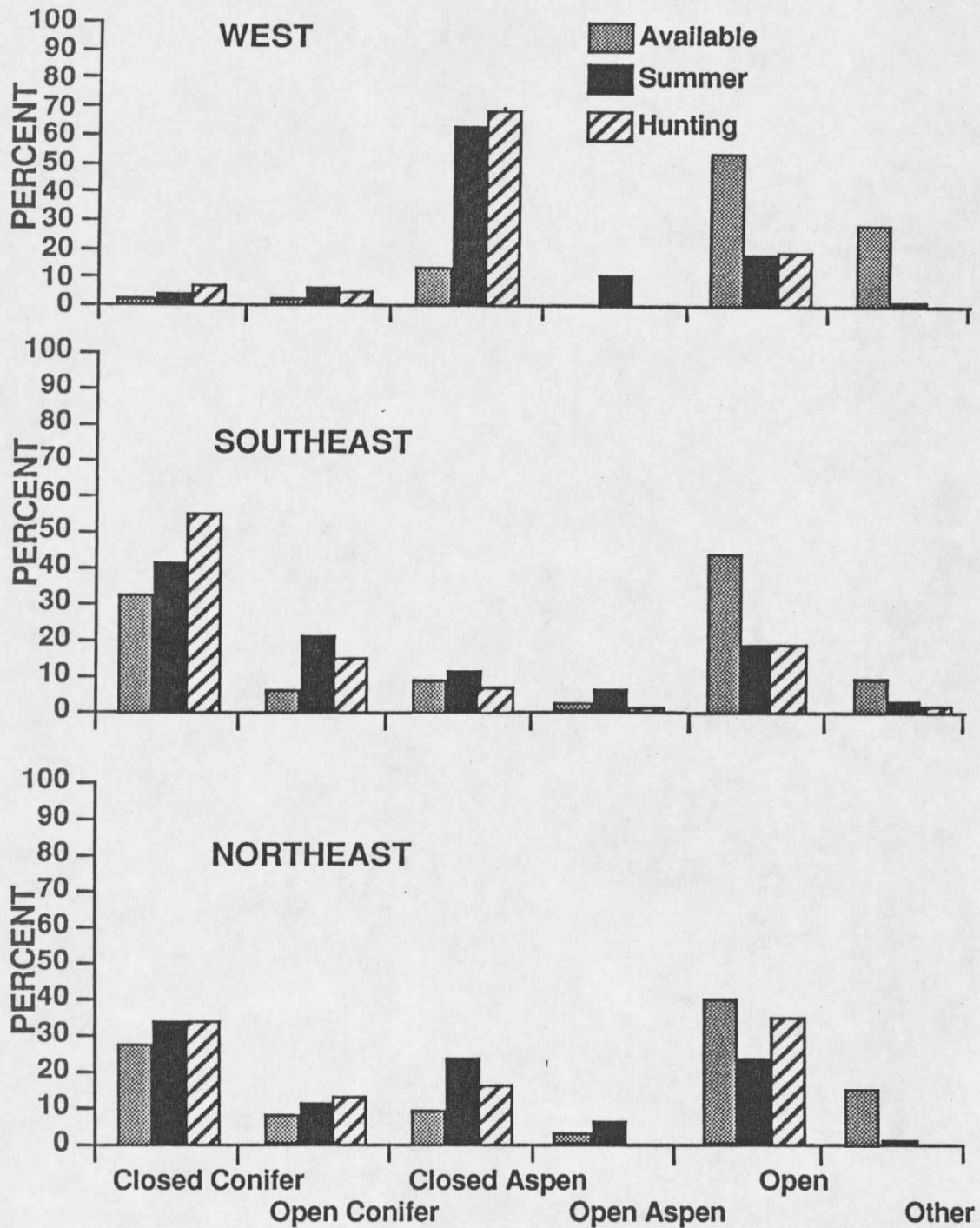


Figure 7. Changes in use of cover type by female deer between summer and hunting season.

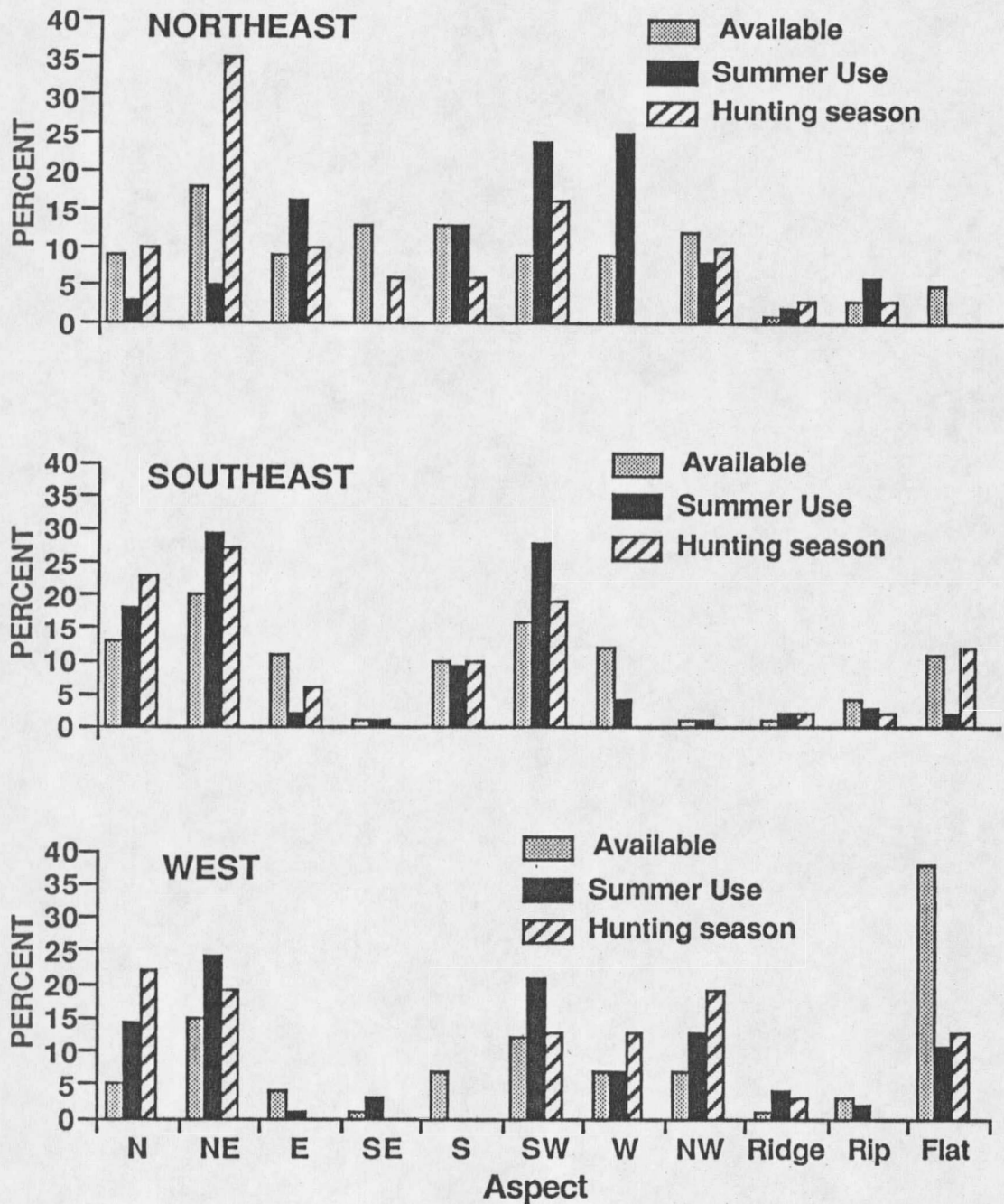


Figure 8. Comparison of changes in use of aspect by female deer between summer and hunting season.

Migration

Discussion of migration corridors is confined to those areas where topographical features confined deer to a relatively narrow passageway. Migration corridors (Figure 9) were defined from a total of 112 radio relocations (83 spring, 29 autumn) and 13 sightings of marked deer. Corridors were broad but followed major topographic features oriented directly toward the summer ranges. Deer used routes similar to those used by elk wintering on WCWR (Trent, pers. comm.). radiomarked deer consistently used the same migration corridors. Deer in the Kepps area followed Willow Creek upstream to Gray's Lake Outlet (GLO) and then followed GLO to Pine Mountain. Deer on the west side of Willow Creek from the Clowards and Blacktail subunits (Figure 1) crossed Willow Creek between Bear Creek and Tex Creek and, with deer from the east side of Willow Creek north of Clowards, used Tex Creek and its tributaries to reach the pass between Tex Creek and Fall Creek (elevation 2195 m). They continued southeast down Fall Creek and the South Fork of Fall Creek (Figure 9). One female wintering in Meadow Creek (Figure 1) consistently crossed the Tex Creek corridor and entered into the GLO corridor. Other females with adjacent summer home ranges used the

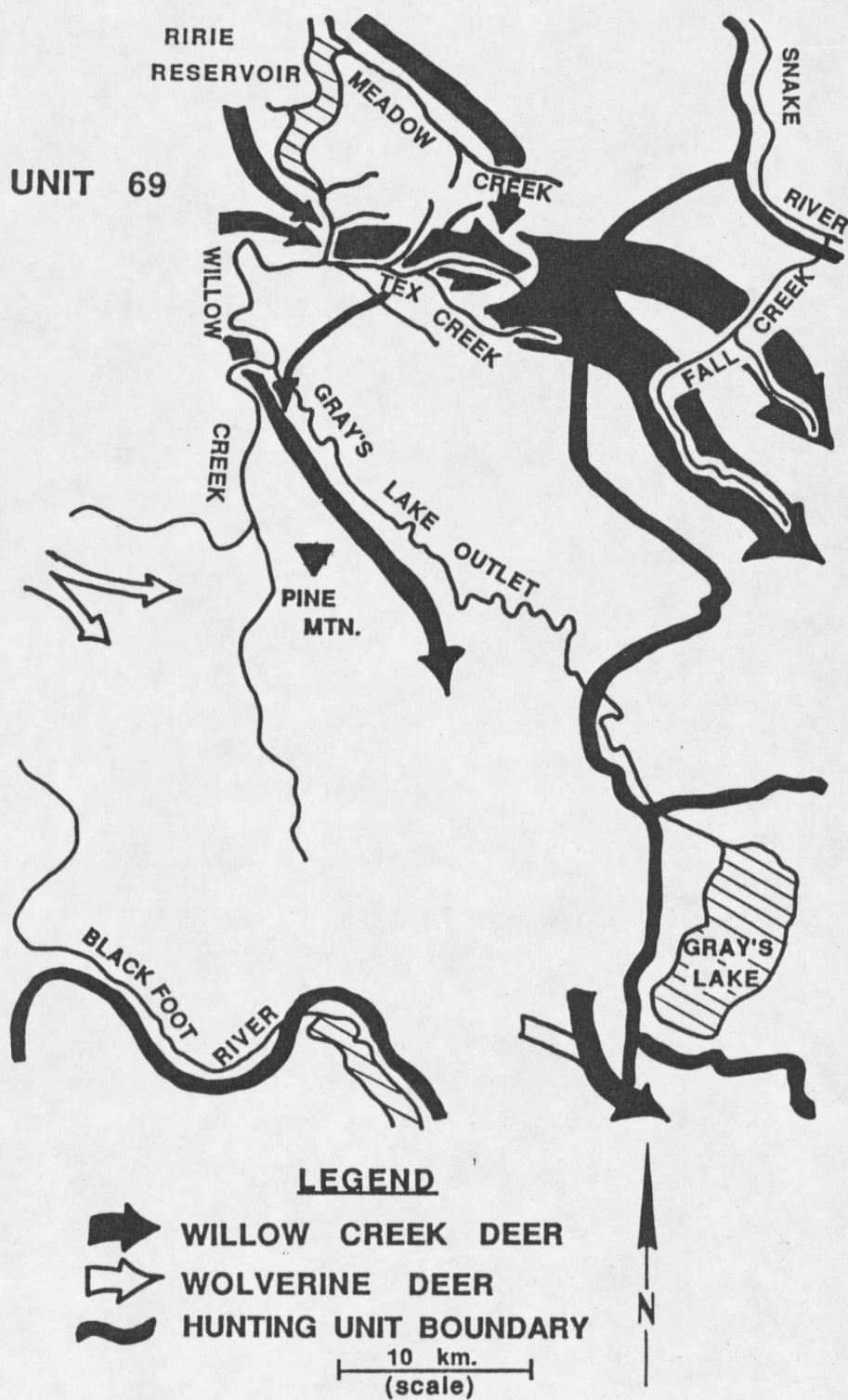


Figure 9. Migration corridors of deer marked on Willow Creek and Wolverine winter ranges.

Tex Creek-Fall Creek corridor. The 10-km wide area between the southwest corner of Gray's Lake and Blackfoot Reservoir was the apparent entryway into HU 76 for deer from WC and the Wolverine winter range using the GLO corridor.

Initiation of spring migration to summer home ranges varied among years and deer (Figure 5). Late winter-spring weather appeared to be the controlling factor. In 1984, a severe winter (Figure 2) lasted well into spring and the mean date on which radiomarked deer left the winter range was May 22. In 1985, a moderate winter (Figure 2), the mean date was April 22 and 82 percent (18) of radiomarked animals had begun migration by April 30. The winter of 1985-86 was mild with spring conditions prevailing by late February; the mean date for leaving the winter range was March 29 and 91 percent (21) of the radiomarked deer were migrating by April 11.

Migration in the spring of 1986 covered a longer time span than in 1984 and 1985 ($t=3.40$, $t=4.17$). Although radioed deer left the winter range significantly earlier in 1986 than 1985 ($t=-6.00$) the mean dates of arrival on the summer range were not different ($t=-0.20$). Deer with greater than 60 km between seasonal GACs did not leave the winter range significantly earlier ($t=-0.80$) than deer with less than 40 km between seasonal GACs.

At least 1 and possibly 4 transition spring ranges occurred along the Tex Creek-Fall Creek corridor. The most prominent of these extended from Cove Creek and upper Tex Creek north to Indian Fork (Figure 10). This area received a minimum of 120 deer-days use by radiomarked animals during 3 spring migration periods (combined). Other probable transition ranges included Porcupine Creek, Gibson Creek-Fall Creek confluence and the head of the South Fork of Fall Creek.

A single transitional range north of Pine Mountain (Figure 10) was identified for the GLO corridor. This area marked the end of a definable corridor because after holding here for a short period, deer apparently moved rapidly to the south end of Gray's Lake. Only 3 relocations (1 spring, 2 fall) were made in this 37-km distance during the study.

Areas identified as spring transition ranges were also used as transition ranges during fall. Deer remained on these ranges until as late as December 8 before moving onto winter home ranges.

With 4 exceptions, fall migration of radiomarked deer began after the opening of deer seasons in all years. The mean dates for the first relocation off summer home ranges (not followed by a detected subsequent return) for 1984 and 1985 were November 18 and November 11,

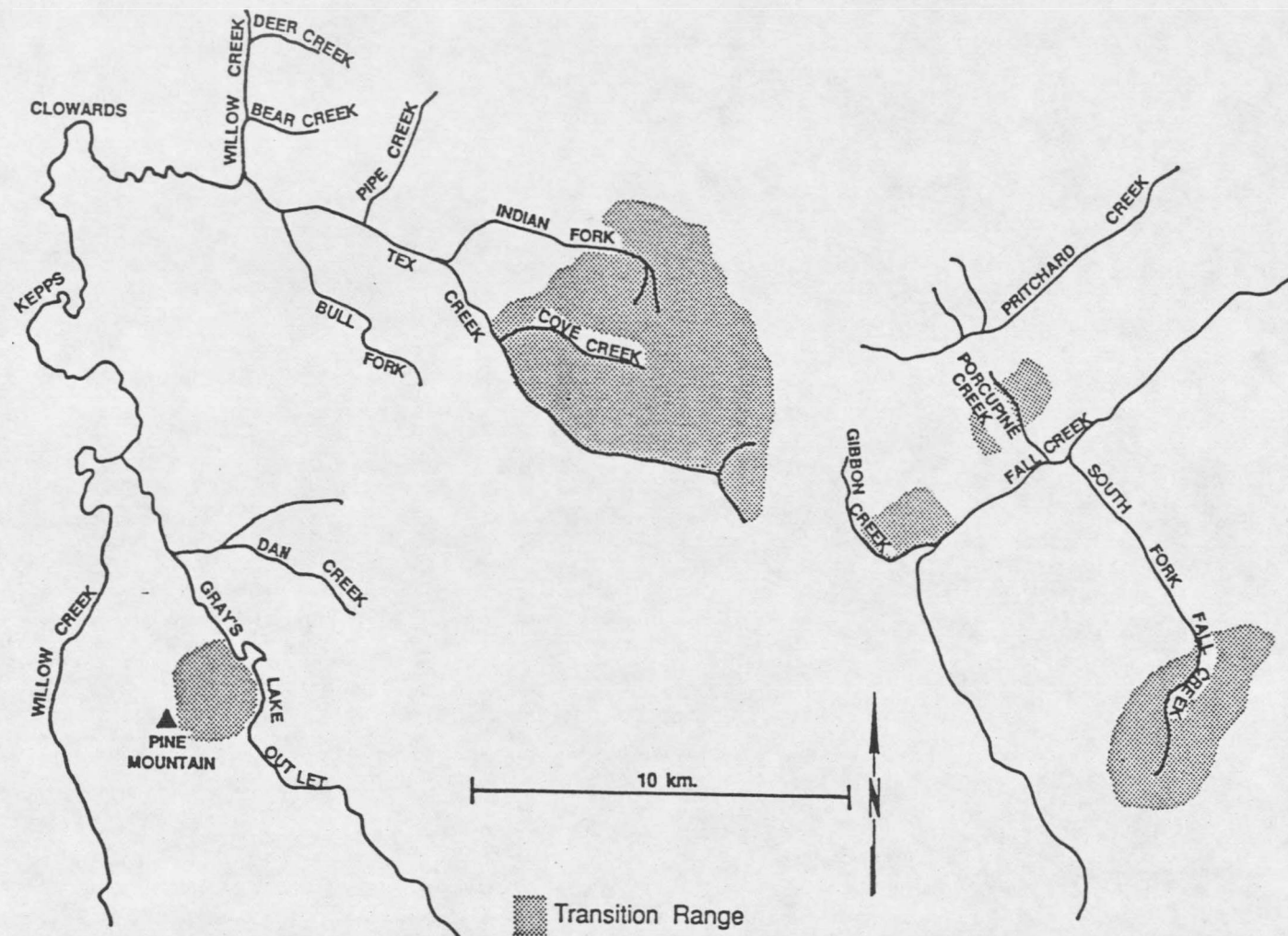


Figure 10. Transition ranges and potential transition ranges identified for Willow Creek deer.

respectively. The 1985 date may be somewhat later than the actual because poor flying conditions made it impossible to monitor deer during most of November. By November 26, 1985, all deer had begun migration. Relocation flights ceased after October 31, 1986, but at that time 7 deer (31 percent) were migrating.

The reason for the initiation of fall migration was unclear but was not entirely related to snow conditions. In 1984, a major storm left 30 cm of snow (Dreweir, pers. comm.) yet it was at least two weeks before the first radiomarked deer left her summer range and two females stayed until mid December. Two winter storms occurred in October 1985; one during the first week, the other in the third week. Neither storm left over 7 cm of snow but each was followed by a protracted period of cold temperatures. One male began migration immediately following the first storm and a female migrated after conditions had moderated.

In 1985, 11 (58 percent) of 19 radiomarked deer remained on summer ranges after October 27. In 1986, 7 (32 percent) of 22 radiomarked deer were migrating on October 31 despite the fact that weather was exceptionally mild and marked with only 1 brief storm. A prolonged period of inclement weather in November 1985 probably was why all deer were migrating by November 26.

Deer moving more than 60 km between seasonal GACs did not vacate summer ranges significantly earlier than deer with less than 40 km between seasonal GACs ($t=-.573$).

In only 6 cases (1 male, 5 females) did deer effectively shorten vulnerability to harvest by migrating into HU 69 (10-day season). Only 2 of these cases (same deer, different years) occurred in the Tex Creek-Fall Creek corridor. Other deer in migration at this time remained in 26-day season HUs (66, 66A and 76) until late November.

Mean dates for arrival of radiomarked deer on winter home ranges for 1984 and 1985 were December 27 and December 5, respectively. The mean date for 1985 was not significantly earlier than 1984 ($t=-1.30$).

Habitat use during migration was similar in spring and fall, therefore, the seasons were combined. Of 112 relocations within migration corridor boundaries, only 4.5 percent (5) were on ridges or in creek bottoms. The remainder were nearly evenly distributed between the upper third (31.3 percent), the middle third (28.6 percent) and the lower third (34.8 percent) of slopes. Deer selected elevations significantly lower (Tex Creek-Fall Creek $t=-7.10$, GLO $t=-5.04$) than available.

Deer in the Tex Creek-Fall Creek corridor selected south and west aspects (Table 11) but limited data suggested that deer in the GLO corridor preferred east aspects.

In both corridors, deer selected open cover types; in Tex Creek-Fall Creek, deer also selected open aspen. Agricultural cover types were used less than their proportionate availability during spring and fall migration (Table 11).

Winter Range

Movements on Winter Range

Only 2 deer, a male marked as a yearling and a female marked as an adult, changed winter ranges during the study. Excluding 1 male with an exceptionally large home range, minimum convex polygon winter home ranges averaged 1.9 km^2 (standard deviation $[s]=1.26$) for 1985-86 and 2.9 km^2 ($s=2.24$) cumulative (Table 12). The mean home range size for 1985-86 was significantly smaller than the cumulative ($t=-2.88$).

Fidelity to specific winter home ranges was high during the study with almost no mixing of radiomarked deer in different subunits. The average minimum distance between minimum convex polygon perimeters of deer in different subunits was 7.8 km (0.0-13.1 km) (Table 13).

Table 11. Chi-square analysis¹ of observed deer use vs. available for cover type and aspect in migration corridors (n= number of relocations).

<u>Corridor</u>	<u>Closed Conifer</u>	<u>Open Conifer</u>	<u>Closed Aspen</u>	<u>Open Aspen</u>	<u>Open²</u>	<u>RIP³</u>	<u>Agri.</u>	<u>Other</u>
Tex/Fall Creek n=37	-	N	N	+	+	-	-	-
GLO n=10	-	-	N	-	+	N	-	N

	<u>Aspect</u>								<u>No Aspect</u>
	<u>N</u>	<u>NE</u>	<u>E</u>	<u>SE</u>	<u>S</u>	<u>SW</u>	<u>W</u>	<u>NW</u>	
Tex/Fall Creek n=90	N	N	-	N	+	N	+	-	N

¹ +/- = Significant positive/negative occurrence.

N = no significant difference from expected.

² Includes mountain brush, sagebrush, mountain brush/sagebrush, and grass cover types.

³ RIP=Riparian.

Table 12. Minimum convex polygon home range sizes (km²) for Willow Creek winter range (n=number of relocations).

Frequency (ID)	n	Minimum Polygon (km ²) 1985-1986	n	Minimum Polygon (km ²) 1983-1986
4019	11	0.9	14	2.0
4028	13	1.1	16	1.4
4076			6	0.3
4202	18	2.3	22	3.5
4300	12	4.9	16	8.0
4340	14	2.2	16	2.3
4614	10	0.8	15	1.4
4750	15	1.1	18	1.2
4825	15	3.5	23	5.6
5276	14	0.9	16	1.3
5375	15	2.2	21	2.5
5587			5	6.8
5612	11	0.5	14	1.4
5638	9	1.8	13	2.4
5688	11	2.0	14	3.4
5851	12	15.9	16	16.1
		$\bar{X}=1.8$		2.8

¹ Females only.

Table 13. Minimum distance (km) between home range perimeters of radiomarked deer with home ranges in different subunits on willow Creek winter range.

Area	Mean (km)	Range (km)	
Kepps-Clowards	4.2	3.1	6.8
Kepps-Blacktail	9.8	8.0	11.2
Kepps-Dam	14.6	13.6	15.2
Kepps-Ritter	6.4	4.7	7.9
Clowards-Blacktail	6.2	4.7	7.9
	(4.9) ¹	(0)	(7.2)
Clowards-Dam	10.4	11.0	11.9
Clowards-Ritter	6.5	5.0	7.9
	(6.0)	(2.7)	(7.4)
Blacktail-Dam	5.3	3.6	6.4
Blacktail-Ritter	8.7	6.0	10.3

¹ () = value when Deer 5851 is included in the sample.

Although radiomarked deer did not shift between subunits (except 1 male whose home range included Blacktail and Clowards subunits), deer neckbanded in the Clowards area were observed during winter 1985-86 in Blacktail, Tex Creek, opposite from the mouth of Bear Creek, on Ritter Bench and on the south rim opposite Kepps as well as in the Clowards area. However, these deer did not abandon the Clowards subunit as winter range. With 1 exception, all marked deer seen elsewhere were observed in the Clowards area at least once.

Habitat Use on Winter Range

Deer showed a general preference for juniper cover types in early winter (December through January) and for agricultural and aspen cover types in late winter (February through March). There was a general selection against north to east aspects and for south to west aspects in early winter and selection for south aspects and plateau tops in late winter (Table 14). Elevations used were lower than the average available in 3 subunits, higher than the mean in 2 subunits in early winter, and not different from means during late winter (Table 15).

In the Clowards subunit, TCWMA fields planted to permanent cover (primarily alfalfa [Medicago sativa]) with an oat (Avena sativa) cover crop in the summer of

Table 14. Chi-square analysis ¹ of observed deer use vs. availability for cover type and aspect on 6 subunits of Willow Creek winter range.

Subunit	Scattered Juniper	Open Juniper	Closed Juniper	Open	Permanent Planting	Agri.	Rip.	Aspen		
<u>Kepps</u>										
Early	+	N	+	N		N	-	N		
Late	-	N	+	-		+	-	N		
<u>Clowards</u>										
Early	+	N	+	N	+	-	N	N		
Late	+	-	-	-	-	+	-	-		
<u>Blacktail</u>										
Early	N	+	+	N		-	N	N		
Late	N	N	N	N		-	N	+		
<u>Meadow Creek</u>										
Early	N	N	-	+		N	N	-		
<u>Deer-Bear</u>										
Early	N	N	-	+	-	-	N	N		
<u>Tex Creek</u>										
Early	-	-	+	+	-	-	+	-		
	<u>N</u>	<u>NE</u>	<u>E</u>	<u>SE</u>	<u>S</u>	<u>SW</u>	<u>W</u>	<u>NW</u>	<u>Top</u>	<u>Flats</u>
<u>Kepps</u>										
Early	-	-	N	+	N	-	+	N	N	
Late	-	-	N	N	-	+	-	N	-	
<u>Clowards</u>										
Early	N	-	N		+	N	+	-	-	
Late	-	-	N		N	-	N	-	+	
<u>Blacktail</u>										
Early	-	-	-		+	N	+	+	N	
Late	-	N	-		+	N	N	N	+	
<u>Meadow Creek</u>										
Early	-	-	-	-	+	+	N	N	N	0
<u>Deer-Bear</u>										
Early	-	N	N	-	N	+	N		-	0
<u>Tex Creek</u>										
Early	-	-	N	N	+	N	+	-	-	0

¹ +/-=significant positive/negative occurrence.
N=no significant selection.

Table 15. Student's t-test values¹ for elevations used by deer during early and late winter vs. the mean available elevation on 6 subunits of the Willow Creek winter range, 1985-86 (n=number of ground observations of deer).

Subunit	t Value		Adult Males (1.5+) vs. Adult Females
	Early Winter	Late Winter	
Kepps	6.10 * n=413	-6.70 * n=122	
Clowards	-9.92 * n=379	7.43 * n=325	-1.09 n=12,111
Blacktail	7.86 * n=234	0.07 n=133	-2.42 * n=12,77
Meadow Creek	-7.18 * n=408		2.02 * n=21,66
Deer-Bear Creek	-3.54 * n=582		1.50 n=27,147
Tex Creek	-1.24 n=528		2.07 * n=22,127

¹ * = significant difference. - = mean elevation available was higher than mean elevation used.

1985, proved highly attractive to deer until winter wheat became easily available in February. Use of winter wheat fields increased sharply in late winter-spring (Table 16). By late spring deer were spending the entire day bedded and feeding in the fields.

Table 16. Fixed-wing grid flight counts of deer use of winter wheat (n = total count).

Date	n	Vegetation Cover Type			
		Native	Stubble	WW ¹	PP ²
4-10-85	933	8	5	925	
1-4-86	326	12	80	2	201
2-4-86	953	139	178	570	66 ³
3-13-86	301	27	48	226	

¹ WW = Winter Wheat.

² PP = Permanently Planted cover.

³ North of Pipe Creek.

Deer fed at all times of the day but feeding peaked at dusk (Figure 11). The low number of deer observed feeding in early morning was due to a paucity of survey routes begun within that time frame. Many deer were observed feeding during the period of 0600-0900 during aerial relocations.

Adult males selected elevations higher and lower than adult females (Table 15). There were also more males noted in the areas with higher mean elevations. However, the high frequency at which males were observed in company of

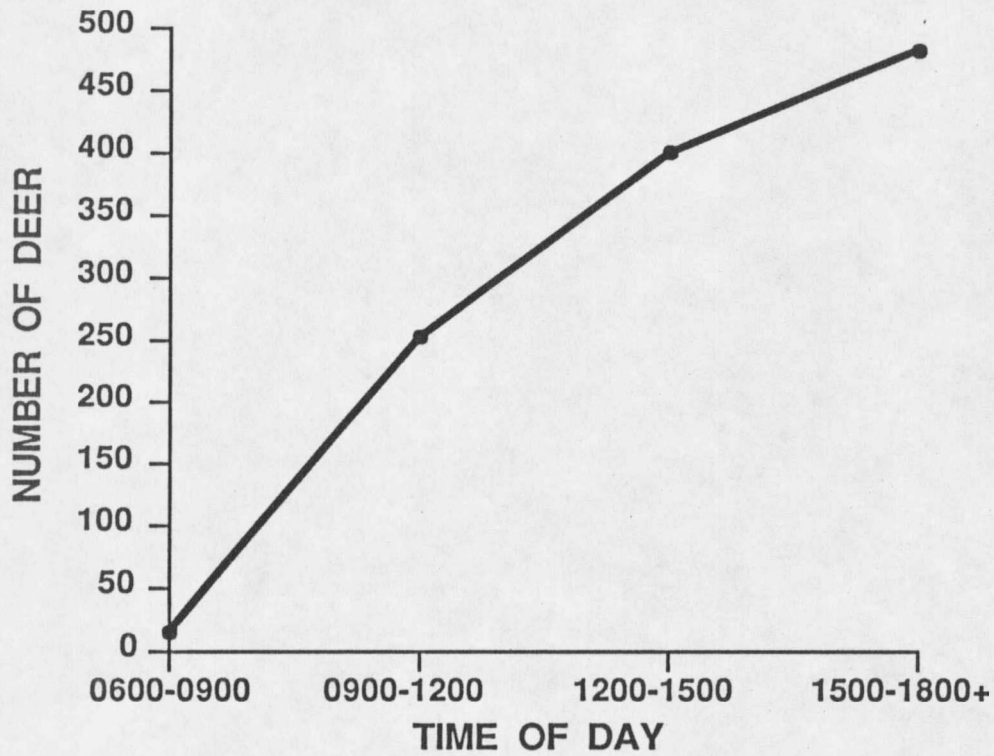


Figure 11. Number of deer observed feeding by time of day (based on 22 ground surveys) on the Willow Creek winter range, 1985-86.

female groups (Figure 12) indicates that this may have been an artifact of sampling and limited elevational variability within subunits. Yearling males were even more strongly associated with female/mixed groups than adult males were.

Factors Affecting Distribution

Elk did not appear to affect deer distributions during 1985-86. Avoidance of elk by individual deer was not noted. Deer were observed feeding adjacent to, and mixed with, elk groups on a number of occasions and only 1 instance of elk aggression toward deer was recorded.

Helicopter disturbance did not cause major movements during the study (Table 17). The average distance moved after helicopter disturbance was less than 0.5 km. The average movement between relocations prior to and following helicopter disturbance was 0.5 km and the mean distance between all relocations for winter 1985-86 was 0.8 km. Average movements during these flights were not significantly longer than the mean winter movement based on 14-day intervals between relocations.

Grid flights to count deer use on winter wheat fields indicated no large scale changes in distribution (between subunits) as availability of winter wheat increased in late winter-spring. However, shifting did appear to

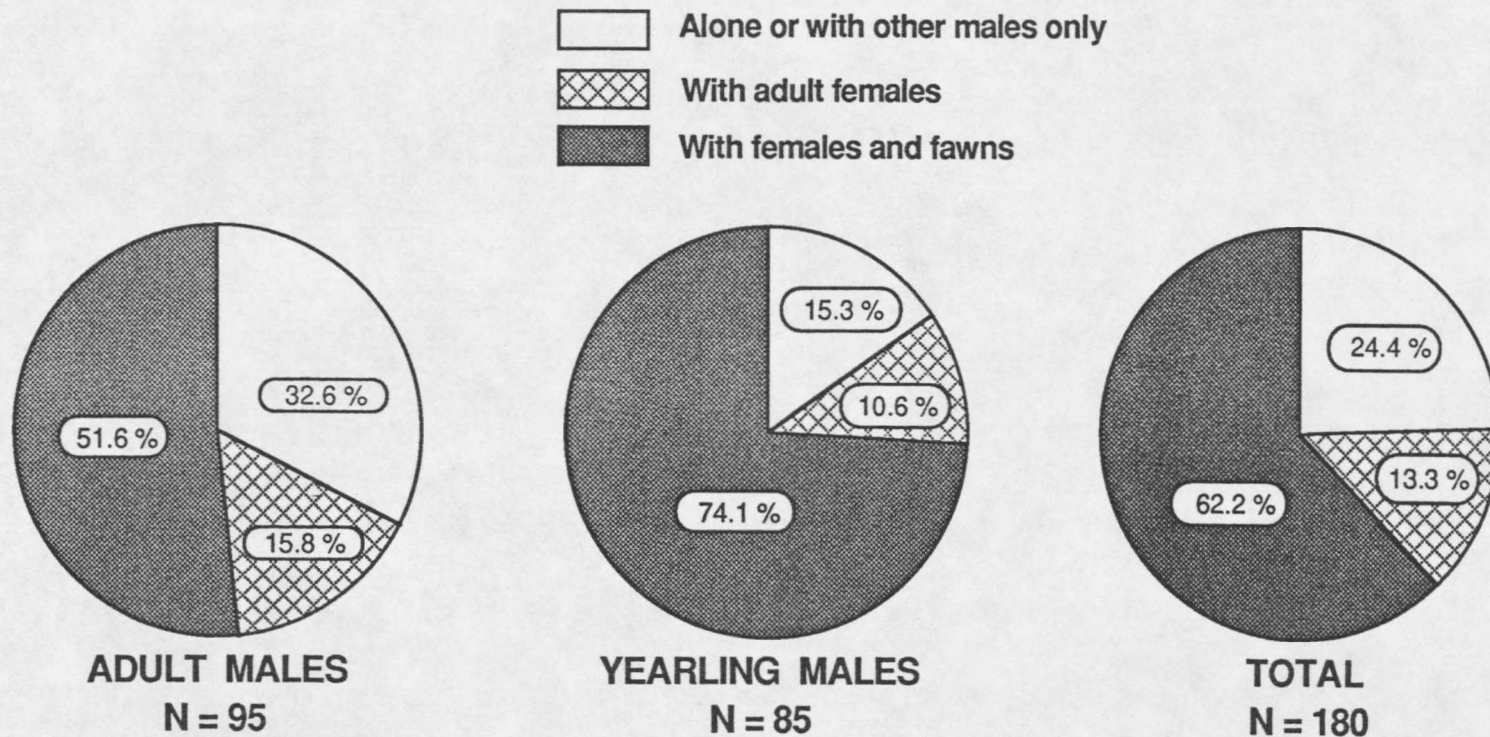


Figure 12. Percentage of times males were observed in company of other males (or alone) and with antlerless groups during early winter on Willow Creek winter range.

Table 17. Minimum distances between radio locations of radiomarked deer on Willow Creek winter range before and after helicopter disturbance.

ID Number	Movements (km) Between Consecutive Relocations					$\bar{X}$ 1985-1986 Winter Movement ²
	Date					
	14Jan. 2Feb.a.m.	2Feb.a.m. ¹ 2Feb.p.m.	2Feb.p.m. 11Feb.a.m.	11Feb.a.m. ¹ 11Feb.p.m.	11Feb.p.m. 24Feb.	
4019	0.2	0.6	0.5	0.0	0.0	0.5
4028	0.3	0.5	0.3	0.6	0.5	0.6
4107				0.3	1.8	0.9
4202	0.3	0.5	0.2	0.2	0.6	0.7
4300	1.1	1.0	0.5	0.3	0.2	1.1
4340	0.8	0.8	0.3	0.3	1.3	0.7
4371				0.3	0.4	0.2
4614	1.4	0.6	1.4	0.3	1.3	0.7
4750	0.6	0.5	0.3	0.2	0.2	0.6
4825	0.6	0.5	0.2	0.2	1.1	1.0
4881				0.2	0.8	0.5
5060				2.3	0.8	1.4
5140				0.2	0.2	0.4
5191				0.3	0.0	1.1
5276	0.3	0.3	1.6	0.3	0.6	0.5
5375	0.3	0.3	0.1	0.2	0.2	1.2
5612	0.6	0.3	0.6	0.0	0.3	0.4
5638	1.1	0.3	0.6		0.3 ³	0.8
5688	0.6	0.2	0.5		0.3 ³	0.7
5851	5.0	0.0	3.5	0.2	1.3	2.4
$\bar{X}$	0.9	0.5	0.8	0.4	0.6	0.8
s	1.22	0.25	0.90	0.50	0.51	0.48

t value⁴ (tested against the $\bar{X}$ 1985-1986 winter movement).

1-14	2-4 a.m.	2-4 p.m.	2-11 a.m.	2-11 p.m.
2-4 a.m.	2-4 p.m.	2-11 a.m.	2-11 p.m.	2-24
0.53 (N)	-2.2 (-)	0.0 (N)	-2.5 (-)	-1.3 (-)

¹ Helicopter disturbance occurred on these dates between the a.m. and p.m. relocations.

² Based on an average of ten relocations at two-week intervals.

³ No p.m. relocation for these deer on February 11, 1986.

⁴ -= significantly shorter movement than the average.

occur within subunits. The TCWMA oat fields also appeared to contribute to shifts in distribution. Between December 5, 1985 and January 4, 1986, deer use on TCWMA fields increased nearly 4 fold. Only part of the increase could have been accounted for by continued arrival of deer onto winter range. Use of TCWMA fields declined rapidly during February to zero by March 1 when deer apparently moved into winter wheat fields in the Clowards-Deer Heaven area.

Shifts in distribution on WCWR generally appeared to coincide with winter wheat rotation patterns. This was illustrated particularly well in the Deer Heaven-Clowards section (Table 18). When winter wheat was available next to the canyon rim, deer numbers were 2-4 times higher than when the nearest winter wheat was 0.6 km from the canyon rim.

Population Characteristics

Population Trends and Characteristics

Helicopter trend counts from 1973-86 (Figure 13) indicate that the WCWR deer population generally increased to winter 1982-83 and remained relatively stable to winter 1985-86. However, the rate of growth during the 1970's may be exaggerated due to incomplete

Table 18. Comparison of helicopter trend counts of mule deer between areas on Willow Creek winter range, 1981-82 through 1985-86.

Area	Date				
	1/20/82	1/24 and 1/26/83	4/9/84	2/28/85	1/13-14 1986
Willow Creek Channel Eastside					
Dam to Meadow Creek	91	1	2	3	2
Meadow Creek-Deer Creek	4	11	8	6	8
Deer Creek-Bear Creek			7	5	0
Bear Creek-Tex Creek			2	2	3
Tex Creek-Kepps		5	7	7	5
Willow Creek Channel Westside					
Dam to Benchland ²		2	3	2	2
Benchland-Blacktail ²			2	2	2
Blacktail area	15	7	7	5	9
Blacktail-Deer Heaven		5	4	1	2
Deer Heaven-Clowards	7	11	6	15	6
Clowards-Kepps		9	5	12	14
Kepps-High Willow		7	6	7	8
Ranch above GLO					
Kepps-High Willow		7	8		2
Ranch below GLO					
Meadow Creek	1	1	2	5	4
Mud Springs Creek	7		0	1	1
Deep Creek		1	4		1
Deer Creek	13	11	6	11	7
Bear Creek	17	10	5	11	13
Bull Fork/Tex Creek	20	7	7	2	10
to Indian Fork					
Spring Canyon		2	4	2	3
Indian Fork/above	8	2	5	2	1
Total count	829	2,154	1,406	2,003	2,170

¹ Percent of total count and may not add to 100 percent due to rounding.

² Counts were combined on the trend count in 1983.

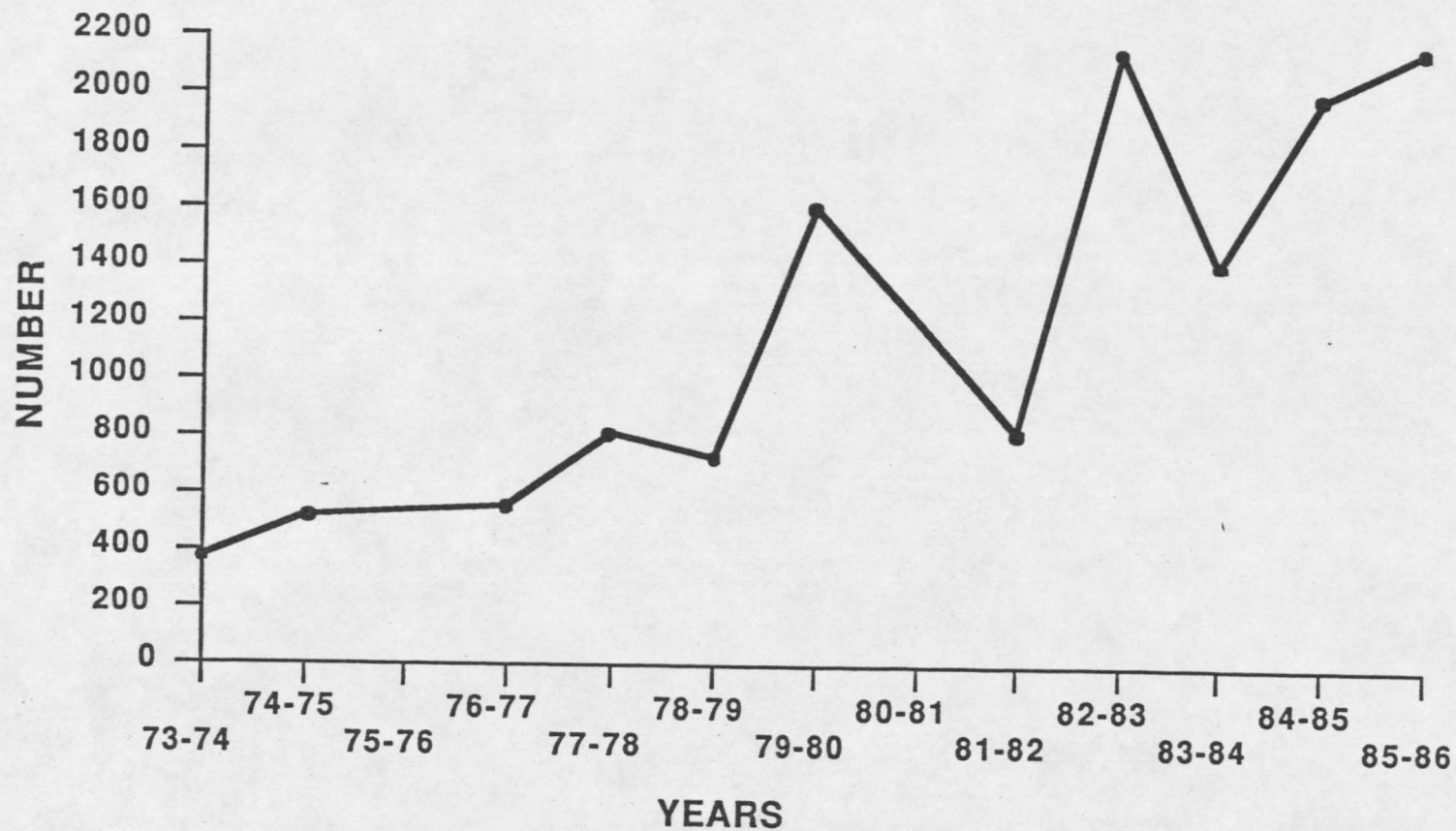


Figure 13. Numbers of mule deer counted on Willow Creek winter range during helicopter trend flights, 1973-86.

and inefficient survey techniques until the early 1980s. The decreased count in 1984 probably resulted from a combination of a late spring survey and relatively high winter mortality.

A population estimate (Davis and Winstead 1980:235) of 6,477 mule deer on WCWR was calculated from sightings of marked animals during helicopter surveys. Ninety-five percent confidence levels were calculated for this estimate using the method of Lackey (1974:44) for small sample size. The lower and upper bounds were 2,945 and 10,009 respectively and indicated a possible range of observations of 22-74 percent. Ackerman's (1986) 2 sightability trials on WCWR during February 1986 had observation rates of 70 and 75 percent. Using his values as upper and lower bounds, the population estimate was 2,900 to 3,100. Using the percent observability indices presented by Mackie et al. (1981) for Missouri River Breaks, Montana, the population estimate for 1986 was 2,900 to 3,340.

There was little difference between sex/age ratios calculated from total numbers of deer classified on ground routes and the mean of 2-3 routes (Table 19). I used ratios calculated from total numbers of classifications as they were slightly more conservative. Overall male:female:fawn ratios observed on WCWR for

1985-86 were 29:100:97 (Table 19). In the 6 subunits the early winter male:female ratios ranged from 15:100 in Kepps to 43:100 in Meadow Creek and fawn:female ratios ranged from 88:100 in Kepps to 116:100 in Meadow Creek (Figure 1). Overall, 43 percent of all deer seen were fawns; the range between subunits was 41-45 percent. this was not significantly different from late winter where fawns made up 42 percent of the population ($t=0.311$).

Mortality

Check station data (IDFG files, Idaho Falls, Idaho) indicated that hunter success in the study area ranged from 4-10 percent during the last 5 years. Twice as many deer were harvested in subunit 1 of HU 69 (Appendix Figure 18, Appendix Table 28) than in the rest of the unit combined. Limited tag returns and summer distribution patterns suggest that deer from subunit 1 are Wolverine canyon deer.

Age structural data (Figure 14) 1981-85 show that harvests of males and females were strongly skewed toward fawns and yearlings. Only 4 percent of the females and 2 percent of the males were older than 5.5 years.

Table 19. Sex and age composition of mule deer on Willow Creek winter range as determined by ground counts during winter 1985-86.

<u>Subunit</u>	<u>n</u>	<u>Total Males</u>	<u>Percent Yearling Males</u>	<u>Males/Females/Fawns ($\bar{X}$)²</u>	<u>Adults/Fawns</u>
Nonroute	185	27	63	30/100/87	100/73
<u>Kepps</u>					
Early ¹	223	16	81	15/100/88 (16/100/89)	100/77
Late	67				100/68
<u>Clowards</u>					
Early	135	19	47	31/100/90 (32/100/90)	100/69
Late	205				100/84
<u>Blacktail</u>					
Early	158	19	32	28/100/107 (29/100/106)	100/84
Late	116				100/72
<u>Meadow Cr.</u>					
Early	145	24	29	43/100/116 (46/100/118)	100/81
<u>Deer-Bear</u>					
Early	341	44	45	30/100/102 (30/100/101)	100/42
<u>Tex Creek</u>					
Early	298	40	45	29/100/88 (31/100/95)	100/43
<u>Total</u>					
Early	1,485	189	49	29/100/97 (31/100/100)	100/67
Late	402				100/67

¹ Early = December-January, late = February-March.

² Cumulative and mean of 2-3 runs.

Seven of 8 radiomarked males died during the study, 1 in 1984 (winterkill), 3 in 1985 (1 general harvest, 1 wounding loss and 1 cause unknown), and 3 in 1986 (2 general harvest and 1 illegal [closed area] kill). I lost contact with 2 (9 percent) of the radiomarked females by July 1986. All others were alive as of October 31, 1986 (Appendix Table 27).

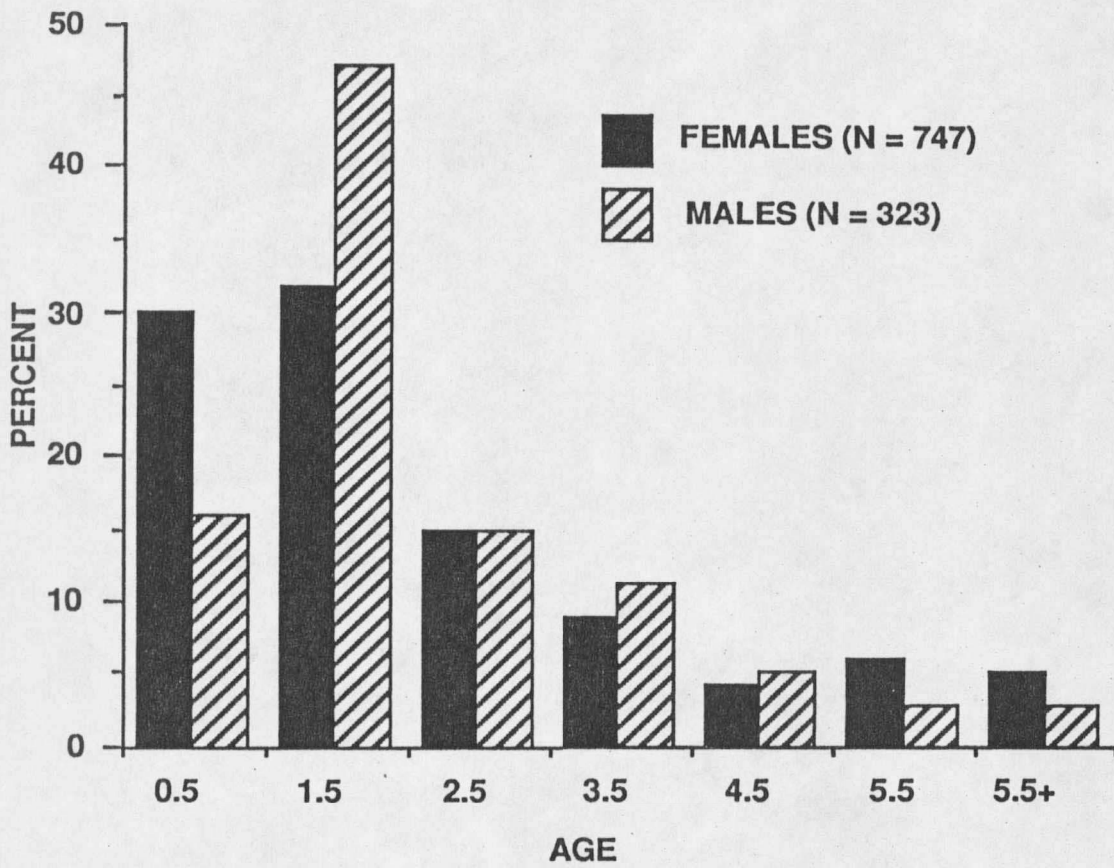


Figure 14. Cumulative age structure of the deer harvest for HUs 66, 66A, 69 and 76 (northern part) 1981-85.

DISCUSSION AND CONCLUSIONS

Seasonal Movements and Habitat Use

Summer Range

High fidelity to particular summer home ranges has been noted in studies in other mountain-foothill habitats in Montana (Pac 1976, Rosgaard 1981, Kasworm 1981 and Ishle 1982), California (Leopold et al. 1951 and Bertram and Rempel 1977) and Utah (Robinette 1966 and Richens 1967). This may be an energy conservation measure as familiar home ranges would require less exploratory movement (Baker 1978:28).

Deer on the western region of the Willow Creek study area had home ranges smaller than or equal in size to those of deer in the more complex mountain habitats to the east. Steery (1979) and Nyberg (1980) found larger home ranges in less complex terrain in Montana. This association was presumed to be a result of the relative ease with which needs (for forage and cover) could be satisfied in a small area in complex mountainous terrain (Mackie et al. 1980).

The differences between my results and findings for Montana may be a function of small, extremely high quality habitat patches scattered through a matrix of

crop/pasture and rangeland at low elevations on the western portions of the Willow Creek study area. Deer in the western region were strongly associated with aspen/shrub stands in island situations. Ackerman et al. (1983) noted heavy use of this cover type by deer during a study south of the Willow Creek study area. Mueggler and Campbell (1982) found that such stands had the highest forage values of the community types they investigated. With 1 exception, deer home ranges in aspen habitats included beaver pond complexes, a form of the mesic situation that other authors (Pac 1976, King and Smith 1980) have identified as selected by female deer.

The majority of home ranges that included aspen were also closely associated with agricultural fields. In autumn at least, deer using these areas ranged in agricultural fields up to 1.8 km from their core home ranges. Other authors (Pac 1976 and Nyberg 1980) have noted the importance of hayfields in late summer as a source of succulent forage. It is possible that the aspen habitats were supplemented to varying degrees by surrounding agricultural activities.

Bertram and Rempel (1977) found that deer summering at lower elevations had smaller home ranges than those summering at higher elevations. This was attributed to

later snowmelt at higher elevations which delayed forage production and forced deer to wander more widely in search of forage in early summer. Late summer home range size for high elevation deer and low elevation deer was similar in their study. A similar pattern was observed on the Willow Creek study area but appeared related to the form of the terrain rather than elevation. Even though mean elevations selected for in the 3 regions of the study area were similar for females, snowmelt in the rolling hills of the western region preceeded that of mountainous terrain by as much as 30 days. During that period, deer in mountain habitats wandered widely and established a large number of their home range polygon perimeter points.

Another factor increasing the home range size for deer in mountainous terrain was the greater propensity of these deer to make long movements during the hunting season. Mountainous terrain afforded deer the opportunity to move away from disturbance. Deer in the patchy habitats of the western region had far less opportunity to do so.

Males had larger and higher elevation summer home ranges than did females. Hamlin (1974) and Pac (1976) found similar results in the Bridger Mountains of Montana. King and Smith (1980) found no significant

differences between elevations of male and female home ranges in Utah but did find that females consistently used wetter sites than males. Bowyer (1984) found differences in male/female distributions and habitats in a mule deer herd in southern California and attributed the segregation to differences in water requirements, population density and/or forage quality needs. Clutton-Brock et al. (1982) found physiological and behavioral requirements between the sexes of red deer (Cervus elaphus) to be so distinct as to warrant management of the sexes as "different species".

Shifts in summer range use coincidental with livestock grazing were similar to those reported in Montana (Knowles 1976, Nyberg 1980 and Hamlin 1978). Deer use of forbs was far greater in ungrazed pastures than adjacent grazed pastures (Knowles 1976). Mackie (1981:494) suggested that in the absence of forbs, deer browse more intensively and pointed out that, due to the limitations of a small rumen, browse alone is insufficient for maintenance (see Amman et al. 1973).

Heavy use of the summer range by livestock may have several detrimental effects on mule deer. Hamlin (1978), Julander et al. (1961) and Short (1981:125) reported increased winter mortality when summer range quality was insufficient to provide necessary fat reserves. Pederson

and Harper (1978, 1984) indicated that lesser quality summer ranges can reduce productivity and alter sex ratios.

Given the high fidelity of mule deer to home ranges, extensive and uniform livestock grazing on summer range could reduce opportunity for deer to maximize habitat use within their home ranges (Mackie 1985:53) and adversely affect herd production initially and "fill" secondarily (Mackie 1983). Intensive and uniform livestock grazing would be particularly detrimental to mule deer populations if it occurs in the elevational zone preferred by lactating females and on spring transition ranges where energy requirements for pregnant females is high and competition between deer and livestock for new grasses is keen (Mackie 1981:501).

Hunting Season

Deer remained on summer ranges through most of the hunting season, but most shifted their GAC with the onset of hunting. There was no apparent change in use of cover types, but deer used north and northwest faces and higher elevations more during hunting season.

Habitat changes and extended movements during the hunting season were associated with the peaks in hunter activity noted by Brown (pers. comm.) on a concurrent

study south of my study area. On the Willow Creek study area, deer which made movements away from disturbance often returned to core areas once hunting pressure subsided. In Brown's study, hunting pressure appeared to be the impetus for migration toward the winter range. In the Bridger Mountains of Montana, deer which made movements away from disturbance often returned to core areas once hunting pressure subsided (Steerey 1979). However, Ackerman et al. (1983) noted a significant increase in conifer use by mule deer beginning in September, indicating that hunting pressure may not be the only reason for shifts in habitat use during fall.

Deer individually employed strategies other than distance to avoid contact with hunters including utilizing steeper slopes, heavier cover, movement away from or toward roads and selection for more open habitat types. Deer went where hunters did not, even if apparent jeopardy was increased.

Migration

Inclement weather influenced fall migration timing on the Willow Creek study area but did not completely explain it. Some deer began migration following autumn snowstorms but others did not.

Many authors (Leopold et al. 1951, Steery 1979, Kasworm 1981, Rosgaard 1981) felt that fall migration was precipitated by snow accumulation on the summer range. In these studies deer typically crossed high elevation passes during migration. Other studies (Nyberg 1980, Ishle 1982 and Brown pers. comm.) have indicated that movements toward winter range may occur, at least in part independent of snow accumulation. Ishle (1982) believed that migrational timing was partly traditional. Bertram and Rempel (1977) associated early migration of deer from higher elevations with dessication of forage due to earlier frost at high elevations. They also noted that early snow storms would set higher elevation deer into downward motion but that a moderation in the weather could reverse migration.

Fall weather apparently influenced the length of time deer remained on transition areas. Radiomarked deer stayed on transition areas until mid December in 1984 but the majority of radiomarked deer were on winter home ranges by the first week in December in 1985 following a period of severe weather in November. Haynes and Trent (IDFG files, Idaho Falls, Idaho) have noted large numbers of deer on transition ranges of Willow Creek and Wolverine winter ranges during helicopter trend flights in late December-early January in mild winters.

The timing of spring migration varied more than that of fall migration and seemed to correspond to moderation of late winter-early spring conditions and green-up as noted by other researchers (Leopold et al. 1951, Pac 1976, Bertram and Rempel 1977, Kasworm 1981, Ishle 1982). However, Nyberg (1980) found that deer remained on winter range in the Bridger Mountains an average of 45 days after migration corridors were snow free.

Migration corridors and transition ranges identified in this study were used in spring and fall as has been found in studies of other migratory herds (Richens 1967, Pac 1976, Bertram and Rempel 1977 and Kasworm 1981). Extent of use of transition ranges in the spring depended on how early deer left the winter range. There was essentially no use of the Tex Creek transition range in 1984, moderate use in 1985 and heavy in use 1986.

Unlike the findings of Ackerman et al. (1984), deer on the Willow Creek study area did not necessarily use the winter range closest to their respective summer ranges. Other authors (Gruell and Papez 1963 and Richens 1967) have noted deer making longer than necessary migrations and attributed it to tradition.

Sidehills dominated by open canopy vegetation types were the most important terrain form in spring/fall migration. This "preference" for open canopy types on

Willow Creek transition ranges in late autumn may be related to little hunting disturbance to force deer away from forage areas. Nyberg (1980) determined that closed canopy cover types were important components to migration corridors. Bertram and Rempel (1977) suggested that hiding cover was important on transition ranges largely because of hunting activity.

Winter Range

Relocation data were too sparse to compare fidelity to home ranges between years except that all deer that returned had winter home ranges in the vicinity of relocations from other years. High fidelity of deer to specific winter ranges and home ranges has been noted by other investigators (Leopold et al. 1951, Gruell and Papez 1963, Pac 1976, Bertram and Rempel 1977, and Ishle 1982). Repeated helicopter disturbance on the WCWR (Table 24) did not alter this fidelity, cause temporary or permanent shifts in distribution, nor greatly influence home range size. Leopold et al. (1951) and Robinette (1966) also noted that deer could not be easily driven from home areas by ground disturbance.

My data were insufficient to determine the effect of winter severity on winter home range size. In severe winters on WCWR I would expect deer to reduce movements,

as reported by Youmans (1979) and Ishle (1982) for Montana, and concentrate in riparian areas as during a period of severe weather in December 1985 (Figure 2). Haynes (pers. comm.) and Youmans (1979) have noted increased use of riparian areas during periods of severe weather.

Junipers, when available, were heavily used on the WCWR in early winter. The benefits of a tall overstory for thermal protection were discussed by Leckenby et al. (1982). In areas where tall vegetative cover was not available, deer utilized sage/shrubland successfully. Leckenby et al. (1982) indicated that shrub cover affords a measure of thermal protection. The south-to-west-facing slopes selected by WCWR deer in early winter generally are warmer and with lower snow depths (Loveless, 1967).

Data on deer distribution by elevation in WCWR canyon complexes cannot be interpreted in the same context as in mountain foothill winter ranges. In mountain-foothill ranges deer move down slopes until tolerable conditions are reached (Kuck et al. 1983) and can retreat upslope if conditions moderate. In contrast, when deer reach their respective subunits on WCWR, opportunity to change elevation is limited by the depth of the canyon (109 m in the Deer Heaven area). However, in early winter, deer

selected lower elevations (canyon walls and riparian areas) and in late winter, higher elevations (grain fields on benches above canyons).

In 1985-86 I noted a sharp increase in use of green wheat in late winter. Signs of deer activity were uncommon in planted fields until a significant portion of the snow accumulated in early winter had melted although wheat was available under the snow throughout the winter. Other researchers (Schwarzkoph 1973, Hamlin 1974 and Nyberg 1980) have noted important use of agricultural fields on or adjacent to winter ranges to mule deer in early spring.

Although use of winter wheat was heaviest in late winter on WCWR, deer were observed feeding in wheat in mid January 1985 in the Deer Heaven area where wind had cleared snow from most fields. Early winter use of winter wheat appeared to be inversely related to snow cover and distance from the canyon rim to green wheat.

Diurnal observation likely underestimates total use of winter wheat in spring. Observed use in the WCWR peaked in late afternoon and presumably continued after sunset. Youmans (1979) indicated that use of agricultural fields in spring increased sharply after dark.

Availability of winter wheat in early spring can be important. Early growth of grass species is nearly 100 percent digestible and is an excellent energy source. Short (1981:125) indicated that March is the period when deer increase forage consumption to meet increased metabolic demands, and females prepare for rapid fetus growth during the third trimester of pregnancy. Large quantities of highly nutritional forage are important at this time.

The role of winter wheat in deer nutrition during the winter is less clear. Deer are physiologically adapted to a low quality diet during winter and voluntarily reduce their intake (Short 1981:113 and Mautz 1980:342), but the presence of an easily available, high quality forage may offset forage inadequacies on the summer range. Mackie (1981) noted that while winter forage is inadequate for maintenance it "also supplement[s] and determine[s] the rate and extent of use of body fat reserves."

Use of winter wheat should relieve pressure on native browse species and could provide supplemental forage to maintain higher wintering populations than could native range alone. If winter wheat were unavailable, winter mortality could be expected to increase in moderate/severe winters as occurred in 1984. Winter

wheat was unavailable until spring due to rotation patterns and below average wind conditions which allowed snow to accumulate on bench tops. Five percent of the deer counted during helicopter surveys in spring 1984 were winter kills.

Population Characteristics

Trend counts (Figure 13) on WCWR indicate that the population had stabilized by 1982-83. However, sex/age structure data indicate that the population was increasing. Fawn:adult ratios were well above the 30:100 adults reported as adequate for population increases by Nyberg (1980) in the Bridger Mountains and the 40-45:100 value calculated by Mackie (1983) for the less diverse Missouri River Breaks of Montana. Male:female ratios observed in the WCWR, 29:100 females, were in the 20-40:100 ratio associated with lightly to moderately hunted herds in Montana (Mackie et al. 1982).

Several scenarios could explain this apparent contradiction. Parameters established for studies in Montana may not apply to the Willow Creek population. However, the Willow Creek study area has the physical characteristics of all 3 of the major mule deer habitat complexes (mountain-foothill, prairie breaks, prairie-agriculture) described by Mackie (1983) and thus

should show population structure characteristics intermediate to those associated with mountain populations and prairie populations.

My winter surveys were concentrated on identified primary winter range. Wolfe (1976) pointed out the difficulties in interpreting trend data when monitoring only prime or "key" areas. These areas are likely to be "filled" in all years of modest population densities. Any significant downward change may appear only after substantial reductions in peripheral winter range herds, and no increases in population size will be noted once fill is achieved.

It is possible that winter severity determined the number of deer actually using core winter range. However, during the past 3 winters of severe, moderate and mild weather, respectively, deer numbers were lowest during the most severe winter, the reverse of what would be expected. Also, trend counts on transition ranges were not appreciably different between years and radiomarked animals always returned to core winter range.

One explanation could be high spring mortality. Early spring fawn:adult ratios were similar to early winter ratios in 1985-86 thus eliminating the possibility of extensive winter predation or winter kill, but this did not account for losses during migration. Pac (1976)

cited Gale (1976) as indicating that fawn mortality occurred in spring while deer occupied transition ranges along migration routes. Pac (pers. comm.) lost 6 radiomarked deer on spring transition ranges following a period of bad weather in April, 1986. No mortality was recorded among radiomarked deer on Willow Creek transition range during equally severe weather, nor has such mortality been reported by IDFG personnel.

Illegal harvest can be a significant mortality factor in Idaho (Ackerman et al. 1983). However, there was no evidence of poaching on WCWR during 1986.

Deer shifted to different winter ranges in 2 cases on my study area (1 male and 1 female adult). Nyberg (1980) and Ishle (1982) had low percentages of animals change winter ranges in studies in Montana. If shifts by marked animals are proportionate to the population, they would account for only 3 percent of the population of adult animals.

Emigration by yearling deer and, particularly, yearling males, is well known (Mackie et al. 1980, 1982 and Robinette 1966) and could account for the discrepancies between population characteristics and trend counts. Robinette (1966) determined that 37 percent of the mule deer males and 22 percent of the females in his study area dispersed more than 4.8 km from

natal areas. Bunnell and Harestad (1984) determined that 27 percent (50 percent of the males and 20 percent of the females) of black-tailed deer (Odocoileus hemionus columbiana) dispersed more than 5.0 km from natal areas. Given the tendency for animals in the genus Odocoileus to form groups in late summer (Geist, 1981:215 and Mackie et al. 1982:868), recently dispersed deer could attach themselves to groups in their new areas and follow dominant animals to new winter ranges.

Associations

Subunits identified on the WCWR for sampling purposes apparently functioned as discrete winter ranges with little or no interchange except during spring and autumn migration periods. With the exception of the Clowards and Ritter subunits, I identified no discrete summer/winter range populations. This situation could indicate overlaps in summer range used by deer from different wintering areas were such that no discrete winter-summer relationships exist (Zalunardo 1965) or it could be due to insufficient sample size. Mackie et al. (1980) found that each winter range population in the Bridger Mountains of Montana had a corresponding summer range but 12-20 radio collars were necessary to delineate each winter/summer range relationship. None of the subunits in the WCWR were sampled at this intensity.

MANAGEMENT IMPLICATIONS AND RECOMMENDATIONS

Habitat Management

Livestock grazing is currently the only land use with high potential for altering the quality of summer ranges on the study area. Heavy grazing pressure in late summer and autumn has the potential for the greatest negative impact on deer (Mackie 1981:502). The western region, because of its more gentle terrain and the relatively small, scattered patches of high quality deer habitat may be most vulnerable to overutilization by livestock. Livestock apparently concentrate in high quality mesic patches of habitat essential to deer and opportunities for deer to shift habitat use appear extremely limited. "Moderate stocking rates should be adhered to (for the benefit of the land, as well as the deer). Livestock operators should be encouraged to move livestock frequently so large areas of uniform disturbance are minimized, leaving deer the opportunity to move into unused parts of their home ranges."

Fencing patterns on public lands could be modified to bisect linear patches of habitat or place adjacent

patches in separate pastures. This would assure some availability of essential high quality patches of habitat to deer locally in all years.

Transition ranges are important components of a deer's seasonal range. In spring, the transition range should allow deer to recover from possible winter malnutrition and provide females with reserves to meet the demands of rapidly growing fetuses. During the fall, transition ranges represent the final opportunity for deer to add to the fat reserves they will depend on in the winter. In addition, high quality transition ranges should hold deer longer, distributing pressure on the range more evenly on a yearly basis.

Management of transition ranges could include elimination of spring livestock grazing where such activity behaviorally or physically limits the amount of succulent new grasses and forbs available to deer. Livestock grazing in the summer should not progress to the point where livestock begin to utilize browse important to deer moving from summer range in autumn (Mackie 1981:501).

Transition ranges could also be improved following the suggestions of Bertram and Rempel (1977). These authors suggest planting 25 percent of the ground cover in early season grasses for spring use and 20-40 percent in preferred browse species for fall migration.

The importance of riparian areas during severe weather on the WCWR indicates attention should be paid to maintaining existing undisturbed riparian areas and improving deteriorated areas. The most critical elements would be dense thermal cover and adjacent stands of important browse species.

Winter wheat/alfalfa plantings could be a valuable tool for modifying deer distributions on winter range. Plantings along the terminal ends of fall migration corridors (below transition ranges) could slow down migration into Willow Creek, and reduce pressure on native vegetation. Shifts in distribution of 3 km or more could be affected on the winter range. The benchland/canyon situation of the WCWR allows deer to visually assess large portions of the winter range for concentrations of other deer that might indicate a superior food source.

Trend Monitoring

Concern over completing helicopter trend flights within a short time period to avoid double counting animals appears unfounded. My data indicate that deer did not shift distributions during mid winter conditions. A flight curtailed in mid January could thus be resumed where it was terminated 1 or 2 weeks later with little worry of duplication.

Harvest

Current rates of harvest appear to be acceptable. The Kepps subunit on WCWR appears to be the only subunit with low male:female ratios indicative of heavy hunting pressure (as used by Mackie et al. 1982:873). This supports a hypothesis that Kepps largely winters deer summering in the western and southern portions of HU 69 as checkstation records (IDFG files Idaho Falls, Idaho) indicate high hunter pressure, low success and few males reported seen for that area. This is also consistent with migration and distribution patterns of Kepps deer.

Currently, the vulnerability of deer to harvest is not increased by fall migration. Only record snows in autumn could move a significant portion of long distance migrating deer onto transition ranges before the hunting seasons in other units were substantially over. Under present regulations there should be little danger of over harvest of the long distance segment of the WCWR deer through double harvest. All seasons start at the same time and the seasons on the winter range (with the exception of the late control hunt on TCWMA) end significantly earlier than the more distant units. A re-evaluation of migration data might be in order if these season structures were to change dramatically.

The HU 69 control hunt is an exception. If the mean migration dates for radiomarked animals in 1984-86 were representative of the population, by the end of the controlled hunt on TCWMA, less than half of the wintering deer are present on the winter range. This could lead to overharvest of resident or some unidentified early migrating segment of the male population.

Further Research Needs

Stable trend counts in the face of contradictory population parameters indicate the need to identify and monitor peripheral winter ranges. It will also be important to distinguish between peripheral and secondary ranges. Peripheral ranges will be occupied regardless of winter conditions when populations are at or above a threshold density on core ranges. Secondary ranges will be occupied only during mild winters. Some possible peripheral ranges include Fall Creek, High Willow Ranch, Hell Creek, Dan Creek and Black's Canyon.

Mortality surveys established on transition ranges in the spring could provide documentation of possible losses to the population during this time. It is possible that fawn mortality on transition ranges far exceeds mortality on winter range areas, at least in some years.

The question of discrete summer range/winter range relationships is still, to a degree, unsettled. Areas of most concern should be the Kepps and Meadow Creek-Deer Creek subunits on WCWR. These are suspected of wintering many of the deer that summer in HU 69 which currently sustains a very low hunter success rate.

The tight association of deer marked in the Clowards subunit points to one of the limitations of the net drive technique of Beasom et al. (1980). Deer may form maternal clans which share summer and winter ranges (Mackie et al. 1982:868) and the possibility of achieving a non-random sample and distribution increases with the number of deer captured and marked on the same site.

REFERENCES CITED

- Ackerman, B. 1986. Mule deer census. Job Prog. Rept., Idaho Depart. Fish Game. Fed. Aid Proj. W-160-R. 19 pp.
- Ackerman, B., L. Kuck, E. Merrill, and T. Hemker. 1983. Big game movements and big game habitat use. Pages 50-62 in Southeast Idaho Wildlife Studies. Job Completion Report. Idaho Depart. Fish Game, Fed. Aid Proj. No. W-160-R.
- Ammann, A.P., R.L. Cowan, C.L. Mothershead, and B.R. Baumgardt. 1973. Dry matter and energy intake in relation to digestibility in whitetailed deer. J. Wildl. Manage. 37:195-201.
- Baker, R.R. 1978. The evolutionary ecology of animal migration. Holmes and Meier, New York. 1012 pp.
- Beasom, S.L., W. Evans, and L. Temple. 1980. The drive net for capturing western big game. J. Wildl. Manage. 44:478-480.
- Bertram, R.C. and R.D. Rempel. 1977. Migration of the North Kings deer herd. Cal. Fish and Game. 63:157-179.
- Bowyer, R.T. 1984. Sexual segregation in southern mule deer. J. Mammal. 65:410-417.
- Bunnell, F.L. and A.S. Harestad. 1984. Dispersal and dispersion of black-tailed deer: models and observations. J. Mammal. 64:201-209.
- Clover, M.R. 1954. A portable deer trap and catch-net. Cal. Fish and Game. 40:367-373.
- Clutton-Brock, T.H., F.E. Guinness S.D. Albon. 1982. Red Deer: behavior and ecology of two sexes. Univ. of Chicago Press, Chicago. 378 pp.
- Davis, D.E. and R.L. Winstead. 1980. Estimating the numbers of wildlife populations. Pages 235-236 in Wildlife management techniques manual. S.D. Schemnitz ed. The Wildlife Society, Washington D.C.
- Gale, R.M. 1976. The North Kings deer herd project. Annual Meeting of New Mexico-Arizona Section of the Wildlife Society. 17 pp.
- Geis, A.D. 1963. Role of hunting regulations in migratory bird management. Pages 164-170 in Transactions 28th North American Wildlife Conference.

- Geist, V. 1981. Behavior. Adaptive strategies in mule deer. Pages 157-223 in Mule and blacktailed deer of North America. O.C. Wallmo ed. Univ. Nebraska Press, Lincoln.
- Gruell, G.E. and N.J. Papez. 1963. Movements of mule deer in northwestern Nevada. J. Wildl. Manage. 27: 414-422.
- Hamlin, K.L. 1974. Ecological relationships of mule deer in the Bridger Mountains, Montana with special reference to daily and seasonal movements. M.S. Thesis, Montana State Univ. Bozeman. 65 pp.
- Hamlin, K.L. 1978. Mule deer population ecology, habitat relationships, and relations to livestock grazing management and elk in the Missouri River Breaks, Montana. Pages 141-176 in Montana Deer Studies. Job Prog. Rep. Fed Aid Proj W-120-R. Montana Dept. Fish, Wildl. Parks, Helena.
- Harestad, A.S. 1981. Computer analysis of home range data. Wildl. Rev. and Tech. Ser. Sec., Fish and Wildl. Branch, Bull., B-1. Ministry of Env., Victoria, B.C. 25 pp.
- Ihsle, H.B. 1982. Population ecology of mule deer with emphasis on potential impacts of gas and oil development along the east slope of the Rocky Mountains, Northcentral Montana. M.S. Thesis, Montana State Univ. Bozeman. 85 pp.
- Julander, O., W.L. Robinette, and D.A. Jones. 1961. Relation of summer range condition to mule deer herd productivity. J. Wildl. Manage. 25:54-60.
- Kasworm, W.F. 1981. Distribution and population characteristics of mule deer along the East Front, Northcentral Montana. M.S. Thesis, Montana State Univ. Bozeman, 73 pp.
- King, M.M. and H.D. Smith. 1980. Differential habitat utilization by male and female mule deer. Great Basin Naturalist. 40:273-281.

- Knowles, C.J. 1976. Mule deer population ecology, habitat relationships, and relations to livestock grazing management in the Missouri River Breaks, Montana---Nichol's Coulee RCA. Pages 95-106 in Montana Deer Studies, Job Prog. Rept, Fed. Aid Proj. W-120-R-7. Montana Dept. Fish, Wildl, Parks, Helena.
- Kuck, L., T. Hemker, and G. Hompland. 1983. Big game movements and habitat use in southeastern Idaho. Pages 37-59 in Southeast Idaho wildlife studies. Job Prog. Rept. Idaho Dept. Fish, Game. Fed. Aid Proj No. W-160-R-10, Boise.
- Lackey, R.T. 1974. Introductory fishery techniques. Virginia Polytechnic Institute and State University. Blacksburg, Virginia. 275 pp.
- Leckenby, D.A., D.P. Sheehy, C.H. Nellis, R.J. Scherzinger, I.D. Yuman, W. Elmore, J.C. Lemos, L. Daughy, and C.E. Trainer. 1982. Wildlife habitats in managed rangelands: the Great Basin of southeast Oregon-mule deer. USDA, For. Serv., B.L.M. Gen. Tech. Rep. PNW-139. 38 pp.
- Leopold, A.S., T. Riney, R. McCain, and L. Tevis, Jr. 1951. The Jawbone deer herd. California Div. Fish, Game. Game Bull. 4. 139 pp.
- Lonner, T. and D. Burkhalter. 1986. TELDAY/TELNEW. A program to manage and analyze animal telemetry relocation data. Montana Depart. Fish, Wildlife Parks, Bozeman, Montana. 14 pp.
- Loveless, C.M. 1967. Ecological characteristics of a mule deer winter range. Colorado Div. Game, Fish, Parks. Tech. Publ. 20. 124 pp.
- Mackie, R.J. 1981. Interspecific relationships. Pages 487-507 in Mule and blacktailed deer of North America. O.C.Wallmo ed. Univ. Nebraska Press, Lincoln.
- _____. 1983. Natural regulation of mule deer populations. Pages 112-125 in Symposium on natural regulation of wildlife populations. F. Bunnell, D.S. Eastman, and J.M. Peek, eds. Forest, Wildland and Range Experiment Station. U. of Idaho. Moscow, Idaho. Proceedings No. 14.

- _____. 1985. The elk-deer-livestock triangle. Pages 51-56 in Western elk management---a symposium. G.E. Workman ed. Utah State Univ. Logan.
- Mackie, R.J., D.F. Pac, and H.E. Jorgensen. 1980. Population ecology and habitat relationships of mule deer in the Bridger Mountains, Montana. Pages 192-203 in Montana Deer Studies. Job Prog. Rept., Fed Aid Proj. W-120-R-11. Montana Depart. Fish, Wildl, Parks, Helena.
- Mackie, R.J., K.L. Hamlin, and D.F. Pac. 1981. Census methods for mule deer. Pages 97-105 in Symposium on census and inventory methods for populations and habitats. F.L. Miller and A. Gunn, eds. Forest, Wildlife and Range Exp. Sta. Univ. Idaho, Moscow.
- _____. 1982. Mule Deer. Pages 862-877 in Wild mammals of North America. J.A. Chapman and G.A. Feldhammer eds. Johns Hopkins Univ. Press, Baltimore.
- Mautz, W.W. 1980. Nutrition and carrying capacity. Pages 321-348 in Big game of North America, ecology and management. J.L. Schmidt and D.L. Gilbert eds. Stackpole Books, Harrisburg, Pa.
- Mohr, C.O. 1947. Table of equivalent populations of North American small mammals. Amer. Midl. Natur. 37:223-249.
- Mueggler, W.F. and R.B. Campbell, Jr. 1982. Aspen community types on the Caribou and Targhee National Forests in southeastern Idaho. USDA, For. Ser. Res. Pap. INT-294, Intermountain For. Range Exper. Sta., Ogden, Utah. 32 pp.
- Neu, C.W., C.R. Byers, and J.M. Peek. 1974. A technique for analysis of utilization-availability data. J. Wildl. Manage. 38:541-545.
- NOAA. 1961-1986. Climatological data for Idaho. National Climatic Data Center, U.S. Depart. Commer., Asheville, North Carolina.
- Nyberg, H.E. 1980. Distribution, movements, and habitat use of mule deer associated with the Brackett Creek winter range. Bridger Mountains, Montana. M.S. Thesis, Montana State Univ., Bozeman. 105 pp.

- Oosting, H.J. 1956. The study of plant communities. Wilt Freeman and Co. 440 pp.
- Pac, D.F. 1976. Distribution, movements, and habitat use during spring, summer and fall by mule deer associated with the Armstrong winter range, Bridger Mountains, Montana. M.S. Thesis, Montana State Univ., Bozeman. 120 pp.
- Pederson, J.C. and K.T. Harper. 1978. Factors influencing productivity of two mule deer herds in Utah. J. of Range Manage. 31:105-110.
- _____. 1984. Does summer range quality influence sex ratios among mule deer fawns in Utah? J. of Range Manage. 37:64-66.
- Pfister, R.D., B.L. Kovalchik, S.F. Arno, and R.C. Presly. 1977. Forest habitat relationships of Montana. USDA, For. Ser., Gen. Tech. Report INT-34, Intermountain For., Range Exper. Sta., Ogden, Utah. 174 pp.
- Picton, H.D. and R.R. Knight. 1971. A numerical index of winter conditions of use in big game management. Pages 29-37 in A.O.Haugen, ed. Proc. Symp. on Snow and Ice in Relation to Wildlife and Recreation. Iowa State University, Ames.
- Ramsey, C.W. 1968. A drop-net deer trap. J. Wildl. Manage. 32:187-190.
- Richens, V.B. 1967. Characteristics of mule deer herds and their range in northeastern Utah. J. of Wildl. Manage. 31:651-666.
- Robinette, W.L. 1966. Mule deer home range and dispersal in Utah. J. Wildl. Manage. 30:335-349.
- Rosgaard, A.I. 1981. Ecology of mule deer associated with the Brackett Creek winter range, Bridger Mountains, Montana. M.S. Thesis, Montana State Univ., Bozeman. 76 pp.
- Schwarzkoph, W.F. 1973. Range use and relationships of mule deer on the west slope of the Bridger Mountains of Montana. M.S. Thesis, Montana State Univ., Bozeman. 65 pp.

- Short, H.L. 1981. Nutrition and metabolism. Pages 99-127 in Mule and blacktailed deer of North America. O.C. Wallmo, ed. Univ. Nebraska Press. Lincoln.
- Steele, R.G.D. and J.H. Torrie. 1980. Principles and procedures of statistics: a biometrical approach. McGraw-Hill book Company. New York. 633 pp.
- Steele, R. S.V. Cooper, D. M. Ondov, D.W. Roberts, and R.D. Pfister. 1983. Forest habitat types of eastern Idaho-western Wyoming. USDA, For. Ser. Gen. Tech. Rep. INT-144. 122 pp.
- Steerey, W. 1979. Distribution, range use and population characteristics of mule deer associated with the Schafer Creek winter range, Bridger Mountains, Montana. M.S. Thesis, Montana State Univ., Bozeman. 119 pp.
- Wolfe, M.L. 1976. Reliability of mule deer population measurements. Pages 93-98 in Mule deer decline in the west, a symposium. Gar Workman, ed. Utah State Univ. Utah Agri. Exper. Sta., Logan.
- Youmans, H.B. 1979. Habitat use by mule deer of the Armstrong winter range, Bridger Mountains, Montana. M.S. Thesis, Montana State Univ., Bozeman. 66 pp.
- Zalunardo, R.A. 1965. The seasonal distribution of a migratory mule deer herd. J. Wildl. Manage. 29: 345-351.

APPENDIX

Table 20. Climatological data¹ ((Bureau of Reclamation, Ririe Dam, Ririe, Idaho)
for the Willow Creek winter range, winter 1975-76 through 1985-86.

Year	November			December			January			February			March			April			May		
	H	L	P	H	L	P	H	L	P	H	L	P	H	L	P	H	L	P	H	L	P
1976-1977	9	-3	0.1	4	-8	0.2	-1	-13	2.4	6	-7	0.6	6	-4	10.3	19	2	0.4	17	4	6.6
1977-1978	7	-4	1.8	2	-5	5.6	2	-6	4.6	4	-5	3.5	12	-1	1.4	13	1	6.8	18	4	5.6
1978-1979	6	-4	1.1	-3	-12	2.4	-4	-16	4.7	3	-7	3.8	7	-3	1.6	13	-6	1.2	22	4	0.3
1979-1980	6	-7	2.5	4	-6	0.9	-2	-10	5.5	4	-5	3.7	6	-3	5.1	18	2	5.0	18	7	12.3
1980-1981	5	-4	1.9	2	-6	1.9	4	-6	1.7	2	-7	1.8	8	-3	2.6	13	1	4.2	14	3	11.6
1981-1982	8	-2	4.5	2	-5	5.3	-2	-11	2.7	1	-11	3.4	8	-2	3.6	11	-2	2.0	16	2	4.1
1982-1983	3	-6	3.1	-2	-11	5.2	1	-6	18.1	3	-7	3.6	5	-3	2.4	9	-2	4.7	13	1	3.8
1983-1984	6	-3	8.6	-4	-13	8.0	-4	-12	1.7	-4	-13	3.6	5	-5	3.1	9	-7	2.0	18	4	1.9
1984-1985	4	-4	3.4	-2	-11	3.4	-2	-13	3.3	-2	-13	4.9	4	-9	3.3	15	1	0.8	20	4	3.0
1985-1986	1	-8	6.3	-2	-13	2.3	2	-8	2.7	3	-4	7.1	14	-1	4.5	11	1	10.7	19	3	1.9
Average	6	-4	3.3	0	-9	3.5	-1	-10	3.1	2	-8	3.6	7	-3	2.9	13	0	3.8	17	4	5.1

¹ H = average daily high temperature (Celsius (°C)), L = average daily low temperature (°C), and P = total monthly precipitation (centimeters).

Table 21. National Forest habitat and community types on the Willow Creek study area (Mueggler et al. 1982 and Steele et al. 1983).

Cover Type	Name ¹	Importance	Distribution Within Study Area	Elevation Range (m)	Major Aspect	Number Sampled
Conifer	PSME/PHMA	Minor	Snake River drainage	1646-2286	N	1
	PSME/ACGL	Minor	Southeast corner	1829-2530	N	2
	PSME/SYAL	Minor	Tincup Creek and north	1737-2255	S and E	
	PSME/OSCH	Major	Throughout	1768-2377	N	2
	PSME/SPBE	Minor	McCoy Creek and north	1829-2499	Various	1
	PSME/CARU	Major	Throughout	1829-2469	Various	2
	PSME/BERE	Major	Southern half	1739-2591	Various	
	PSME/SYOR	Minor	Middle section	2012-2530	Various	
	ABLA/ACGL	Minor	Eastern half	1316-1737		4
	ABLA/ACRU	Minor	Throughout	2042-2499	Various	
	ABLA/PHMA	Minor	McCoy Creek and south	1829-2255	N	1
	ABLA/LIBO	Minor	East of Afton, WY	2164-2591	Various	
	ABLA/VAGL/PAMY	Major	North and south ends	1737-2652	N-E	
	ABLA/VAGL/VASC	Major	North and south ends	2012-2591	N-E	2
	ABLA/VAGL/VAGL	Minor	Southern end	1981-2987	Various	
	ABLA/SYAL	Minor	Idaho-Wyoming border	1737-2316	Various	
	ABLA/THOL	Minor	Northern end	2316-2713	Various	
	ABLA/OSCH/PAMY	Minor	Throughout	1981-2591	N-E	1
	ABLA/SPBE	Minor	Northeast corner	2042-2316	W-S	
	ABLA/CARU	Major	Throughout	1859-2591	Various	4
	ABLA/BERE	Minor	Eastern border	2012-2713	N	1
	PICO/VAGL	Minor			N-E	1
Aspen	POTR/ABLA/SYOR	Minor	Throughout	2100-2320	Various	
	POTR/PICO/CARU	Minor	Scattered throughout	1740-2450	S	
	POTR/AMAL/PAMY	Common	Throughout	1740-2290	Various	
	POTR/AMAL/SYOR	Major	Throughout	1585-2225	S-various	12
	POTR/AMAL/CARU	Common	Throughout	1675-2225	S	2
	POTR/PAMY/CARU	Minor	Scattered throughout	1850-2450	N	
	POTR/PAMY/GEVI	Minor	Scattered throughout	2100-2500	Various	
	POTR/SYOR/CARU	Major	Throughout	1740-2290	S	1
	POTR/SYOR/RUOC	Major	Throughout	1740-2195	S	
	POTR/GEVI	Minor	Throughout	1920-2500	Various	2
	POTR/WYAM	Minor	Throughout	1920-2050	Various	
	POTR/CARU	Major	Throughout	1700-2500	Various	1
	POTR/POPR	Major	Throughout	1830-2290	Bottoms	

¹ See Table 22 for key to 4-letter plant species abbreviations.

Table 22. Key to 4-letter plant species abbreviations.

	Scientific Name	Common Name
ABLA	<u>Abies lasiocarpa</u>	Subalpine fir
ACGL	<u>Acer glabrum</u>	Mountain maple
ACRY	<u>Actea rubra</u>	Baneberry
AMAL	<u>Amelanchier alnifolia</u>	Serviceberry
BERE	<u>Berberis repens</u>	Oregon creeping grape
CARU	<u>Calamagrostis rubescens</u>	Pinegrass
GEVI	<u>Geranium viscosissimum</u>	Sticky geranium
LIBO	<u>Linnea borealis</u>	Twinflower
OSCH	<u>Oshmorhiza chilensis</u>	Mountain sweetroot
PAMY	<u>Pachistima myrsinites</u>	Pachistima
PHMA	<u>Physocarpus malvaceus</u>	Ninebark
PICO	<u>Pinus contorta</u>	Lodgepole pine
POPR	<u>Poa pratensis</u>	Kentucky bluegrass
POTR	<u>Populus tremuloides</u>	Quaking aspen
PSME	<u>Pseudotsuga menziesii</u>	Douglas fir
RUOC	<u>Rudbeckia occidentalis</u>	Western cone flower
SPBE	<u>Spiraea betulifolia</u>	White spirea
SYOR	<u>Symphoricarpos oreophilus</u>	Mountain snowberry
SYAL	<u>Symphoricarpos albus</u>	Common snowberry
VAGL	<u>Vaccinium globulare</u>	Blue huckleberry
VASC	<u>Vaccinium scoparium</u>	Grouse wartleberry
WYAM	<u>Wyethia amplexicaulis</u>	Mule's ear

Table 23. Percent availability of cover types¹ on winter survey routes on Willow Creek winter range (n=total number of random points analyzed in that subunit).

Subunit	Closed Juniper	Open Juniper	Scattered Juniper	Open						
				Sage	MB	Grass	Aspen	RIP	Agri.	PP
Kepps n=411	7.1	8.5	4.1	67.4	0.2	0.5	1.0	5.4	4.4	0
Clowards n=575	13.4	7.5	1.4	20.2	0.3	0	2.3	6.8	42.8	3.8
Blacktail n=315	1.9	2.2	0.6	75.0	0.9	6.0	2.5	0.3	10.5	0
Meadow Creek n=517	2.7	1.9	1.4	55.1	4.1	0	11.8	6.4	15.9	0
Deer-Bear n=686	4.1	2.9	1.5	37.9	4.8	1.6	6.6	0.4	12.5	1.6
Tex Creek n=469	0.9	6.4	1.7	51.4	1.5	0	10.0	3.4	8.3	16.4

¹ MB=Mountain Brush, RIP=Riparian, Agri.=Agricultural, PP=Permanent Planting.

Table 24. Percent availability of topographical features in subunits on Willow Creek winter range (n= number of points analyzed).

Subunit	n	$\bar{X}$ Elev. (m)	Percent Aspect									
			N	NE	E	SE	S	SW	W	NW	Flats	Top
Kepps	279	1485	12.9	8.6	10.4	3.9	4.3	5.7	11.8	1.1	0	28.3
Clowards	303	1447	17.2	5.3	4.0	0	11.2	7.9	2.3	3.0	0	44.6
Blacktail	262	1451	7.2	1.5	20.2	0	5.7	3.4	10.3	1.0	0	45.0
Meadow Creek	343	1456	13.5	8.8	13.8	3.1	12.5	11.3	14.1	1.6	9.0	3.1
Deer-Bear Creek	325	1480	22.7	1.2	7.0	4.4	7.9	6.1	19.0	0	17.8	7.6
Tex Creek	292	1535	11.3	8.6	3.8	14.0	21.9	2.4	5.5	12.7	4.5	6.8
$\bar{X}$	301	1476	14.1	5.7	9.4	4.2	10.6	6.1	10.5	3.2	5.2	22.6

Table 25. Percent availability of cover types¹ on summer range of the Willow Creek study area (n=number of 35 mm slides analyzed).

Region ²	Closed Conifer	Open Conifer	Closed Aspen	Open Aspen	Open			Grass	Agri.	RIP
					Sage	MB	S/MB			
W n=100	2.6	1.0	12.6	0.2	47.4	0.2	0.8	4.8	24.9	0.7
SE n=79	31.7	6.3	8.9	0.5	33.7	8.7	0	1.5	7.0	1.3
NE n=121	27.7	7.8	9.3	0.9	22.9	7.3	5.7	3.6	9.1	0.5

¹ MB=Presence of 5 percent or more of mountain brush (MB) species Purshia tridentata, Amalanchier alnifolia, and Acer glabrum. S/MB= Sagebrush dominated stands with 1-5 percent mountain brush species.

² W=Western, SE=Southeastern, NE=Northeastern.

Table 26. Status as of October 31, 1986, of all deer radiomarked on Willow Creek and Wolverine winter ranges, 1983-1986.

ID1	Age2/Sex3	Capture Site	Summer HU	Area	Status
4019	Ad./F	Clowards	66A	Squaw Cr.	Alive
4028	Ad./F	Clowards	66A	Trail Cr.	Alive
4076	Ad./M	Clowards	WY	Big Elk Cr.	GH ⁴
4107	Ad./F	Ritter	66A	Trail Cr.	Alive
4202	Ad./F	Deer Heaven	69	Dan Cr.	Alive
4300	Ad./F	Meadow Cr.	66A	Bridge Cr.	Missing
4340	Y/M	Clowards	66	Bear Cr.	GH
4341	Y/M	Ririe Dam			WK ⁵
4371	Ad./F	Ritter	66A	Jackknife Cr.	Alive
4427	Ad./F	Wolverine	76	Enoch Valley	Alive
4510	Y/M	Wolverine	69	Sheep Mtn.	GH
4526	Ad./F	Wolverine	69	Cellars Cr.	Missing
4614	Ad./F	Ririe Dam	66A	Iowa Cr.	Alive
4689	Ad./F	Wolverine	76	Sheep Cr.	Alive
4750	Ad./F	Clowards	66A	Trail Cr.	Alive
4825	Ad./F	Blacktail	66	Shirley Cr.	Alive
4881	Ad./F	Ritter	66A	Jackknife Cr.	Alive
5060	Ad./F	Ritter	76	Lanes Cr.	Alive
5140	Ad./F	Ritter	69	Meadow Cr.	Alive
5191	Ad./F	Ritter	66A	Bridge Cr.	Alive
5276	Ad./F	Blacktail	66	Deadman Cr.	Alive
5375	Ad./F	Blacktail	66A	Harrison Cr.	Alive
5587	Y/M	Blacktail	69	Birch Cr.	RK(?) ⁶
5612	Ad./F	Clowards	66A	Squaw Cr.	Alive
5638	Ad./F	Kepps	76	Enoch Valley	Alive
5663	Y/M	Kepps	WY	Rock Lake	Alive
5688	Ad./F	Kepps	76	Stump Cr.	Alive
5851	Ad./M	Deer Heaven	69	Corral Cr.	IK ⁷
5916	Ad./M	Kepps	69	Dan Cr.	GH
5990	Ad./F	Clowards	66A	Squaw Cr.	Alive

1. Freq. = frequency.
2. Y = Yearling and ad. = adult.
3. M = Male and F = Female.
4. GH = General Harvest.
5. WK = Winter Kill.
6. RK(?) = possible Road Kill.
7. IK = Illegal Kill.

Table 27. Number and classification of mule deer harvested, by subunit, in Hunting Unit 69 of the Willow Creek study area, 1981-85.

Class ⁴	1981 ¹					1982					1983 ²					1984 ³					1985				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
F/fawn	0	1	1	3	0	0	0	1	0	0	23	7	0	2	1						8	2	0	2	0
F/Y	0	2	3	3	0	1	2	1	2	0	32	3	1	3	0						4	2	1	0	0
F/Ad.	0	2	2	10	1	2	4	1	3	0	55	8	5	4	2						14	1	0	5	1
Antl./UC	0	0	1	1	0	0	1	0	0	0	0	0	0	2	0						0	0	0	0	0
M/fawn	2	2	13	0	0	1	2	1	0	0	41	4	2	1	0						6	1	1	1	2
M/Y	0	2	6	13	0	3	6	6	15	2	54	10	13	8	2	24	2	4	5	0	30	3	2	4	1
M/Ad.	3	1	1	9	0	12	10	12	22	2	63	4	4	16	4	34	5	5	3	2	36	4	3	8	0
M/UC	0	0	0	0	0	0	1	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum	3	0	16	52	1	19	26	22	44	4	268	37	25	36	9	58	7	9	8	2	98	13	7	20	4
											107										26				
																					44				

¹ No antlerless season in Subunit 1.

² Wolverine Canyon Check Station established.

³ No antlerless season in entire unit.

⁴ F=female, M=male, Antl.=antlerless, UC=unclassified, Y=yearling, Ad.=adult.

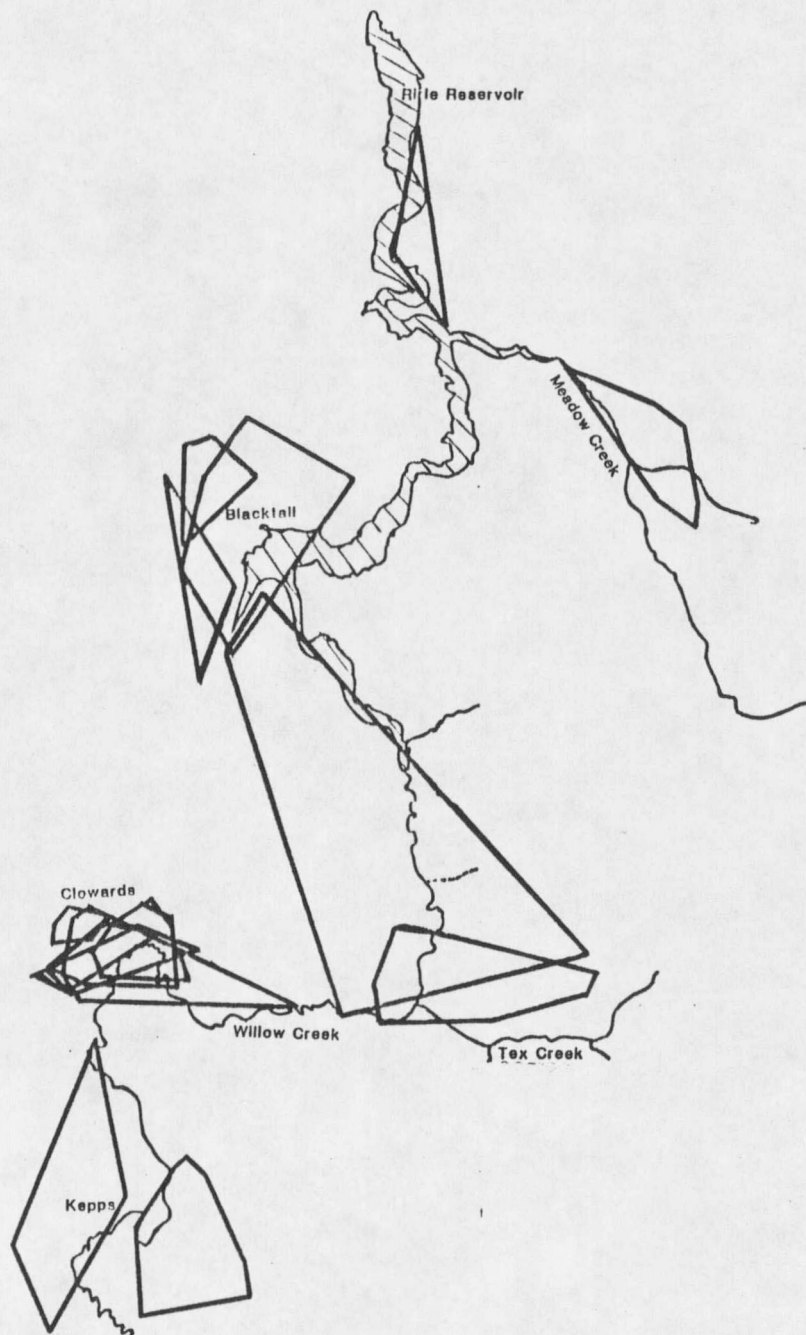


Figure 15. Winter home range minimum convex polygons (years combined) for deer radiomarked on Willow Creek winter range, 1984-86.

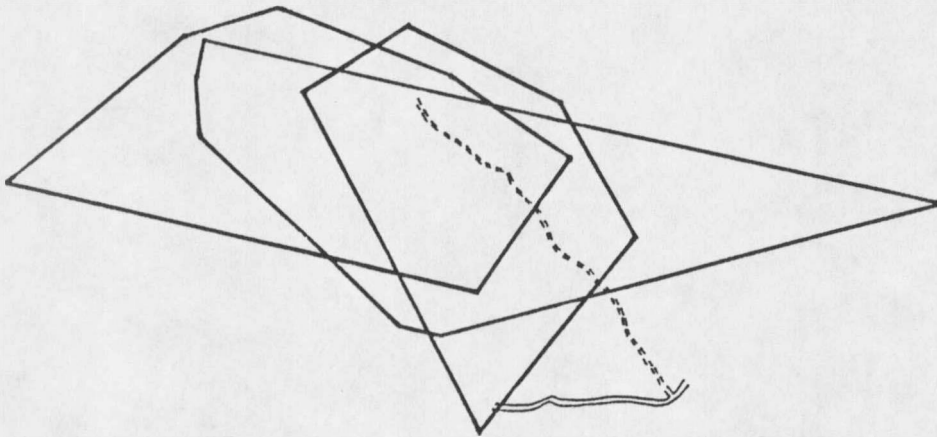


Figure 16. Summer home range overlap of 3 female deer radiomarked in the Clowards subunit of Willow Creek winter range, January 1985.

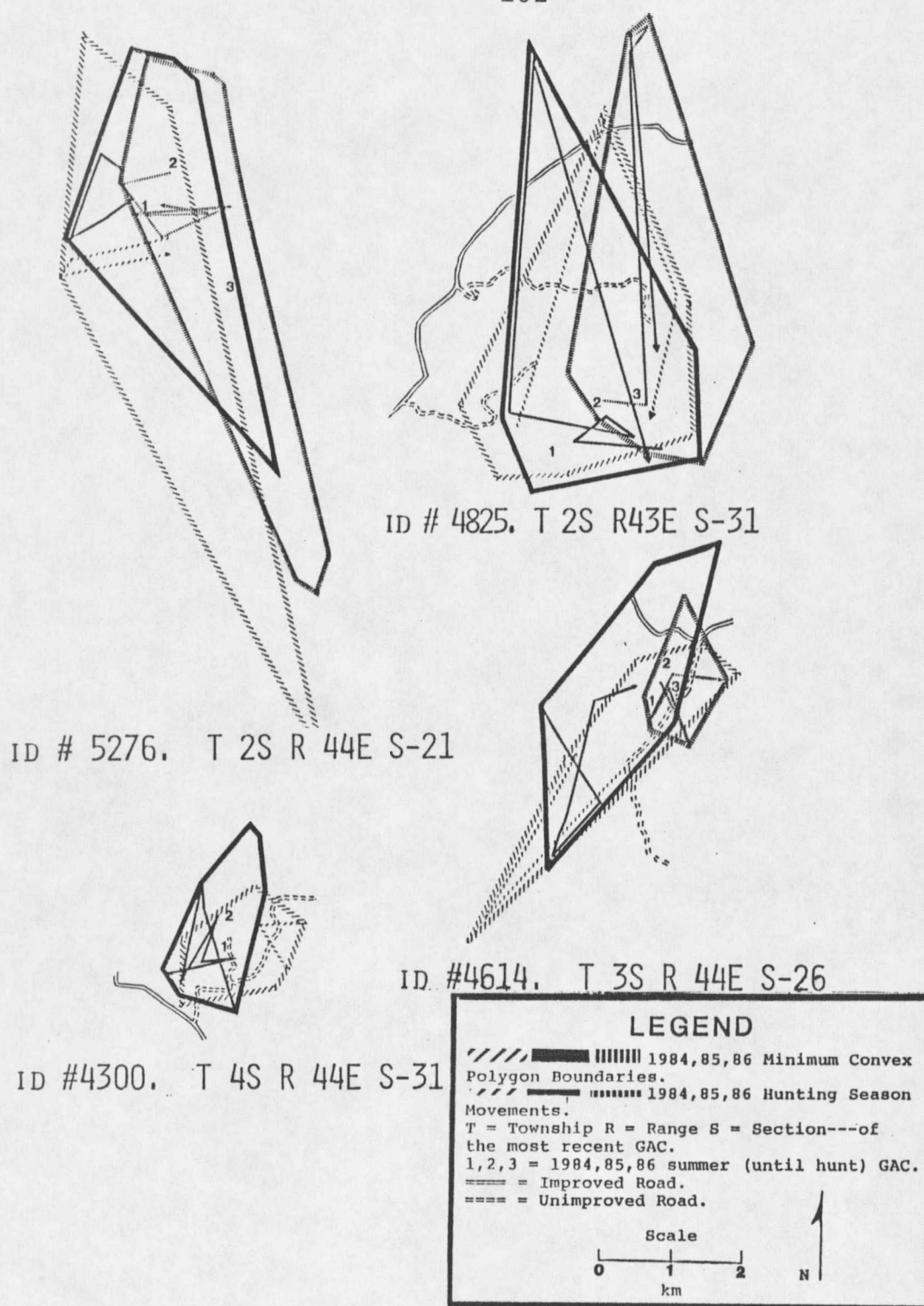
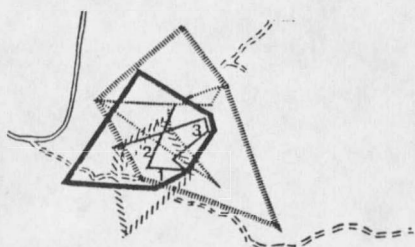
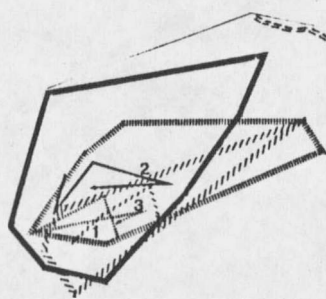


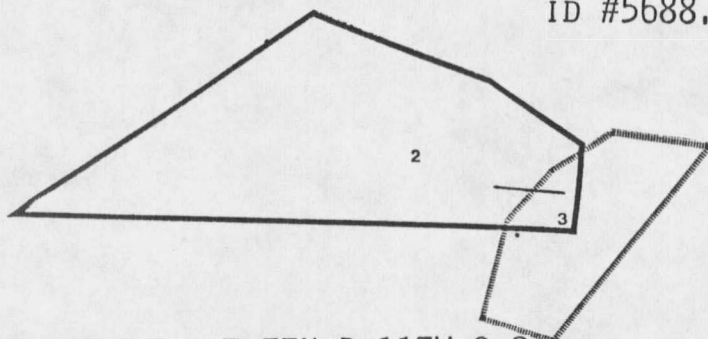
Figure 17. Minimum convex polygon summer home ranges for deer radiomarked on WCWR and Wolverine Canyon.



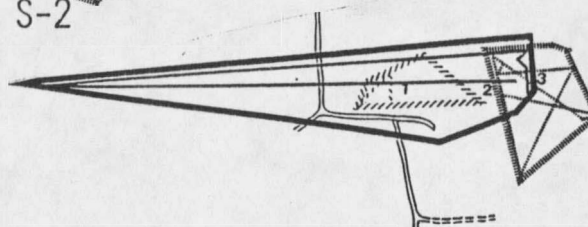
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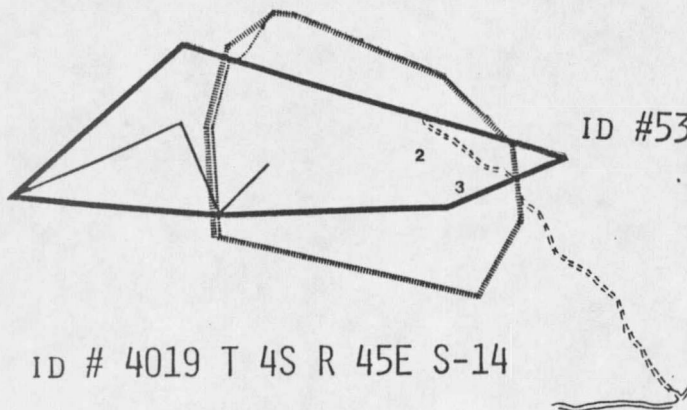
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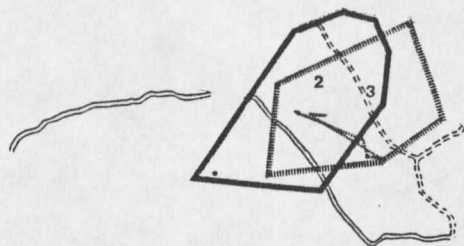
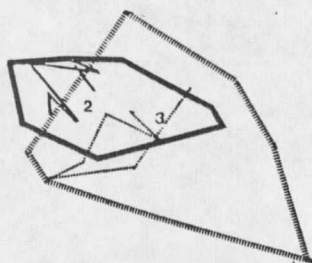


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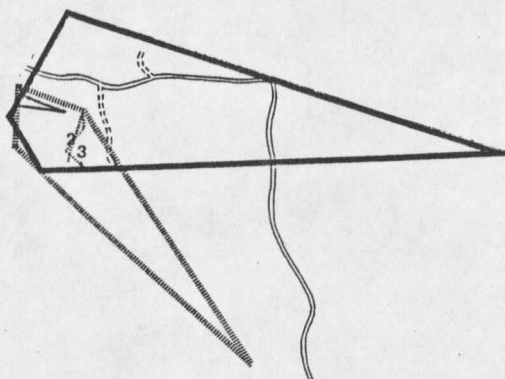
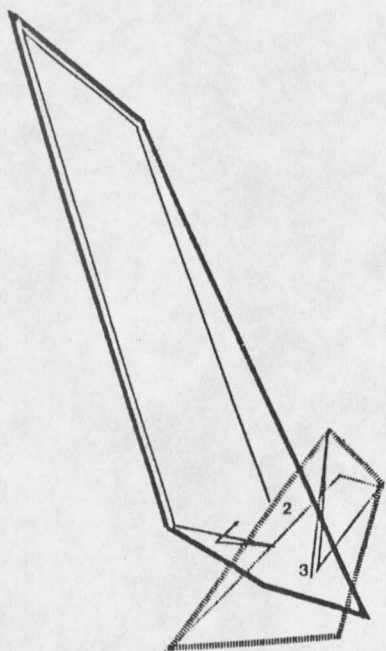


ID # 4019 T 4S R 45E S-14

Figure 17. Continued.

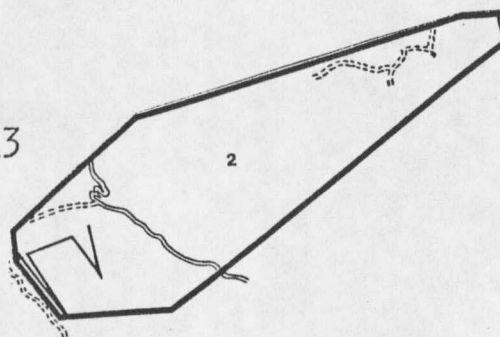
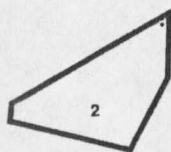


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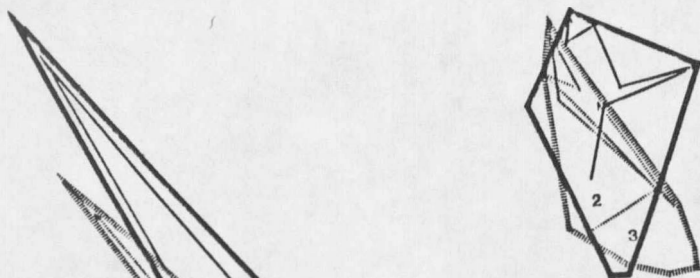
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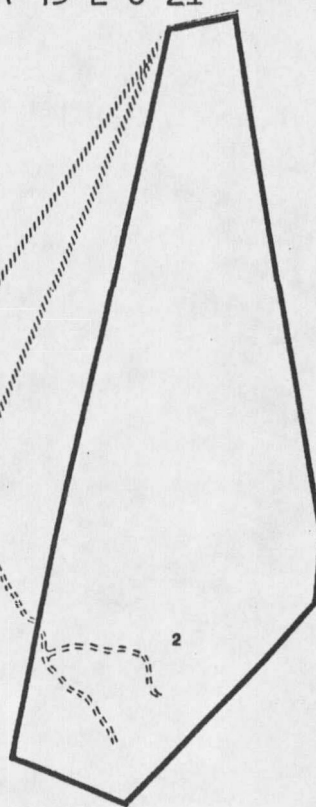
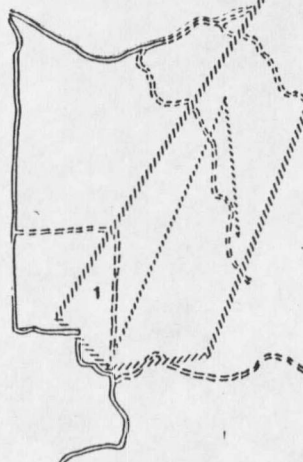
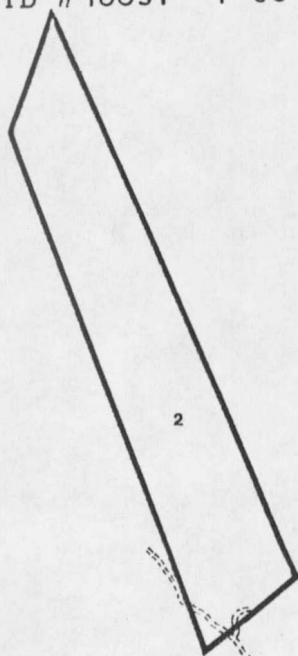
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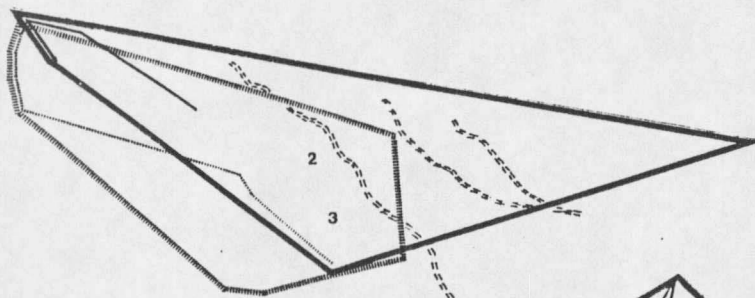
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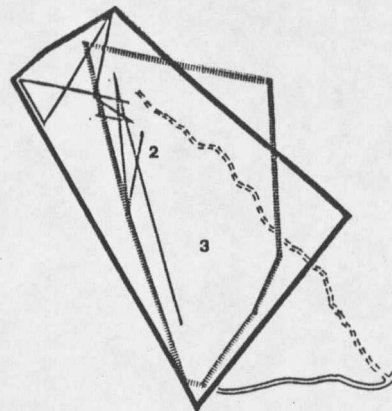
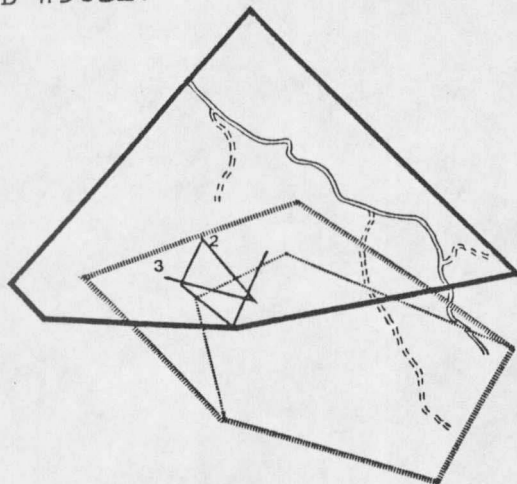
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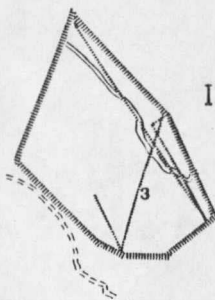


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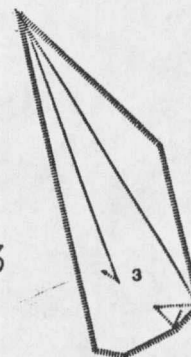
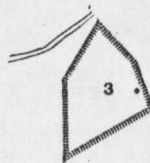


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ID #5851. T 2S R 42E S-1



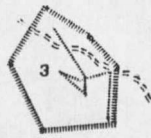
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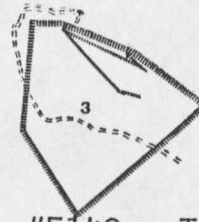
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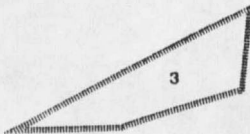
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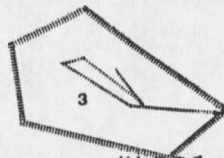
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ID #4881. T 4S R 45E S-29

Figure 17. Continued.

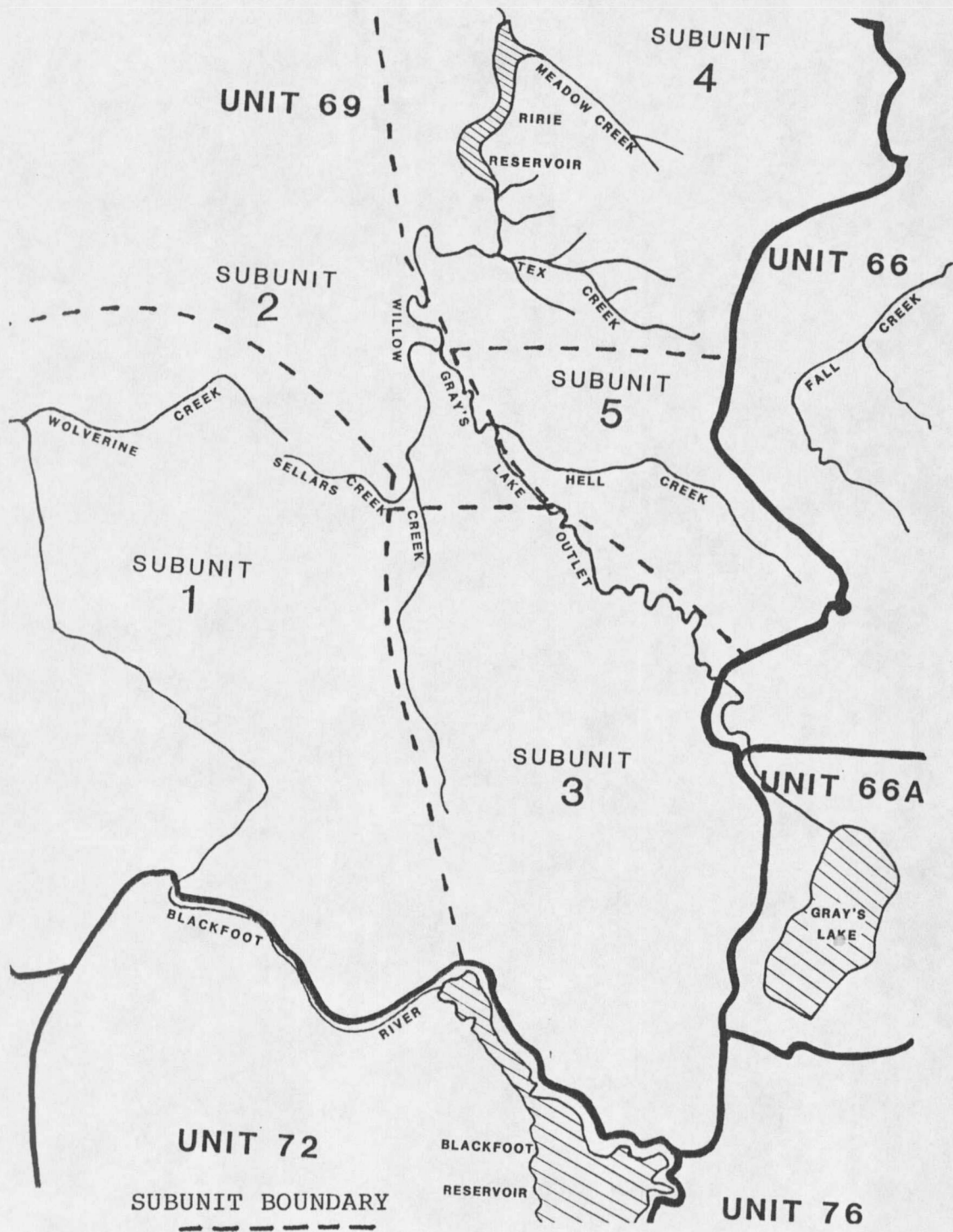


Figure 18. Subunits of Hunting Unit 69 of the Willow Creek study area.

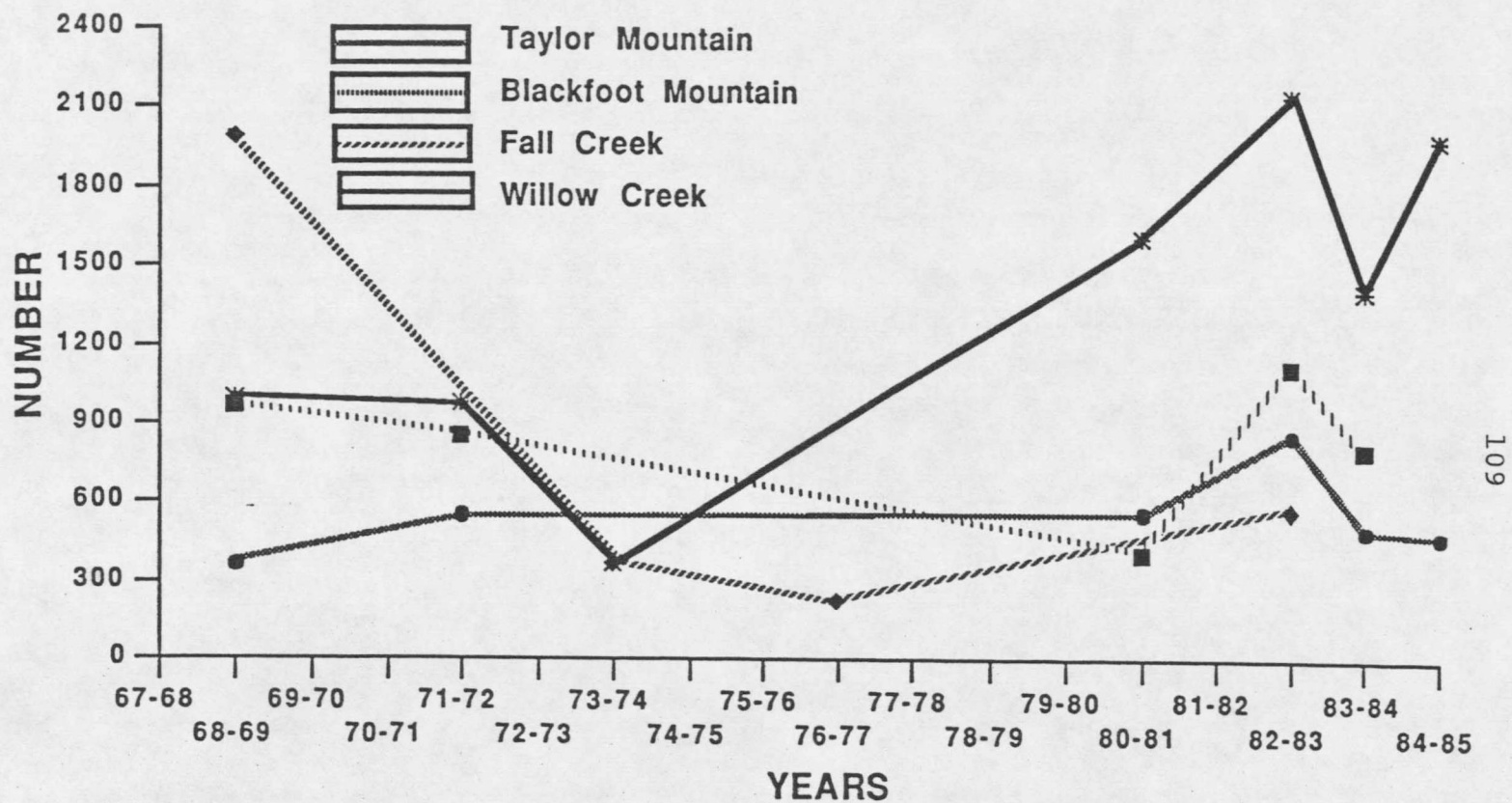


Figure 19. Comparison of mule deer trend counts on Willow Creek and surrounding winter ranges, 1967-68 through 1984-85.

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