

Mule deer habitat use in the Owyhee Mountains, Idaho
by Gregory Bryan Milner

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:
Ten mule deer (Odocoifeus hemionus) were selected from 50 deer captured and radiocollared during winter 1992-93. These deer were relocated 196 times from the ground and 296 times from the air during the summer (June - August) - fall (September -November) 1993 study period. Home ranges were computed for the 10 deer (4 males and 6 females) based on ground and aerial locations. In summer - fall 1994, 11 radiocollared deer were located 248 times from the ground and 59 times from the air. Home ranges were calculated for 9 of them (2 males and 7 females). Two males and 2 females were tracked in both years. Detailed information on vegetation and site characteristics was recorded at each ground location. Ninety-nine percent of ground locations were visual. Characteristics at ground locations were contrasted with characteristics at 346 random points measured during 1993 and 1994 using univariate and multivariate analysis techniques. The 2-year study allowed a contrast of deer habitat use in a wet year (1993) with that in a dry year (1994). During 1994, deer were tied more closely to wet areas and traveled less. In both years, females tended to use more heavily vegetated, moister habitats than males. Males tended to use areas with more bare ground and less complex site structure. In a dry year, males used lower elevation, moister habitats more than in a wet year. Females used the same home ranges and habitats in wet and dry years but concentrated activities on more mesic aspects in a dry year. The potential for cattle/deer competitive interactions increased during a dry year.

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APPROVAL

of a thesis submitted by

Gregory Bryan Milner

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

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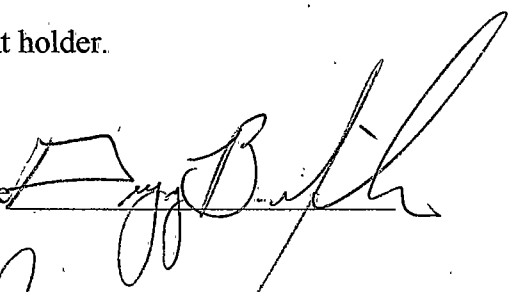
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ABSTRACT

Ten mule deer (Odocoileus hemionus) were selected from 50 deer captured and radiocollared during winter 1992-93. These deer were relocated 196 times from the ground and 296 times from the air during the summer (June - August) - fall (September - November) 1993 study period. Home ranges were computed for the 10 deer (4 males and 6 females) based on ground and aerial locations. In summer - fall 1994, 11 radiocollared deer were located 248 times from the ground and 59 times from the air. Home ranges were calculated for 9 of them (2 males and 7 females). Two males and 2 females were tracked in both years. Detailed information on vegetation and site characteristics was recorded at each ground location. Ninety-nine percent of ground locations were visual. Characteristics at ground locations were contrasted with characteristics at 346 random points measured during 1993 and 1994 using univariate and multivariate analysis techniques. The 2-year study allowed a contrast of deer habitat use in a wet year (1993) with that in a dry year (1994). During 1994, deer were tied more closely to wet areas and traveled less. In both years, females tended to use more heavily vegetated, moister habitats than males. Males tended to use areas with more bare ground and less complex site structure. In a dry year, males used lower elevation, moister habitats more than in a wet year. Females used the same home ranges and habitats in wet and dry years but concentrated activities on more mesic aspects in a dry year. The potential for cattle/deer competitive interactions increased during a dry year.

INTRODUCTION

Although mule deer are one of the most studied animals in North America, much remains to be learned in order to accomplish desired management goals. Much of the missing information can be attributed to the difficulty in measuring interactions between an animal and its environment. Add to this the relatively recent widespread impacts of intensive human land use and the different habitat use strategies utilized by mule deer in different areas, and it becomes evident why many questions remain unanswered.

The relationships of mule deer in the Owyhee study area (Idaho Fish and Game Region 3) to the primary land use in this area, livestock grazing, are not well understood. Although numerous studies have been conducted on the impacts of livestock grazing on mule deer (Mackie 1981), the results are usually site-specific and cannot be broadly applied to other areas (Kie et al. 1991, Ragotzkie and Bailey 1991).

Effects of cattle on mule deer noted in the literature vary from detrimental to neutral to beneficial. In years of average and above average precipitation, mule deer and cattle diets have little overlap in many regions (Mackie 1970, Currie et al. 1977). This overlap probably increases during years of drought (Short 1977) or when overgrazing limits forage. In spite of this, mule deer have been shown to prefer ungrazed pastures even in years of adequate forage production (Loft et al. 1991, Ragotzkie and Bailey 1991).

Moderate grazing by cattle on mule deer summer range in the Sierra Nevadas was shown to decrease the availability of hiding cover for deer in meadow-riparian and aspen habitats (Loft et al. 1991), to reduce use of preferred habitats by deer (Loft et al. 1991), to increase home range size of deer (Loft 1988), and to increase the time deer spent feeding

compared to areas with no grazing (Kie et al. 1991). These factors could adversely affect mule deer through increased exposure to predators and increased costs of foraging.

Although negative or neutral effects are frequently noted in the literature, cattle grazing may be an effective tool for enhancing forage availability for mule deer. Willms et al. (1979) found increased spring mule deer use of a pasture grazed the previous fall. On 2 adjacent ungrazed pastures in central Arizona, Wallace and Krausman (1987) reported higher deer densities in the pasture that was grazed the previous year. A rest-rotation grazing system is used on several elk winter ranges managed by the Montana Department of Fish, Wildlife, and Parks to enhance forage (Frisina pers. comm. 1992). Livestock grazing may also promote diversity in habitat (Mackie 1978).

Despite the potential detrimental effects of cattle grazing on mule deer, cattle grazing will likely continue to be a dominant aspect of public land use in the West, and mule deer will likely continue to justify their presence on public land. Mule deer are Idaho's most important big game animal, providing over 1,000,000 days of recreation in 1991 (Unsworth 1992). In a bioeconomic analysis, Loomis et al. (1991) found that the incremental benefits of deer hunting gained under a 2-years-off, 1-year-on grazing system are greater than the lost net economic value of the forage to the rancher. Managers need to develop methods for management of both deer and cattle on the same lands.

In addition to the need for better understanding of the effects of cattle grazing on mule deer, more information is needed concerning general habitat use and selection by mule deer in the Owyhee area. Based on findings from other areas, male and female mule deer probably use their habitat differently (Geist 1981, Bowyer 1984, Hamlin and Mackie

1989), but little is known about habitat segregation in the Owyhee study area. An evolutionary advantage may be gained with resource partitioning by reducing intersexual competition and ultimately enhancing reproductive success and survival (Bowyer 1984). Hamlin and Mackie (1989) described buck habitat in the Missouri Breaks as being characterized by the more rugged Pinus-Juniperus-shale habitats, and doe habitat as being characterized by open and moderate density Douglas fir (Pseudotsuga menziesii)-juniper, scattered density pine-juniper-grass, moderate density pine-juniper, and river riparian types.

Information collected in this study on mule deer/livestock interactions as well as general habitat use by mule deer will provide managers with necessary information to insure that healthy mule deer populations can be maintained in the Owyhee study area. The applicability and validity of this study will be increased via comparisons with a parallel study to be conducted in the Bennett Mountain area by J. Unsworth, Principal Wildlife Research Biologist, and C. Gray, Graduate Research Assistant.

Specific objectives addressed in this study were:

1. Determination of physical and biological characteristics of preferred habitat for male and female mule deer in the Owyhee Mountains.

2. Assessment of changes in habitat selection in relatively wet vs dry years.

3. Determination of impacts of habitat availability and variation in rainfall on home range size.

4. To provide useful information for the management of mule deer habitat.

STUDY AREA

The Owyhee study area is located in southwest Idaho, approximately 40 miles southwest of the city of Nampa. It lies within Big Game Management Unit 40 of Idaho Fish and Game Region 3. It is entirely within Owyhee County. The north boundary is the Salmon Creek drainage, and the south boundary is the Babbington/Little Cottonwood divide. Reynold's Creek makes up the eastern boundary and Cottonwood Creek is on the west side (Fig. 1). The majority of summer deer relocations were found on the east front of the main divide between Reynold's Creek and Cottonwood Creek. Elevations range from 1,060m in the east side to 1,830m on the main divide.

Nine cover types were identified based upon the vegetation composition and structure present. These types were: grass, low sage (Artemesia arbuscula) (<1m), high sage (Artemesia tridentata) (>1m), sage/bitterbrush (Artemesia spp. and Purshia tridentata), mahogany (Cercocarpus ledifolius), mountain brush, riparian, aspen (Populus tremuloides), and rock/cliff.

The grass type was found on medium elevation south exposure slopes and low elevation flats in association with streams and springs. This type included a diverse set of grasses and forbs in several plant communities, but covered <6% of the study area.

The low sage type consisted of Artemesia arbuscula and associated shrubs and forbs. Shrubs commonly encountered in this type were bitterbrush (Purshia tridentata), rabbitbrush (Chrysothamnus spp.), and serviceberry (Amelanchier alnifolia). Common forbs associated with this type included lupine (Lupinus spp.), arrowleaf balsamroot (Balsamorhiza sagittata), fireweed (Epilobium spp.), and tansymustard (Descurainia

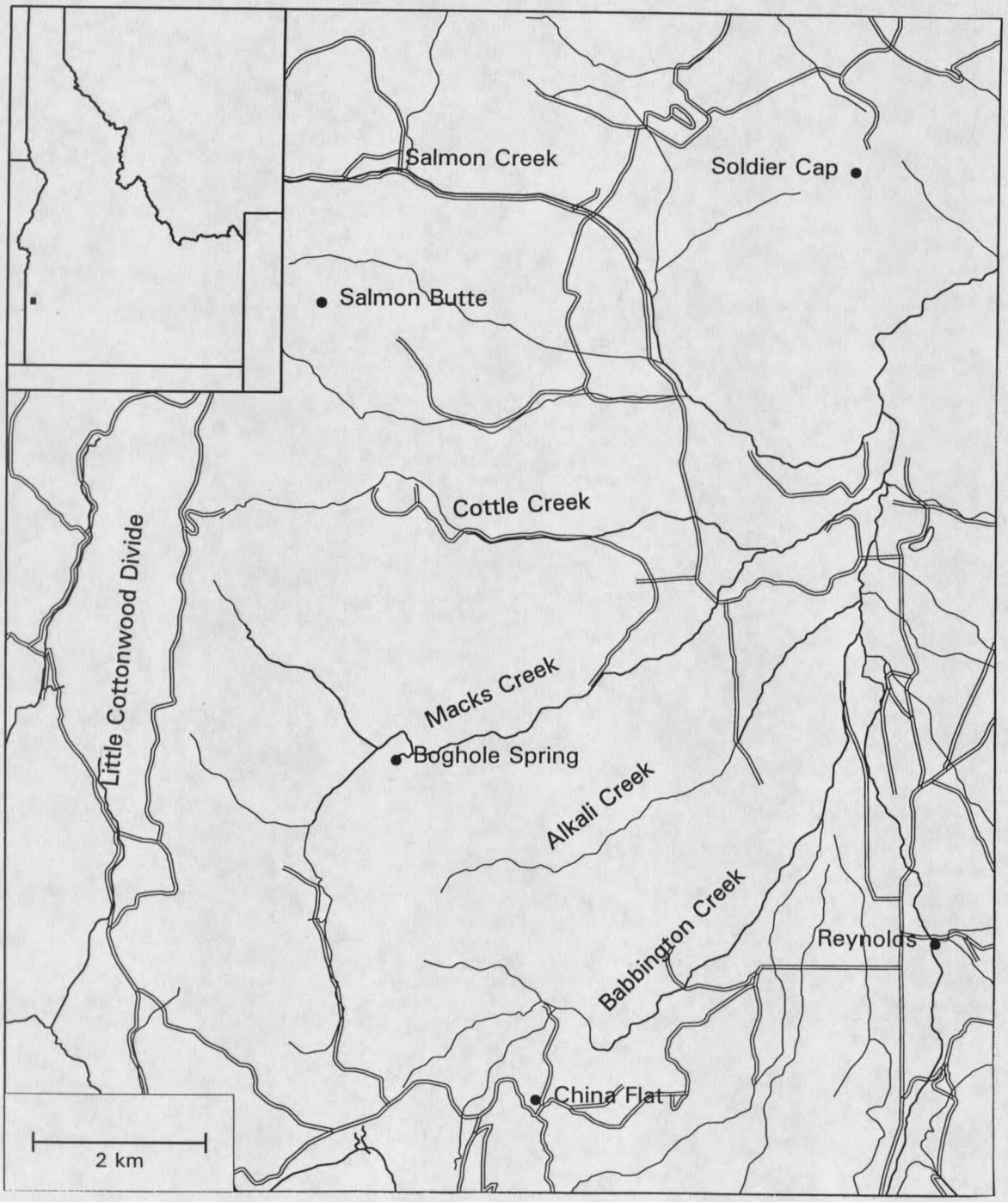


Figure 1. Map of Owyhee Study Area. Double lines are roads; single lines are streams.

sophia). The grass understory was usually composed of Idaho fescue (Festuca idahoensis), cheatgrass (Bromus spp.), and squirreltail (Sitanion hystrix).

The high sage type was dominated by big sagebrush (Artemesia tridentata vaseyana). Other shrubs include bitterbrush, rabbitbrush, serviceberry, snowberry (Symphoricarpos oreophilus), and basin big sagebrush (A. t. tridentata). Among the associated forbs were wild onion (Allium spp.), goatsbeard (Tragopogon dubius), sego lily (Calochortus macrocarpus), buckwheat (Eriogonum spp.), yarrow (Achillea millefolium), collomia (Collomia spp.), gromwell (Lithospermum ruderale), and hawksbeard (Crepis spp.). The grass understory was composed of cheatgrass, squirreltail, wheatgrass (Agropyron spp.), bluegrass (Poa spp.), and occasionally giant wildrye (Elymus cinereus) in the wetter areas.

The sage/bitterbrush type was dominated by big sagebrush and bitterbrush. In addition, rabbitbrush, serviceberry, cheatgrass, wheatgrass, and squirreltail were common. The mahogany type consisted of mahogany (Cercocarpus ledifolius) dominated areas with sparse understories because of the thick mahogany canopy.

The mountain brush type was the most diverse type on the study area. These areas were composed of an association of big sagebrush, bitterbrush, rabbitbrush, serviceberry, snowberry, wild rose (Rosa woodsii), and currant (Ribes spp.). The forbs within this type included wild onion, goatsbeard, yarrow, lupine, buckwheat, collomia, toadflax (Comandra pallida), and horsemint (Agastache spp.). Wheatgrass, bluegrass, sqirreltail, and cheatgrass were the most common grasses.

The riparian type was found in a narrow band along streambeds. Due to the dry

nature of the area, these areas were sometimes constrained to the actual streambed. Hawthorn (Crataegus douglasii) and willow (Salix spp.) were the dominant shrubs. Because of the relative moisture associated with the streambed, the forb and grass components were very diverse. Some of the more common species were non-woody sage (Artemesia ludoviciana), wild onion, yarrow, curly dock (Rumex crispus), geranium (Geranium spp.), dandelion (Taraxacum officinale), mullein (Verbascum thapsus), bedstraw (Galium spp.), wild licorice (Osmorrhiza spp.), bluegrass, wheatgrass, and wildrye.

Stands of aspen (Populus tremuloides) occurred in areas with surface or near-surface springs. The shrub component was dominated by snowberry, but the forb/grass component was similar to that of the riparian type.

The rock/cliff type was predominantly a high elevation type. These areas consisted of at least 50% rock. Vegetation was sparse and scattered and consisted of small patches of xeric forb and grass combinations and occasional clumps of more mesic vegetation types in microsites that trapped moisture. The majority of the sites occurred along ridgelines or steep, sparsely vegetated slopes.

The primary land use on the study area was livestock grazing. The only livestock type present was cattle. A large portion of the study area was within Bureau of Land Management Reynold's Creek Grazing Allotment Number 0508. This allotment was made up of 7 separate pastures; however, the northern 2 were beyond the study area boundary (Fig. 2, pastures 1 and 2). In the 1993 grazing season, Pasture 3 was grazed from 1 May to 15 June. Pasture 4 was grazed from 16-30 June and, with a reduced

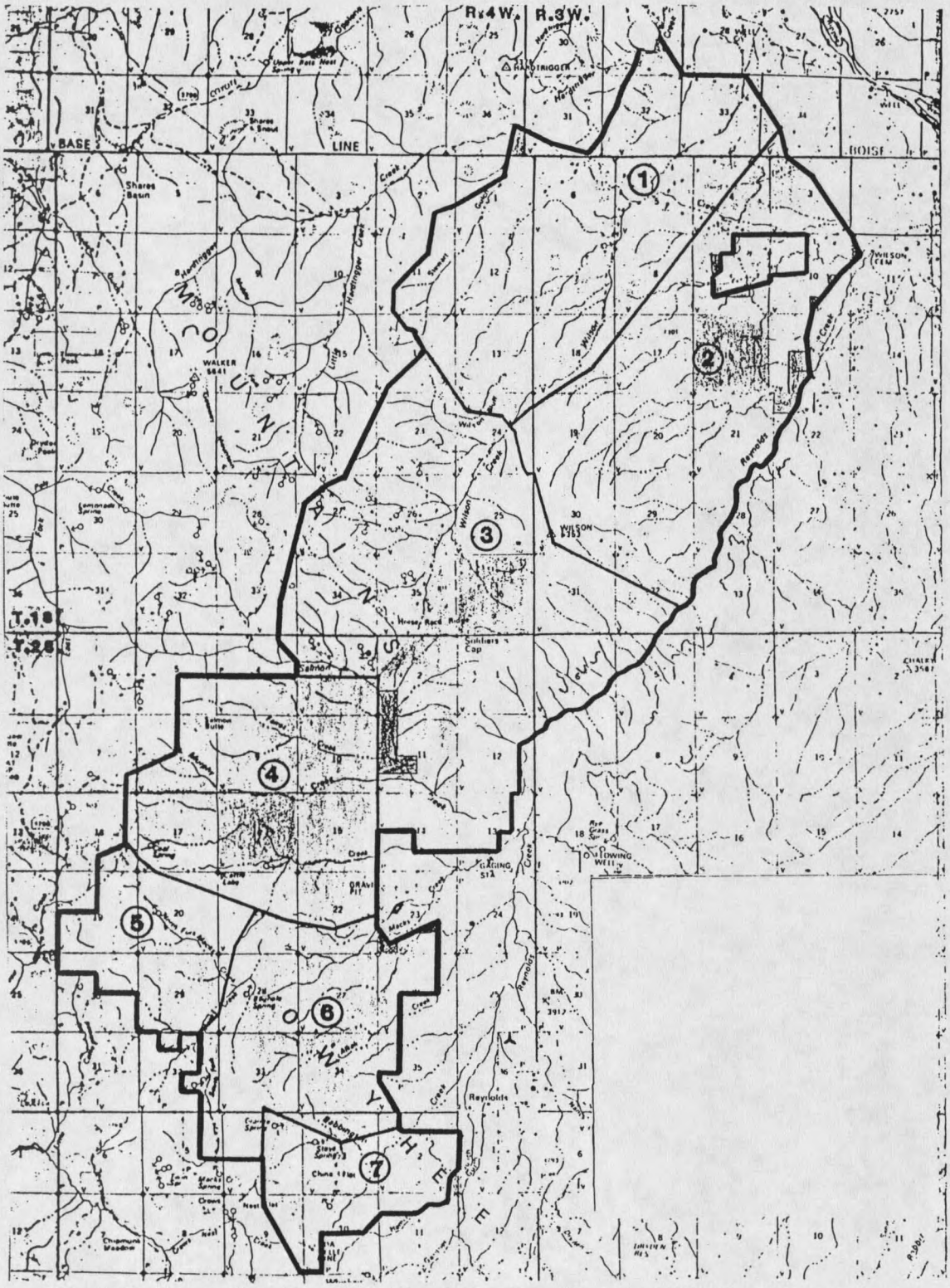


Figure 2. Map of the Reynold's Creek Grazing Allotment #0508, with pasture numbers.

number of livestock, from 1 July to 15 September. Pasture 5 was grazed from 20 September to 1 October. Pastures 6 and 7 were rested. In 1994, Pastures 6 and 7 were grazed from 1 May to 30 June, Pasture 3 was grazed from 1 July to 15 September, and Pastures 4 and 5 were rested.

Yearly Climatic Differences

The 1993 and 1994 field seasons had very different weather patterns. The summer and fall of 1993 was very wet compared to 1994. The Reynold's Creek Agricultural Research Station has a network of rain gauges set up throughout the Reynold's Valley. Daily precipitation information is collected from these rain gauges and analyzed. Table 1 illustrates the moisture difference between the two years and uses a 32-year average as a standard.

Table 1. Monthly precipitation measurements (inches) from the Quonset and Whiskey Hill rain gauges, with a 32-year average.

			Quonset			
	June	July	August	September	October	Total
1993	1.200	0.540	0.854	0.000	0.530	3.124
1994	0.110	0.070	0.000	0.050	1.429	1.659
32-yr. ave.	1.169	0.309	0.603	0.528	0.721	3.330
			Whiskey Hill			
1993	1.912	0.479	0.690	0.000	0.763	3.844
1994	0.309	0.170	0.000	0.170	1.520	2.169
32-yr. ave.	1.453	0.454	0.697	0.760	1.252	4.616

The Quonset rain gauge is located at the Reynold's Creek Agricultural Research Station on the east edge of the study area. The Whiskey Hill rain gauge is located on

Whiskey Hill approximately 600m below China Flat on the south edge of the study area. The Whiskey Hill rain gauge is approximately 1280m higher in elevation than the Quonset rain gauge.

At both rain gauges, the 1994 amounts of precipitation were less than half of the 32-year average. The 1993 amounts were much closer to the long term average.

METHODS

Capturing and Radio Collaring Mule Deer

Fifty mule deer were captured using net-guns fired from a helicopter and fitted with radio collars during January and February of 1992. Radio collars were equipped with a transmitter that has a time delay, mortality-sensing device. At the time of capture, age was determined by tooth replacement and wear (Robinette et al. 1957) and a blood sample was taken. Twenty-six radio collared deer survived the winter. Of these, 3 males moved off of the study area and were not tracked from the ground. Four males and 6 females were selected from the remaining deer to be tracked intensively on the ground, and the rest were tracked when the opportunity arose.

In December of 1993, an additional 27 deer were captured and radio-collared. Thirty-eight deer remained alive at the start of the 1994 field season. Of these, 13 females and 6 males remained on the study area. Seven females and 4 males were selected for radio-tracking in 1994. Of the 7 females, 2 were also radio-tracked in 1993; and, of the 4 males, 2 were also radio-tracked the previous year. Unfortunately, in the summer of 1994, 1 male slipped his collar and 1 male migrated off of the study area. At the end of the 1994 field season, all 7 of the females remained alive and on the study area.

Habitat Use Monitoring

Radio-collared deer were relocated from a fixed wing aircraft (Maule M5-235) bi-monthy during June, July, and August, and weekly during September, October, and

November. This schedule was followed as closely as possible, but occasional weather and/or pilot constraints caused some deviation. The coordinates of each relocation were recorded on an aircraft geographical positioning system. In addition to the coordinates, information on cloud cover, ambient temperature, wind speed, habitat type, date, and time were recorded. When a mortality signal was received, the deer was located on the ground and the cause of death was determined.

Error of aerial locations can range from <100 meters to 1 kilometer (Patric et al. 1988) so intensive ground tracking was employed to attain more precise locations for use in micro-level habitat analysis. Ground tracking was done with a Telonics 2-element, H-antenna and reciever/scanner. With the open terrain found in the Owyhee study area, visual observations were feasible and made whenever possible. If I could not see the animal without disturbing it, the location was triangulated from 3 bearings taken from as close as practical and with the greatest possible separation of angles to reduce the size of the error polygon (Heezen and Tester 1967, Springer 1979). Relocations were plotted on topographic maps, and latitude and longitude were recorded to the nearest 0.01 minute by using a Garmin Geographic Positioning System (GPS) Unit. Habitat use analysis was based only upon ground relocations. Aerial relocations were used only for home range size calculations. To complete home range analysis, aerial locations were converted to Universal Transverse Mercator (UTM) coordinates.

At each deer relocation site, vegetation present within a $375m^2$ circular plot was recorded by species or genus. Cover class and utilization were estimated visually as percentages for common species. Phenologic stages of shrubs, forbs, and grasses were

also noted. In addition to vegetation characteristics, information was also noted on weather, elevation, aspect, slope, position, habitat type, horizontal configuration, distance to roads, distance to and type of water, pasture number, distance to and type of stock, bed shade, sex, age, activity, group size, number of fawns, and percent bare ground. Elevation was determined from topographic maps (scale=1:24,000). Slope was measured with a hand-held clinometer. The appendix includes a sample data sheet and corresponding code key.

I categorized the main Reynold's Creek Road (eastern study area boundary) as the only primary road on the study area because it was the only one with a paved surface. I categorized the Whiskey Hill (southern boundary) and Salmon Creek (northern boundary) roads as secondary, because they were maintained gravel. The rest of the roads were jeep/four-wheeler trails that were not maintained.

Habitat Availability

This study addresses habitat use at the second- and third-order selection levels as outlined by Johnson (1980). Micro feature availability was determined by visiting randomly selected plots and recording the same information recorded at deer relocations. Three hundred forty-six random plots were located. Plots were selected within the study area using a random number table to draw latitude and longitude coordinates at a 0.01 minute scale. Selected coordinates were programmed into the Garmin GPS unit and located on the ground.

Home Range Size

Home range, "that area traversed by the individual in its normal activities of food gathering, mating, and caring for young" (Burt 1943), was calculated and plotted for each radio-collared deer from June until early November each year. The minimum convex polygon method (Mohr 1947, Jennrich and Turner 1969), the harmonic mean method (Dixon and Chapman 1980), and the adaptive kernel methods (Worton 1989) were used to determine home ranges. The Calhome program (Kie et al. 1994) was used in the analysis. Home ranges were not calculated for deer with <10 relocations.

Food Habits

In 1993, fecal pellet groups were collected for food habits analysis. Seven to 10 pellets were collected from sites twice a week from July through October. The freshest materials possible were collected in order to acquire a time scaled sample. These samples were dried, stored in plastic bags, numbered, and dated. At the end of the field season, the samples were sent to the AAFAB Composition Analysis Laboratory in Fort Collins, Colorado for microhistological analyses. Due to a lack of funds, this procedure was not repeated in 1994.

Statistical Methods

Univariate Methods

Significant differences between the use and availability of specific habitat

characteristics were determined with Student's t-tests (Freedman et al. 1978) and the Chi-square goodness of fit test (Zar 1984). Continuous variables such as elevation, slope, distance from roads and water, and percent bare ground were analyzed with t-tests to compare group means. Groups that were compared included random locations versus: 1993 males, 1994 males, 1993 females, 1994 females, all deer in 1993, all deer in 1994, all males, all females, and all deer in 1993 and 1994. Four additional comparisons were made for 1993 males versus 1994 males, 1993 females versus 1994 females, all deer in 1993 versus all deer in 1994, and all males versus all females.

Categorical variables such as habitat type, aspect, position, and horizontal configuration were analyzed with Chi-square tests. For each variable, tests were run for random locations versus: 1993 males, 1994 males, 1993 females, 1994 females, all deer in 1993, and all deer in 1994. Lotus 1-2-3 release 4.01 was used to complete the procedures.

Multivariate Methods

Multivariate analysis was completed by doing logistic regression on SAS (Windows version 6.1). The SAS procedure, log - likelihood scores, was used to determine entry of variables into the model; variables enter until reordered X^2 values do not reach $p<0.05$. Intercepts and model parameter estimates apply to the first ordered value.

The form of the model I used was:

Prob (location being in 1st group)=

$$\frac{e^{[\text{Intercept} + (\text{Parameter est. V1})\text{V1} + (\text{Parameter est. V2})\text{V2}]}}{1+e^{[\text{Intercept} + (\text{Parameter est. V1})\text{V1} + (\text{Parameter est. V2})\text{V2}]}}$$

Prob (location being in 2nd group)= 1- $Prob_{1st\ group}$

where: positive parameter estimates = positive correlation.

Parameters used in the model were: elevation (ELEV), solar radiation index (SORA), slope (SLOP), postion (POS), structure index (SI), horizontal configuration (CON), distance to water (DW), and percent bare ground (BG).

The solar radiation index and the vegetation structure index were subjectively developed based on discussions with L. R. Irby and H. D. Picton (Biol. Dept. Montana State University). The solar radiation index was derived from the data collected on aspects. Each aspect was assigned a value from 10 - 90; where 10 = the lowest evaporation and temperature index and 90 = the highest evaporation and temperature index. The values were assigned in the following order: north=10, northeast=20, east=30, northwest=40, flat=50, southeast=60, west=70, south=80, and southwest=90.

The structure index was determined by ranking habitat types according to the amount of hiding structure for deer. The habitat types were ranked in the following order: grass=1, agriculture=1.5, low sage=2, high elevation park=2.5, high sage=3, sage/bitterbrush=4, other=4.5, mahogany=5, rock/cliff=5.5, juniper=6, mountain brush=7, riparian=8, aspen=9, and conifer=10.

The remaining parameters were continuous or numerical variables. Data type and codes are given in the data sheet key in the appendix.

Logistic regressions were run for all deer vs random locations, 1993 females vs randoms, 1993 males vs randoms, 1994 males vs randoms, 1994 females vs randoms, 1993 males vs 1993 females, 1994 males vs 1994 females, 1993 females vs 1994

females, and 1993 males vs 1994 males. The alpha-error level for entry of variables retained in final models was 0.05 based on the Analysis of Maximum Likelihood Estimates (Hosmer and Lemeshow 1989).

RESULTS

In 1993, the 10 selected deer were relocated from the ground 151 times throughout the summer and fall. Visual observations were made on 97% of the relocations. The other 13 radio-collared deer were located 45 times from the ground for a total of 196 ground relocations. In addition, all of the deer were relocated a total of 296 times from the air.

Mortality throughout the summer and early fall was 23% (6 of 26). One adult doe was killed by a mountain lion (Felis concolor) in September. Two adult bucks were legally harvested in the permit hunting season, and 1 adult buck was an illegal, unretrieved hunting loss in the general hunting season. Collars of 1 adult doe and 1 yearling buck were found with no remains in the vicinity. These were classified as unknown mortalities.

In 1994, the 11 selected deer were relocated 248 times from the ground and 59 times from the air. Visual observations were made on 99% of the relocations. The mortality was much lower in the second field season (2 of 38). One yearling buck was legally harvested in the general hunting season, and 1 adult buck had an unknown cause of death. In addition, 1 adult buck moved off the study area in the summer. Home ranges for the latter two were not calculated due to insufficient numbers of relocation points.

Univariate Analysis

Tables 2 and 3 list the t-tests and Chi-square tests that were run and the critical p-values.

Table 2. P-values for t-tests on continuous variables.

Random vs:	Elev.	Slope	Dis 2 rd[a]	Dis oth rd[b]	Dis H2O[c]	% Bare[d]
Males 93	<0.001*	<0.001*	--	0.015*	0.066	0.105
Males 94	<0.001*	0.832	0.654	0.001*	0.694	0.895
Females 93	<0.001*	<0.001*	--	0.585	<0.001*	<0.001*
Females 94	0.633	0.135	0.657	0.022*	0.005*	<0.001*
All Deer 93	<0.001*	<0.001*	--	0.193	<0.001*	<0.001*
All Deer 94	0.125	0.199	0.593	0.012*	0.021*	<0.001*
Males 93,94	0.822	0.002*	0.617	0.011*	0.226	0.234
Females 93,94	<0.001*	0.075	0.657	0.278	<0.001*	<0.001*
All Deer 93,94	0.007*	0.007*	0.578	0.100	<0.001*	<0.001*
Males 93 vs Males 94	<0.001*	<0.001*	--	0.013*	0.062	0.187
Females 93 vs Females 94	<0.001*	<0.001*	--	0.046*	<0.001*	<0.001*
All Deer 93 vs All Deer 94	<0.001*	<0.001*	--	0.072	<0.001*	<0.001*
All Males vs All Females	0.099	0.099	0.911	0.064	<0.001*	<0.001*

* Indicates that the test showed a significant difference (P< .05).

[a]Dis 2 rd = Distance to secondary road

[b]Dis oth rd = Distance to other road

[c]Dis H2O = Distance to water source

[d]% Bare = Percent bare ground at site

Table 3. Chi-square values of categorical variables with degrees of freedom.

Random vs:	Habitat Type	Aspect	Position	Horiz. Config.
Males 93	150.08*	28.47*	32.49*	51.54*
Males 94	50.27*	20.48*	7.77	52.33*
Females 93	227.95*	23.2*	15.9*	24.14*
Females 94	197.38*	23.49*	30.81*	48.05*
All Deer 93	178.68*	18.28*	15.52*	31.28*
All Deer 94	119.53*	17.35*	18.34*	45.04*
df	11	8	5	3

* Indicates significant difference (P<.05).

Male and female deer did not use aspects according to availability. Males selected for east aspects and against southeast and south aspects (Table 4). The availability of eastern aspects was 19.7%; whereas, 31% of male relocations were on eastern aspects in both years. The east aspects were associated with mesic vegetation and afternoon shade.

Females selected for northeast and east aspects (Table 4). The percent of female relocations on east aspects was 28.8 and 28.2 in 1993 and 1994, respectively. Northeast aspects accounted for 20.0% and 17.5% of female relocations in 1993 and 1994, respectively. The availability of northeast aspects was only 14.5%. Significant differences were found for 1993 males, 1994 males, 1993 females, 1994 females, and all deer for both years when compared to random plots (Table 3).

Male deer selected for upper slope positions in 1993 (Table 5), often in rock habitat. This led to a higher percent of bare ground at male relocation sites than females (Table 6). In 1994, locations for both sexes had increases in bare ground. In 1994, the males

Table 4. Summer/fall use and availability of aspect (% use) by male and female deer, with sample size.

Aspects	Total Locations		Male Deer		Female Deer		Random
	93	94	93	94	93	94	
N	14.3	18.5	19.7	11.3	11.2	21.5	12.4
NE	16.3	16.9	9.9	15.5	20.0	17.5	14.5
E	29.6	29.0	31.0	31.0	28.8	28.2	19.7
SE	8.2	9.3	11.3	7.0	6.4	10.2	15.6
S	9.7	6.5	5.6	9.9	12.0	5.1	15.6
SW	6.1	6.0	8.5	12.7	4.8	3.4	8.1
W	7.1	6.5	9.9	8.5	5.6	5.6	5.5
NW	4.1	6.9	1.4	4.2	5.6	7.9	6.9
NONE	4.6	0.4	2.8	0.0	5.6	0.6	1.7
n	196	248	71	71	125	177	346

selected for midslope positions and against ridge tops (Table 5). The females selected for lower slope positions in both years (Table 5). The availability of lower slopes was 23.7% and females were located 33.6% and 39.0% in 1993 and 1994 respectively in these areas. Significant differences were found for 1993 males, 1993 females, 1994 females, and all deer for both years when positions were compared with random plots (Table 3). When percent bare ground was tested, 1993 females, 1994 females, and all deer in both years resulted in significant differences when compared to random plots; and, there were significant differences between females, all deer, and all males/all females between years (Table 2).

Table 5. Summer/fall use and availability of positions (% use) by male and female deer, with sample size.

Position	Total Locations		Male Deer		Female Deer		Random
	93	94	93	94	93	94	
R. Top	2.6	2.0	1.4	0.0	3.2	2.8	5.8
U. Slope	32.3	16.9	41.4	16.9	27.2	16.9	20.2
M. Slope	28.2	36.7	32.9	49.3	25.6	31.6	42.8
L. Slope	26.7	35.1	14.3	25.4	33.6	39.0	23.7
Str. Bed	3.1	6.0	2.9	2.8	3.2	7.3	2.0
Bench	7.2	3.2	7.1	5.6	7.2	2.3	5.5
n	195	248	70	71	125	177	346

Table 6. Average and standard deviation of percent bare ground at deer location and random plot sites, with sample size.

	Total Locations		Male Deer		Female Deer		Random
	93	94	93	94	93	94	
% Bare Ground	31.0	39.7	39.2	44.6	25.9	37.7	44.9
Std Bare Ground	21.7	16.7	23.6	19.1	18.6	15.2	18.3
n	196	248	71	71	125	177	346

Deer of both sexes selected for concave (wet) site configurations (Table 7). The availability of concave horizontal configurations was 30.6%. Males were located in concave configurations 62.0% and 53.5% of the time in 1993 and 1994 respectively; whereas, females were located in concave configurations 52.0% and 62.1% of the time in 1993 and 1994 respectively. Significant differences were found for 1993 males, 1994

males, 1993 females, 1994 females, and all deer in both years when horizontal configurations were compared to random plots (Table 3).

Table 7. Summer/fall use and availability of horizontal configurations (% use) by male and female deer, with sample size.

Horizontal Config.	Total Locations 93	Total Locations 94	Male Deer 93	Male Deer 94	Female Deer 93	Female Deer 94	Random
Convex (Dry)	16.3	8.5	8.5	2.8	20.8	10.7	22.0
Straight	10.7	10.0	8.5	8.5	12.0	10.7	25.1
Concave (Wet)	55.6	59.7	62.0	53.5	52.0	62.1	30.6
Undulating	17.3	21.8	21.1	35.2	15.2	16.4	22.3
n	196	248	71	71	125	177	346

Relocations were more frequent in the unstocked pastures for both sexes and both years (Table 8). The two pastures with the most relocations were each rested one year (#6 in 1993 and #5 in 1994). Use exceeded availability for females in both years and males in 1993.

Table 8. Percent of deer locations and random plots located in stocked and unstocked pastures, with sample size.

	Total Locations 93	Total Locations 94	Male Deer 93	Male Deer 94	Female Deer 93	Female Deer 94	Random
Stocked	9.2	16.5	8.5	35.2	9.6	9.0	26.9
Unstocked	90.8	83.5	91.5	64.8	90.4	91.0	73.1
n	196	248	71	71	125	177	346

The elevations (Table 9) used by male and female deer were very similar in 1993,

with the males having a slightly higher variation. In 1994, the males came down from the high, dry, rocky areas and spent considerably more time in the lower, wetter areas. When elevations were tested against random plots, significant differences were found for 1993 males, 1994 males, 1993 females, all deer 1993, all females in both years, and all deer in both years (Table 2). Significant differences were also found for males between years, females between years, and all deer between years (Table 2).

Table 9. Average and standard deviation of elevation (in meters) use by male and female deer, with sample size.

	Total Locations		Male Deer		Female Deer		Random
	93	94	93	94	93	94	
Ave Elev.	1554.8	1416.9	1554.6	1338.3	1554.9	1448.4	1440.4
Std Elev.	166.6	186.0	186.1	172.5	154.6	181.9	178.1
n	196	248	71	71	125	177	346

Slope use (Table 10) was similar between the 2 sexes across years with both sexes selecting gentler slopes in 1994. In both years, males had a higher variation than females. Significant differences were found for 1993 males, 1993 females, all deer 1993, all males in both years, and all deer in both years when slopes were compared to random plots (Table 2). There were also significant differences between males yearly, females yearly, and all deer yearly (Table 2).

Females tended to be associated more commonly with other deer (Tables 11 and 12) than males in both years. The number of deer associated with males increased in late

October as the rut approached. Female group size tended to remain consistent through October.

Table 10. Average and standard deviation of slope (in percent) use by male and female deer, with sample size.

	Total Locations		Male Deer		Female Deer		Random
	93	94	93	94	93	94	
Ave. Slope	31.9	22.3	32.9	23.4	31.3	21.9	23.8
Std. Slope	14.2	12.8	14.9	11.8	13.8	13.2	14.2
n	196	248	71	71	125	177	346

Table 11. Average and standard deviation of group size between male and female deer, with sample size.

	Total Locations		Male Deer		Female Deer	
	93	94	93	94	93	94
Ave. Group Size	2.16	2.98	1.80	2.00	2.37	3.38
Std. Group Size	1.88	2.86	1.46	1.39	2.06	3.19
n	196	248	71	71	125	177

Table 12. Average and standard deviation of the number of deer sighted within 1 km of locations, with sample size.

	Total Locations		Male Deer		Female Deer		Random
	93	94	93	94	93	94	
Ave.# w/in 1km	1.58	2.31	1.03	1.45	1.90	2.66	0.25
Std.# w/in 1km	2.29	2.97	1.70	1.79	2.51	3.26	0.78
n	196	248	71	71	125	177	346

In this area, water seems to be the main limiting factor for livestock distribution. The Bureau of Land Management (BLM) has installed catch-tanks on many of the natural springs in the area to make water available for livestock. Table 13 shows deer distribution with regard to these artificial water sources and natural sources. In 1994, deer use of BLM catch tanks increased as creeks and untapped springs failed.

When I located bedded deer, I noted if they used shaded areas or not (Table 14). Male and female selection of shade for bedding sites was different. While both sexes selected sagebrush, males also selected rock and females chose serviceberry.

Table 13. Percent of deer and random plots with natural and artificial water nearest, with sample size.

Water Type	Total Locations		Male Deer		Female Deer		Random
	93	94	93	94	93	94	
Natural	94.4	92.7	93.0	91.5	93.6	93.2	96.2
Artificial	2.0	7.3	2.8	8.5	1.6	6.8	3.8
Both	4.6	0.0	4.2	0.0	4.8	0.0	0.0
n	196	248	71	71	125	177	346

Male and female deer did not use cover types equally. Males selected for mountain brush and rock/cliff types in 1993 and the sage/bitterbrush type in 1994 (Table 15). Females selected mountain brush and high sage in 1993 and sage/bitterbrush and riparian in 1994 (Table 15). The sage/bitterbrush type received moderate to heavy use by deer for

Table 14. The 5 most common sources of shade on deer beds and the percent of total beds they shaded for male and female deer, with sample size.

Shaded by	Total Locations		Male Deer		Female Deer	
	93	94	93	94	93	94
Big sagebrush	38.1	37.1	33.3	38.5	41.7	36.4
Serviceberry	15.9	11.4	3.7	10.3	25.0	12.1
Bitterbrush	7.9	11.4	14.8	7.7	2.8	13.6
Willow	12.7		11.1		13.9	
Rock	12.7	17.1	29.6	33.3	0.0	7.6
Mahogany		5.7				7.6
Snowberry				5.1		
n	63	105	27	39	36	66

foraging and bedding. The mountain brush type was used less extensively for feeding and bedding. The rock/cliff type was used for occasional bedding and traveling activities. When cover types were compared to random plots, significant differences were found for 1993 males, 1994 males, 1993 females, 1994 females, all deer in 1993, and all deer in 1994 (Table 3).

When activity types were compared between males and females, males spent more time during the day bedded than females. Females spent more time feeding and travelling (Table16). Does were often seen travelling to and from their fawns hiding places to nurse them. Males were seldom seen out in the open during the day until late October when the rut was beginning.

Table 15. Summer/fall use and availability of cover types (% use) for male and female deer, with sample size.

Cover Type	Total Locations		Male Deer		Female Deer		Random
	93	94	93	94	93	94	
Grass	2.0	1.2	1.4	1.4	2.4	1.1	5.2
Low Sage (<1m)	8.2	6.0	12.7	4.2	5.6	6.8	27.7
High Sage (>1m)	13.8	19.0	8.5	28.2	16.8	15.3	15.3
Sage/Bitterbrush	23.5	36.3	19.7	40.8	25.6	34.5	33.8
Mahogany	1.5	1.6	2.8	0.0	0.8	2.3	1.2
Mountain Brush	30.6	13.3	28.2	7.0	32.0	15.8	5.2
Riparian	8.2	12.9	5.6	2.8	9.6	16.9	1.7
Aspen	2.0	0.8	0.0	0.0	3.2	1.1	0.3
Rock/Cliff	10.2	5.6	21.1	11.3	4.0	3.4	9.0
n	196	248	71	71	125	177	346

Table 16. Percent of activity types between male and female deer, with sample size.

Activity	Total Locations		Male Deer		Female Deer	
	93	94	93	94	93	94
Feeding	14.0	25.4	10.0	19.7	16.3	27.7
Bedding	48.2	47.2	58.6	60.6	42.3	41.8
Traveling	17.6	14.9	12.9	8.5	20.3	17.5
Escaping	1.6	0.4	0.0	0.0	2.4	0.6
Rutting	1.0	0.4	2.9	1.4	0.0	0.0
Unknown	17.6	11.7	15.7	9.9	18.7	12.4
n	193	248	70	71	123	177

Multivariate Analysis

The logistic regression models are shown in Table 17.

Table 17. The best fit logistic regression models for response variables, with % concurrence.

Resp. var.	Logistic regression model	concur.
Deer	1.38-0.0005ELEV+0.4202SI+0.2570CON-0.0271BG	74
♀ 93	-1.7456+0.0283SLOP+0.3263SI-0.0497BG	82
♂ 93	-3.498+0.0358SLOP+0.339SI-0.0178BG	77
93♂ vs 93♀	-2.7054+0.4756CON+0.0277BG	70
♀ 94	2.3513-0.0007ELEV-0.0166SORA+0.4727SI-0.0232BG	78
♂ 94	3.1960-0.0015ELEV+0.2917SI+0.69CON-0.0237BG	78
94♂ vs 94♀	1.7331-0.0012ELEV+0.0138SORA+0.7408CON	75
93♀ vs 94♀	-0.0157+0.0252SORA+0.0532SLOP-0.5613CON-0.0506BG	80
93♂ vs 94♂	-5.3951+0.0014ELEV+0.0533SLOP-1.1399DW	81

The model for all deer suggests that there was a higher probability of deer locations at sites with lower elevations, higher stand structure, wetter horizontal configuration, and lower percent bare ground.

The model for 1993 females suggests that in 1993, female deer were more likely to be found in sites with steeper slopes, higher stand structure, and less bare ground than was available.

The model for 1993 males suggests that compared to random locations, male deer in 1993 tended to use steeper slopes, higher stand structure, and less bare ground.

The model for 1993 males vs 1993 females suggests that compared to females, males

in 1993 used wetter horizontal configurations and more bare ground.

The model for 1994 females suggests that in 1994, female locations differed from random locations in that females were at lower elevations, had lower solar radiation index, had higher stand structure, and were at sites with less bare ground.

The model for 1994 males suggests that in 1994, males were generally at lower elevations, areas of higher stand structure, wetter horizontal configurations, and in areas with less bare ground than random points.

The model for 1994 males vs 1994 females suggests that in 1994, males were generally at lower elevations, on aspects with higher solar radiation indices, and on wetter horizontal configurations than females.

The model for 1993 females vs 1994 females suggests that in 1993, females tended to use areas with higher solar radiation indices, steeper slopes, drier horizontal configurations, and areas with less bare ground than in 1994.

The model for 1993 males vs 1994 males suggests that in 1993, males tended to use areas with higher elevations, steeper slopes, and closer water sources than in 1994.

Home Range Analysis

Summer home ranges were computed for 5 radio collared males and 11 females (Tables 18 and 19). Most deer arrived on summer range between May 20 and June 1. Most deer were still on summer range when the summer/fall study was concluded. The average home range size computed with the minimum convex polygon (MCP) method for males in 1993 was 14.79 km^2 and for females was 5.44 km^2. The MCP average for

1994 males was 5.85 km^2 and for 1994 females was 4.81 km^2 . The average home range size computed with the 95% harmonic mean (HM) method in 1993 for males was 18.46 km^2 and for females was 4.93 km^2. The HM average for 1994 males was 5.96 km^2 and for 1994 females was 4.15 km^2. The average home range size computed with the adaptive kernel (AK) method for 1993 males was 26.35 km^2 and for females was 12.16 km^2. The AK average for 1994 males was 14.58 km^2 and for 1994 females was 8.91 km^2.

Male home ranges were larger in 1993 than in 1994, while female home ranges remained relatively constant. The male with the largest home range (710) had a home range with a higher proportion of the rock/cliff cover type while males with smaller home ranges were tied to riparian complexes.

Table 18. Home range sizes (km^2) for male deer with number of locations and averages in 1993 and 1994.

Deer #	MCP[a]		HM		AK		# Locations	
	93	94	93	94	93	94	93	94
40	9.51	5.51	14.82	5.80	18.94	10.80	30	32
350	8.16		16.27		18.58		29	
441		6.19		6.12		18.36		35
671	11.19		20.02		23.30		26	
710	30.31		22.72		44.59		24	
Ave	14.79	5.85	18.46	5.96	26.35	14.58	27.25	33.5

[a]MCP=minimum convex polygon; HM=harmonic mean; AK=adaptive kernel.

Table 19. Home range sizes (km^2) for female deer with number of locations and averages in 1993 and 1994.

Deer #	MCP		HM		AK		# Locations	
	93	94	93	94	93	94	93	94
10		1.19				1.98		30
21		2.22		1.02		2.63		31
91	8.72		4.64		19.02		27	
240	3.35	7.98	4.50	3.85	6.17	8.52	26	31
280	9.45		10.66		26.91		26	
330	5.46		3.62		9.66		31	
371	2.12	1.57	2.50	2.07	5.19	2.65	25	31
392		8.22		7.23		21.56		27
572		4.45		4.81		7.66		29
630	3.53		3.63		6.02		27	
1392		8.06		8.98		17.36		28
Ave	5.44	4.81	4.93	4.15	12.16	8.91	27.00	29.5

Females with larger home ranges lived in areas characterized by the sage/bitterbrush cover type. Females with smaller home ranges lived in habitats that were within riparian complexes.

Food Habits

The microhistological analysis indicated that the majority of the summer/fall diet of Owyhee mule deer in 1993 consisted of bitterbrush and mahogany. Table 20 shows a partial list of the species identified in fecal material and the percentages of each in the

Table 20. Average and standard deviation of percentages of forage species identified in mule deer diets by month.

	July		August		September		October	
	ave	sd	ave	sd	ave	sd	ave	sd
GRAMINOIDS								
Agropyron					2.07	1.92		
Bromus					0.61	1.36	1.36	1.86
Festuca	0.78	1.75			1.40	1.94		
Total Graminoids	0.78				4.18		1.36	
SHRUBS								
Artemesia tridentata	2.21	2.08						
Cercocarpus	52.35	6.29	40.35	5.56	19.91	4.22	40.70	5.82
Purshia	30.53	5.97	44.39	10.09	52.17	8.20	44.30	5.18
Total Shrubs	85.09		84.74		72.08		85.00	
FORBS								
Composite	1.43	2.01			0.60	1.33		
Legume Pod			2.09	3.27	4.01	2.75	2.08	3.10
Lupinus	2.21	2.08	10.95	7.88	13.16	2.98	7.60	5.07
Total Forbs	3.64		13.04		17.77		9.68	
Fern	2.54	3.86						
Seed	5.47	2.49	1.41	1.97	4.67	3.24	3.39	3.38

diet of mule deer for the months of July through October in 1993. Seven species (Poa, Stipa, Arthropod, Berberis, Descurania, Melilotus, and Potentilla) were not included in the table because they totaled < 1% of the diet in only one of the sampled months.

DISCUSSION

Physical Habitat Features

Aspect Use

Male and female mule deer in the Owyhee area were selective in use of aspects. Males and females selected for east aspects and against southeast and south aspects. Deer used the more mesic eastern aspects disproportionately, probably because they were cooler and had more vegetation for cover and food than other aspects. This is especially important for does that are trying to raise fawns.

Topography

In 1993, males selected for upper slope positions, which led to a high percentage of bare ground because the upper slopes were often in rock habitat. In 1994, males selected for mid-slope positions. I attribute this drop in positions to the change in moisture between the 2 years. In 1993, moisture was sufficient to support green vegetation through most of the summer on sites throughout the study area. In 1994, green forage at high elevations was much less common due to the dry year and subsequent lower vegetation levels. Females adopted a different strategy. They selected for lower slope positions in both years. In the lower, wetter areas, there was much less bare ground. Radio-collared females apparently established home ranges in areas which were likely to support reasonable forage in both wet and dry years. The high nutrient and energy requirements of raising fawns presumably drive this difference among sexes.

Deer of both sexes selected for wetter site configurations. These sites hold the most lush, thick vegetation for feeding and cover. The decline in wet configurations between years was likely due to the difference in availability of moisture at potentially wet sites between the field seasons. The increase in female use of wet areas between years seems to suggest that they were actively seeking the wetter areas and restricted habitat use to these areas. Gray (1995) noted a similar pattern for females in the Bennett Hills of southwest Idaho.

In 1993, the elevations used by male and female deer were very similar (0.3 m different in averages). In 1994, male deer abandoned the higher areas and moved to the lower flats. This change explained the decrease in average slope for males between years (32.9% in 1993 vs 23.4% in 1994). Since the higher elevations held the steepest slopes and the dryest cover types, it appears that the males were searching for cooler, moister areas with more vegetation in 1994.

Females also exhibited a decrease in elevation and slope between 1993 and 1994; however, the elevational drop was less than that for males. Females sampled in this study were associated with relatively mesic habitat types such as in the Mack's Creek drainage in both years. Radio-collared males followed in 1994 were concentrated in the Alkali Creek drainage which was at lower elevations than those used by females. Gray (1995) noted no significant change in elevations between 1993 and 1994.

Biological Factors

Cover Types

Male and female deer did not use cover types in proportion to availability, nor did males and females use cover types in the same way. Males selected for mountain brush and rock/cliff types and against low sage and grass types in 1993. In 1994, males selected for sage/bitterbrush and against low sage and grass types. The increase in use of sage/bitterbrush and the decrease in use of rock/cliff and mountain brush types between years by males, suggests that bitterbrush types may function as important refuges in dry summers when forbs tend to be less abundant (Austin and Urness 1983).

Females selected for mountain brush and high sage and against rock/cliff and low sage types in 1993. In 1994, females selected for sage/bitterbrush and riparian and against rock/cliff, grass, and low sage types. In the wetter year of 1993, the mountain brush type and its associated forb structure could be used as food and cover for females that had high nutrition requirements for lactating and good cover requirements for hiding fawns. In the dryer year of 1994, the sage/bitterbrush use increased most likely as a food and cover source since forb production was apparently much lower in the mountain brush type in 1994.

Food Habits

In the Owyhee Mountains, bitterbrush consumption increased throughout summer and peaked in September at 52%. At the same time, mahogany use declined from 52% in July to 20% in September. Mountain mahogany use exceeded bitterbrush use in July.

Forb intake was moderate and variable and graminoid intake was low through the 1993 sampling season. The importance of bitterbrush to deer and cattle has been noted in the literature. Ferguson and Medin (1983) report that in Idaho, bitterbrush is considered the most valuable forage shrub on many mule deer winter ranges. Martin (1983) states that Purshia is one of the most important browse plants for big game in the Northwest. Julander and Robinette (1950), Hoskins and Dalke (1955), and McConnell and Dalke (1960) all report that bitterbrush is a highly preferred browse species for big game in the Western U.S. Leach (1956) and Tueller (1979) both report that bitterbrush is a major fall shrub for mule deer. Austin and Urness (1983) point out the importance of bitterbrush on summer range as well as winter range. In their study, bitterbrush consumption by mule deer increased steadily throughout summer and reached a peak in September of 92%. At the same time, forb consumption decreased.

Activity Patterns

Males spent more time bedded during the day than females. The increased time that females spend on diurnal travelling and feeding could be attributed to the raising of young. Females have increased nutritional needs due to lactation (Mackie et al. 1982, Short 1981). This may require more feeding time, which may require more travel time. In addition, females will leave their fawns in seclusion when they are not nursing to avoid drawing attention to them. This increases travel activities for females who must move between fawns and other areas so fawns may nurse.

Both males and females tended to concentrate feeding, travelling, and bedding in

areas that provided topographic or vegetative cover. Sage and grassland were infrequently used for all activities during daylight hours. Gray (1995) found similar patterns in the Bennett Hills. Association of mule deer activities with cover is noted by Mackie et al. (1982).

The low numbers of escaping behavior in the Owyhee deer can be explained by the open nature of the terrain. With only brush and topography for cover, deer were easily spotted from a distance. When deer were jumped, it was usually possible to ascertain their activity because beds are easily identified on the ground. If a deer was up, it could usually be seen above the brush. Exceptions to this would be the riparian and some of the high sage types. These types were where the majority of the unknown activity types were recorded.

Home Range Analysis

Mule deer summer home ranges in this study were relatively large compared to non-migratory populations in more mesic areas (Dickinson and Garner 1979, Wood et al. 1989), but were within the range of reported sizes in drier areas (Eberhardt et al. 1984, Hayes and Krausman 1993). Female home ranges were larger than those reported in the Bennett Hills (Gray 1995), but females sampled in the Bennett Hills were all located in mesic pockets in an otherwise dry environment.

The home range sizes for both sexes decreased from 1993 to 1994. Individual deer were more closely tied to water sources and wetter sites in the dryer year. If standing water is not readily available, mule deer can obtain moisture from the surrounding

vegetation (Unsworth, personal communication). This would give deer the option of limiting their activities to areas where the vegetation is succulent enough to meet this need if surface water was not available..

The Adaptive Kernel method yielded the largest home range sizes for both males and females. The Minimum Convex Polygon method yielded the smallest home range sizes for males, while the Harmonic Mean method showed the smallest home ranges for females. By all three methods, male home range sizes were considerably larger than females.

Group Activity

Females tended to be associated with other deer more often than males did. The average group size for males was 1.80 and 2.00 in 1993 and 1994 respectively; whereas, for females, the average group sizes were 2.37 in 1993 and 3.38 in 1994. The number of deer sighted within 1 km^2 of locations was also higher for females in both years (1.90 vs 1.03 in 1993 and 2.66 vs 1.45 in 1994). This can be attributed to the fact that deer associate in matriarchal groups (Hawkins and Klimstra 1970, Mackie et al. 1982), so there are usually relatives of females in the vicinity, and females are accompanied by fawns. Most males leave these groups at the age of 1 or 2 to find their own niche and either move alone or join to form small male groups (Mackie 1970). There was an increase in the group size that males were associated with in late October of both years. This increase was due to the pursuit of does in preparation for the breeding season (Mackie et al. 1982).

Livestock Interactions

Deer relocations were more frequent in unstocked pastures for both sexes over both years. The 2 pastures which did have the most relocations were each rested one year. The interactions between deer and cattle were difficult to assess because of the difference in precipitation and the difference in stocking between years. Water appeared to be the limiting factor for cattle distribution in the study area. The use of BLM catch tanks by deer and livestock increased in 1994 as natural water sources dried up. Male deer use of artificial water sources increased from 2.8% in 1993 to 8.5% in 1994. Female deer use increased from 1.6% to 6.8%. These increases are most likely products of the hotter, dryer conditions in 1994.

Livestock use of bitterbrush seems to follow a similar pattern to that of deer (lower in early/wet summers; higher in late/dry summers) (Austin and Urness 1983). Livestock presence did not directly result in movement of deer, but their use of forage could influence habitat quality for deer. Smith and Doell (1968) stated that grazing from May to July appears acceptable for mule deer. In the Owyhee Study Area, the highest potential for direct competition between mule deer and cattle would occur in late summer and fall when grasses and forbs become less palatable. Excessive use of bitterbrush by cattle on the Owyhee Study Area, would have the greatest impact on the northern end of the area near Soldier Cap (Fig. 1) because of its importance as winter range to the Owyhee mule deer. In 1994, this area was grazed in late summer/early fall which would leave little time for regrowth of forage for wintering deer.

Interaction Among Factors

Multivariate analyses incorporated 8 of the 10 variables I considered individually. Results supported the same factors identified as important in individual factor analyses. In a wet year, male deer distribution was predicted by high elevation, steeper topographic structure, and high vegetation average at ground level. In a dry year, male use of sites was best predicted by low elevation, wet site configuration, complex stand stucture, and high ground coverage by vegetation.

Female presence in a wet year was best predicted by steep slopes, complex stand structure, and high availability of ground coverage by vegetation. In a dry year, wetter aspects and lower elevations entered into the model while slope steepness was not included. Major differences between male and female habitat selection in 1993 involved site configuration (males selected wetter, concave configurations) and bare ground (males were associated with areas with more bare ground than females). In 1994, males were more likely to be at lower elevations, on drier aspects, and on wetter, concave configurations than females.

Overall, males responded to dry conditions by changing elevation, spatial use, and cover type use. Females changed cover type use patterns. The dependence of deer of both sexes on shrub communities was similar to that observed by Gray (1995) in the same years, but deer in the Owyhee range had to make greater adjustments to drought than those in mesic sites in the Bennett Hills.

In 1993, cattle presence appeared to decrease the likelihood that a deer would occupy a site. In 1994, under very dry conditions, both cattle and deer used many of the same

sites. Conditions were such that neither species had many options. They foraged where edible vegetation was available. Short (1977), Mackie (1970), and Currie et al. (1977) noted this pattern in deer-livestock relations in other areas.

CONCLUSIONS

The Owyhee Mountains appear to be good mule deer habitat based on the fact that mule deer are able to survive on average to small home ranges. The sage/bitterbrush cover type is very important because of its status as a feeding zone for deer. In the dry year its importance was increased because forbs were less available on the study area. This cover type should be monitored and not allowed to degrade.

Male deer adapt to dry conditions by shifting to lower, cooler areas nearer to riparian zones. Females remained higher in elevation but shifted cover use patterns. The dry year also thrust cattle and deer into the same areas because of forage conditions. The effects of livestock grazing on deer could not be directly quantified, because of the lack of a controlled grazing system. However, I recommend the continuation of a rest rotation system, but recommend that winter range pastures only be grazed in spring or early summer to assure adequate forage for wintering deer.

MANAGEMENT IMPLICATIONS

1. Bitterbrush is a significant forage species (especially in dry years) and should be maintained at current levels.

2. Winter range pastures should only be grazed in spring or early summer to assure adequate forage for wintering deer.

3. Water appears to limit distribution and activity of deer and cattle; therefore, riparian zones should not be allowed to degrade.

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APPENDIX

SAMPLE DATA SHEET AND

CORRESPONDING KEY

DEER/RANDOM_____
DATE_____
TIME_____
WEATHER_____
LOCATION:
LAT._____
LONG._____
ELEV._____
ASPECT_____
SLOPE_____
POSITION_____
HAB. TYPE_____
HORIZ. CONFIG._____

DIST. TO ROAD:
2°_____
OTHER_____
DIST. TO WATER_____
TYPE OF WATER: N A
STOCKED?_____
PASTURE #_____
UTILIZATION_____
DISTANCE_____
LIVESTOCK TYPE_____
DEER W/IN 1 KM_____
IF BEDDED:
SHADED?_____
SHADED BY?_____

SEX_____
AGE_____
LOCATION TYPE_____
ACTIVITY_____
GROUP SIZE_____
OF FAWNS_____

COMMENTS:

TREES	U	P	C		U	P	C
1.				4.			
2.				5.			
3.				6.			
SHRUBS							
1.				7.			
2.				8.			
3.				9.			
4.				10.			
5.				11.			
6.				12.			
FORBS							
1.				11.			
2.				12.			
3.				13.			
4.				14.			
5.				15.			
6.				16.			
7.				17.			
8.				18.			
9.				19.			
10.				20.			
GRASS							
1.				5.			
2.				6.			
3.				7.			
4.				8.			

SEX
1= Male
2= Female

AGE
1= Yearling
2= Adult

LOCATION TYPE
1= Visual
2= Close triangulation

ACTIVITY
1= Feeding
2= Bedding
3= Traveling
4= Escape
5= Rutting
6= Unknown

WEATHER
1= Clear
2= Partly cloudy
3= Overcast
4= Raining
5= Snowing

HORIZ. CONFIG.
1= Convex (dry)
2= Straight
3= Concave (wet)
4= Undulating

DISTANCE
1= 0-25m
2= 26-100m
3= >100m (give estim.)

PHENOLOGY

SHRUBS
1= Flower
2= Fruit set
3= Fruit swelling
4= Fruit turning color
5= Fruit ripe
6= Fruit dry/dropping

FORBS AND GRASS
1= Veg. growth
2= Flower buds
3= Flower
4= Fruit set
5= Fruit swelling
6= Plant curing

UTILIZATION
1= 0-5%
2= 6-20%
3= 21-40%
4= 41-60%
5= 61-80%
6= 81-100%

ASPECT
1= North
2= Northeast
3= East
4= Southeast
5= South
6= Southwest
7= West
8= Northwest

POSITION
1= Ridge top
2= Upper slope
3= Mid-slope
4= Lower slope
5= Stream bed
6= Bench or Flat

HABITAT TYPE
1= Grass
2= Low sage (<1m)
3= High sage (>1m)
4= Sage/Bitter brush
5= Mahogany
6= Juniper
7= Mtn. Brush
8= Riparian
9= Aspen
10= Conifer
11= High elev. park
12= Agriculture
13= Rock/cliff
14= Other

COVER CLASS
1= 1-5%
2= 5-25%
3= 25-50%
4= 50-75%
5= 75-95%
6= 95-100%
7= Trace

CATTLE STOCKING
1= Yes
2= No

LIVESTOCK TYPE
1= Cows
2= Sheep
3= Goats
4= Horses

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