MONTANA STATE UNIVERSITY

Distribution, movements, and habitat use during spring, summer, and fall by mule deer associated with the Armstrong winter range, Bridger Mountains, Montana

by David Frank Pac

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 in the Bridget Mountains of southwestern Montana from June through September 1974 and from June through December 1975. Objectives were to obtain data on summer and fall distribution, movements, habitat use and food habits, including ' nutritional relationships, of mule deer associated with the Armstrong winter range. Special emphasis was directed to use of forest habitat types by monitoring five radio-collared adult females. Fourteen habitat types and five phases associated with five major climax series were recognized and described. Deer numbers, productivity, distributions, movements, and range use characteristics were determined from 22 aerial flights and regular ground surveys. Approximately 210 deer occurred on the Armstrong Range in early winter 1975, of which only 139 survived the severe winter and dispersed onto summer ranges in the spring of 1975. Observed fawn:doe ratios declined from 26:100 in early fall 1975 to 9:100 by early winter, with most of the change occurring during a period of severe weather in late November when deer were concentrated on fall "holding" areas. Relocations of individually marked animals showed that 73 percent had summer and/or fall ranges within 6 kilometers of the winter range. The remainder migrated greater distances north and south of these areas as well as along the east slope of the Bridget Range. Most deer appeared to habitually use the same summer and winter home ranges each year. Seasonal migrations followed definite routes which included local "holding" areas where deer aggregated for variable time periods during spring and fall. Normal summer home ranges averaged 52 hectares (128 acres) for the five radio-collared females, while total home ranges averaged 107 hectares (264 acres). Heavy usage of forested habitats, especially the Pseudotsuga menziesii series, was observed during late spring, summer, and fall 1975. The DF/Caru, DF/Cage, and DF/Agsp habitat types were most important during spring and fall. The DF/Caru and Krummholz types were most important in summer. Relocations of radioed deer indicated that use of the Pseudotsuga menziesii series may have been overestimated by general observations while usage of Abies lasiocarpa and Pinus albicaulis series were underestimated. Significant shifts in use of habitat types occurred during late summer, apparently in response to shortages of succulent forage caused by dessication and killing frosts. Food habit studies showed that forbs and browse, in order of importance, were used during late spring (June); while forbs, browse, and grass and browse, forbs, and grass were orders of importance for use during summer and fall, respectively. Protein contents of important forage plants were highest at emergence in spring and declined steadily to fall dormancy.

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DISTRIBUTION, MOVEMENTS, AND HABITAT USE DURING SPRING, SUMMER, AND FALL BY MULE DEER ASSOCIATED WITH THE ARMSTRONG WINTER RANGE, BRIDGER MOUNTAINS, MONTANA

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Approved:

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ABSTRACT

A study was conducted in the Bridger Mountains of southwestern Montana from June through September 1974 and from June through December 1975. Objectives were to obtain data on summer and fall distribution, movements, habitat use and food habits, including nutritional relationships, of mule deer associated with the Armstrong winter range. Special emphasis was directed to use of forest habitat types by monitoring five radio-collared adult females. Fourteen habitat types and five phases associated with five major climax series were recognized and described. Deer numbers, productivity, distributions, movements, and range use characteristics were determined from 22 aerial flights and regular ground surveys. Approximately 210 deer occurred on the Armstrong Range in early winter 1975, of which only 139 survived the severe winter and dispersed onto summer ranges in the spring of 1975. Observed fawn:doe ratios declined from 26:100 in early fall 1975 to 9:100 by early winter, with most of the change occurring during a period of severe weather in late November when deer were concentrated on fall "holding" areas. Relocations of individually marked animals showed that 73 percent had summer and/or fall ranges within 6 kilometers of the winter range. The remainder migrated greater distances north and south of these areas as well as along the east slope of the Bridger Range. Most deer appeared to habitually use the same summer and winter home ranges each year. Seasonal migrations followed definite routes which included local "holding" areas where deer aggregated for variable time periods during spring and fall. Normal summer home ranges averaged 52 hectares (128 acres) for the five radio-collared females, while total home ranges averaged 107 hectares (264 acres). Heavy usage of forested habitats, especially the *Pseudotsuga menziesii* series, was observed during late spring, summer, and fall 1975. The DF/Caru, DF/Cage, and DF/Agsp habitat types were most important during spring and fall. The DF/Caru and Krummholz types were most important in summer. Relocations of radioed deer indicated that use of the *Pseudotsuga menziesii* series may have been overestimated by general observations while usage of *Abies lasiocarpa* and *Pinus albicaulis* series were underestimated. Significant shifts in use of habitat types occurred during late summer, apparently in response to shortages of succulent forage caused by dessication and killing frosts. Food habit studies showed that forbs and browse, in order of importance, were used during late spring (June); while forbs, browse, and grass and browse, forbs, and grass were orders of importance for use during summer and fall, respectively. Protein contents of important forage plants were highest at emergence in spring and declined steadily to fall dormancy.

INTRODUCTION

Studies of mule deer in the Bridger mountain range were initiated in 1955-56 when Wilkins (1957) determined range use and food habits of mule deer associated with the Armstrong winter range. Since 1972, continuing intensive investigations have included studies to provide current information on range use and food habits, describe seasonal distributions, movements, and behavioral characteristics, and determine population trends and dynamics of mule deer on that area (Schwarzkoph 1973, Hamlin 1974, Mackie *et al.* 1976). Ecological characteristics of the Armstrong winter range, including the distribution, forage production and utilization of key browse plants, were described by Buscis (1974), while Morton (1976) evaluated nutritional values of important winter forage plants.

Results of these studies have provided considerable information on winter habitat requirements and relationships. Although the studies of Wilkins (1957), Schwarzkoph (1973), and Hamlin (1974) included observations on summer habits, difficulties in observing deer on rugged, heavily forested spring, summer, and fall range areas precluded precise definition of habitat use and requirements during these seasons. The findings of Schwarzkoph (1973) and Hamlin (1974) that fawns and some females enter winter with omental fat reserves close to the critical level indicated that range usage and conditions during

those periods may be important in the ecology of mule deer on the area. Hamlin (1974) also reported that females with fawns appeared to mainly use heavily forested habitat types, while unproductive does and males made greater use of high elevation, mountain meadows during summer.

This study was designed to obtain summer and fall information on the distribution, movements, habitat use, and food habits, including nutritional relationships, of mule deer associated with the Armstrong Range. Special emphasis was given to use of forested areas and types by monitoring five adult females equipped with radio-transmitters during the winter and spring of 1975. Field studies were conducted from June through early September 1974 and from June through December 1975.

DESCRIPTION OF STUDY AREA

The study area (Fig. 1) comprised approximately 50 square kilometers (19.4 square miles) and was located about 32 kilometers (20 miles) north of Bozeman, Montana along the west slope of the Bridger mountain range. The Bridger Range extends from Bridger Canyon northward for 37 kilometers (23 miles) to Blacktail Mountain, in Gallatin County. It is bounded on the east by the Crazy Mountain Basin, on the west by the Gallatin Valley, on the north by the Maudlow Basin, and on the south by a major oblique fault. Geological characteristics of the Bridger Range have been described in detail by McMannis (1955).

Boundaries of the study area were, approximately, Johnson Canyon on the north, Tom Reese Creek on the south, the Bridger divide on the east, and the Gallatin Valley floor on the west. During 1974, observations to relocate marked deer were made periodically over a larger area, extending approximately from Pass Creek on the north to Ross Peak on the south and from the Gallatin Valley floor on the west to the Bridger Canyon-Flathead Pass roads on the east.

Elevations within the study area range from 1600 meters to 2914 meters (5250-9560 feet) with abrupt changes in elevation of 300 meters (985 feet) within one kilometer (0.6 mile) occurring frequently. The main topographic features are numerous east-west ridges which drop off into steep-sided canyons on the north and south. The ridges separate

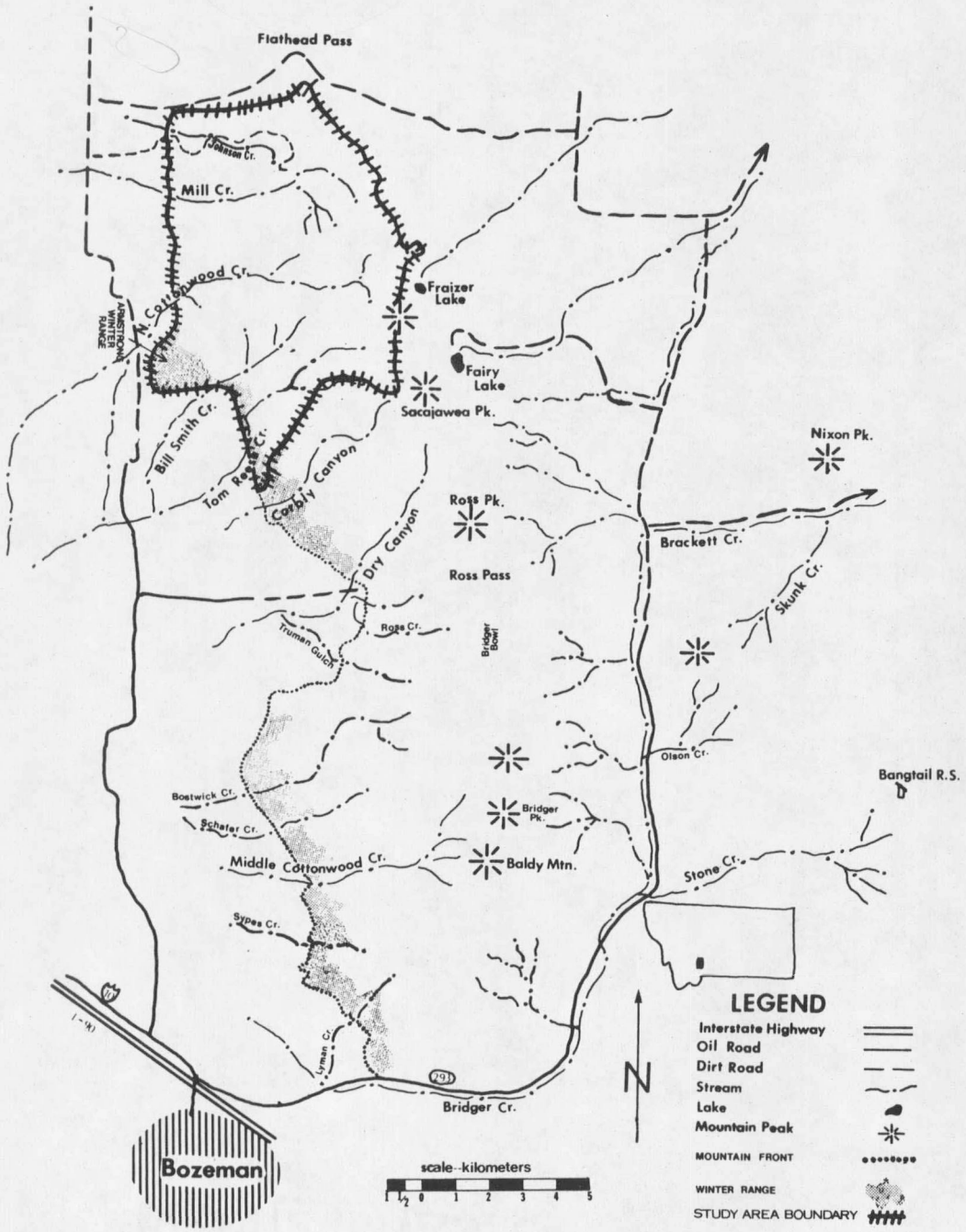

Figure 1. Map of the study area, showing major features.

the study area into five distinct drainages. Tom Reese Creek, North Cottonwood Creek, and Mill Creek originate in high elevation basins along the Bridger divide and flow year round. Bill Smith Creek and Johnson Creek are intermittent streams originating in the Montane forest at lower elevation.

Approximately 90 percent of the study area is federally owned and administered by the U.S.D.A. Forest Service, Gallatin National Forest. The remainder, including most of the footslope area is privately owned. A U. S. Forest Service road into Johnson Canyon provided public access to the north end of the study area. Access into all other canyons was restricted by private ownership and was limited primarily to foot travel.

Vegetation characteristics of portions of the study area were described previously by Wilkins (1957), Schwarzkoph (1973), Hamlin (1974), and Buscis (1974). The recent classifications and descriptions of forest habitat types (Pfister *et al.* 1974) and mountain grassland and shrubland habitat types (Mueggler and Handl 1974) of western Montana also apply to this area, though slight modifications appear necessary to accurately describe certain habitat types.

Four major climax habitat series including twelve habitat types occurred within the forested portion of the study area. These included a *Pseudotsuga menziesii* series occurring from 1645 meters to 2440 meters (5397-8005 feet), a *Pinus flexilis* series occurring between

2135 meters and 2590 meters (7005-8498 feet), an *Abies lasiocarpa* series at elevations from 2075 meters to 2620 meters (6808-8596 feet), and a *Pinus albicaulis* series occurring from 2250 meters to 2695 meters (7382-8842 feet). Both series and component habitat types overlapped elevationally as the temperate forest series extended to higher elevations on southerly exposures and the subalpine forest series extended downward on northerly exposures. Alpine meadows and subalpine (krummholz) habitats occurred at elevations from 2320 meters to 2900 meters (7612-9514 feet). Descriptive characteristics and distributions of these forest series and types, as well as alpine and subalpine habitat types will be discussed under results.

A Winter Range series, comprised of bunchgrass prairie and shrubland habitat types, occurred on slopes, footslopes, and the valley floor below the forest at elevations from 1600 to 2015 (5250-6611 feet) (Buscis, 1974).

Climatological data (U. S. Department of Commerce) for two U. S. Weather Bureau Stations, Belgrade FAA and Bozeman 12 NE, for 1974 and 1975, as well as the 24-year means, are listed in Table 1. Belgrade FAA is located in the Bunchgrass Prairie Zone, 16.1 airline kilometers (10 miles) southwest of the study area at an elevation of 1357 meters (4452 feet). Bozeman 12 NE station is located on the east slope of the Bridger Range, 19.3 airline kilometers (12 miles) northeast of Bozeman at an elevation of 1814 meters (5950 feet) within the

TABLE 1. CLIMATOLOGICAL DATA GATHERED BY THE U. S. DEPARTMENT OF COMMERCE FROM THE BELGRADE FAA AND BOZEMAN 12 NE WEATHER STATIONS.

	Temperature (Degrees C.)												Yearly
	J	F	M	A	M	J	J	A	S	O	N	D	Ave.
Belgrade FAA (24 year average)	-8.3	- 4.8	-3.4	4.4	10.2	14.8	19.4	18.5	12.4	6.7	-0.8	-5.8	5.4
Belgrade 1974	-8.7	- 0.6	-1.9	6.8	8.4	17.3	20.6	16.9	12.2	7.4	-0.1	-6.6	6.0
Belgrade 1975	-8.4	-10.2	-4.7	0	7.8	12.8	20.4	16.3	11.9	5.7	-3.7	-3.9	3.7
Bozeman 12 NE (24 year average)	-6.7	- 4.8	-3.4	1.3	6.6	11.0	14.6	14.0	9.2	4.8	-1.6	-5.1	3.2
Bozeman 1974	-8.3	- 2.7	-3.4	3.1	4.7	12.5	15.4	12.5	8.4	5.9	-1.0	-6.2	3.4
Bozeman 1975	-7.4	-8.8	-5.2	-2.7	4.9	9.4	16.1	12.1	8.5	3.8	-3.6	-2.7	2.0
	Precipitation (Centimeters)												
Belgrade FAA (24 year average)	1.68	1.07	2.18	2.87	5.49	6.17	2.64	3.02	3.00	2.95	1.83	1.45	34.38
Belgrade 1974	.69	.38	2.74	1.22	6.20	.68	2.69	4.47	3.17	3.28	2.13	3.17	30.84
Belgrade 1975	3.30	3.86	2.67	2.18	5.38	4.09	5.51	2.64	1.93	8.05	2.46	1.83	43.92

TABLE 1. Continued.

	Temperature (Degrees C.)												Yearly
	J	F	M	A	M	J	J	A	S	O	N	D	Ave.
Bozeman 12 NE (24 year average)	7.32	5.74	7.06	8.00	10.5	11.99	4.52	6.17	7.59	7.11	6.68	6.37	89.43
Bozeman 1974	7.72	3.48	16.28	11.07	12.06	4.88	3.05	10.24	4.27	5.28	3.40	5.79	87.53
Bozeman 1975	11.15	5.38	7.98	6.45	12.65	16.10	8.46	10.72	7.47	14.48	11.76	6.05	118.57

Pseudotsuga menziesii series. Mean annual temperature and precipitation for Belgrade during the period 1952-1975 were 5.4°C. (41.7°F.) and 34.38 centimeters (13.5 inches), respectively. During 1974, the mean annual temperature and total precipitation were 6.0°C. (42.8°F.) and 30.84 centimeters (12.1 inches), respectively. The annual mean recorded for temperature during 1975 was 3.7°C. (38.7°F.) and total precipitation was 43.92 centimeters (17.3 inches).

Mean annual temperature and total precipitation for 1952-75 at the Bozeman 12 NE Station were 3.2°C. (37.8°F.) and 89.43 centimeters (35.2 inches), respectively. The mean temperatures for 1974 and 1975 were 3.4°C. (38.1°F.) and 2.0°C. (35.6°F.), respectively. Total precipitation was 87.53 centimeters (34.5 inches) for 1974 and 118.57 centimeters (46.7 inches) for 1975. For both stations, monthly temperatures were consistently lower during 1975 as compared with 1974; and monthly precipitation totals were generally higher.

Lilac bloom dates are used as standard phenological indicators by bioclimatologists. The long-term average bloom date corrected for the lower elevational limit of the study area (1600 meters or 5250 feet) was June 3 (Caprio 1966). During 1974 the lilac bloom date was 10 days later than the long-term average (Caprio 1974). The bloom date for 1975 was 15-20 days later than the long-term average (Caprio 1975).

METHODS

Habitat Analysis

Habitat types within the forested portion of the study area were delineated on the basis of the classification developed by Pfister *et al.* (1974) for western Montana forests, although some modifications were necessary to more accurately describe some habitat types. Those of subalpine and alpine areas were defined on the basis of descriptions made during the present study. Initially, types were identified by field reconnaissance. Later, to characterize and verify species composition, three sample sites were examined in a relatively homogeneous and undisturbed portion of each habitat type. When possible, these sites were located in different drainages. At sample sites in forested habitat types, the climax habitat series was characterized on the basis of species composition and successional relationships of the overstory timber and the tree seedlings that were present. Understory vegetation of forested, subalpine, and alpine habitat types was measured by the canopy coverage method (Daubenmire 1959). Canopy coverage and frequencies of low growing taxa were recorded within each of ten 2 x 5 decimeter plots placed at 2.5 meter (8.2 feet) intervals along the contour of the slope. Plant frequencies and canopy coverages were recorded in a similar manner at mule deer feeding sites. Where available, these were combined with

data recorded at sample sites to provide a more complete description of each habitat type. To map and measure the extent of each habitat type, boundaries were determined by moving away from the central, homogeneous portion of each stand until a change in species composition of the understory and/or overstory was observed. Botanical nomenclature followed Booth (1950), Booth and Wright (1966), and Booth (1972).

Mule Deer Populations, Range Use, and Movements

All mule deer observations during 1974 and 1975 were classified as to time, number of animals, age and sex classes, activity, markings, exposure, location, and habitat type where first sighted. Changes in use of habitat type and/or activity by undisturbed deer during the observation period were recorded as additional observations for evaluating habitat usage. Deer observations obtained from ground surveys were pooled with those made during the aerial flights for each season and year. Two flights, using a fixed-wing aircraft (Piper Supercub) were made during the summer of 1974. From June 1 through December 15, 1975, nineteen flights employed the Piper Supercub and one a Bell 47 G 3B helicopter. Productivity and population characteristics were determined from fawn:female, fawn:adult, and male:female ratios.

Thirty-nine deer marked during the winters of 1972-1974 with neckbands made of "armortite" material were known to have dispersed from the Armstrong winter range during the spring of 1974. During winter and spring of 1975, five females were equipped with radio transmitter collars by live-trapping on the Armstrong winter range (Mackie *et al.* 1976). An additional 55 deer marked with neckbands during the winters of 1972-1975 dispersed from the winter range during late May and early June of 1975.

Radio-marked deer were relocated periodically both from the air and on the ground. The overall frequency of relocation for each radioed deer was approximately once every 4-5 days for the period June 1-December 15, 1975. Due to difficulties in observability in timbered habitats, most relocations were determined from signal fixes based on triangulation. Relocations were plotted on photocopies of aerial photographs. Home range data were analyzed according to the minimum area method (Mohr 1947) and/or as modified by Harvey (1965) when data failed to justify connecting the outlying points. Home range size, habitat type areas, and kilometers of edge occurring within home ranges were computed using an electronic planimeter.

Food Habits

Mule deer food habits were determined by examination of recently vacated feeding sites. The use of one rooted stem for grasses, one

stem or leaf for forbs, and one twig or leaf for shrubs was considered one instance of use (Cole and Wilkins 1958). From June through mid-August 1975, the utilization of plant species eaten at feeding sites was recorded qualitively as light, moderate, or heavy use. Light use constituted less than 50 bites, moderate use 50-100 bites, and heavy use greater than 100 bites. During summer of 1974 and from late summer through autumn of 1975, actual counts of individual instances of use were recorded for each species utilized. The availability of plant taxa on feeding sites during spring and summer were determined by recording the canopy coverages and frequencies of plant species within twenty 2 x 5 decimeter plots. The frames were spaced at 2.5 meter (8.2 feet) intervals along two transect lines which were perpendicular to each other with the crossing at their centers. Analysis of data from feeding sites followed the aggregate percentage method by Martin *et al.* (1946).

Plant Nutritional Analysis

Samples of plant species utilized at feeding sites were collected for determination of protein content. Only those plant parts utilized by deer were collected for analysis. Collections comprised composite samples of individual forage species, hand-clipped from twenty or more randomly selected plants. Samples were weighed green to the nearest .01 gram using a Mettler balance, oven-dried at 90°C. (194°F.) for 24

hours, and reweighed. Moisture content was expressed as percentage of green weight according to the formula:

$\frac{\text{green weight - dry weight}}{\text{green weight}} \times 100$. A Wiley Mill was used to grind oven-dried samples and protein contents were determined by the Chemistry Station Analytical Laboratory, Montana State University. Protein contents were expressed as percentage of oven-dry weight.

Hunting Season Statistics

During 1975, hunter check stations were operated on access roads along the east and west slopes of the Bridgers during the first three weekends of the hunting season. Locations, hog-dressed weights, sex, and age were recorded for each hunter-killed deer. Ages were estimated by the eruption and wear of mandibular teeth (Robinette *et al.* 1957). In addition, information on hunter success ratios and hunter sightings of marked deer was obtained from interviews with hunters both at check stations and in the field. Some information of this type was also obtained by using voluntary hunter check boxes posted along major access roads.

RESULTS

Habitat Series and Types

Six major habitat series, each comprised of one or more habitat types (hereafter abbreviated h.t.) or phases thereof were recognized on the study area (Fig. 1). These include a Winter Range series, *Pseudotsuga menziesii* series, *Pinus flexilis* series, *Abies lasiocarpa* series, *Pinus albicaulis* series, and Subalpine-Alpine series. Collectively these series encompass all habitat or vegetational types and zones described in previous studies on the area (Wilkins 1957, Schwarzkoph 1973, Hamlin 1974) excepting bunchgrass prairie-agricultural types which occur on the valley floor below 1600 meters (5250 feet). The latter consists of bunchgrass-forb stands interspersed with big sagebrush near the base of slopes and foothills, local stands of deciduous trees and shrubs on mesic sites, and pasture, hay, and croplands on the flats adjacent to the foothills. Schwarzkoph (1973) described these as Sagebrush-Grassland, Fescue-Wheatgrass, Creek Bottom, and Agricultural Types within a Bunchgrass Prairie Zone. These types received very little use by mule deer during the present study.

Winter Range Series

This series comprised the vegetation of steep slopes and footslopes between Bill Smith and North Cottonwood Creeks at elevations from 1600 meters to 2015 meters (5250-6611 feet). It encompassed 6

percent of the study area. Buscis (1974) provided detailed descriptions and local distributions for fourteen habitat types comprising this Winter Range series. Those including *Artemisia tridentata* and/or *Purshia tridentata* were most important to mule deer.

The Winter Range series and component habitat types included all vegetation of the Sagebrush-Bitterbrush Type of Wilkins (1957) and the Sagebrush-Bitterbrush, Juniper, Fescue-Wheatgrass, Bitterbrush, Sagebrush-Grassland, and Douglas Fir-Sagebrush Park Types within the Douglas Fir Zone described by Schwarzkoph (1973). Distributions of the other five major habitat series on the study area and the 14 component habitat types and five phases thereof are shown in Figures 2 and 3. These figures also outline the distribution of grass-forb and shrub understory vegetation found on the study area with the exception of the Winter Range series. A list of habitat types and phases; and a key to associated map symbols used in Figures 2 and 3 are presented in Table 2. Canopy coverage and frequencies of occurrence of plant species at sample sites within each habitat type and phase are presented in Tables 3 and 4.

Pseudotsuga menziesii Series

The *Pseudotsuga menziesii* series occupied the lowest limit of forest development on the study area. It occurred along an elevational gradient of increasing moisture and decreasing temperature

Figure 2. Aerial view of the habitat types and phases occurring on the study area within the Johnson and Mill Creek drainages.

Figure 3. Aerial view of the habitat types and phases occurring on the study area within the North Cottonwood, Bill Smith, and Tom Reese Creek drainages.

TABLE 2. LIST OF MAJOR HABITAT SERIES, COMPONENT HABITAT TYPES AND PHASES, AND KEY TO ASSOCIATED MAP SYMBOLS USED IN FIGURES 2 AND 3.

1. *Pseudotsuga menziesii* Series
   - 1A. *Pseudotsuga menziesii/Agropyron spicatum* h.t. (DF/Agsp)
   - 1B. *Pseudotsuga menziesii/Symphoricarpos albus* h.t. *Symphoricarpos albus* phase (DF/Syal)
   - 1C. *Pseudotsuga menziesii/Calamagrostis rubescens* h.t. *Calamagrostis rubescens* phase (DF/Caru)
   - 1D. *Pseudotsuga menziesii/Carex geyeri* h.t. (DF/Cage) *Pseudotsuga menziesii/Vaccinium globulare* h.t.
   - 1E. *Vaccinium globulare* phase (DF/Vagl)

2. *Pinus flexilis* Series
   - 2A. *Pinus flexilis/Juniperus communis* h.t. (PF/Juco)

3. *Abies lasiocarpa* Series
   - 3A. *Abies lasiocarpa/Clematis pseudoalpina* h.t. (AF/Clps)
   - 3B. *Abies lasiocarpa/Arnica cordifolia* h.t. (AF/Arco)
   - 3C. *Abies lasiocarpa/Vaccinium globulare* h.t. (AF/Vagl)
   - 3D. *Abies lasiocarpa/Vaccinium scoparium* h.t. *Vaccinium scoparium* phase ((AF/Vasc)
   - 3E. *Abies lasiocarpa/Vaccinium scoparium* h.t. *Thalictrum occidentale* phase (AF/Vasc)

4. *Pinus albicaulis* Series
   - 4A. *Pinus albicaulis/Vaccinium scoparium* h.t. (WBP/Vasc)
   - 4B. *Pinus albicaulis/Carex geyeri* h.t. (WBP/Cage)

5. Subalpine-Alpine Series
   - 5A. Krummholz h.t.
   - 5B. Alpine Meadow h.t.

Key to Map Symbols
- -Arabic numeral denotes major habitat series.
- -Letters denote specific habitat types within a series.
  - -Large case letters indicate overstory timber is climax.
  - -Small case letters indicate overstory timber is subclimax.
  - -Small case letters enclosed by dotted lines indicate overstory timber has been clearcut.
- -Solid lines enclose habitat types.
  - -Solid heavy lines enclose shrub understories.
  - -All other areas have grass-forb understories.

TABLE 3. MEAN PERCENTAGE CANOPY COVERAGE AND FREQUENCY OF OCCURRENCE OF PLANT TAXA WHICH OBTAINED A MEAN COVERAGE OF .5 PERCENT OR A FREQUENCY OF GREATER THAN 5 PERCENT IN ONE OR MORE HABITAT TYPES.

	Habitat Types and Phases							
TAXA	DF/Agsp[1] (4)[2] (40)[3]	DF/Syal Syal Phase (2) (20)	DF/Caru Caru Phase (7) (90)	DF/Cage (3) (30)	DF/Vagl Vagl Phase (3) (30)	PF/Juco (3) (40)	AF/Clps (3) (30)	AF/Arco (3) (30)
GRASSES AND SEDGES:								
Agropyron spicatum	28/90[4]							
Agropyron spp.		Tr.[5]/5	Tr./1					
Bromus carinatus			1/3	4/10		Tr./7	1/7	Tr./3
Bromus tectorum	2/12							
Calamagrostis rubescens		6/40	34/68		22/60		4/17	
Carex geyeri	2/10	26/70	30/65	20/77			8/17	
Festuca idahoensis	4/45			12/80				
Koeleria cristata	2/15			Tr./3				
Poa secunda	5/25					Tr./2		
Unidentified Grasses	Tr./2	1/10		Tr./7			Tr./3	
FORBS:								
Achillea millefolium	3/37	1/5	2/15	5/40		7/23	1/13	
Actaea rubra		3/10						1/7
Agoseris glauca	Tr./5	Tr./5	1/2	Tr./7		7/28		
Allium brevistylum		1/5	1/4	2/13		6/25	4/33	
Allium cernuum	1/12							
Alyssum desertorum	4/50							
Androsace spp.	1/5							
Anemone multifida							3/20	
Antennaria anaphaloides				24/30				
Antennaria racemosa			Tr./3		2/20		15/77	
Aquilegia flavescens			1/3			1/5	Tr./3	Tr./3

TABLE 3. Continued.

TAXA	DF/Agsp[1] (4)[2] (40)[3]	DF/Syal Syal Phase (2) (20)	DF/Caru Caru Phase (7) (90)	DF/Cage (3) (30)	DF/Vagl Vagl Phase (3) (30)	PF/Juco (3) (40)	AF/Clps (3) (30)	AF/Arco (3) (30)
			Habitat Types and Phases					
FORBS: (Continued)								
Arabis nuttallii						1/7		
Arenaria congesta				2/27				
Arnica cordifolia		9/55	12/56	6/37	11/63	11/52	15/53	18/73
Arnica latifolia						Tr./3	2/17	
Aster conspicuus		14/45	17/59		1/13	17/73	9/27	1/13
Aster foliaceus						7/30	12/63	1/7
Aster perelegans				1/10				
Astragalus aboriginum						3/7		
Astragalus spp.						5/37	3/23	
Balsamorhiza sagittata	22/57	1/5		14/60				
Besseya wyomingensis				2/23			1/10	
Campanula rotundifolia	2/10		Tr./1	Tr./3		Tr./3	1/13	
Castilleja miniata							1/13	
Cerastium arvense	5/37							
Chimaphila umbellata					6/33			
Chrysopsis villosa	1/5							
Clematis columbiana							1/7	Tr./3
Crepis acuminata	1/10	Tr./5		Tr./10				
Cymopterus bipinnatus						1/7		
Eriogonum spp.		1/5						
Eriogonum umbellatum				3/30				
Erythronium grandiflorum			Tr./1			Tr./3	1/7	
Fragaria vesca		7/45	15/28	1/7	Tr./3			
Fragaria virginiana		4/25						
Galium boreale			1/9			7/45	5/40	
Geranium viscosissimum		1/10				1/2		

TABLE 3. Continued.

TAXA	Habitat Types and Phases							
	DF/Agsp[1] (4)[2] (40)[3]	DF/Syal Syal Phase (2) (20)	DF/Caru Caru Phase (7) (90)	DF/Cage (3) (30)	DF/Vagl Vagl Phase (3) (30)	PF/Juco (3) (40)	AF/Clps (3) (30)	AF/Arco (3) (30)
FORBS: (Continued)								
Goodyera oblongifolia					Tr./3		Tr./3	1/10
Helianthella uniflorus				6/43		Tr./3		
Hieracium albiflorum					4/33			Tr./3
Hieracium cynoglossoides	Tr./2	1/5		1/13				
Lithospermum arvense	2/15							
Lomatium cous				Tr./3			1/13	
Lupinus caudatus				1/3				
Lupinus sericeus			1/1					
Lupinus spp.	1/5	2/15	1/12	2/27	Tr./3			
Mertensia ciliata						1/3		
Osmorhiza chilensis		1/5				1/7	2/27	
Pedicularis racemosa			1/3					
Phacelia linearis	Tr./5							
Polygonum douglasii	1/15			Tr./3				
Potentilla spp.		1/10	Tr./1	Tr./3				
Pyrola secunda					1/7		1/17	6/60
Sedum lanceolatum	Tr./2			1/7		1/15	1/13	
Senecio indecorus						3/20	3/17	1/7
Smilacina stellata			1/4					
Smilacina racemosa		2/15	1/9					
Taraxicum spp.	Tr./2	3/15	Tr./1				Tr./3	
Thalictrum occidentale	Tr./5	1/10				20/55	12/40	4/17
Tragapogon dubius	2/12							

TABLE 3. Continued.

TAXA	Habitat Types and Phases							
	DF/Agsp[1] (4)[2] (40)[3]	DF/Syal Syal Phase (2) (20)	DF/Caru Caru Phase (7) (90)	DF/Cage (3) (30)	DF/Vagl Vagl Phase (3) (30)	PF/Juco (3) (40)	AF/Clps (3) (30)	AF/Arco (3) (30)
FORBS: (Continued)								
Umbelliferae		1/5						
Valeriana dioica			1/3	6/13		2/18		
Viola nuttallii			1/7	1/27		Tr./7		Tr./3
Unidentified Forbs	Tr./7	Tr./15	1/14	Tr./10	1/7	1/17	2/17	Tr./3
SHRUBS:								
Amelanchier alnifolia			1/3					
Berberis repens		9/50	4/34	Tr./7		5/48	1/13	
Juniperus communis						6/22		
Lonicera utahensis					2/7			
Menziesia ferruginea							1/10	Tr./3
Prunus virginiana	1/5							
Rosa spp.		1/5						
Rubus idaeus							1/7	
Shepherdia canadensis						1/3		
Spiraea betulifolia	3/17	12/70	4/29		13/67	6/43	4/20	
Symphoricarpos albus	Tr./10	21/90	2/12		Tr./3	Tr./3		
Symphoricarpos occidentalis		2/25	Tr./1					
Vaccinium membranaceum			2/8		40/87			1/17
Vaccinium scoparium					8/33			

TABLE 3. Continued.

TAXA	Habitat Types and Phases							
	DF/Agsp[1] (4)[2] (40)[3]	DF/Syal Syal Phase (2) (20)	DF/Caru Caru Phase (7) (90)	DF/Cage (3) (30)	DF/Vagl Vagl Phase (3) (30)	PF/Juco (3) (40)	AF/Clps (3) (30)	AF/Arco (3) (30)
TREES:								
Abies lasiocarpa							Tr./3	19/50
Picea engelmanni							1/3	
Pinus flexilis						1/2		
Pseudotsuga menziesii					1/3		Tr./3	
FERNS:								
Woodsia scopulina	1/5							
MOSSES:								
Politricum spp.			1/3					
CLUB MOSSES:								
Selaginella densa				5/17	2/7			

[1]Standard forester's tree species abbreviation for climax overstory/first two letters of generic and specific name of dominant understory.

[2]Number of sites examined in each habitat type.

[3]Total number of 2x5 decimeter frames examined in each habitat type.

[4]Mean canopy coverage (% area covered)/frequency (% occurrence among plots).

[5]Tr. = trace; a value less than 0.5% canopy coverage.

TABLE 4. MEAN PERCENTAGE CANOPY COVERAGE AND FREQUENCY OF OCCURRENCE OF PLANT TAXA WHICH OBTAINED A MEAN COVERAGE OF 0.5 PERCENT OR A FREQUENCY OF GREATER THAN 5 PERCENT IN ONE OR MORE HABITAT TYPES.

	Habitat Types and Phases							
TAXA	AF/Vagl[1] (3)[2] (40)[3]	AF/Vasc Vasc Phase (4) (40)	AF/Vasc Thoc Phase (1) (10)	WBP/Vasc (2) (20)	WBP/Cage (4) (50)	Krummholz Mesic Meadow (4) (50)	Krummholz Xeric Meadow (3) (30)	Alpine Meadow (2) (20)
GRASSES AND SEDGES:								
Agropyron caninum						5/40[4]	3/23	
Agropyron scribneri					1/7		4/27	
Agropyron spp.								1/10
Bromus carinatus					Tr.[5]/2	8/45	1/3	
Calamagrostis rubescens	4/32							
Carex geyeri	7/43	5/22	Tr./10	6/25	28/65			
Carex spp.								32/80
Festuca idahoensis					1/10			
Melica spectabilis						4/30		
Phleum alpinum						1/10		
Poa alpina							Tr./15	3/5
Poa spp.								2/10
Trisetum spicatum					Tr./2	2/25	1/5	
Unidentified Grasses					2/14	1/20		
FORBS:								
Achillea millefolium					9/59	6/30	7/40	
Agoseris glauca					3/31	2/22	5/47	
Antennaria racemosa	1/7							
Aquilegia flavescens	Tr./5					1/5		

TABLE 4. Continued.

TAXA	Habitat Types and Phases							
	AF/Vagl[1] (3)[2] (40)[3]	AF/Vasc Vasc Phase (4) (40)	AF/Vasc Thoc Phase (1) (10)	WBP/Vasc (2) (20)	WBP/Cage (4) (50)	Krummholz Mesic Meadow (4) (50)	Krummholz Xeric Meadow (3) (30)	Alpine Meadow (2) (20)
FORBS: (Continued)								
Arabis drummondi						1/15		
Arabis nuttallii						1/5	5/40	
Arenaria spp.								11/40
Arnica cordifolia	12/72	5/40	22/100	6/50	6/35	Tr./4		
Arnica latifolia					1/2	1/7	9/53	2/20
Artemisia michauxiana					6/35	27/25	2/13	
Aster alpigenus								1/10
Aster conspicuus	1/18	Tr./10	6/40		1/5			
Aster engelmannii						1/5		
Aster foliaceus			5/40			13/50	1/10	
Astragalus aboriginum						1/10		12/75
Astragalus alpinus						Tr./2	1/13	
Besseya wyomingensis						1/5		
Campanula rotundifolia						Tr./5	1/7	
Castilleja cusickii								1/10
Cerastium arvense							2/20	
Chimaphila umbellata	1/10	2/17		Tr./5				
Cirsium foliosum							1/13	
Claytonia lanceolata						2/26		
Collomia spp.						2/30		
Cruciferae								3/20
Cymopterus bipinnatus							Tr./3	8/50
Delphinium bicolor						1/7		
Delphinium occidentale						8/25		
Dryas octopetala								14/20

TABLE 4. Continued.

TAXA	AF/Vagl[1] (3)[2] (40)[3]	AF/Vasc Vasc Phase (4) (40)	AF/Vasc Thoc Phase (1) (10)	WBP/Vasc (2) (20)	WBP/Cage (4) (50)	Krummholz Mesic Meadow (4) (50)	Krummholz Xeric Meadow (3) (30)	Alpine Meadow (2) (20)
	Habitat Types and Phases							
FORBS: (Continued)								
Epilobium angustifolium				1/5	5/22		1/10	
Erigeron simplex							1/13	
Eriogonum umbellatum					1/2			
Eritrichium nanum								6/60
Erythronium grandiflorum		5/22	3/20		2/15	Tr./12		
Fragaria vesca	1/13				Tr./5			
Fragaria virginiana					2/9			
Fraseria speciosa						Tr./2	1/10	2/15
Galium boreale						1/15	3/13	
Geranium viscosissimum					Tr./5	1/11		
Helianthella uniflorus						5/15		
Heracleum lanatum						2/5		
Heuchera spp.					2/2			
Hieracium albiflorum	Tr./3	6/7		3/40				
Hydrophyllum capitatum					Tr./6	1/12		
Ivesia tweedyi								1/5
Leguminosae								Tr./5
Linum perenne							7/33	
Lomatium cous							2/33	2/55
Lupinus spp.					3/3	2/14		
Mertensia ciliata					Tr./1	2/25		
Mertensia oblongifolia						4/20		
Microseris nutans						1/9		
Osmorhiza chilensis					1/4			

TABLE 4. Continued.

TAXA	Habitat Types and Phases: AF/Vagl[1] (3)[2] (40)[3]	AF/Vasc Vasc Phase (4) (40)	AF/Vasc Thoc Phase (1) (10)	WBP/Vasc (2) (20)	WBP/Cage (4) (50)	Krummholz Mesic Meadow (4) (50)	Krummholz Xeric Meadow (3) (30)	Alpine Meadow (2) (20)
FORBS: (Continued)								
Osmorhiza occidentalis						13/45		
Pedicularis paysoniana						Tr./5		
Penstemon attenuatus					Tr./2		1/13	
Penstemon spp.								2/15
Phacelia hastata							1/10	
Phlox spp.								6/35
Physaria didymocarpa							1/7	3/30
Polemonium pulcherrimum						1/2		
Polygonum spp.								4/25
Potentilla ovina							Tr./10	
Potentilla spp.								5/30
Pyrola secunda	Tr./3		5/20					
Ranunculus eschscholtzii						1/15		
Senecio indecorus				1/10	1/12			
Senecio serra						16/75	1/13	
Senecio triangularis			Tr./10					
Silene spp.								3/10
Thlaspi fendleri						Tr./12	Tr./3	
Thalictrum occidentale			37/90			2/2		
Trifolium haydenii							3/27	3/5
Umbelliferae								6/45
Valeriana sitchensis						5/25		
Viola nuttallii					2/25	7/69		
Zygadenus spp.								5/45
Unidentified Forbs			Tr./10		1/11	3/37	1/27	

TABLE 4. Continued.

TAXA	Habitat Types and Phases							
	AF/Vagl[1] (3)[2] (40)[3]	AF/Vasc Vasc Phase (4) (40)	AF/Vasc Thoc Phase (1) (10)	WBP/Vasc (2) (20)	WBP/Cage (4) (50)	Krummholz Mesic Meadow (4) (50)	Krummholz Xeric Meadow (3) (30)	Alpine Meadow (2) (20)
SHRUBS:								
Juniperus communis	Tr./3	Tr./5						
Penstemon fruiticosus					1/5			
Potentilla fruticosa								2/15
Salix spp.								Tr./15
Spiraea betulifolia	1/13	1/32		2/15	Tr./6			
Vaccinium membranaceum	27/83	5/31	8/60	5/20	1/3			
Vaccinium scoparium		62/100	50/100	66/100				
TREES:								
Abies lasiocarpa	8/18	6/7						
Pinus albicaulis				1/2				
Pinus contorta		1/2						
Pseudotsuga menziesii	1/2							

[1]Standard forester's tree species abbreviation for climax overstory/first two letters of generic and specific name of dominant understory.

[2]Number of sites examined in each habitat type.

[3]Total number of 2x5 decimeter frames examined in each habitat type.

[4]Mean canopy coverage (% area covered)/frequency (% occurrence among plots).

[5]Tr. = trace; a value less than 0.5% canopy coverage.

between 1645 meters and 2440 meters (5397-8005 feet). Covering approximately 34 percent of the study area, it was the most extensively distributed series. Five habitat types, including three phases, comprised this series. The *Pseudotsuga menziesii* series and component habitat types included some vegetation of the Montane Forest Type of Wilkins (1957) and all vegetation of the Lodgepole Pine and Douglas Fir Type within the Douglas Fir Zone described by Schwarzkoph (1973).

Pseudotsuga menziesii/Agropyron spicatum (DF/Agsp) h.t. (Pfister *et al.*).- This habitat type represented the warmest and driest extreme of the *Pseudotsuga menziesii* series and occurred between 1706 meters and 2100 meters (5597-6890 feet). DF/Agsp stands occupied 279 hectares (689 acres) or 6 percent of the study area. It was found in all major drainages on xeric, south exposures and had a savanna-like appearance with widely spaced trees and a grassy understory (Figures 2 and 3). Many of the Douglas fir *(Pseudotsuga menziesii)* trees were dead as a result of past budworm infestations, red belt, or winter dessication (U. S. Forest Service 1972) and seedling regeneration was extremely low. *Pinus flexilis*, seral on limestone soils within this habitat type (Pfister *et al.* 1974), was well represented on only one localized site which had been logged during the early 1900's.

Understory vegetation typically was patchy and rather sparse due to unstable soils and dry conditions. Important species included

bluebunch wheatgrass *(Agropyron spicatum)*, Sandberg bluegrass *(Poa secunda)*, *Alyssum desertorum*, arrowleaf balsamroot *(Balsamorhiza sagittata)*, field chickweed *(Cerastium arvense)* and white spiraea *(Spiraea betulifolia)*. Adjacent habitat types were DF/Cage and DF/Caru on dry sites and DF/Syal on more mesic sites.

Idaho fescue *(Festuca idahoensis)* achieved an average canopy coverage of 4 percent on the four sites sampled and was more dominant at the upper limits of this habitat type. It is possible that further sampling could warrant delineation of a *Pseudotsuga menziesii/Festuca idahoensis* h.t. locally in these areas.

Pseudotsuga menziesii/Symphoricarpos albus (DF/Syal) h.t. (Pfister *et al.*). - The DF/Syal h.t. contained three phases based on distinct differences in understory composition (Pfister *et al.* 1974). Only the *Symphoricarpos albus* phase occurred on the study area, occupying 117 hectares (289 acres) or 2 percent of the study area at elevations between 1675 meters and 1980 meters (5495-6496 feet). Stands were restricted to creek bottoms and north exposures near the mouths of major drainages (Figures 2 and 3). Locally, they extended onto the valley floor for short distances along major stream banks. Because of this, the type occurred at lower elevations than other habitat types on the study area. The overstory consisted of a pure stand of climax Douglas fir, with some black cottonwood *(Populus trichocarpa)* along

creek bottoms. Douglas fir usually dominated most seral stages on this habitat type.

Much of the understory vegetation has been disturbed by heavy livestock grazing. Important species (Table 3) at the present time include pinegrass *(Calamagrostis rubescens)*, elk sedge *(Carex geyeri)*, heartleaf arnica *(Arnica cordifolia)*, showy aster *(Aster conspicuus)*, woodland strawberry *(Fragaria vesca)*, Oregon grape *(Berberis repens)*, white spiraea, and common snowberry *(Symphoricarpos albus)*. Adjacent types include the DF/Agsp h.t., DF/Caru h.t., and DF/Cage h.t.

Pseudotsuga menziesii/Calamagrostis rubescens (DF/Caru) h.t. (Pfister *et al.*). - The DF/Caru h.t. occupied 11 percent of the study area or 546 hectares (1349 acres). Pfister *et al.* (1974) described three phases, of which only the *Calamagrostis rubescens* phase occurred on the study area. The DF/Caru h.t. was widely distributed throughout the study area on cool, dry sites at elevations ranging from 1830 meters to 2380 meters (6004-7808 feet). It was found on northerly exposures at lower elevations and on westerly exposures at intermediate elevations. It also occurred on southerly exposures between 2195 meters and 2380 meters (7201-7808 feet) in shallow draws where conditions were slightly more mesic than surrounding areas occupied by the DF/Cage h.t. DF/Caru stands, occupying more mesic areas, particularly northerly aspects, had greater proportions of living

Douglas fir trees and greater overstory coverage than those found on drier westerly and southerly aspects. Differences in overstory coverage and available moisture consequently affected the relative amount of *Calamagrostis rubescens* and *Carex geyeri* that was present. Canopy coverage of *Carex geyeri* steadily increased as conditions varied from mesic to xeric while that of *Calamagrostis rubescens* steadily decreased. On sites where the canopy coverage of *Calamagrostis rubescens* fell below 5 percent, the habitat type was classified as DF/Cage. Most stands of the DF/Caru h.t. appeared to be climax although dead trees were prevalent on drier sites where regeneration was very poor. Seral stages of the DF/Caru h.t. were also dominated by Douglas fir.

Understory species included pinegrass, elk sedge, heartleaf arnica, showy aster, woodland strawberry, Oregon grape, and white spiraea (Table 3). Adjacent habitat types included DF/Cage, DF/Vagl, and DF/Agsp.

Pseudotsuga menziesii/Carex geyeri (DF/Cage) h.t. (Pfister *et al.*). - The DF/Cage h.t. appeared to be an ecological replacement for DF/Caru in areas too dry to support *Calamagrostis rubescens* (Pfister *et al.* 1974). It occupied 423 hectares (1045 acres) or 8 percent of the study area, on southerly and southwesterly aspects between 1890 meters and 2440 meters (6201-8005 feet). DF/Cage occurred in all

major drainages except Johnson Canyon (Figures 2 and 3). Stands typically were dominated by climax Douglas fir, although high proportions of dead or dying trees occurred. Seral stages were also dominated by Douglas fir.

Carex geyeri was abundant and *Festuca idahoensis* was well represented in lower elevation stands. Important forbs included yarrow *(Achillea millefolium)*, *Antennaria anaphaloides*, arrowleaf balsamroot, and heartleaf arnica (Table 3). Adjacent habitat types included DF/Agsp, DF/Caru, and WBP/Cage.

Pseudotsuga menziesii/Vaccinium globulare (DF/Vagl) h.t. (Pfister *et al.*). - The DF/Vagl h.t. was represented exclusively by the *Vaccinium globulare* phase (Pfister *et al.* 1974) on the study area. It occurred between 2010 meters and 2320 meters (6594-7612 feet), predominantly on northern exposures, although it was found on a westerly aspect on one site at the upper limit of its range. It occupied 7 percent of the study area or 344 hectares (850 acres) and was found in all major drainages except Mill Canyon (Figures 2 and 3). The present overstory of all stands was dominated by lodgepole pine *(Pinus contorta)*, a seral species. The understories were dominated by a rather dense layer of thinleaved huckleberry *(Vaccinium membranaceum)* which Pfister *et al.* (1974) considered as an equivalent of *Vaccinium globulare*. Other important species included pinegrass,

heartleaf arnica, common pipsissewa *(Chimaphila umbellata)* and white spiraea. Low red huckleberry *(Vaccinium scoparium)* intergraded with thinleaved huckleberry at the upper limits of distribution of this habitat type. Important adjacent habitat types included AF/Vasc, WBP/Vasc, and DF/Caru.

Pinus flexilis Series

This series was comprised of a single habitat type limited to an area of 102 hectares (252 acres) or 2 percent of the study area of westerly aspect at the head of Johnson Canyon (Figure 2).

Pinus flexilis/Juniperus communis (PF/Juco) h.t. (Pfister *et al.*). - This habitat type was found between 2135 meters and 2590 meters (7006-8497 feet) on calcareous soils. Douglas fir and limber pine *(Pinus flexilis)* were present in the overstory and both were reproducing, though most of the older limber pine trees in the stand were dead or dying. Seedling reproduction of both species was very poor on a portion of this habitat type which had been clearcut six years prior to the study.

Grasses were lacking in the understory but forb composition was diverse and formed a dense layer about 3 decimeters (11.8 inches) high. Important species included yarrow, false dandelion *(Agoseris glauca)*, *Allium brevistylum*, heartleaf arnica, showy aster, *Astragalus* spp., leafybract aster *(Aster foliaceus)*, northern bedstraw *(Galium*

boreale), and western meadow rue *(Thalictrum occidentale)*. Shrubs included common juniper *(Juniperus communis)* and white spiraea (Table 3). Common juniper was present in small, widely scattered clumps. Its average canopy coverage among the three sites sampled was only 6 percent, slightly more than the 5 percent required to recognize this habitat type (Pfister *et al.* 1974). The poor representation of common juniper plus the greater representation of Douglas fir among tree seedlings casts some doubt as to the validity of the type designation. AF/Clps h.t. was an important adjacent type, occupying mesic draws coursing through the drier area occupied by PF/Juco h.t.

Abies lasiocarpa Series

The *Abies lasiocarpa* series occupied an intermediate position along an elevational gradient of forest composition and included all forest stands potentially dominated at climax by subalpine fir *(Abies lasiocarpa)*. It was bordered at lower elevations by the *Pseudotsuga menziesii* series and at higher elevations by the *Pinus albicaulis* series. The *Abies lasiocarpa* series occupied 20 percent of the study area and was well represented in all major drainages at elevations ranging from 2075 meters to 2620 meters (6808-8596 feet). This series has been subdivided into three elevational categories (Pfister *et al.* 1974): (1) temperate forests, (2) subalpine forests, (3) timberline. Four habitat types and two phases were described within this series,

all within the temperate forest category. The *Abies lasiocarpa* and *Pinus albicaulis* series and their respective habitat types includes some vegetation of the Montane Forest Type (Wilkins 1957) and all vegetation within the Spruce-Fir (Closed Canopy) Type described by Schwarzkoph (1973).

Abies lasiocarpa/Clematis pseudoalpina (AF/Clps) h.t. (Pfister *et al.*). - The AF/Clps h.t. occupied 242 hectares (598 acres) or 5 percent of the study area and represented the warm, dry, lower limits of this series. It was restricted to calcareous substrates between 2195 meters and 2620 meters (7201-8596 feet) in Johnson Canyon and Mill Canyon. At the lower limits of its distribution on the study area, this habitat type occurred on northerly and easterly aspects and was found on south and southwesterly aspects at higher elevations. Pfister *et al.* (1974) state that the presence of *Pinus flexilis* was diagnostic as this species rarely occurs even as a minor seral plant in any other habitat type of the *Abies lasiocarpa* series. Although classified as climax, subalpine fir did not appear to be a vigorous competitor in all stands within this habitat type. Stands at lower elevation were dominated by Douglas fir with lesser amounts of *Picea* spp. and *Pinus flexilis*; while those of higher elevations were often dominated by *Pinus flexilis*. Also, many understory species characteristically found in the *Abies lasiocarpa*

series were scarce or lacking in this habitat type. Elk sedge, *Antennaria racemosa*, heartleaf arnica, showy aster, leafybract aster, northern bedstraw, and western meadow rue were the important constituents of the understory (Table 3). Adjacent habitat types included PF/Juco on calcareous substrates and DF/Cage and AF/Vasc on non-calcareous substrates.

Abies lasiocarpa/Arnica cordifolia (AF/Arco) h.t. (Pfister *et al.*). - This relatively minor habitat type occurred on 77 hectares (190 acres) or approximately 1 percent of the study area. It occupied slopes of northerly aspect along Johnson, Mill, and North Cottonwood Canyons (Figures 2 and 3), between 2135 meters and 2375 meters (7005-7792 feet). On the study area it occurred on localized, cool, moist sites that appeared to be especially favorable to the growth of *Abies lasiocarpa*. Pfister *et al.* (1974) indicated that all but the oldest stands were dominated by Douglas fir or lodgepole pine. Most stands on the study area were mature and had very dense overstories dominated almost entirely by subalpine fir; although one seral stand was dominated by lodgepole pine. Douglas fir was never an important component. Understory vegetation typically was very sparse. Heartleaf arnica was the only species that achieved any appreciable coverage. Other species present included showy aster, *Goodyera oblongifolia*, side-bells wintergreen *(Pyrola secunda)* and western

meadow rue (Table 3). This habitat type was usually closely associated with AF/Vagl or AF/Vasc h.t.'s.

Abies lasiocarpa/Vaccinium globulare (AF/Vagl) h.t. (Pfister *et al.*). - The AF/Vagl h.t. occupied approximately 6 percent of the study area or 298 hectares (736 acres). It was found in all major drainages except Tom Reese Creek (Figures 2 and 3). This habitat type occurred on temperate, moist exposures between 2075 meters and 2435 meters (6808-7989 feet). Most stands were situated on northerly and easterly aspects, although some occurred on southwesterly and northwesterly aspects and one was located on a low bench along North Cottonwood Creek. All were dominated by seral overstory vegetation. The bench stand and all stands on northerly aspects were dominated by *Pinus contorta*. Another, situated on a very steep, unstable, rocky slope near the upper elevational limits of this habitat type in Mill Canyon, was dominated by a mixture of lodgepole pine and whitebark pine *(Pinus albicaulis)*. The understory of this stand consisted of elk sedge and clumps of thinleaved huckleberry confined to the area around tree trunks. Stands on easterly and northwesterly aspects were more nearly climax but Douglas fir continued to be well represented. Lodgepole pine was absent.

The undergrowth of typical stands formed a patchy layer, about 3 decimeters (11.8 inches) high, consisting of thinleaved huckleberry

interspersed with pinegrass, elk sedge, and heartleaf arnica (Table 4). Adjacent habitat types included DF/Caru, DF/Cage, AF/Arco, and AF/Vasc.

Abies lasiocarpa/Vaccinium scoparium (AF/Vasc) h.t. (Pfister *et al.*). - Two phases of this habitat type were represented on the study area. The *Vaccinium scoparium* phase was located on cold, relatively dry sites between 2135 meters and 2620 meters (7005-8596 feet). It was widely distributed within all major drainages, except Bill Smith Creek, and encompassed 364 hectares (900 acres) or 7 percent of the study area. Most stands occurred on northerly exposures and currently are dominated by dense stands of lodgepole pine, a seral species. Succession to climax dominance by *Abies lasiocarpa* is slow, due either to lack of a seed source or apparent low vigor of this species in the dry, cold conditions (Pfister *et al.* 1974). Douglas fir was very rare or absent. Two stands placed in this habitat type were dominated by subalpine fir but included good representation of *Pinus albicaulis*. Both occurred on very steep easterly and northeasterly aspects at high elevations ranging from 2525 meters to 2620 meters (8284-8596 feet). It is possible that these stands might be more appropriately classified as an *Abies lasiocarpa (Pinus albicaulis)/Vaccinium scoparium* h.t.

The understory of all stands was dominated by a layer of low red huckleberry, 2 decimeters (7.9 inches) high. Other species included

elk sedge, heartleaf arnica, dogtooth lily *(Erythronium grandiflorum)*, white hawkweed *(Hieraceum albiflorum)* and thinleaved huckleberry (Table 4). Important adjacent habitat types were AF/Arco, AF/Vagl, and WBP/Vasc.

The *Thalictrum occidentale* phase represented moist, cool environments within this habitat type. On the study area, the phase was restricted to one stand located between 2195 meters and 2285 meters (7201-7497 feet) on a low bench along the headwaters of Mill Creek. It occupied 87 hectares (215 acres) or 1 percent of the study area. The site was dominated by an almost pure stand of climax *Abies lasiocarpa*. *Picea* spp. was present only as a very minor constituent of the stand. The dense understory layer was dominated by a mixture of western meadow rue and low red huckleberry. Other species present included heartleaf arnica, showy aster, and side-bells wintergreen (Table 4). Important adjacent habitat types included the *Vaccinium scoparium* phase on non-calcareous substrates and AF/Clps on bordering calcareous substrates (Figure 2).

Pinus albicaulis Series

This series was not specifically recognized by Pfister *et al.* (1974). However, both habitat types included in the series could be classified as the *Pinus albicaulis* h.t. discussed under their timberline habitat types. Weaver and Dale (1974) recognized *Pinus*

albicaulis/Vaccinium scoparium as a climax community on their Montana study areas.

The *Pinus albicaulis* series occupied 23 percent of the study area and was found on cold, relatively dry slopes between 2250 meters and 2695 meters (7382-8842 feet). On the study area, it formed the upper belt of contiguous forest. It was bordered at lower elevations predominantly by the *Abies lasiocarpa* series and at higher elevations by the Subalpine-Alpine series. Two habitat types were described.

Pinus albicaulis/Vaccinium scoparium (WBP/Vasc) h.t. - The WBP/Vasc h.t. was the most extensive of all habitat types on the study area occupying 996 hectares (2460 acres) or 20 percent of the study area. It was found in all major drainages except Johnson Canyon (Figures 2 and 3). Individual stands were extremely large and homogeneous, occurring on cold, well drained sites between 2250 meters and 2695 meters (7382-8842 feet). WBP/Vasc h.t. was found on all aspects; although at lower elevations, it was more prevalent on northerly aspects. Nearly pure stands of whitebark pine were typically "open" due to the occurrence of trees in closely spaced clumps. Subalpine fir was scarce and usually stunted or deformed if present. Lodgepole pine occurred in stands at lower elevation, adjacent to the AF/Vasc habitat types. A large proportion of the whitebark pine stands on the study area had been burned in forest fires during the late 1800's

or early 1900's. All seral stages appear to be dominated by whitebark pine.

Understory vegetation was very similar to the AF/Vasc h.t., consisting of a homogeneous layer of low red huckleberry with heartleaf arnica, elk sedge, and white hawkweed typically present (Table 4). AF/Vagl, Af/Vasc, and Krummholz are important adjacent habitat types.

Pinus albicaulis/Carex geyeri (WBP/Vasc) h.t. - This minor habitat type occupied 132 hectares (326 acres) or 3 percent of the study area. It occurred on relatively dry sites on steep south exposures in North Cottonwood Creek, Bill Smith Creek, and Tom Reese Creek between 2375 meters and 2620 meters (7792-8596 feet). The overstory was usually a pure stand of whitebark pine. Subalpine fir was scarce while Douglas fir often occurred in stands bordering the lower elevation *Pseudotsuga menziesii* series. The understory was patchy and sparse due to unstable substrates. Important species included elk sedge, yarrow, heartleaf arnica, *Artemisia michauxiana*, and fireweed *(Epilobium angustifolium)*. Adjacent habitat types included DF/Agsp, WBP/Vasc, and Krummholz.

Subalpine-Alpine Series

This series comprised the vegetation of high elevation basins along the Bridger divide between 2320 meters and 2900 meters (7612-

9514 feet). It occupied 706 hectares (1744 acres) or approximately 15 percent of the study area and included two major habitat types. Vegetation within the Subalpine-Alpine series was previously described by Schwarzkoph (1973) as the Spruce-Fir (Open Canopy) Type, Willow Bottom Type, Sedge Meadow Type, Sedge-Grass Meadow Type, Grass-Forb Meadow Type, and the Alpine Zone. Wilkins (1957) referred to this area as the Mountain Meadow Type.

Krummholz h.t. - This habitat type was found between 2320 meters and 2805 meters (7612-9203 feet) and occupied 691 hectares (1707 acres) or 14 percent of the study area. It comprised collectively the entire area commonly referred to as subalpine at the headwaters of Mill, North Cottonwood, and Tom Reese Creeks (Figures 2 and 3). Krummholz h.t. occurred on all exposures, although the northerly and easterly aspects were of minor extent. It extended to lower elevations in creek bottoms than along ridges. Vegetation consisted of grass-forb meadows interspersed with clumps or "islands" of stunted conifers. Three subtypes were classified within this habitat type.

Tree Clump Subtype. - *Abies lasiocarpa* was the predominant species comprising the tree clumps. *Picea* spp. and *Pinus albicaulis* were also represented but to a lesser extent; and *Pinus flexilis* comprised most clumps growing on dry sites, such as steep limestone cliffs and south exposures. The frequency of tree clumps was greatest

on westerly aspects and lowest on southerly aspects. The frequency of tree clumps decreased with increasing elevations on all exposures.

The understory of tree clumps was especially sparse. Species normally present under the canopy of clumps included spreading wheatgrass *(Agropyron scribneri)*, alpine bluegrass, *Poa alpina*, yellow columbine *(Aquilegia flavescens)*, *Arnica latifolia*, *Cymopteris bipinnatus*, *Senecio serra*, western meadow rue, Hayden clover *(Trifolium haydenii)* and *Ribes* spp. (Table 4). This subtype was not quantitatively sampled, but was described from general observations.

Mesic Meadow Subtype. - This subtype was characterized by very lush grass-forb meadows interspersed as parks among the tree clumps on moist sites within the Krummholz h.t. It was the more prevalent of the two meadow subtypes included in this habitat type. Mesic meadows occupied the floor of Mill, North Cottonwood, and Tom Reese Creek basins and were also very prevalent on the west exposure of these basins between 2440 meters and 2685 meters (8005-8809 feet). The mesic meadow subtype consisted of a dense layer of grasses and forbs ranging from .3 to .5 meters (13-20 inches) in height. Species diversity was very high with forbs predominating. Important species included slender wheatgrass *(Agropyron caninum)*, California brome *(Bromus carinatus)*, purple onion grass *(Melica spectabilis)*, leafybract aster, tall larkspur *(Delphinium occidentale)*, western sweetroot

(Osmorhiza occidentalis), *Senecio serra*, and Nuttall violet *(Viola nuttallii)*. Sedge meadows, sedge-grass meadows, and willow bottoms described by Schwarzkoph (1973) exist on very wet sites within the Mesic Meadow Subtype. They occupied minor areas and were collectively considered as atypical microsites within the Mesic Meadow Subtype.

Xeric Meadow Subtype. - The Xeric Meadow Subtype was interspersed among the tree clumps on the drier sites within the Krummholz h.t. It was found on southerly exposures and on westerly exposures between 2685 meters and 2900 meters (8809-9514 feet). This subtype was also found interspersed among the Mesic Meadow Subtype where it occupied drier sites on the windward side of tree clumps. Vegetation was considerably more depauperate than that of mesic meadows with greater proportions of exposed bare ground. Species were predominantly those adapted to drier conditions, including spreading wheatgrass, yarrow, false dandelion, *Arnica latifolia*, Nuttall rockcress *(Arabis nuttallii)*, *Linum perenne*, Hayden clover, elk thistle *(Cirsium foliosum)*, and common twinpod *(Physaria didymocarpa)*.

Alpine Meadow h.t. - The Alpine Meadow h.t. was found on the study area along the west slope of the Bridger divide at high elevations within Mill Canyon, North Cottonwood Canyon, and Tom Reese Canyon (Figures 2 and 3). It occupied only 15 hectares (37 acres) or less than 1 percent of the study area. Individual stands were found

between 2805 meters and 2900 meters (9203-9514 feet) on exposed ridgetops and fairly level strips along old faults described by McMannis (1955). This habitat type existed above the upper limit of tree growth and was characterized by patchy, mat-forming vegetation adapted to the severe environment. Species composition was relatively diverse. Important taxa included *Carex* spp., *Arenaria* spp., Indian milkvetch *(Astragalus aboriginum)*, *Cymopterus bipinnatus*, eight-petal dryas *(Dryas octopetala)*, *Eritrichium nanum*, *Phlox* spp., and *Potentilla* spp. (Table 4).

Mule Deer Population Characteristics

Results were based on 967 observations of mule deer recorded on the study area during 1974 and 1975. A total of 280 deer were classified during summer of 1974, including 72 observed during two aerial surveys and 47 observed on the east slope of the Bridgers (Appendix Table 19). During the period June 1-December 15, 1975, 452 and 235 deer were observed during ground surveys and 20 aerial flights, respectively. Additional data were provided by 207 relocations of five radio-collared does.

Population Dynamics

Considerably fewer deer were associated with the Armstrong winter range during 1975 than in 1974 and previous years in which studies have been conducted on the area. Of approximately 210 deer present in

early January 1975, Mackie *et al.* (1976) estimated that only about 139 survived the winter and dispersed onto summer ranges during late May and June of 1975. In early spring of 1973 the population was estimated at approximately 230. A population of at least 400 animals occurred on the area during the winter and early spring of 1956 (Mackie *et al.* 1976).

Fewer fawns were produced and/or survived to fall and early winter on the study area during 1975 than in any previous year in which adequate data have been obtained. Fawn:female ratios were 25 per 100 and 27 per 100 for October and November, respectively (Table 5). Observations on the winter range during December indicated only 11 fawns per 100 does and a helicopter survey of the area on January 2, 1976 (Mackie, R. J. personal communication, January 1976) showed a ratio of 9 per 100. These data indicated that fewer than 50 percent of the fawns observed in the fall survived to early winter. Much of this loss appeared to occur during a week of heavy snowfall and sub-zero temperatures in late November. Gale (1976) indicated that spring and late fall fawn losses occurred while deer occupied local "holding" areas situated along seasonal migration routes. Only one of the five radio-collared adult females may have produced a fawn during 1975. Fawn:female ratios determined from helicopter surveys during early January of 1972, 1974, and 1975 were 68, 43, and 30 fawns per 100 females, respectively (Mackie *et al.* 1976). Incidence of twins was

TABLE 5. SEX AND AGE COMPOSITION OF MULE DEER OBSERVED DURING GROUND AND AERIAL COUNTS ON THE STUDY AREA BY MONTH DURING 1974 AND 1975.

Time Period	Total No. Observed	Males	Fe-males	Fawns	Uncl.	Males: 100 Females	Fawns: 100 Females	Fawns: 100 Adults	Method of Survey
July, 1974	84	23	42	8	11	55	19	13	Ground
Aug. 1974	85	48	33	3	1	145	9	4	Ground & Air
Sept. 1974	58	20	29	6	3	67	21	12	Ground & Air
June 1975	224	23	103	3	95	22	3	2	Ground & Air
July 1975	35	1	21	3	10	5	14	14	Ground & Air
Aug. 1975	72	16	41	7	8	39	17	12	Ground & Air
Sept. 1975	52	1	47	2	2	2	4	4	Ground & Air
Oct. 1975	119	7	87	22	3	8	25	23	Ground & Air
Nov. 1975	56	3	26	7	20	12	27	24	Ground & Air
Dec. 1975	80	14	57	6	3	25	11	8	Ground & Air

low during both 1974 and 1975, with only four sets of twins recorded among the 54 fawns observed during this study. Robinette *et al.* (1955) reported that twins were the most common litter size for adult does on good quality range in Utah.

Group Size

Average mule deer group sizes by month and season for 1974 and 1975 are shown in Table 6. Group sizes decreased during spring as deer dispersed from the winter range and were smallest during summer when deer were widely distributed and using a variety of habitat types. Aggregation occurred during the fall with use of more open areas during migration toward the winter range. Average group sizes during spring, summer, and fall of 1975 were 2.7, 1.7, and 2.8, respectively. Average group size during summer of 1974 was also 1.7 (Table 6). During 1972, average group sizes on the study area during summer and fall were 2.0 and 4.0, respectively (Schwarzkoph 1973). Knowles (1975) related smaller group sizes to better forage conditions on his prairie breaks study area. Smaller group sizes observed during 1975 as compared to 1972 may have resulted from better forage conditions, lower population density, and fewer fawns.

TABLE 6. AVERAGE MULE DEER GROUP SIZE OBSERVED BY MONTH AND SEASON DURING 1974 AND 1975 ON THE STUDY AREA.

	Spring		Summer				Fall			
	June	Season	July	August	Sept.	Season	Oct.	Nov.	Dec.	Season
1974			1.4(51)[1]	1.7(49)	1.9(15)	1.7(115)				
1975	2.7(79)	2.7(79)	1.4(28)	1.9(35)	1.8(28)	1.7(91)	2.8(15)	2.9(13)	2.6(31)	2.8(59)

[1]Number of groups in sample period.

Mule Deer Range Use

Distribution, Movements, and Home Ranges

Observations during the summer of 1974 were predominantly at higher elevations and the majority of deer classified were observed on the Krummholz h.t. During 1975, observations were more uniformly distributed across the study area, and most deer were observed within the forested portion (Fig. 4). Relatively light use of high elevation summer range (Krummholz h.t.) was indicated. The heaviest concentration occurred within the forest between North Cottonwood Creek and Bill Smith Creek at elevations between 2000 meters (6561 feet) and 2320 meters (7612 feet). This was due partially to relatively heavy use by deer considered resident during summer. Ten individually marked deer, including 8 females, were observed in this area and within two kilometers (1.25 miles) of the upper limits of the winter range during the summer of 1975 (Fig. 5). However, deer also concentrated in this area in large numbers during spring and fall migrations. Other areas of heavy use during spring and fall included the north side of Bill Smith Creek, just below its headwaters, and the north side of Mill Canyon below the confluence of its two branches. Observations on the winter range (Fig. 4) were recorded in early June before all deer had dispersed and in early December as animals returned to winter home ranges.

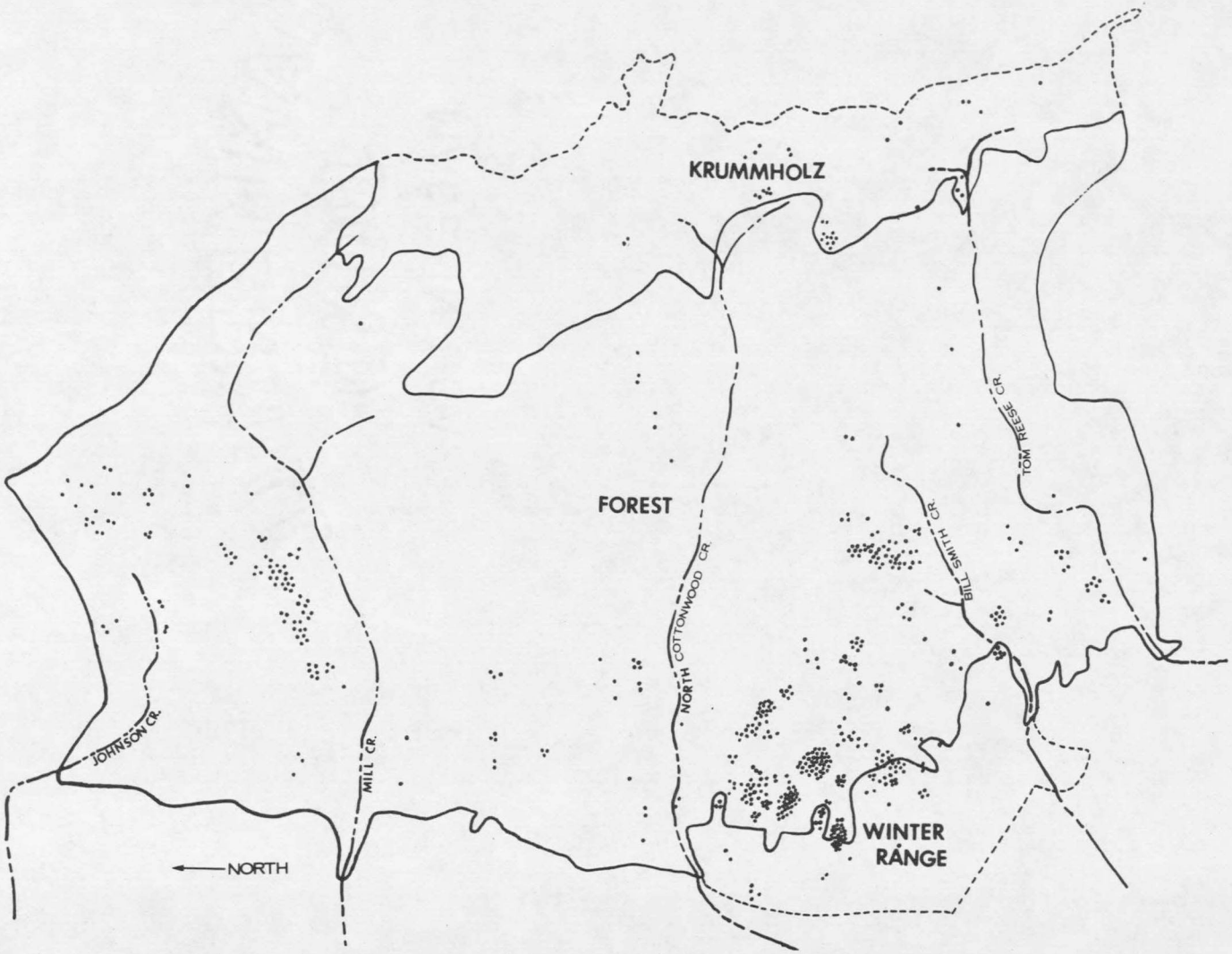

Figure 4. Distribution of each deer observation recorded on the study area during spring, summer, and fall of 1975.

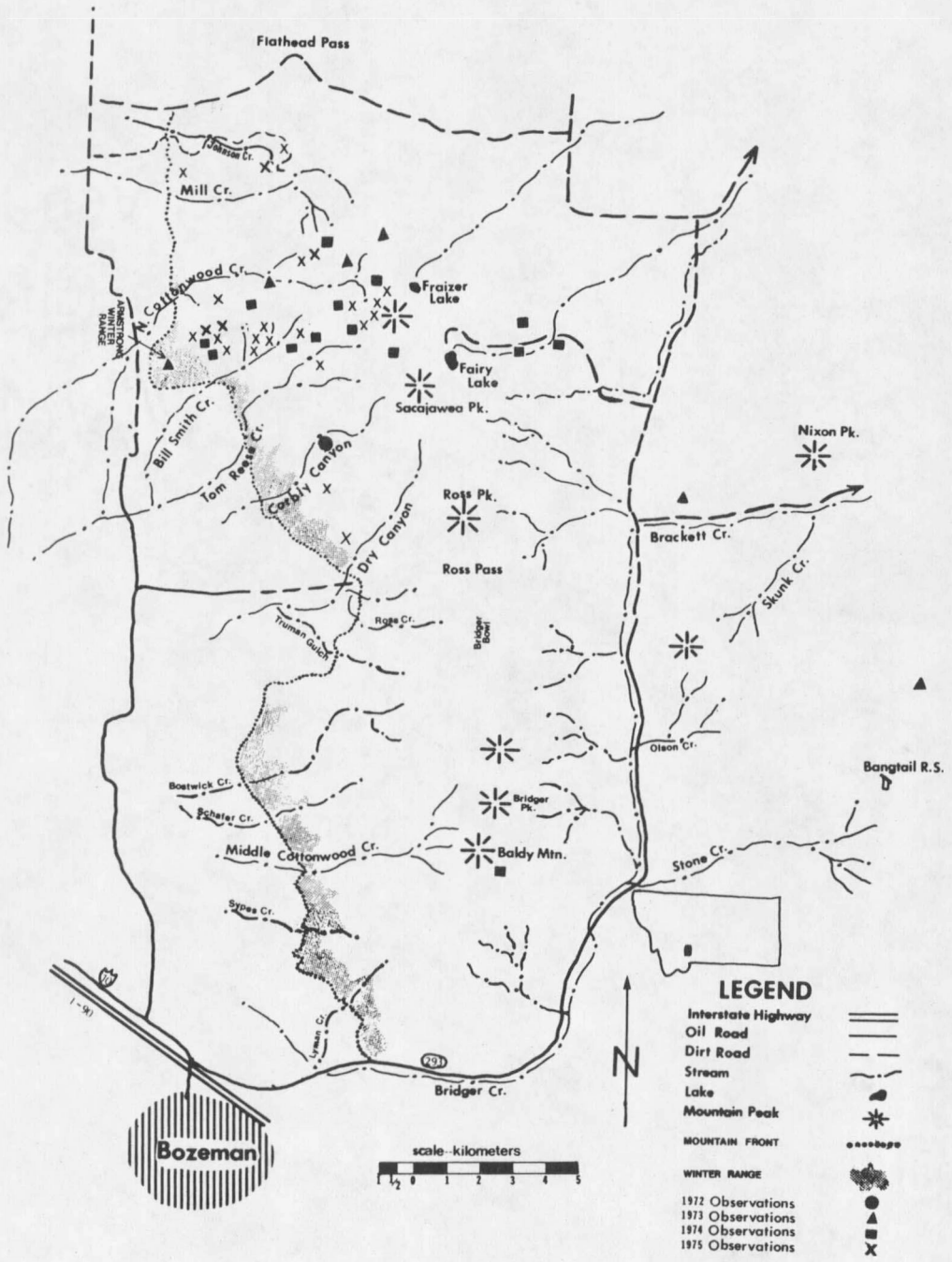

Figure 5. Summer and fall distribution during 1972-1975 of mule deer individually marked on the Armstrong winter range.

The distribution of all deer individually marked on the Armstrong winter range and relocated during summer and fall in 1974 and 1975 as well as previous years is shown in Figure 5. Of the 45 deer relocated on summer and/or fall ranges, 33 (73 percent) were on the west slope of the Bridger Range between North Cottonwood and Tom Reese Creeks, suggesting that this area constitutes the summer range of a majority of the deer wintering on the Armstrong area. The remaining relocations indicate, however, that many deer from this area may migrate greater distances to summer-fall ranges north and south of this area as well as along the east slope of the Bridger Mountains. Three marked adult females were observed during 1975 in the vicinity of Johnson Canyon between 5 kilometers (3.1 miles) and 7 kilometers (4.3 miles) northeast of the winter range. During 1973 and 1974 a total of five marked deer were observed on the east slope. Three (2 adult females, 1 adult male) of the five were observed during the summer of 1974, 11 kilometers (6.8 miles) east of the Armstrong winter range along the Fairy Lake road. Both females returned to the winter range during late fall 1974. The marked buck was not positively identified. Hamlin (1974) observed a marked adult female along Brackett Creek about 16 kilometers (10.0 miles) southeast of the winter range. This deer was in approximately the same location when last seen on October 6, 1973. Hamlin also reported that a 2.5 year old marked male, observed on Bangtail Ridge about 26 kilometers (16.1 miles) southeast of the

winter range during summer, was killed by a hunter 1.6 kilometers (1 mile) southeast of the summer location in late October. It is questionable whether this buck would have returned to the Armstrong winter range (Hamlin 1974). Two other marked males known to have dispersed in a southerly direction from the winter range also failed to return. One, marked as a fawn during the spring of 1974, was observed the following fall on the east slope near Baldy Mountain 18 kilometers (11.2 miles) south of the winter range and wintered at the extreme south end of the Bridger Range, 5 kilometers (3.1 miles) south of the fall location during both 1974-75 and 1975-76. The other, marked as an adult in late winter 1975, was observed during January and March of 1976 near Dry Canyon approximately 7 kilometers (4.3 miles) south of the Armstrong winter range (Mackie, R. J. personal communication January 1976). In addition, two marked males, one a yearling (Schwarzkoph 1973) and the other an adult, were shot by hunters in the vicinity of Corbly Canyon, about 6 kilometers (3.7 miles) southeast of the Armstrong winter range.

Relocations of individually marked animals indicated that in general, deer in the Bridger Range habitually use the same summer and winter home ranges each year. Nearly all of the deer marked on the Armstrong winter range have returned in subsequent winters. The three exceptions were all males, including two juveniles. Robinette (1966) noted that yearling mule deer frequently dispersed (moved more than 1.6

kilometers (1 mile)) from the area of birth and established new home ranges. The third male that used a different winter home range was about 5 years old when tagged. Published evidence of winter home range shifts by adult deer is scarce.

Numerous examples of habitual use of the same summer home range by individual deer were recorded. Two marked adult does observed during the summer of 1973 (Hamlin 1974) were reobserved in the same vicinity during 1974. Similarly, one marked adult male was observed during the summers of 1973 (Hamlin 1974) and 1974 in the same vicinity; and another was observed in the same location during the summers of 1974 and 1975. Only one adult deer has been observed to change the location of its summer home range. In this case, a marked adult male twice observed within the Krummholz h.t. along the Mill-North Cottonwood divide during late August of 1974, was relocated on August 18, 1975 in the DF/Cage h.t. in Bill Smith Canyon, 3.5 kilometers (2.2 miles) southwest of the previous summers' location. Bryant (1924) discussed the use of different summer home ranges by a semi-domesticated female mule deer; and Robinette (1966) reported one example of a summer home range shift by an adult doe and mentioned another probable shift by an adult buck. To date, no year to year changes in seasonal home ranges have been recorded for female mule deer in the Bridger Mountains.

Seasonal movements or migrations to and from the Armstrong winter range appeared to follow definite routes (Fig. 6). These routes included local "holding" areas where deer aggregate for variable periods of time during spring and fall. Two main routes were used. One, used by a large segment of the herd, extended north-easterly; the other appeared to be oriented in an east and southeasterly direction (Fig. 6). Large numbers of deer using the northerly route were observed during the first two weeks of June 1975 in the lower part of holding area 1. From this point some continued to move north to Mill and Johnson Canyons, while others moved northeasterly into North Cottonwood Canyon. Some deer, apparently moving toward summer ranges to the south and east were observed on holding area 2A during early June, while somewhat greater numbers moved directly east and by mid-June were using holding area 2. Some marked deer from holding area 2 moved east into upper Bill Smith Canyon and the North Cottonwood basin, while others moved southeast into Tom Reese Canyon. The two dashed lines extending the North Cottonwood and Tom Reese Creek Routes (Fig. 6) probably represent the routes used by deer that summer along the east slope of the Bridgers. These were the only points on the study area where deer could readily cross the Bridger divide.

Deer returned to the winter range in fall along the same general migration routes used in spring. Three of the four holding areas were used during both spring and fall migrations. The fourth (1A) was used

Figure 6. Migration routes and holding areas used by the Armstrong herd during spring and fall.

only in fall, primarily during late October and November. Although holding areas 1, 2, and 2A were used during both spring and fall, spring usage was concentrated on lower slopes where plant growth was more advanced; while during fall, greater use occurred on the higher or upper slopes just below ridge tops. All four holding areas were situated on southerly or westerly aspects and were characterized by the DF/Agsp, DF/Cage, and/or DF/Caru h.t.'s. Holding areas occupied sites where plant phenology was more advanced during spring and where snow melted earlier during spring and fall in comparison to adjacent areas at the same elevation.

Approximately 43 percent of the estimated 139 deer which left the Armstrong winter range during spring of 1975 were marked (Mackie *et al.* 1976). Marked deer comprised only 23 percent of all adult deer observed within the study area during the summer. This suggested: (1) that many deer from the Armstrong area moved beyond the study area boundaries; (2) that unmarked deer from other winter ranges also used summer range within the study area; and/or (3) that a greater proportion of the marked deer occupied less observable habitats on the area.

In describing movements of five radio-collared adult females during summer and fall of 1975, differentiation was made between normal and total home range. Normal home range included only areas of intensive use, while the total comprised all points of relocation

in vicinity of the general home range. For all five females, the average normal home range was 52 hectares (128 acres) and the total home range was 107 hectares (264 acres) (Table 7). Normal home ranges

TABLE 7. NORMAL AND TOTAL SUMMER HOME RANGE SIZE IN HECTARES AND ACRES FOR FIVE RADIO-COLLARED FEMALE MULE DEER.

	Normal Home Range		Total Home Range	
	Hectares	Acres	Hectares	Acres
Channel 2	30	74	63	156
Channel 3	33	81	108	266
Channel 6	64	157	106	261
Channel 8	51	126	124	306
Channel 10	84	207	134	331
Average	52	128	107	264

among individual females varied from 30 hectares (74 acres) to 84 hectares (207 acres), while total home ranges varied from 63 hectares (156 acres) to 134 hectares (331 acres). Robinette (1966) concluded that the size of a mule deer's home range probably depended upon the distance between sources of food, water, and other habitat requirements. Knowles (1975) reported normal summer home range sizes of 754 hectares (1,863 acres) for a 2.5 year old male and 311 hectares (767 acres) for a 1.5 year old female on his prairie "breaks" study area in north-central Montana; while White (1960) reported a home range size of 40 hectares (100 acres) for mule deer on summer range in the mountains of western Montana.

Average activity radii (Robinette 1966) were computed for all marked deer observed three or more times during a season (Table 8). During spring, average activity radii for all females was 411 meters (450 yards) with a range of 178 meters (195 yards) to 844 meters (923 yards). An adult female accompanied by a fawn had the smallest average activity radius during June. The maximum distance between observations for any individual deer, 2.0 kilometers (1.2 miles), was recorded in early June when migration was undoubtedly occurring. This factor probably contributed to the large average activity radii for some deer, particularly deer numbers 5 and 6 during spring. No males were observed a sufficient number of times to compute average activity radii for this season.

Summer observations permitted the computation of average activity radii of four females and three males. The average activity radius for four females during summer was 333 meters (364 yards), with a range of 178 meters (195 yards) to 555 meters (607 yards). The smallest average activity radius was again computed for an adult female with a fawn. The average summer activity radius for three males was 488 meters (534 yards) with a range of 266 meters (291 yards) to 666 meters (728 yards). Hamlin (1974) computed average activity radii of 314 meters (344 yards) and 542 meters (594 yards) for a female and male, respectively, observed during the summer of 1973. Dasmann and Taber (1956) reported males had larger home ranges and

TABLE 8. AVERAGE ACTIVITY RADIUS IN METERS, FOR 13 INDIVIDUALLY MARKED MULE DEER.

			Spring			Summer			Fall		
Deer No.	Capture Date	Sex	No. of Observations	Time Span of Observations	*AAR	No. of Observations	Time Span of Observations	AAR	No. of Observations	Time Span of Observations	AAR
1 (#9-73)	1/29/73	F				3	9/11/75-9/30/75	289			
2 (#14-73	2/10/73	F				4	8/19/75-9/30/75	178			
3 (#18-74)	4/26/74	F				3	7/4/74-7/28/74	333			
4 (#35-74)	4/30/74	F	3	6/4/75-6/25/75	266						
5 (#1-75)	2/22/75	F	3	6/2/75-6/14/75	733						
6 (#16-79)	4/9/75	F	3	6/2/75-6/23/75	844				4	10/15/75-11/21/75	333
7 (#17-75)	4/10/75	F	3	6/2/75-6/13/75	333				3	10/15/75-10/29/75	289
8 (#20-75)	4/13/75	F	5	6/2/75-6/25/75	244						
9 (#23-75	4/13/75	F	3	6/4/75-6/25/75	178						
10 (#28-75)	4/28/75	F				3	6/20/75-8/20/75	555			
		Average for females			411			333			311

TABLE 8. Continued.

Deer No.	Capture Date	Sex	Spring No. of Observations	Spring Time Span of Observations	Spring *AAR	Summer No. of Observations	Summer Time Span of Observations	Summer AAR	Fall No. of Observations	Fall Time Span of Observations	Fall AAR
11 (#10-73)	1/31/73	M				3	7/23/74-8/13/74	400			
12 (#12-73)		M				4	8/27/74-9/6/74	266			
13 (#32-74)	4/30/74	M				7	7/28/74-8/29/74	666			
		Average for males						488			
		Average for all deer			411			422			311

*AAR = Average activity radius in meters.

were more mobile within their home ranges than females. Maximum distances between observations were 1.5 kilometers (.9 miles) for females and 2.0 kilometers (1.2 miles) for males.

During fall, the average activity radius for two females was 311 meters (340 yards). The maximum distance between observations was .84 kilometers (.52 miles). No males were observed a sufficient number of times to allow the calculation of average activity radii.

Seasonal Use of Habitat Types

Data showing seasonal habitat use by mule deer on the study area during 1974 and 1975 are presented in Tables 9 and 10, respectively.

Spring (June). - During 1975, deer left the winter range several weeks later than normal with much of the spring migration occurring throughout the month of June. This was probably related to snowmelt and greenup of forage which occurred later than normal as indicated from phenological standards based on lilac bloom dates (Caprio 1975). During June, 26 percent of the observations were recorded on the winter range series with the heaviest use occurring early in the month (Table 10). The *Artemisia tridentata/Festuca idahoensis* h.t. was the most important winter range type and ranked fourth in importance for the season. Use of other winter range types was minor. Overall for June, the *Pseudotsuga menziesii* series was the most important accounting for 71

TABLE 9. PERCENT OF GROUND AND AERIAL OBSERVATIONS OF MULE DEER ON THE STUDY AREA BY HABITAT SERIES AND TYPES DURING SUMMER OF 1974.

HABITAT SERIES AND TYPES	Summer				
	June	July	August	September	Season
PSEUDOTSUGA MENZIESII SERIES:					
Pseudotsuga menziesii/Agropyron spicatum h.t.				22	6
Pseudotsuga menziesii/Symphoricarpos albus h.t. *Symphoricarpos albus* phase					
Pseudotsuga menziesii/Calamagrostis rubescens h.t. *Calamagrostis rubescens* phase	25	13	2		6
Pseudotsuga menziesii/Carex geyeri h.t.		10	1	22	9
Pseudotsuga menziesii/Vaccinium globulare h.t. *Vaccinium globulare* phase		1			Tr.*
Total		24	3	44	21
PINUS FLEXILIS SERIES:					
Pinus flexilis/Juniperus communis h.t.				3	1
Total				3	1
ABIES LASIOCARPA SERIES:					
Abies lasiocarpa/Clematis pseudoalpina h.t.					
Abies lasiocarpa/Arnica cordifolia h.t.					
Abies lasiocarpa/Vaccinium globulare h.t.		2			1
Abies lasiocarpa/Vaccinium scoparium h.t. a. *Vaccinium scoparium* phase b. *Thalictrum occidentale* phase					
Total		2			1

TABLE 9. Continued.

HABITAT SERIES AND TYPES	Summer				
	June	July	August	September	Season
PINUS ALBICAULIS SERIES:					
Pinus albicaulis/Vaccinium scoparium h.t.		12	6	12	10
Pinus albicaulis/Carex geyeri h.t.		12	1		4
Total		24	7	12	14
SUBALPINE-ALPINE SERIES:					
Krummholz h.t.	75	45	90	41	61
Alpine Meadow h.t.		5			2
Total		50	90	41	63
Number of Deer Observed	4	83	88	58	233
Percent of Deer Observed	2	36	38	24	100

*Tr. = trace, less than .5% of the total deer occurring in a series or type during a month or season.

TABLE 10. MONTHLY AND SEASONAL PERCENTAGES OF ALL GROUND AND AERIAL OBSERVATIONS OF MULE DEER ON THE STUDY AREA BY HABITAT SERIES AND TYPES DURING SPRING, SUMMER AND FALL OF 1975.

HABITAT SERIES AND TYPES	Spring		Summer				Fall			
	June	Season	July	August	September	Season	October	November	December	Season
WINTER RANGE SERIES:										
Festuca idahoensis/Agropyron spicatum h.t.	1	1						7	6	4
Agropyron spicatum/Agropyron smithii h.t.										
Purshia tridentata/Agropyron spicatum h.t.	5	5						2		Tr.*
Purshia tridentata/Artemisia tridentata h.t.	4	4							22	7
Artemisia tridentata/Festuca idahoensis h.t.	16	16							9	3
Acer glabrum/Philadelphus lewisii h.t.										
Populus tremuloides/Prunus virginiana/Symphoricarpos albus h.t.										
Juniperus scopulorum/Purshia tridentata/Artemisia tridentata h.t.	Tr.	Tr.								
Juniperus scopulorum/Purshia tridentata/Agropyron spicatum h.t.										
Juniperus scopulorum/Purshia tridentata/Festuca idahoensis h.t.										
Pseudotsuga menziesii/Prunus virginiana h.t.										
Pseudotsuga menziesii/Symphoricarpos albus h.t.										
Pseudotsuga menziesii/Festuca idahoensis h.t.										
Total	26	26						9	37	14
PSEUDOTSUGA MENZIESII SERIES:										
Pseudotsuga menziesii/Agropyron spicatum h.t.	20	20		3	6	3	14	13	20	16
Pseudotsuga menziesii/Symphoricarpos albus h.t. *Symphoricarpos albus* phase				3		1				
Pseudotsuga menziesii/Calamagrostis rubescens h.t. *Calamagrostis rubescens* phase	32	32	24	22	26	25	28	48	28	32
Pseudotsuga menziesii/Carex geyeri h.t.	18	18	18	11	5	10	50	30	15	34
Pseudotsuga menziesii/Vaccinium globulare h.t. *Vaccinium globulare* phase	1	1	2	1	15	7			1	
Total	71	74	44	40	52	46	92	91	64	82
PINUS FLEXILIS SERIES:										
Pinus flexilis/Juniperus communis h.t.	1	1		17	4	9				
Total	1	1		17	4	9				
ABIES LASIOCARPA SERIES:										
Abies lasiocarpa/Clematis pseudoalpina h.t.				4		2				
Abies lasiocarpa/Arnica cordifolia h.t.	Tr.	Tr.			8	3	1			Tr.
Abies lasiocarpa/Vaccinium globulare h.t.			24	8		8	3			1
Abies lasiocarpa/Vaccinium scoparium h.t.										
a. *Vaccinium scoparium* phase	1	1		8	7	5				
b. *Thalictrum occidentale* phase										
Total	1	1	24	20	15	18	4			1
PINUS ALBICAULIS SERIES:										
Pinus albicaulis/Vaccinium scoparium h.t.			7	1	12	7	4			2
Pinus albicaulis/Carex geyeri h.t.			7			2				
Total			14	1	12	9	4			2
SUPALPINE-ALPINE SERIES:										
Krummholz h.t.			16	21	16	18	1			Tr.
Alpine Meadow h.t.			2			Tr.				
Total			18	21	16	18	1			
Number of Deer Observed	238	238	38	76	73	187	119	56	87	262
Percent of Deer Observed	35	35	5	11	11	27	17	8	13	38

*Tr. = trace, less than .5% of the total deer occurring in a zone or type during a month or season.

percent of the observations. The DF/Caru h.t. received the greatest use of all types. The DF/Agsp h.t. and DF/Cage h.t. were second and third in importance, respectively. The heavy use of these three habitat types by deer during spring migrations through timbered areas reflected the availability and relatively early "green-up" of forb species here. Only 2 percent of all observations in June were recorded in all other forest habitat types. Relocations of radio-marked deer suggested that these observational data may have been biased in favor of types in which deer were more readily seen. Fifteen percent of the pooled radio relocations for spring (June) were made in habitat types belonging to the *Abies lasiocarpa* series (Table 11),

TABLE 11. PERCENTAGE USE OF MAJOR HABITAT SERIES INDICATED BY RADIO-TRACKING RELOCATIONS OF FIVE FEMALE MULE DEER DURING SPRING, SUMMER, AND FALL.

Vegetation Series	Spring	Summer	Fall
Winter Range Series	4	--	5
Pseudotsuga menziesii Series	80	34	76
Pinus flexilis Series	--	--	--
Abies lasiocarpa Series	15	43	7
Pinus albicaulis Series	--	23	12
Subalpine-Alpine Series	--	--	--
Number of Relocations	40	91	76

indicated that at least some deer were utilizing habitat types other than those indicated by observational data.

Summer (July-September). - Sixty-three percent of all deer observations recorded on the study area during the summer of 1974 were made in the Subalpine-Alpine series (Table 9). Relatively little field time was spent in lower forested areas. All observations were in the *Pseudotsuga menziesii* and *Pinus albicaulis* series, with the former being more important.

Observations during the summer of 1975 indicated that deer were widely distributed and made use of all habitat types with the exception of the Winter Range series. The *Pseudotsuga menziesii* series continued to be the most important series and accounted for 46 percent of the summer observations (Table 10). The DF/Caru h.t. continued to receive the heaviest use among individual types. The Krummholz h.t. ranked second. The DF/Agsp h.t., which was important during spring, received only minor use during summer, possibly because of the greater diversity and availability of succulent forbs at higher elevations. Use of the DF/Vagl h.t. increased during late summer. The relatively small PF/Juco h.t. was important during mid-summer, but use sharply declined during September. The *Abies lasiocarpa* series was second in importance among the major forest series, accounting for 18 percent of the summer observations. The AF/Vagl h.t. was equally important to the DF/Caru h.t. during early summer, but usage declined steadily through August and September. The other three habitat types within this series together accounted for 10 percent of the total summer observations.

Only 9 percent of the summer observations were recorded in the extensive *Pinus albicaulis* series. The WBP/Vasc h.t., which was the most widely distributed habitat type on the study area, accounted for most of this use which was greatest in September.

Relocations of radioed deer (Table 11) suggested that use of the *Abies lasiocarpa* series and *Pinus albicaulis* series may have been underestimated and use of the *Pseudotsuga menziesii* series was overestimated during summer due to differential observability of deer in these types. The *Abies lasiocarpa* series appeared to be the most important forest habitat for use by the five radio-collared females. The *Pseudotsuga menziesii* series was of secondary importance, and the *Pinus albicaulis* series was the least important of the three major forest series. The three most important habitat types for use by these deer were AF/Vagl, DF/Caru, and WBP/Vasc.

Deer use of the Subalpine-Alpine series has been intensively studied since 1972. During the summer of 1975 this series accounted for 18 percent of all seasonal observations. Practically all deer observed were recorded in the Krummholz h.t. (Table 10). In 1975, deer did not arrive on the Subalpine-Alpine series until late July and none were observed there after September 10. In 1974, deer began using this series in early July and usage progressively increased until field work was terminated on September 7. Sixty-three percent of all deer observed were on this series (Table 9).

Average numbers of deer observed per observation period on Krummholz and Alpine Meadow h.t.'s in North Cottonwood and Tom Reese Basins have progressively declined in recent years. For the period July 15-September 12, Wilkins (1957) observed 11 deer per observation period (23 observation periods) in 1955, while Hamlin (1974) recorded 8.5 deer per observation period (35 observation periods) in 1973. During the current study, 5.8 deer were seen per observation period (19 observation periods) in 1974 and 2.2 deer were observed per period (14 observation periods) in 1975.

Figure 7 compares monthly trends in numbers of deer recorded per observation period in the Subalpine-Alpine series during the summer and early fall from 1972 through 1975. Greatest numbers of deer were recorded during early September in all years except 1973 when numbers were highest in early August with a second, slightly lower peak in early September. Increased usage also occurred in October 1973. Hamlin (personal communication April 1976) attributed the latter to movements of deer into the area from east slope summer ranges. The rather consistent increase in use of Subalpine-Alpine habitat in late summer during all four years suggested an annual influx of deer into this area at that time. Schwarzkoph (1973) and Hamlin (1974) both observed a general increase in the percentage of females and fawns among deer recorded in the Subalpine-Alpine series during late summer (Table 12). Similar trends were evident in 1974 and 1975, though

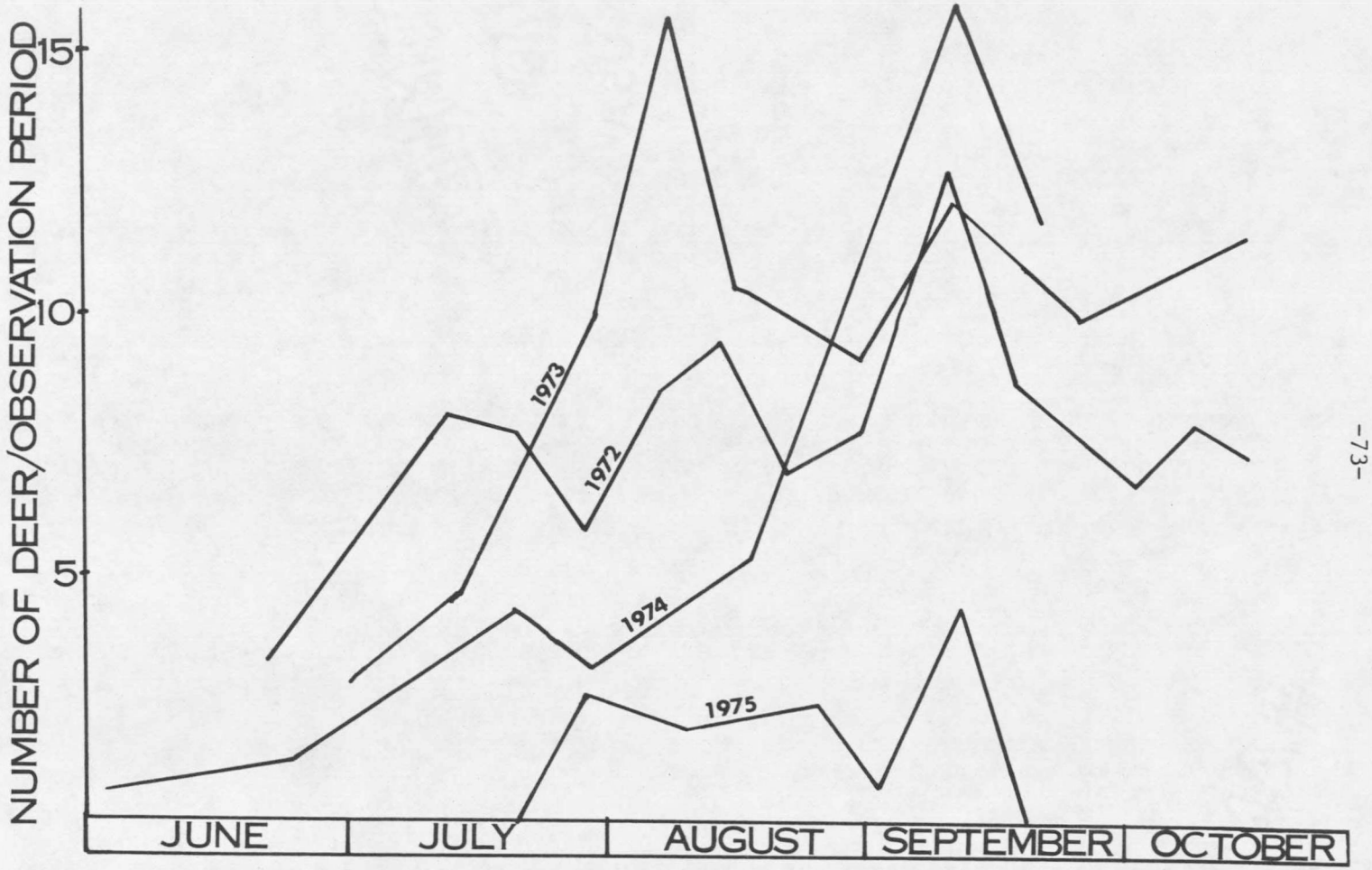

Figure 7. Numbers of deer recorded per observation period in the Subalpine-Alpine series of North Cottonwood and Tom Reese Basins by monthly periods during 1972-1975.

TABLE 12. PERCENTAGE OF MALE AND FEMALE MULE DEER OBSERVED DURING SUMMER AND EARLY FALL IN THE KRUMMHOLZ AND ALPINE MEADOW HABITAT TYPES DURING GROUND OBSERVATIONS IN NORTH COTTONWOOD AND TOM REESE BASINS FROM 1972-1975.

	July		August		September		October	
	Males	Females and Fawns	Males	Females and Fawns	Males	Females and Fawns	Males	Females and Fawns
1972 (Schwarzkoph)	51	49	43	57	40	60	17	83
1973 (Hamlin)	67	33	44	56	28	72	12	88
1974 (Pac)	62	38	67	33	57	43	--	--
1975 (Pac)	25	75	77	23	9	91	--	--
			Sample Size					
1972	35	33	86	114	25	37	1	5
1973	68	34	91	116	21	55	6	50
1974	13	8	45	22	13	10	--	--
1975	1	3	10	3	1	10	--	--

fewer deer were observed. In 1972, the percentage of females and fawns increased substantially during August and slightly during September. During 1973, observations of males greatly outnumbered those of females and fawns during July, but by September the opposite was true. The percentage of females and fawns observed during the summer of 1974 remained fairly constant until early September, when this percentage increased and the percentage of males declined. These data, plus the fact that females and fawns observed during late August and September of 1974 and 1975 were usually close to the forest-krummholz ecotone, suggested an upward movement of females and fawns from forested habitats to the Krummholz h.t. during late summer with peak numbers apparently arriving in early September during most years.

Hamlin (1974) indicated that deer were differentially distributed by sex and age on the study area. Females with fawns apparently predominated in forested habitat types, while males and unproductive females used higher elevation, mountain meadow types. During the summer of 1974, males occurred in much greater proportion among deer observed in the Subalpine-Alpine series than in the total population. The male:female ratio among 108 deer classified in the Subalpine-Alpine series during the summer of 1974 was 192 males per 100 females. Classifications on the Armstrong winter range during early January and late spring of 1975 showed 47 males:100 females and 45 males:100 females, respectively (Mackie *et al.* 1976). During the summer of 1975,

a ratio of 75 males:100 females was recorded for 28 deer classified as to sex and age within the Subalpine-Alpine series. Practically all of the males were observed in August. These data supported other indications that a much smaller proportion of the herd used the Subalpine-Alpine series during 1975 as compared with previous years; and suggested that at least part of the decline may be attributed to decreased use of this area by males. Very few males (11:100 females) were also recorded in forested habitats where most females were observed during the summer and fall of 1975. This might imply either that males were much more difficult to observe than females when both used heavily timbered habitats or that large numbers of males used areas outside of the study area boundaries during 1975.

Fall (October-December). - An abrupt change in habitat usage from September occurred as a result of heavy snowfall in early October. Use of habitat types included in the *Pinus flexilis*, *Abies lasiocarpa*, *Pinus albicaulis*, and Subalpine-Alpine series was very minor during October and completely lacking during November and December. Loveless (1967) reported snow depths of .3 meters (1.0 feet) to .45 meters (1.5 feet) greatly reduced deer use of an area and snow accumulations of .6 meters (2 feet) or over essentially precluded all deer use.

During the fall, 82 percent of all observations were recorded in the *Pseudotsuga menziesii* series, 14 percent were recorded on the

Winter Range series, and the remaining 4 percent on all other series combined (Table 10). Nearly all deer observed in forested habitats were on *Pseudotsuga* dominated types on southerly and westerly aspects. As deer moved downward along migration routes, they appeared to remain at the highest possible elevations and moved only when snow depths caused forage to become unavailable in higher areas. The DF/Cage h.t. and the DF/Caru h.t. were the two most important types, accounting for 66 percent of the total observations during fall. The DF/Agsp h.t. was the third most important type and accounted for 16 percent of all observations. Percentages of observations recorded for each of these three habitat types changed markedly through the fall (Table 10). The DF/Cage h.t. was most important during early fall, possibly due to its prevalence at elevations and on slopes where deer were concentrated. As deer moved to lower elevations in November, westerly aspects occupied predominantly by the DF/Caru h.t. became more prevalent and received greater usage. Usage of the DF/Agsp h.t. remained essentially the same during October and November, but increased during December. Deer using this type during October and November may have been summer residents at or near elevations where this type occurred and usage increased only as migratory deer moved downward in December. Low elevation types, particularly *Purshia tridentata/Artemisia tridentata* h.t., became increasingly important during December as deer moved onto the winter range. The DF/Caru h.t. and DF/Cage h.t. significantly

declined in importance as deer moved to areas below their respective distributional limits.

Radio relocations during the fall (Table 11) suggested somewhat greater usage of the *Abies lasiocarpa* and *Pinus albicaulis* series during early fall than was indicated by general observations.

Seasonal Use of Habitat Types by Five Radio-Collared Females

Figures 8-12 show specific habitat types and relocations by month within the summer home range of each radio-collared female. Total home range is indicated by a heavy solid line, normal home range by a heavy dashed line. Monthly relocations are coded by number: 1 representing June relocations, 2 July ... and 7 December. Specific habitat types are identified by number-letter combinations enclosed in circles. These are the same symbols listed in Table 2 and found on the habitat type map of the study area (Figures 2 and 3).

The home ranges of all five radio-collared females were located within forested habitats. Two of the females (channel 2 and channel 10) spent the summer in areas above and adjacent to the winter range, while the others migrated to more distant summer ranges. The summer home range of channel 8 was located in Bill Smith Canyon about 2.9 kilometers (1.8 miles) east of the winter range; channel 3 utilized a summer home range in North Cottonwood Canyon 4.0 kilometers (2.5 miles) northeast of the winter range; and channel 6 summered 5.8

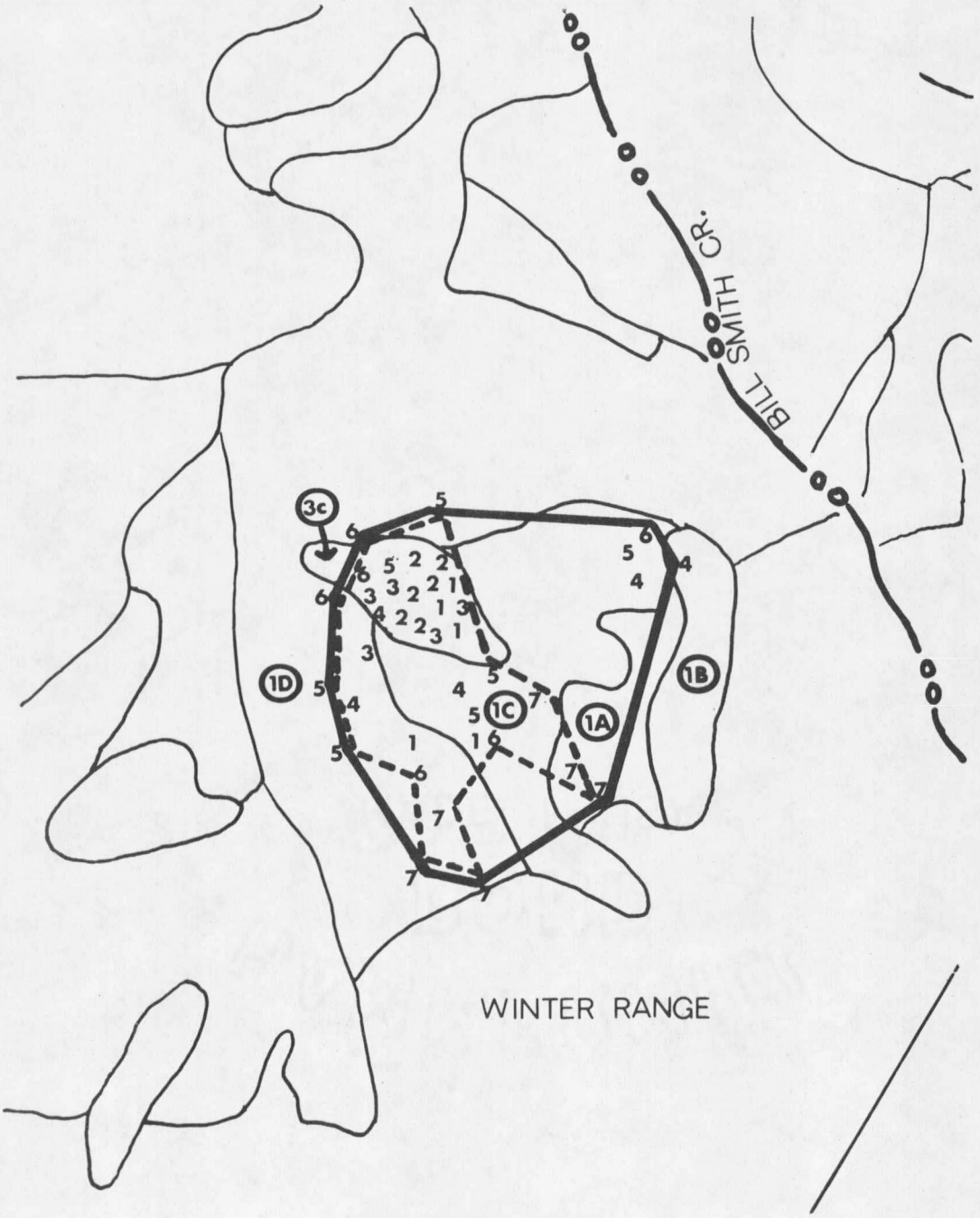

Figure 8. Summer home range of radio-marked female (channel 2) showing specific habitat types and relocations by month. See text.

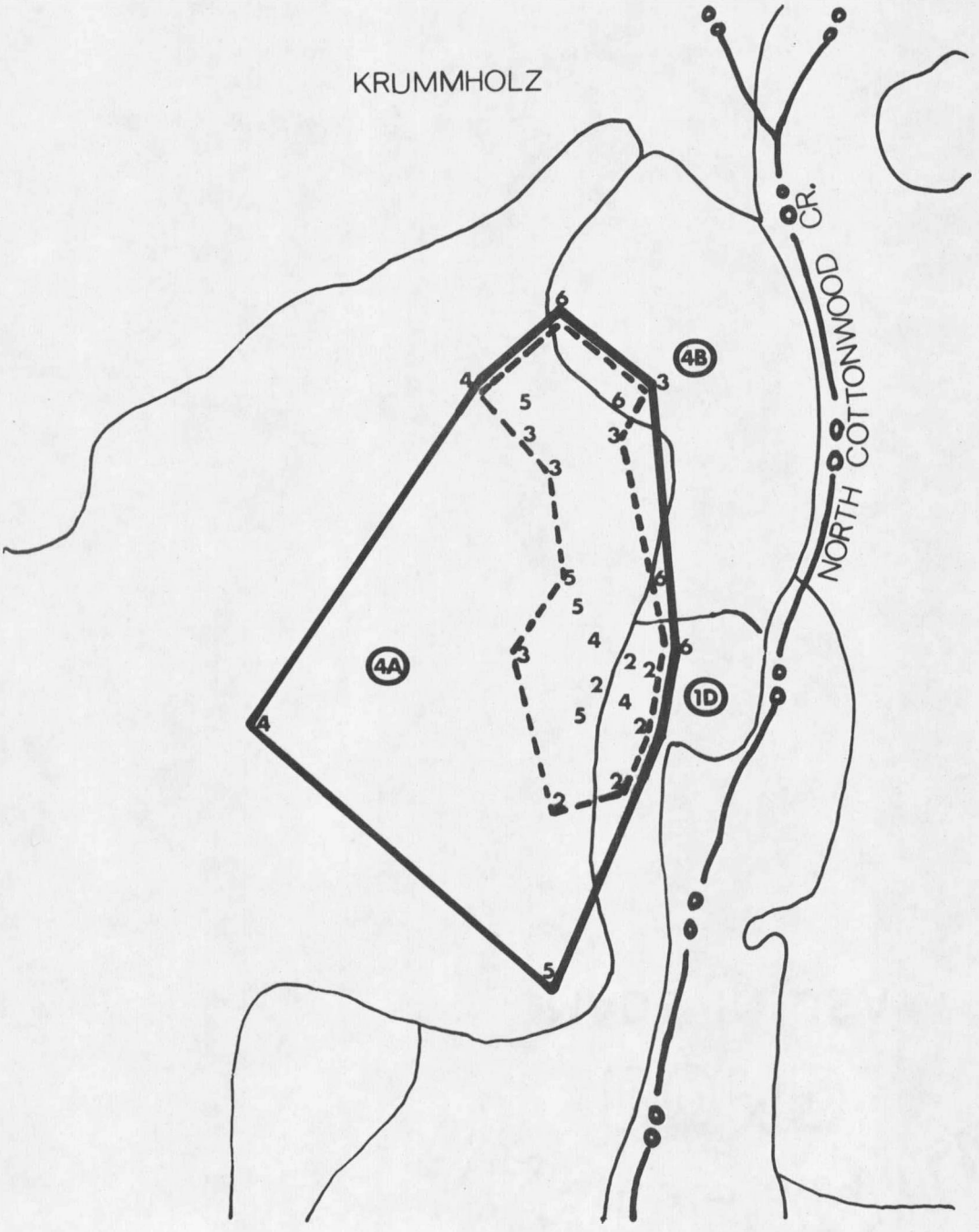

Figure 9. Summer home range of radio-marked female (channel 3) showing specific habitat types and relocations by month. See text.

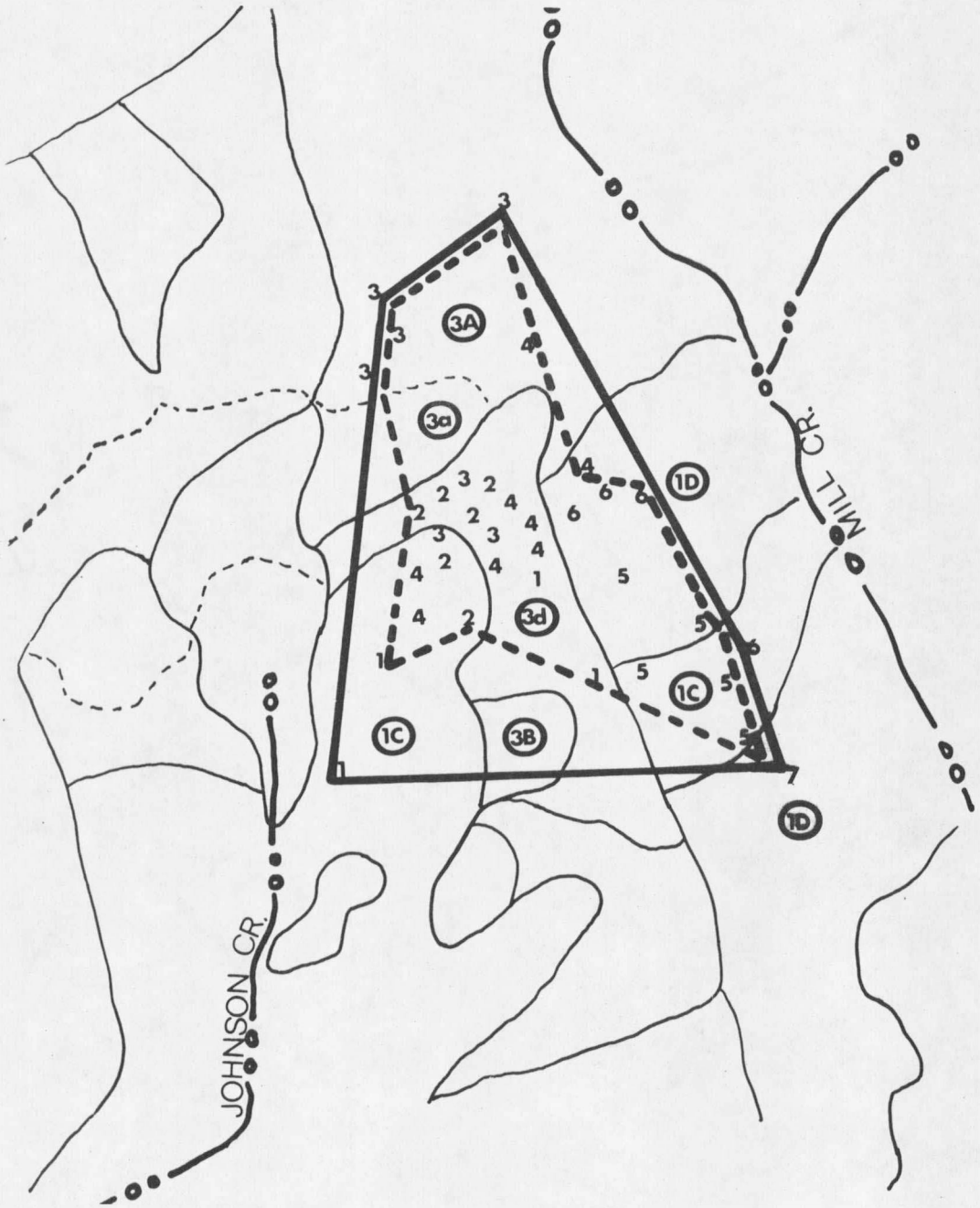

Figure 10. Summer home range of radio-marked female (channel 6) showing specific habitat types and relocations by month. See text.

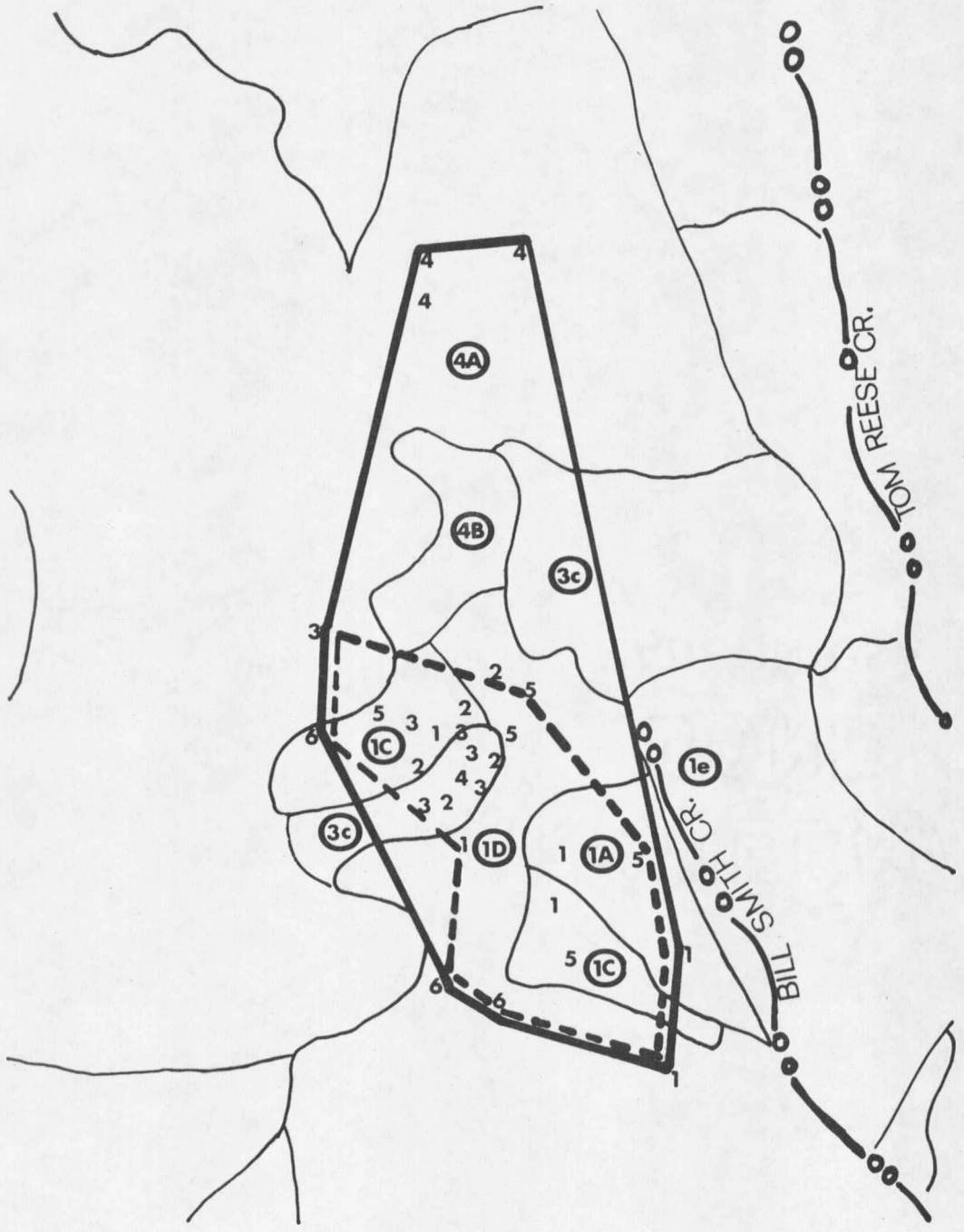

Figure 11. Summer home range of radio-marked female (channel 8) showing specific habitat types and relocations by month. See text.

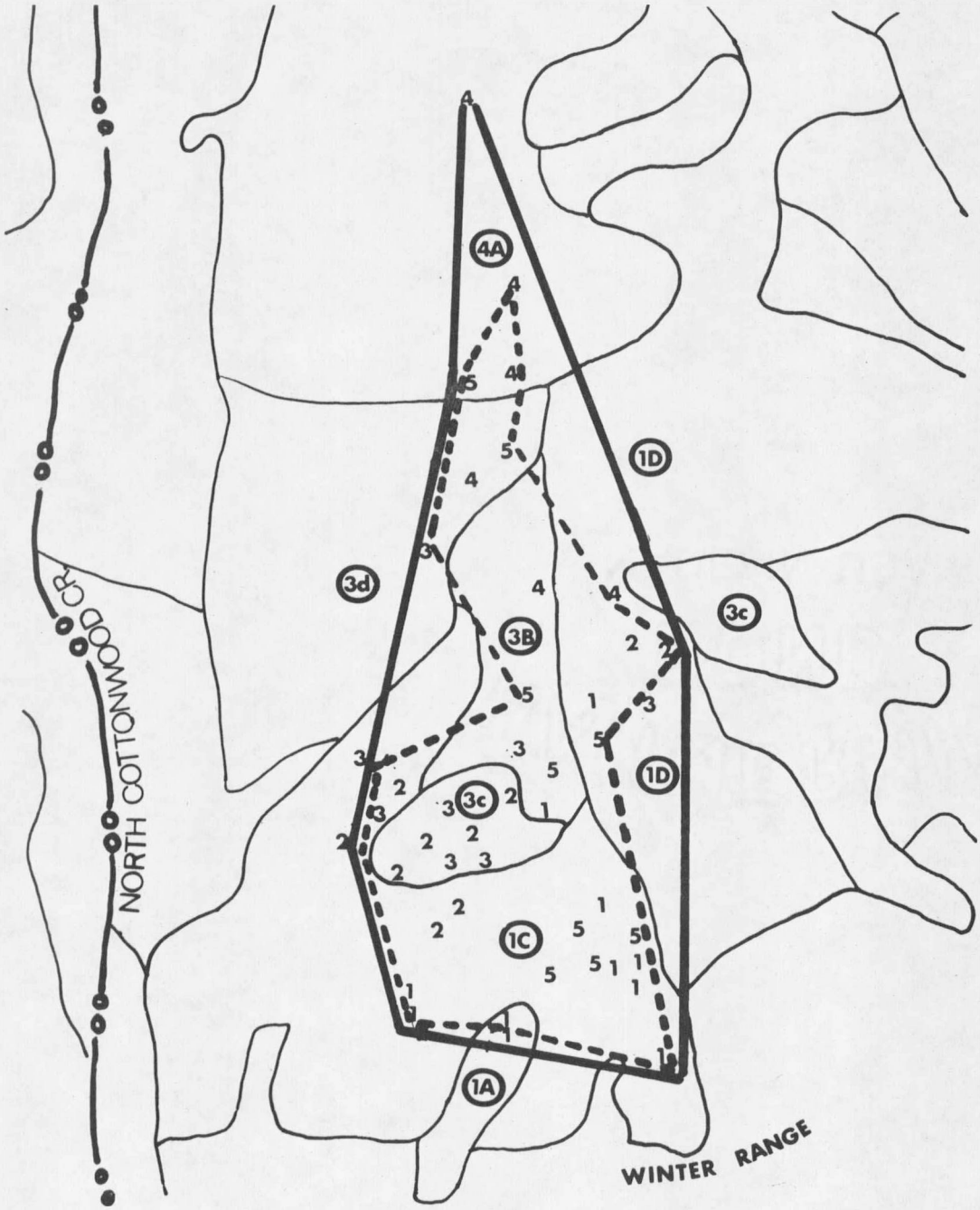

Figure 12. Summer home range of radio-marked female (channel 10) showing specific habitat types and relocations by month. See text.

kilometers (3.6 miles) northeast of the winter range in Johnson Canyon. All five home ranges were situated on upper slopes and included at least one major ridge top.

Spring (June). - Radio-collared deer spent much of June in migration to summer home ranges. Channel 2 (Fig. 8) and channel 10 (Fig. 12) were situated on their relatively low elevation home ranges by June 10. Three days later channel 6 (Fig. 10) and channel 8 (Fig. 11) arrived on their home ranges at intermediate elevations. Channel 3 (Fig. 9) spent all of June on transitional range and arrived on its high elevation summer home range about July 1. The DF/Caru h.t. (1C) was the most important type used by all five females during June. The DF/Cage h.t. was also used by channels 2, 3, 8, and 10 and the DF/Agsp type received some use by channel 8 and channel 10 during mid-June. By late June, channel 2 (Fig. 8) had moved into a relatively small "island" of AF/Vagl h.t. (3C) and channel 6 began utilizing the AF/Vasc h.t. (3D). Predominant use of the various *Pseudotsuga* types during June probably resulted from the relatively early "green-up" of forbs which occurred on these types.

Summer (July-September). - Trends in habitat use by radio-collared females during summer were similar and characterized by concentrated use of certain localized types during early summer and greater activity with pronounced shifts in use of habitat types during late summer.

During July, channels 2, 8, and 10 were closely associated with small "islands" of AF/Vagl h.t. These "islands" of subalpine fir with a shrubby understory of thinleaved huckleberry were almost always surrounded by *Pseudotsuga* types with grass-forb understories. All relocations of channel 2 during July were within the AF/Vagl h.t., while channel 8 and 10 were periodically relocated in the adjacent DF/Caru h.t. but never very far from the periphery of the subalpine fir "island". Channel 6 (Fig. 10) centered its activities within the AF/Vasc h.t. but was occasionally relocated in the nearby stand of the DF/Caru h.t. Channel 3 was almost always relocated along the ecotone between the DF/Cage h.t. and the WBP/Vasc h.t. (4A) with the former accounting for most of the relocations during July.

Throughout most of August, channels 2, 8, and 10 maintained use patterns similar to those noted in July. During early August, channel 3 (Fig. 9) moved upward and heavily used the WBP/Vasc h.t. Channel 6 (Fig. 10) vacated the AF/Vasc h.t. during the second week in August and moved .7 kilometers (.4 miles) uphill into a mesic draw occupied by the AF/Clps h.t. (3A). This shift may have been caused by dessication of forbs resulting in a shortage of forage within the AF/Vasc h.t.

Marked changes in habitat use were observed beginning about the first of September. Relocations of channel 8 (Fig. 11) and channel 10 (Fig. 12) on August 28 indicated that both deer had terminated their

associations with the "islands" of AF/Vagl h.t., and by September 1, both had moved to higher elevations and were utilizing localized areas within the interior of extensive timbered areas with understories dominated by *Vaccinium scoparium*. Channel 10 used both the AF/Vasc h.t. and the WBP/Vasc h.t., while channel 8 used only the latter type. During a snowstorm in mid-September, both deer moved to lower elevations and utilized other habitat types for a few days before returning to their former locations. In early September, channel 6 discontinued use of the AF/Clps h.t. and returned to the lower elevation AF/Vasc h.t. that had been used during July and early August. Channel 3 continued to make extensive use of the WBP/Vasc h.t. This deer made one unusual move briefly in late September to the interior of a WBP/Vasc stand. During early September, channel 2 terminated its close association with the "island" of AF/Vagl h.t. In late September it was relocated in a stand of the DF/Syal h.t. (1B) in a corner of its total home range far removed from areas of previous use.

It has been well documented that usage of habitat types by deer often varies with changes in forage preferences and availability of preferred forage plants (Mackie 1970, Knowles 1975, Komberec 1976). The late summer shift by radio-marked deer from areas dominated by grass-forb understories to habitats with extensive shrubby understories occurred concommitant to an apparent change in the diet of deer from predominant use of forbs to browse. Wilkins (1957) also reported

that the diet of mule deer on the study area shifted from forbs to browse during fall. Due to difficulties in observing deer feeding in shrub types, food habits data did not indicate utilization of *Vaccinium membranaceum* or *Vaccinium scoparium* which were the dominant browse species available in habitats used in September. Deer use of these species has been documented in other studies (Wilkins 1957, White 1960, Schwarzkoph 1973).

Fall (October-December).- During the fall, most relocations of radio-marked deer were confined to *Pseudotsuga* types in stands of southerly and westerly aspect. Some relocations, particularly of channels 3, 6, and 8 occurred along migration routes between the winter and summer ranges and are not shown on Figures 8-12. Channel 2 (Fig. 8) predominantly used the DF/Caru and DF/Cage h.t.'s during October and November; but occasionally associated with the AF/Vagl h.t. (3C) during mild weather periods in October and November. During periods of very severe weather in October and November, this animal was relocated in close association with the DF/Syal h.t. Channel 3 spent most of October in the WBP/Vasc h.t. During a late October snowstorm, it moved downward to what appeared to be a small holding area in the DF/Cage h.t. just above the mouth of North Cottonwood Canyon, which it also used during spring migration. During a period of mild weather in early November, it returned to its summer home range where it used

the DF/Cage and WBP/Cage h.t.'s until late November. Channels 6 and 8 predominantly used the DF/Cage h.t. and/or DF/Caru h.t. during October and November after vacating the shrubby habitat types during the first snowstorms of early October. Channel 10 used similar habitats during October until shot by a hunter on October 29. Channel 6 moved off its home range in late November and utilized the DF/Agsp h.t. near the mouth of Mill Canyon during a period of severe weather. It later returned to its summer home range for a few days in early December. During late November and early December most relocations of channels 2, 3, and 8 occurred within the DF/Cage, DF/Caru, and DF/Agsp h.t.'s on areas adjoining the winter range. Channel 6 spent much of December on transitional range located between Mill Canyon and North Cottonwood Canyon and used DF/Caru and DF/Agsp h.t.'s. By mid-December, channel 2 and channel 8 were using the *Purshia tridentata/ Artemisia tridentata* h.t. on the winter range.

Use of Exposures

Deer observability varied greatly among the four major exposures as a result of variable densities of timber. Observability ranged from very good on south exposures to very poor on north exposures. Data on use of slopes of various exposure during the period June 1-December 15, 1975 (Table 13) indicated that the distribution of all mule deer observations by exposure were closely comparable to that of

TABLE 13. COMPARISON OF USE OF VARIOUS EXPOSURES FOR ALL MULE DEER OBSERVED, INDIVIDUAL MARKED ANIMALS, AND RADIO-RELOCATIONS. DATA ARE PERCENTAGES OF ALL DEER OBSERVED OR RELOCATED DURING THE PERIOD JUNE 1-DECEMBER 15, 1975.

	Sample Size	Exposure			
		North	South	East	West
All Mule Deer	557	10	39	12	39
Marked Mule Deer	137	12	34	15	39
Radio Deer Relocations	200	27	37	13	23

mule deer marked with neckbands. Thus, these two populations apparently were equally observable on each of the four exposures. However, when the percentages of relocations of radio-collared deer on slopes of various exposure are compared to those for all deer observed or for marked deer, some differences are evident, especially in use of north and west exposures. Apparently, visual observations closely approximate actual deer use of south and east exposures; however, north exposures accounted for 10 percent of all deer observations and 27 percent of all radio relocations, indicating that northerly exposures and their associated habitats were probably used to a much greater extent than indicated from visual observations. Deer use of west exposures was probably overestimated when based on visual observations.

Edge-Effect of Home Ranges

Leopold (1933) stated that the maximum population of a particular

game species on any given tract of land depended on the composition and interspersion of essential environmental types in relation to the cruising radius of the species. He further stated that game occurs where essential types providing food and cover come together; i.e., where their edges meet. Radio-collared deer, particularly channels 6, 8, and 10, had summer home ranges in areas where interspersion of a wide variety of habitat types created an extensive edge-effect. Kilometers of edge between habitat types found on normal and total summer home ranges of each radio-collared deer are given in Table 14. Amount

TABLE 14. KILOMETERS OF EDGE BETWEEN HABITAT TYPES FOUND ON THE SUMMER HOME RANGES OF FIVE RADIO-COLLARED FEMALE MULE DEER.

	Channel 2	Channel 3	Channel 6	Channel 8	Channel 10
Normal Home Range	1.23	.85	2.63	2.70	3.17
Total Home Range	2.90	1.25	4.11	5.62	5.35

of edge within normal home ranges varied from .85 kilometers (.52 miles) to 3.17 kilometers (2.0 miles). Edge which occurred within total home ranges varied from 1.25 kilometers (.77 miles) to 5.62 kilometers (3.50 miles).

Food Habits and Nutritional Relationships

Seasonal trends of mule deer food habits were determined during late spring, summer, and fall by the examination of 39 feeding sites.

Use of individual forage species at 16 feeding sites examined during spring and early summer of 1975 (Table 15) was qualitatively estimated as to light (less than 50 bites), moderate (50-100 bites), or heavy use (greater than 100 bites). During the late summer and fall seasons of 1975, 3,800 individual instances of use were recorded at 16 feeding sites (Table 16). A total of 1,430 individual instances of use were recorded at 7 feeding sites during the summer of 1974 (Table 17).

Spring (June)

Forbs were the most important forage class used during June. Browsing occurred at only one of the nine feeding sites examined. The three most important forb species listed in order of importance were arrowleaf balsamroot *(Balsamorhiza sagittata)*, feather Solomon's Seal *(Smilacina racemosa)*, and heartleaf arnica *(Arnica cordifolia)* (Table 15). Use of arrowleaf balsamroot was primarily confined to the DF/Agsp and DF/Cage h.t.'s, while feather Solomon's Seal and heartleaf arnica were both frequently used in the DF/Caru and DF/Vagl h.t.'s. Early leaf stages of arrowleaf balsamroot, feather Solomon's Seal, and heartleaf arnica were especially heavily used. Samples of these three species collected during June averaged 30.0, 32.0, and 29.0 percent protein, respectively (Table 18). By late June, western meadow rue *(Thalictrum occidentale)* became increasingly important in the *Pseudotsuga* types. Protein contents for this species ranged from 24.7

TABLE 15. SPRING AND EARLY SUMMER FOOD HABITS OF MULE DEER BY MONTH AND SEASON AS DETERMINED FROM EXAMINATION OF 16 FEEDING SITES DURING THE PERIOD JUNE 1-AUGUST 15, 1975.

Taxa	Spring (June) Use Rating[1]				Early Summer (July 1-August 15) Use Rating			
	Frequency (9 sites total)	Light	Moderate	Heavy	Frequency (7 sites total)	Light	Moderate	Heavy
FORBS:								
Agoseris glauca					43	3		
Aquilegia flavescens					29		1	1
Arnica cordifolia	33[2]	1[3]	2		11		1	
Arnica latifolia					11			1
Aster conspicuus					11			1
Balsamorhiza sagittata	33	1		2	11	1		
Besseya wyomingensis	11		1					
Erythronium grandiflorum	33	2	1					
Geranium viscosissimum	11			1	29		1	1
Hydrophyllum capitatum	11	1						
Ranunculus eschscholtzii					11	1		
Smilacina racemosa	44	1	3					
Thalictrum occidentale	11			1	29	1		1
Trifolium haydenii					11		1	
BROWSE:								
Acer glabrum					11			1
Spiraea betulifolia	11		1		11		1	
Symphoricarpos albus					11		1	

[1]Light: <50 bites at feeding site; Moderate: 50-100 bites at feeding site; Heavy: >100 bites at feeding site.
[2]Frequency of occurrence of usage among feeding sites.
[3]Number of feeding sites at a given use rating for a particular species.

TABLE 16. LATE SUMMER AND FALL FOOD HABITS OF MULE DEER BY MONTH AND SEASON AS DETERMINED FROM EXAMINATION OF 16 FEEDING SITES DURING THE PERIOD AUGUST 15-DECEMBER 15, 1975.

Taxa	Aug. 1 site (425 bites)	Sept. 5 sites (943 bites)	Late Summer Season 6 sites (1368 bites)	Oct. 1 site (371 bites)	Nov. 4 sites (614 bites)	Dec. 5 sites (1447 bites)	Fall Season 10 sites (2432 bites)
GRASSES AND SEDGES:							
Agropyron caninum		5/20[1]	3/17				
Carex geyeri					8/25	2/20	3/20
Total Grasses and Sedges		5/20	3/17		8/25	2/20	3/20
FORBS:							
Agoseris glauca		3/20	4/17				
Aster conspicuus		37/40	26/33		59/25		15/10
Aster foliaceus		4/20	3/17				
Arnica cordifolia		9/40	6/33				
Balsamorhiza sagittata				24/100	4/25	2/20	6/20
Cirsium spp.					8/25		2/10
Epilobium angustifolium		11/40	8/33				
Helianthella uniflorus				76/100			12/10
Thalictrum occidentale	59/100		18/17				
Valeriana sitchensis	29/100		9/17				
Total Forbs	88/100	64/100	74/100	100/100	71/75	2/20	35/50
BROWSE:							
Artemisia tridentata						14/60	8/30
Penstemon fruiticosus					9/25	13/20	10/20
Prunus virginiana		4/20	2/17				
Purshia tridentata						69/60	41/30

TABLE 16. Continued.

Taxa	Aug. 1 site (425 bites)	Sept. 5 sites (943 bites)	Late Summer Season 6 sites (1368 bites)	Oct. 1 site (371 bites)	Nov. 4 sites (614 bites)	Dec. 5 sites (1447 bites)	Fall Season 10 sites (2432 bites)
BROWSE: Continued							
Ribes spp.	12/100		4/17				
Rosa spp.					8/25		2/10
Rubus idaeus		4/20	2/17				
Salix spp.					4/25		1/10
Symphoricarpos albus		23/40	15/33				
Total Browse	12/100	31/20	23/50		21/50	96/80	62/60

[1]Percent of monthly or seasonal diet/frequency (percent occurrence among sites).

TABLE 17. SUMMER FOOD HABITS OF MULE DEER BY MONTH AND SEASON AS DETERMINED FROM EXAMINATION OF 7 FEEDING SITES IN THE SUBALPINE-ALPINE SERIES DURING THE PERIOD JULY 1-SEPTEMBER 5, 1974.

Taxa	July 2 sites (598 bites)	August 4 sites (755 bites)	September 1 site (77 bites)	Summer Season 7 sites (1430 bites)
FORBS:				
Agoseris glauca	5/50[1]	13/25		10/29
Aquilegia flavescens		31/50		16/29
Arnica latifolia		20/25		10/14
Artemisia michauxiana			19/100	1/14
Epilobium angustifolium	30/50			12/14
Geranium viscosissimum	35/25	13/25		22/28
Lomatium cous	10/50			4/14
Polemonium pulcherrimum		3/25		1/14
Ranunculus eschscholtzii		3/25		1/14
Thalictrum occidentale			45/100	2/14
Trifolium haydenii	17/50		36/100	9/29
Total Forbs	97/100	83/100	100/100	88/100
BROWSE:				
Acer glabrum	3/50			2/14
Ribes spp.		17/25		10/14
Total Browse	3/50	17/25		12/29

[1]Percent of monthly or seasonal diet/frequency (percent occurrence among sites).

TABLE 18. PERCENT DRY WEIGHT OF PROTEIN IN MULE DEER FORAGE PLANTS USED DURING SPRING, SUMMER, AND FALL OF 1975.

Plant Species	Number of Collections	Collection Date	Habitat Type Abbreviation[1]	Stage of Plant Phenology[2]	Percent Water[3]	Percent Protein[4]	Exposure[5]	Plant Parts Collected[6]
Arnica cordifolia	1	6/6	DF/Cage	Early Leaf	85	28.5	S	1
	2	6/10	DF/Caru	Full Leaf	85	21.9	NW	1
	3	6/11	DF/Caru	Early Leaf	86	27.5	W	1
	4	6/15	DF/Vagl	Early Leaf	87	32.0	NW	1
	5	6/17	DF/Vagl	Early Leaf	85	27.8	NW	1
	6	6/24	DF/Agsp	Full Leaf	83	21.4	S	1
	7	7/12	WBP/Cage	Full Leaf	81	16.0	S	1
(a.)[7]	8	7/12	DF/Vagl	Full Flower	85	12.4	E	1
	9	9/1	AF/Arco	Pre-dormancy	83	10.4	N	1
	10	9/23	AF/Vasc	Pre-dormancy	84	8.0	N	1
Balsamorhiza sagittata	1	6/4	DF/Agsp	Early Leaf	92	30.1	S	1
	2	6/6	DF/Cage	Early Leaf	83	32.0	S	1
	3	6/6	DF/Cage	Flower Bud	84	26.8	S	1
(a.)	4	6/20	Acgl/Phle	Full Flower	83	21.8	W	1
	5	6/24	DF/Cage	Early Leaf	83	29.7	S	1
	6	8/6	PF/Juco	Seed Head	70	17.6	W	4
	7	8/21	DF/Cage	Seed Head	11	8.8	S	4
(b.)[8]	8	10/8	DF/Agsp	Dormant	76	5.1	S	1+4
Aster conspicuus	1	8/9	DF/Caru	Full Leaf	74	11.1	W	1
	2	9/23	DF/Caru	Full Leaf	75	12.0	W	1
	3	9/30	DF/Caru	Full Leaf	77	11.3	W	1
(b.)	4	11/19	DF/Caru	Dormant	44	4.7	W	1+4
Geranium viscosissimum	1	6/20	Acgl/Phle	Full Leaf	82	17.5	W	1
(b.)	2	7/8	DF/Caru	Full Leaf	89	19.8	S	1
	3	7/25	Krummholz	Flower Bud	81	19.6	W	1

TABLE 18. Continued.

Plant Species		Number of Collections	Collection Date	Habitat Type Abbreviation[1]	Stage of Plant Phenology[2]	Percent Water[3]	Percent Protein[4]	Exposure[5]	Plant Parts Collected[6]
Geranium viscosissimum (Continued)	(a.)	4	8/6	PF/Juco	Full Flower	77	13.5	W	1
		5	9/4	Krummholz	Seed Head	72	13.6	W	1
Erythronium grandiflorum		1	6/10	DF/Caru	Full Flower	85	17.2	NW	1
		2	6/15	DF/Vagl	Early Leaf	88	27.8	NW	1
		3	6/17	DF/Vagl	Early Leaf	87	26.1	NW	1
	(a.)	4	7/8	DF/Caru	Seed Head	89	22.8	S	1
	(a.)	5	8/5	Pial/Vasc	Full Leaf	88	15.0	NW	1
Symphoricarpos albus		1	8/9	DF/Caru	Full Flower	65	12.7	W	1+5
		2	9/26	DF/Caru	Full Fruit	67	10.8	W	1+5
		3	9/30	DF/Caru	Post-fruit	60	7.8	W	1+5
Thalictrum occidentale	(a.)	1	6/15	DF/Vagl	Early Leaf	90	37.5	NW	1
		2	6/17	DF/Vagl	Early Leaf	84	35.1	NW	1
	(a.)	3	6/25	DF/Caru	Early Leaf	80	24.7	W	1
	(a.)	4	8/5	DF/Caru	Seed Head	70	12.1	W	1
		5	8/6	PF/Juco	Seed Head	70	13.1	W	1
		6	8/9	DF/Caru	Seed Head	70	13.9	W	1
		7	8/23	Krummholz	Seed Head	71	14.7	W	1
Smilacina racemosa		1	6/10	DF/Caru	Early Leaf	85	29.1	NW	1
		2	6/11	DF/Caru	Early Leaf	85	26.7	NW	1
		3	6/15	DF/Vagl	Early Leaf	85	35.5	NW	1
		4	6/17	DF/Vagl	Early Leaf	85	35.6	NW	1
		5	6/25	DF/Caru	Full Leaf	83	19.4	W	1
	(a.)	6	7/8	DF/Caru	Full Flower	85	15.8	S	1
		7	8/9	AF/Vagl	Seed Head	89	13.0	NE	1

TABLE 18. Continued.

Plant Species	Number of Collections	Collection Date	Habitat Type Abbreviation[1]	Stage of Plant Phenology[2]	Percent Water[3]	Percent Protein[4]	Exposure[5]	Plant Parts Collected[6]
Agoseris glauca	1	7/12	WBP/Cage	Full Leaf	86	21.3	S	1
	2	8/6	PF/Juco	Flower Bud	83	13.7	W	2
(a.)	3	8/6	PF/Juco	Flower Bud	85	15.5	W	1
	4	8/12	Krummholz	Full Leaf	81	17.7	W	1
	5	9/5	Krummholz	Flower Bud	83	15.5	W	1
Hydrophyllum capitatum	1	6/6	DF/Cage	Flower Bud	88	30.2	S	1+2
	2	6/24	DF/Agsp	Full Leaf	82	21.3	S	1
Aquilegia flavescens	1	7/24	AF/Vagl	Full Flower	80	13.4	NE	1
	2	8/6	PF/Juco	Seed Head	83	11.9	W	1
Acer glabrum	1	8/9	DF/Caru	Post-Flower	65	10.5	W	1+5
	2	8/19	PF/Juco	Post-Flower	60	11.2	W	1+5
Epilobium angustifolium	1	9/5	Krummholz	Full Leaf	78	14.4	E	1
	2	9/26	DF/Caru	Post-Seed Head	85	15.8	W	1
Penstemon fruiticosus	1	8/20	DF/Caru	Seed Head	72	14.0	W	1+5
(b.)	2	11/5	DF/Cage	Full Leaf	56	7.1	S	1+5
(b.)	3	12/3	DF/Cage	Full Leaf	60	8.5	W	1+5
Helianthella uniflorus	1	9/1	PF/Juco	Seed Head	69	13.2	W	4
	2	10/8	DF/Agsp	Dormant	55	15.4	S	4
Hieracium cynoglossoides (a.)	1	8/21	DF/Cage	Flower Bud	73	11.9	S	1
Carex geyeri	1	11/19	DF/Caru	Dormant	62	9.2	W	1
Cirsium spp.	1	11/17	DF/Caru	Dormant	45	9.8	W	1
Silene parryi	1	7/24	DF/Caru	Flower Bud	79	15.4	W	1+2

TABLE 18. Continued.

Plant Species	Number of Collections	Collection Date	Habitat Type Abbreviation[1]	Stage of Plant Phenology[2]	Percent Water[3]	Percent Protein[4]	Exposure[5]	Plant Parts Collected[6]
Valeriana sitchensis	1	8/23	Krummholz	Full Flower	79	10.8	W	1
Prunus virginiana	1	9/26	DF/Caru	Full Fruit	66	11.4	W	1+5
Ranunculus eschscholtzii	1	7/25	Krummholz	Full Leaf	80	14.5	E	1
Trifolium haydenii	1	8/12	Krummholz	Late Flower	74	14.8	W	1+3
Ribes spp.	1	6/4	DF/Cage	Full Leaf	67	19.6	W	1+5
Berberis repens (a.)	1	9/26	DF/Caru	Full Fruit	67	12.9	W	1
Aster foliaceus	1	9/5	Krummholz	Flower Bud	76	15.6	E	1+2
Arnica latifolia	1	8/12	Krummholz	Full Flower	81	13.1	W	1+3
Rubus idaeus	1	9/26	DF/Caru	Full Fruit	70	14.0	W	1+5
Besseya wyomingensis	1	6/24	DF/Cage	Flower Bud	86	20.6	S	1+2
Spiraea betulifolia	1	6/20	Acgl/Phle	Full Leaf	71	10.6	W	1+5
	2	8/9	DF/Caru	Full Flower	57	14.6	W	1+5

[1]Habitat type of collection site.
[2]Stage of phenology of collected plant.
[3]Percent water computed by $\frac{\text{wet weight-dry weight}}{\text{wet weight}}$.
[4]Percent oven-dry weight of protein.
[5]Exposure at collection site.
[6]Code for plant parts collected: leaves-1, flower buds-2, flowers-3, seed heads-4, stems-5.
[7](a.) - Comparative nutrition sample. No deer use of plant at time and place of collection.
[8](b.) - Percent water is inflated by presence of moisture on collected vegetation.

percent for samples collected in the DF/Caru h.t. to 37.5 percent in the DF/Vagl h.t.

Summer (July-September)

During early summer (July-mid-August) important forb species included yellow columbine *(Aquilegia flavescens)*, sticky geranium *(Geranium viscosissimum)*, western meadow rue, fireweed *(Epilobium angustifolium)*, *Arnica latifolia*, and Hayden clover *(Trifolium haydenii)* (Tables 15 and 17). In forested habitats, heavy past utilization, in addition to current use recorded at feeding sites, was noted on yellow columbine, western meadow rue, and sticky geranium in the PF/Juco h.t. Western meadow rue and yellow columbine were also frequently utilized in the DF/Caru h.t. and the AF/Vagl h.t., respectively. Sticky geranium, yellow columbine, *(Arnica latifolia)*, fireweed, and Hayden clover were the most frequently used species in the Krummholz h.t. during early summer. Use of browse species during early summer was light and primarily confined to forested habitat types. Common snowberry *(Symphoricarpos albus)*, white spiraea *(Spiraea betulifolia)*, and Rocky Mountain maple *(Acer glabrum)* appeared to be the most frequently used species.

By late summer important forb species were showy aster *(Aster conspicuus)*, western meadow rue, fireweed, Sitka valeriana *(Valeriana sitchensis)*, and false dandelion *(Agoseris glauca)* (Tables 16 and 17).

Showy aster was especially prevalent within the DF/Caru h.t. and DF/Syal h.t. and was heavily used throughout September. It remained green 2-3 weeks longer than other important forb species such as western meadow rue and fireweed. Forbs comprised 88 percent of plant use recorded in the Krummholz h.t. during summer (Table 17). Sitka valeriana, false dandelion, and western meadow rue were the important species used in late August and early September. Browse plants, of which *Ribes* spp. was most important, accounted for only 12 percent of the summer diet in this habitat type. Browse use in forested types increased from 12 percent of the diet in August to 31 percent in September (Table 16). Common snowberry accounted for most of this increase and was heavily utilized both in the DF/Syal h.t. and at lower elevation sites, adjacent to creek bottoms, within the DF/Caru h.t.

Protein contents of plants used as forage during summer were much lower than those of spring forages. Protein levels of western meadow rue and yellow columbine were similar and ranged from 12 to 14 percent for samples collected at feeding sites during the summer. Protein in sticky geranium declined from 19.8 to 13.5 percent during the summer. *Arnica latifolia* and Hayden clover contained 13.1 and 14.8 percent protein, respectively, at the time they were used by deer. Showy aster contained about 12 percent protein while false dandelion averaged 16.6 percent protein during late summer. Sitka valeriana and

fireweed had protein contents around 11 and 15 percent, respectively, at the time of their use in late summer. Protein levels in samples of common snowberry ranged from 7.8 to 10.8 percent when heavily utilized during September.

Fall (October-December)

Dried forbs appeared to be important in the diet during early fall when deer made extensive use of the DF/Cage h.t. The dried leaves and seed heads of little sunflower *(Helianthella uniflora)* and arrowleaf balsamroot were particularly important (Table 16). In November, the dried leaves and seed heads of showy aster were heavily used, particularly in the DF/Caru h.t. Some use of elk sedge *(Carex geyeri)* and thistle *(Cirsium* spp.*)* was noted during a period of severe weather in late November. Shrubby penstemon *(Penstemon fruiticosus)* was the only important browse species used in forested types during November, although it accounted for only 9 percent of the monthly diet (Table 16). Some use of *Salix* spp. and *Rosa* spp. was observed when deer moved onto very low footslopes during severe weather in November. During December, browse made up 96 percent of the diet with antelope bitterbrush *(Purshia tridentata)* accounting for the largest proportion. Big sagebrush *(Artemisia tridentata)* and shrubby penstemon were less important.

Protein contents of most fall forages were appreciably lower than those of summer forage plants. The seedheads of little sunflower collected on October 8 contained 15.4 percent protein; the highest of any plant used during fall (Table 18). Showy aster, elk sedge, and thistle contained 4.7, 9.2, and 9.8 percent protein, respectively, during November. Shrubby penstemon contained from 7.1 to 8.5 percent protein during fall. Average protein contents of antelope bitterbrush and big sagebrush on winter range types in December were 9.0 and 9.5 percent, respectively (Morton, M. A. personal communication, May 1976).

Protein levels in individual forage plants selected by deer during spring and summer generally declined during the period of use in relation to growth and phenological development (Figure 13). Protein contents were highest during early leaf stages in the spring when values ranged from 30-35 percent for *Balsamorhiza sagittata*, *Thalictrum occidentale*, *Smilacina racemosa*, and *Arnica cordifolia*. During later phenological stages in summer, protein contents varied among species but a downward trend was evident. By early fall, the four species were in dormant condition and protein content ranged from 5-10 percent for the two species collected at that time. Dietz (1965) noted a similar seasonal decline in protein content among deer forage plants in Colorado.

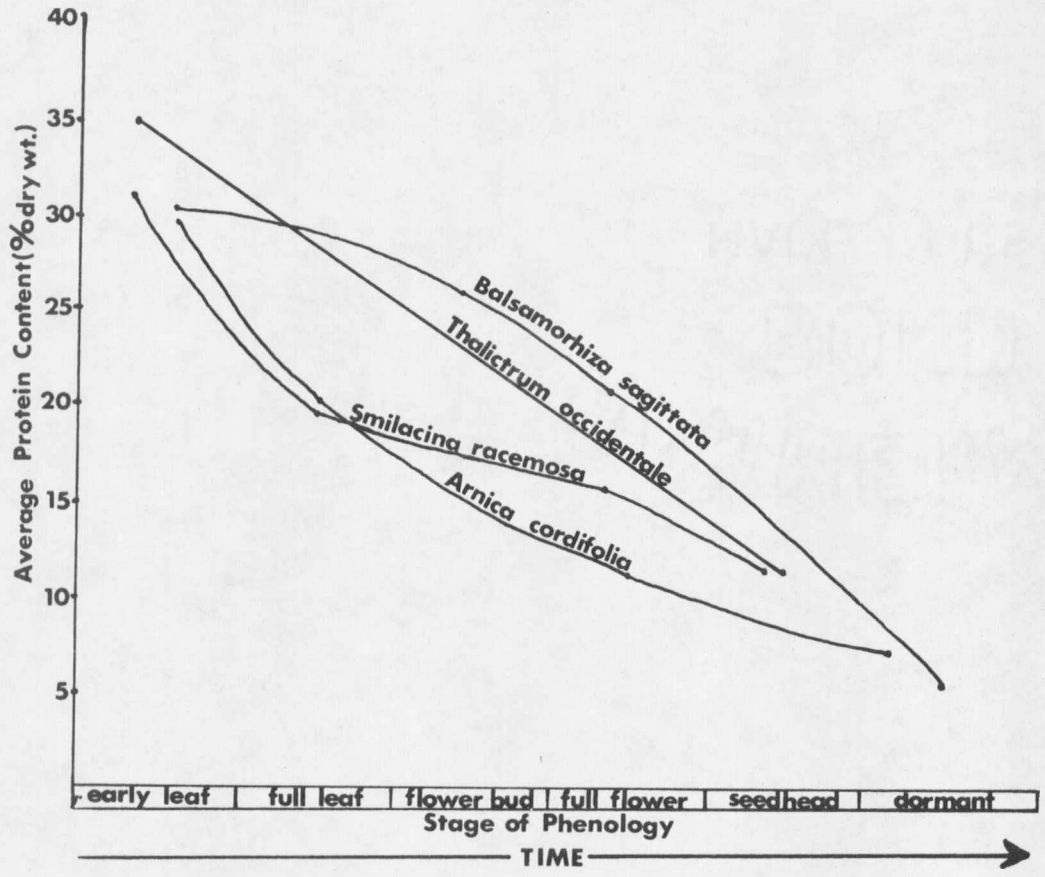

Figure 13. Changes in percent dry weight protein with successive stages of phenology of four species of herbaceous deer forage.

Hunting Season and Harvest

The hunting season was from October 19th through November 23rd during 1975. Deer of either sex were legal game during the first three weeks and bucks only thereafter. Checking station and field checks of 931 persons hunting the Bridger Range revealed 62 deer killed. Of these, 58 were reported to personnel operating check stations on main access roads along the east and west sides of the Bridgers during the first three weekends of the hunting season. The other four deer were reported by hunters at voluntary check boxes. The total harvest consisted of 27 males and 35 females. Among the males 15 percent were fawns, 48 percent were yearlings, 11 percent were 2.5 year olds, 19 percent were mature adults, and 7 percent were unclassified. The harvest of females consisted of 20 percent fawns, 11 percent yearlings, 14 percent 2.5 year olds, 51 percent mature adults, and 3 percent were unclassified. Weights of female fawns and male fawns averaged 18.2 kilograms (40 pounds) and 25.9 kilograms (57 pounds), respectively. Average weights of yearling females was 40.0 kilograms (88 pounds), while that of yearling males was 49.5 kilograms (109 pounds). Mature females weighed an average of 48.6 kilograms (107 pounds) and mature males averaged 90.4 kilograms (199 pounds). Only four deer were killed within the study area boundaries. Wilkins (1957) reported an estimated 50 deer were killed between North Cottonwood Creek and Tom Reese Creek on the study area

during the regular 1955 hunting season, and an additional 50 deer were harvested during a special late season. Hamlin (1974) reported that 28 deer were killed on this same portion of the study area during the 1973 deer season.

Only two marked deer were known to have been killed during the 1975 season. One was a mature, radio-collared female (channel 10) shot in North Cottonwood Canyon on October 29. The other was a mature, neck-banded male shot 3.0 kilometers (1.9 miles) south of the study area near Corbly Canyon on November 23.

Elk, Mountain Goat, and Black Bear Observations

During spring of 1975, two elk, an adult female and a male were observed in the DF/Cage h.t. in North Cottonwood Canyon and Johnson Canyon, respectively. Eighty-three observations of elk (19 calves, 58 females, 6 males) were recorded on and adjacent to the Armstrong winter range and just north of North Cottonwood Creek during the first two weeks of December 1975. The largest group observed at one time numbered 42 (10 calves, 30 females, 2 males).

Seventeen observations of mountain goats including 3 kids were made in North Cottonwood Basin during the summer of 1974. In 1975, fifty-one observations of goats including 8 kids were recorded in the North Cottonwood and Tom Reese Basins. All goat observations during both years were confined to the Subalpine-Alpine series and the talus

slopes along the crest of the Bridger divide. The largest number of individual goats observed at one time was eight including two kids during 1974 and eleven including two kids in 1975.

Thirty observations of black bear were recorded during the summers of 1974 and 1975. These included seven observations of cubs (three sets of twins). All cubs were observed in forested habitats.

DISCUSSION AND CONCLUSIONS

The results of this study serve to further define and/or clarify findings of previous studies on distribution, movements, and habitat usage of mule deer associated with the Armstrong winter range (Wilkins 1957, Schwarzkoph 1973, Hamlin 1974). Some important differences also were noted, possibly relating to weather and range conditions, decreased numbers of mule deer using the area, and/or the use of radio-marked animals during 1975.

Findings supported earlier observations that a majority of the deer associated with the Armstrong winter range spend summer and fall along the west slope of the Bridger Range in an area between North Cottonwood and Tom Reese Creeks. However, appreciable numbers, possibly 30-40 percent, may migrate to summer-fall ranges north and south of this area as well as along the east slope of the Bridger Mountains.

Hamlin (1974) reported that many of the deer individually marked on the Armstrong winter range in 1972 and 1973 were reobserved on the winter range during the winter of 1973-74. Results of the current study indicate that mule deer in the Bridger Mountains habitually use the same summer and winter home ranges year after year, as reported for other areas by Leopold *et al.* (1951), Gruell and Papez (1963), and Robinette (1966). Some exceptions were noted for males. During

1975, very few males were observed on the study area relative to numbers on the Armstrong winter range. This, plus the fact that males appeared more flexible in their annual selection of seasonal home ranges than females, may indicate that proportionately more males than females used ranges outside of the study area boundaries.

Spring and fall migrations between seasonal home ranges appeared to follow definite routes in the same manner as reported for migratory deer herds in other areas (Gruell and Papez 1963, Gale 1976). These routes included local "holding areas" where deer aggregated for variable periods of time during migrations. Gale (1976) believed that such holding areas might be "key" habitats for migrating deer since 20 percent of the fawns which left summer ranges on his study area were lost during late fall when deer occupied these areas.

During 1975, fewer than 50 percent of the fawns observed in fall survived to early winter. Much of this loss probably occurred during a week of severe weather in late November. Hamlin (1974) reported that fawns and some females were entering the winter with omental fat reserves close to the critical level. Mackie *et al.* (1976) indicated that low fat reserves might be related to nutritional deficiencies during summer and/or fall. However, they also indicated that a decrease in the proportion of fawns among deer observed in the vicinity of the study area from fall to early winter could be indicative of an influx of less productive animals from summer-fall

ranges outside of the primary study area. Other investigators have reported that the quality of summer ranges may be very important in determining the productivity of cervid populations (Edwards and Ritcey 1958, Julander *et al.* 1961).

Intermittent periods of severe weather during the fall caused rapid changes in mule deer use of habitat types accompanied by frequent, rapid changes in forage utilization. As succulent, high quality herbaceous forage disappeared during late August and early September at least some deer selected habitat types with shrub understories, presumably due to the availability of browse. By early October, heavy snowstorms forced deer from these shrubby habitat types on north exposures onto areas of southerly and westerly aspects where their diet consisted primarily of dried forbs, some of which have been shown to be rather low in protein. Dried forbs may be less preferred at this time but were heavily utilized because of their high availability relative to browse which was scarce on the DF/Cage and DF/Caru types used during this period. During a period of heavy snow and cold temperatures in late November, the deer were forced to even lower elevation to slopes on or in the vicinity of the winter range where the diet was again predominated by browse species, particularly antelope bitterbrush. Freeland and Janzen (1974) indicated that detrimental physiological effects can occur whenever herbivores are subjected to rapid fluctuations in the diet without ample time for

rumen microflora to adapt to toxins present in the ingested forage plants. Fawns in poor condition as a result of dietary deficiencies experienced on summer and/or fall ranges may have succumbed during late fall as a result of additional physiological stresses incurred when the diet rapidly fluctuated during periods of severe weather.

Evidence obtained during this study generally supported Hamlin's (1974) observation that deer were differentially distributed by sex and age during summer, with females and fawns predominantly using forested habitats and males and unproductive females using the Subalpine-Alpine series. However, somewhat different habitat use patterns were noted during 1975 as compared to 1974 and earlier years in which studies were conducted in the Bridger Mountains.

Snowmelt and "green-up" of forage was delayed during the spring of 1975 as compared with other years; and as a result deer remained on the winter range until late May or early June. Migration occurred predominantly during June as forbs began to appear in the DF/Caru, DF/Cage, and DF/Agsp types. Moist and cool conditions prevailed throughout the summer resulting in continued availability of green succulent forage in most areas into early September. Extensive dessication of forbs was noted only on foothill and low elevation timbered habitat types. This probably explains the observed heavy usage of forested habitats, particularly those belonging to the *Pseudotsuga menziesii* series during 1975. Radio relocations indicated

that habitat types within the *Abies lasiocarpa* series may also have received important usage during the summer. Relatively few observations were made and little deer usage had been recorded in these types during earlier studies (Wilkins 1957, Schwarzkoph 1973, Hamlin 1974) in which data were recorded only on the basis of visual observations of deer. Subalpine-alpine areas and habitat types received much lower usage during 1975 than in earlier years. This may have reflected the relatively lush forage conditions and greater deer usage of timbered habitats at lower elevations as well as lower population densities on the study area during the summer of 1975. There was some evidence that proportionally fewer males, in particular, used subalpine-alpine types in 1975.

Observations during this as well as previous studies on the area indicated an upward movement of females and fawns into the Subalpine-Alpine series during late summer, with peak usage in early September during most years. During 1975, both the influx of females into the Krummholz h.t. and the shift to use of shrub types by radio-collared females in forested habitats corresponded closely with the occurrence of the first killing frosts during the last few days of August. At that time, most herbaceous plants in the sparsely vegetated understories of timbered types at lower elevations were killed, while many of those which occurred at lower levels within the dense herbaceous understory of the Krummholz h.t. appeared to remain green into September. Mule deer

have been shown to display strong preferences for green herbaceous forage over browse whenever the former is available (Wilkins 1957, Lovaas 1958, Mackie 1970, Knowles 1975). Joslin (1975) reported that elk had the ability to select feeding sites where forbs were superior in moisture content. The greater availability of green succulent forage in the Krummholz h.t. probably provided a stimulus for movement of deer to that area from adjacent timbered habitats during early September, while deer at somewhat lower elevations shifted their feeding to browse species on shrub-understoried timber types within their total home ranges. The predominant earlier summer use of heavily timbered habitats by females, especially those with or which earlier had fawns, may reflect their selection for high security habitats as long as supplies of succulent, high quality forbs were adequate in all areas. Darling (1937) indicated that, compared to males, red deer females had a higher requirement for security which was related to maternal instincts. During dry years, dessication of green herbaceous forage would undoubtedly be more extensive in forested habitat types during summer, and earlier and more frequent shifts in habitat use by deer might be expected in those areas. At the same time, changes in habitat use in response to killing frost in late summer might be less pronounced.

After early October, all deer were observed in timbered areas predominantly on southerly and westerly aspects occupied by the DF/Cage,

DF/Caru, and DF/Agsp h.t.'s. Deer appeared to move downward along migration routes toward the winter range only when snow accumulations caused forage to become unavailable in higher areas. This pattern of movement and habitat usage was suggested by earlier studies on the area, and is similar to that described for mule deer elsewhere (Loveless 1967).

Data on food habits and nutritional relationships showed that the protein content of herbaceous forage plants consistently declined from high percentages at spring emergence to much lower percentages at fall dormancy. This decline appeared to be more closely correlated with the phenological progression of plant development rather than with the passage of time, per se. Dasmann and Dasmann (1963) reported that along a climatic gradient, the seasonal changes in protein content were greatest for forage species in Montane forest communities and least in sagebrush-grassland communities. They related the scarcity of resident mule deer in sagebrush communities during summer to the greater availability of highly nutritious forage species in the Montane forest communities at a time when protein values of 13 percent or more are required for maximum growth and reproduction.

APPENDIX

TABLE 19. NUMBERS OF MALES, FEMALES, AND FAWNS OBSERVED WITHIN MAJOR HABITAT SERIES ON THE EAST SLOPE OF THE BRIDGER MOUNTAINS DURING SUMMER OF 1974.

	June			July			August			September		
	Males	Females	Fawns	Males	Females	Fawns	Males	Females	Fawns	Males	Females	Fawns
Pseudotsuga menziesii Series	-	2	-	2	5	-	-	1	2	-	-	-
Abies lasiocarpa Series	1	2	-	1	1	-	1	-	-	6	3	1
Subalpine-Alpine Series	-	2	-	-	-	-	1	-	-	16	-	-
Number of Deer	1	6	-	3	6	-	2	1	2	22	3	1

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