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HABITAT USE BY DESERT MULE DEER

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HABITAT USE BY DESERT MULE DEER

by

Leonard L. Ordway

A Thesis Submitted to the Faculty of the
SCHOOL OF RENEWABLE NATURAL RESOURCES
In Partial Fulfillment of the Requirements
For the Degree of
MASTER OF SCIENCE
WITH A MAJOR IN WILDLIFE AND FISHERIES SCIENCE
In the Graduate College
THE UNIVERSITY OF ARIZONA

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PREFACE

This thesis was written according to the format and style specifications of THE JOURNAL OF WILDLIFE MANAGEMENT to facilitate immediate submission for journal publication. Approval for doing this was based upon (1) approval by the Graduate College, and (2) my graduate committee's agreement.

I am especially grateful to Dr. Paul R. Krausman, major advisor, for his guidance, advice, and assistance during all phases of this study. Dr. Lyle K. Sowls and Albert LeCount, graduate committee members, provided guidance and critical review of the manuscript. I acknowledge John Hervert, Steven Torres, MaryEllen Chilelli, Richard Ockenfels, and Dave Smith for technical assistance, and Bruce Leopold, Brian Maurer, and Dr. Robert O. Kuehl for advice on statistical analysis.

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ABSTRACT

I studied habitat use by desert mule deer (Odocoileus hemionus crooki) in the Sonoran desert of southern Arizona from January 1981 to July 1982. Use and preference for vegetative association, slope position, slope class, and aspect were determined from 1610 radiotelemetry locations of 10 females and 7 males. Seasonal distribution relative to elevation and the nearest available water source was evaluated. Males used and preferred both mountainous and nonmountainous vegetative associations. Females used and preferred mountainous vegetative associations. Males used lower slope positions, gentler slopes, and lower elevations compared to females. All deer were closer to water sources during dry periods.

INTRODUCTION

Desert mule deer inhabit the southwestern United States and Mexico (Wallmo 1981), but populations are being threatened from habitat loss and increasing demands from recreational users (Ariz. Game and Fish Dept. 1980). This increased demand on desert mule deer populations has accentuated the need for knowledge of habitat use.

Rocky Mountain mule deer (O.h. hemionus) and black-tailed deer (O.h. columbianus) habitat use studies are numerous (Cowan 1956, Dasmann and Taber 1956, Lovaas 1958, Julander and Jeffery 1964, Mackie 1970, Miller 1970, King and Smith 1980), but data pertaining to habitat use by desert mule deer are lacking. Clark (1953) studied behavior and movement patterns of desert mule deer. Truett (1972) studied the general ecology of desert mule deer with minor emphasis on habitat use. Anthony and Smith (1977) evaluated desert mule deer habitat selection in relation to habitat selection by Coues white-tailed deer (O. virginianus couesi). In Texas, studies by Phillips (1974), Dickinson and Garner (1979), and Koerth (1981) illustrated preferential selection for vegetative associations by desert mule deer.

I looked at habitat use by desert mule deer in relation to vegetational and physical characteristics of the environment within the Sonoran desert. My objective was to determine habitat use by desert mule deer relative to sex, season, habitat availability, vegetation, topography, slope, aspect, elevation, and water distribution.

STUDY AREA

The study area included the Picacho Mountains and surrounding areas north of Interstate 10, Pinal County, Arizona, located approximately 65 km northwest of Tucson (Fig. 1). Elevations range from 485m to 1374m. In lower elevations outwash plains are dissected by dry washes. Soils within these alluvial plains are generally deep, ranging in texture from coarse to fine (U.S. Soil Conservation Service 1971, Yeend 1976). Advancing upward, the terrain becomes steep and rough with granite and schist rock outcrops, ridges, saddles, and peaks. The geology of the Picacho Mountains was discussed by Wilson and Moore (1959), Peterson (1962), Briscoe (1967), and Johnson (1981).

Weather data recorded 13km east of the study area at Eloy, Arizona from 1951 to 1972 shows that on the average 172 days out of the year have maximum temperatures of 32°C and above, and 26 days have a minimum temperature of 0°C and below (Sellers and Hill 1974). Daily maximum temperatures range from 19°C in January to 41°C in July, and daily minimum temperatures range from 2°C in January to 24°C in July (Sellers and Hill 1974). The area has an arid climate with an annual average of 21 cm of precipitation; 40% of this falls during the summer months of July, August, and September (Sellers and Hill 1974). Data for 1981-82 were not significantly different from the 20 year averages given above (US Dept. of Commerce 1981, 1982).

The upper and lower Sonoran life-zones (Lowe 1964) are represented in and around the Picacho Mountains. The lower Sonoran life-zone, which

covers most of the area, consists of two basic plant communities, paloverde-saguaro (Cercidium microphyllum - Carnegiea gigantea) on the mountain slopes and bajadas, and creosote-bursage (Larrea tridentata - Franseria deltoidea) on the flats. Along the dry washes in both of these communities there are diverse stands of lush vegetation. The upper Sonoran life-zone is represented by a desert grassland community found in the higher elevations where perennial grasses, agave (Agave spp.), staghorn cholla (Opuntia spp.), prickly pear (Opuntia spp.), ocotillo (Fouquieria splendens), and a few juniper (Juniperus monosperma) trees occur.

Close to and within the mountainous terrain water was available in 6 big game water catchments, 1 spring, and ephemeral rain pools. During dry periods the Arizona Game and Fish Department hauled water to the big game water catchments. In the flats away from the mountains there were at least 21 stock ponds which were dependent upon precipitation runoff.

The majority of the land on the study area is state owned. Small portions belong to the Bureau of Land Management and private landowners (Ariz. State Land Dept. 1979). Cattle grazing and recreational hunting, trapping, and camping are the major land uses.

METHODS

Seventeen deer (10 does and 7 bucks) were captured in January and March 1981 and March 1982. Desert mule deer were located with a helicopter, immobilized with M-99 fired from a CO₂ powered rifle, fitted with color-coded radio telemetry collars (Telonics, Mesa, Arizona 85201), and released. Based on the results of two systematic helicopter surveys in September 1981 and April 1982 approximately 10% of the population was radio instrumented.

Locations of collared deer were obtained both from fixed-wing aircraft (Cessna 182 and 172) and by a ground observer using a TR-2 receiver, TAC-2 RLB antenna control unit (used in aerial tracking system), and RA-2AK antennas (Telonics, Mesa, Arizona 85201). Systematically all collared deer were located once a week by air using techniques developed by Krausman et al. (1984) and at least once a month on the ground. Locations were spread out over the diurnal hours. I collected data from January 1981 to July 1982.

Data collected for each location included vegetative association, slope position, slope class, aspect, elevation (m), and distance (km) to nearest available water source. There were two slope positions: flats and bottoms ($\leq 25\%$ slope), and slopes and ridges; five slope classes: 0-10%, 11-25%, 26-50%, 51-75%, and $\geq 76\%$; and three aspects: northern ($271^\circ - 90^\circ$), southern ($91^\circ - 270^\circ$), and level ($\leq 10\%$ slope).

Seasons, based on temperature and precipitation patterns along with plant phenology of the area, used in our study follow those described by

Truett (1972). Spring lasted from 1 February to 30 April; early summer lasted from 1 May to 15 July; late summer lasted from 16 July to 31 October; and winter lasted from 1 November to 31 January.

Locations of deer were plotted on a 7.5 minute U.S. Geological Survey topographical map and circumscribed by a line defining the exact study area boundaries. Using the nonmapping technique described by Marcum and Loftsgaarden (1980) 385 (Error of estimation = 0.05, $\alpha = 0.05$) random points were distributed over the study area to determine habitat availability. Vegetative association, slope position, slope class, and aspect were determined for each random point. The derived frequency distribution for each habitat component defined the availability distribution. For 283 (95% C.I. of not more than 0.2 km) random points distributed over the study area, the distance (km) to the nearest water source was measured to determine the mean random distance to water.

I used ground reconnaissance to determine vegetative associations on the study area. During the springs of 1981 and 1982 I determined the vegetative characteristics of each association. Perennial vegetation was enumerated in at least 100 0.004 ha circular plots randomly located in each association to determine tree, shrub, grass, forage, succulent (cacti and allies), and total composition, density, and diversity. Changes in the perennial vegetation over this study were insignificant. Shannon and Weaver (1949) diversity indices were used to define diversity. Percent thermal cover (any vegetation a deer could stand or lay under to seek shelter from the sun) for each association was

determined by running 305 m of line intercept transects (Canfield 1941) in each association.

Contingency table analysis (Fienberg 1980) was used to evaluate sex by season by habitat component (vegetative association, slope position, slope class, and aspect) interactions. Comparisons of deer use with availability of habitat components were made using chi-square analysis (Conover 1980). If use was significantly different from availability I looked at preference for individual vegetative associations, slope positions, slope classes, and aspects by using the binomial test for comparing equality of 2 proportions (Zar 1974). Comparisons of vegetative characteristics (composition, density, and diversity) for preferred vegetative associations (use > availability) with those of nonpreferred vegetative associations (use \leq availability) were made using Mann-Whitney nonparametric tests (Conover 1980). Analysis of variance and Student-Newman-Keuls' (SNK) tests (Steel and Torrie 1980) were used to evaluate differences among sexes and seasons for elevation use and distance to nearest available water source. The seasonal mean distances to nearest available water source were compared to the mean random distance to water using hypothesis testing (Steel and Torrie 1980). Results are considered significant when $P \leq 0.05$.

RESULTS

Habitat Availability

The study area was 228 km² and partitioned into habitat components (Table 1). Nine vegetative associations were defined which were distinguished easily in the field: 5 associations in and around the mountainous terrain comprising 38% of the area; and 4 associations in the flats away from the mountainous terrain comprising 62% of the area. These associations were dominated by the species for which they were named. The mountainous vegetative associations include paloverde-saguaro north slope (PSNS) (7.5%), paloverde-saguaro south slope (PSSS) (7.0%), paloverde-saguaro bajada (PSB) (20.0%), paloverde-saguaro-jojoba (Simmondsia chinensis) (PSJ) (2.3%), and juniper-grass (JG) (1.3%). The nonmountainous vegetative associations include paloverde-saguaro flats (PSF) (7.8%), creosote-mesquite (Prosopis juliflora) (CM) (45.0%), creosote-ironwood (Olneya tesota) (CI) (6.8%), and mesquite bosque (MB) (2.6%).

The PSNS association occurs on northern slopes greater than 25%. Dominant overstory plants include paloverde and saguaro with a dominant understory of flattop buckwheat (Eriogonum fasciculatum) and triangle-leaf bursage. The PSSS association occurs on southern slopes greater than 25%. It has a dominant overstory of paloverde and saguaro and a understory of brittlebush (Encelia farinosa) and triangle-leaf bursage. The PSB association occurs on alluvial fans less than 25% slope going

away from the mountainous terrain. Bajada areas with 11-25% slope could have either northern or southern aspects, but areas with less than 11% slope were considered level. Paloverde and saguaro are the dominant overstory vegetation and the understory is dominated by triangle-leaf bursage. The PSJ association is a mixture of the above associations with the presence of jojoba. Juniper-grass is analogous to the upper Sonoran life-zone occurring above 1100 m elevation. It has a sparse overstory, consisting mainly of Arizona rosewood (Vauquelinia californica) and a few junipers, along with a diverse understory of shrubs and perennial grasses. The CM association is in the eastern flats below the bajada association. Washes which carry water during heavy rains are interspersed throughout this association. Open creosote stands with a few interspersed mesquite trees occur in areas between washes, comprising 36.4% of the area. Vegetation along washes, (8.3%), include stands of mesquite trees with an understory of triangle-leaf bursage and burroweed (Aplopappus tenuisectus). The CI association is on the western side of the study area. This is a narrow strip of land bordered on the west by orange orchards and cotton fields. The PSF association is on the extreme northern part of the study area. Due to sandy substrate, there is better water penetration into the soil allowing paloverdes and saguaros to occur in an area which normally would be a creosote dominated association. Overstory includes a mix of paloverde, saguaro, and creosote with an understory of triangle-leaf bursage and white bursage (Franseria dumosa). Finally, bordering along the major wash of the area, MacClellan (Fig. 1), occurs the MB

association. Overstory vegetation consists primarily of dense stands of mesquite trees with an understory of burroweed. Vegetative characteristics for the associations are presented in Table 2.

Deer Use

I located female deer 905 times and males 705 times. In spring I located deer 509 times; 286 female and 223 male; in early summer deer were located 511 times: 286 female and 225 male; in late summer deer were located 263 times: 150 female and 113 male; and in winter 327 locations of deer were made: 183 female and 144 male.

A 3-way interaction was significant ($X^2 = 31.88$, $df = 15$, $P = 0.0067$) between sex, season, and vegetative association (Fig. 2). Female use in all seasons was confined to the mountainous vegetative associations, whereas, males used both mountainous and nonmountainous associations. Male and female use was most similar in early summer. Use by both sexes peaked in the PSB association where the big game catchments are located. During both wet seasons, spring and late summer, use patterns by deer were similar; although, use between sexes was different in both seasons. Female use peaked in the PSNS and PSJ associations during the winter season. Similarly, male use peaked in the PSJ association. These two associations were important during the fawn rearing and breeding periods, late summer and winter, respectively. Males showed significant use in the CM association in all seasons except early summer when only 3.5% of the males located were in the CM associations. Locations for males within the CM association were primarily in the wash areas ranging from 88% of the CM locations in the

winter to 68% of the CM locations in the spring. No use was shown by either sex for the CI association in any season.

During early summer, use of bottoms and flats was greatest, whereas, use of slopes and ridges was greatest during winter. Males use bottoms and flats and females use slopes and ridges predominately. Season by slope position ($\chi^2 = 117.75$, $df = 3$, $P < 0.001$) and sex by slope position ($\chi^2 = 99.24$, $df = 1$, $P < 0.001$) interactions were significant (Fig. 3).

The sex by season by slope class interaction was significant ($\chi^2 = 24.39$, $df = 12$, $P = 0.0180$; Fig. 4). In all seasons, use by males was greatest for the 0-10% slope class. Females used the middle slope classes most, except during early summer when the lesser slope classes had higher use. During winter, the season containing the rutting period, males showed a marked increase in use of the middle slope classes. Steep slopes ($\geq 76\%$) were avoided by deer.

Season by aspect ($\chi^2 = 70.31$, $df = 6$, $P < 0.001$) and sex by aspect ($\chi^2 = 173.31$, $df = 2$, $P < 0.001$) interactions were significant (Fig 5.). Use of southern aspects remained constantly low across seasons. Northern aspect use was highest during winter and lowest during early summer. The opposite occurs for level areas with use being highest in early summer and lowest in winter. Males used level areas more than northern and southern aspects. In contrast, females used northern and southern aspects more than level areas. Both sexes used northern aspects more than southern aspects.

For both sexes lowest mean elevation use occurred in early summer

and highest mean elevation use occurred in winter. In all seasons males used lower mean elevations than females. The main effects of season ($F = 44.02$, $df = 3$, $P = 0.001$) and sex ($F = 74.09$, $df = 1$, $P = 0.001$) were significant (Fig. 6). All seasons were significantly different from one another.

Both sexes use habitat similarly in relation to distance to water, occurring closer to water during the hot seasons, early and late summer, and occurring further away from water during the cool seasons, winter and spring. Season ($F = 11.08$, $df = 3$, $P = 0.001$) was the only significant main effect (Fig. 7). Early and late summer were similar, but different from spring and winter which were also similar. Mean distances to nearest available water source for spring and winter were not significantly different from the mean distance to water for the sample of random points; however, mean distances for early and late summer were significantly different (Fig. 7).

Habitat Availability vs. Deer Use

Deer did not use habitat components in proportion to availability (Table 3). Males in general preferred the mountainous associations and the washes in the CM associations during spring, late summer, and winter and the MB association during late summer. Females prefer mountainous associations.

Males

Areas selected by males in the spring had higher shrub, grass, and forage densities; higher shrub and grass species diversities; and a

higher total number of shrub, grass, and forage species ($U = 0$, $P = 0.0159$) than areas avoided by males.

In early and late summer no vegetative differences were detected between areas preferred and not preferred. During winter, associations preferred by males had higher grass densities and shrub diversities ($U = 0$, $P = 0.0238$), and more species of shrubs and grasses ($U = 1$, $P = 0.0476$) than areas not preferred.

Females

Areas selected by females had similar vegetation characteristics in all seasons. Habitats that were preferred in the winter, spring, and late summer had more forage and succulent species and higher grass diversities ($U = 1$, $P = 0.0476$) than areas not preferred. Areas preferred in early summer had higher forage diversities and more succulent species ($U = 1$, $P = 0.0317$) than the areas that were avoided.

Both sexes preferred slopes and ridges with one exception. In early summer males showed no preference for slopes and ridges or bottoms and flats. Both sexes preferred slopes $\geq 11\%$. Females preferred northern and southern aspects during all seasons; males preferred northern aspects during all seasons except spring when they, also, preferred southern aspects. Neither sex preferred level areas.

DISCUSSION

Sexual segregation and habitat partitioning by mule deer has been documented (Clark 1953, Dasmann and Taber 1956, Cowan 1956, DeVos et al. 1967, Mackie 1970, Miller 1970, Truett 1972, Schwarzkoph 1973, Phillips 1974, Robinette et al. 1977, King and Smith 1980, Bowyer 1984). In general mature males occupy more open habitat with less quality forage than females during the non-breeding period of the year. My observations were similar. The mature males were separate from the females and used habitats differently from females during the non-breeding period of the year. Possible explanations of this sexual segregation have been suggested. Geist and Petocz (1977), McCullough (1979), and King and Smith (1980) suggest that if sexes separate, the loss of energy to agonistic expression between males and females is reduced, thus, allocating more energy for the female to raise young. Females not in competition with males produce more offspring. (Wilson 1975, Geist and Petocz 1977, McCullough 1979, King and Smith 1980).

Desert mule deer males showed more diversity using both mountainous and nonmountainous vegetative associations, whereas, females only used mountainous vegetative associations. Both sexes preferred mountainous vegetative associations. However, depending on season males also showed preference for nonmountainous vegetative associations. Nonmountainous associations are lower quality relative to forage and more open compared to mountainous associations. Most deer (collared and uncollared)

observed in the flat areas distant from the mountainous terrain were mature males. These areas could be analogous to the "mature buck habitat" discussed by Mackie (1970) and Schwarzkoph (1973).

Age specific habitat use data is needed to test the hypothesis that habitat use by young males is more closely related to that of females and different from that of mature males. Based on body size, antler configuration, and behavior, 2 of the 7 collared males were younger and had similar body size to that of a female. These 2 males used mountainous vegetative associations more than the other 5 collared males, and were in closer association with females during the nonbreeding period of the year. A larger sample size and a better representation of the population's male age structure is needed prior to making definite conclusions.

Looking at the vegetative characteristics between preferred and nonpreferred vegetative associations females prefer associations with better forage characteristics in all seasons, however, the relationships with vegetative characteristics for males are either very complex or non-existent. White-tailed deer bucks have the ability to subsist on a lower quality diet than do females because of a larger rumen size to body size ratio and a lower metabolism rate per unit of body weight (Short 1973, McCullough 1979). If this is also true for desert mule deer males it provides a possible explanation as to why females prefer areas with better quality forage and males show no preference.

Males used lower slope positions and lower elevations compared to females in all seasons. Rocky Mountain mule deer and black-tailed deer

studies have shown males to occupy areas above females relative to slope position and elevation (Cowan 1956, Miller 1970 Schwarzkoph 1973, Robinette et al. 1977, King and Smith 1980). I found use of gentler slopes and flats to be greater by males than females. Male Rocky Mountain mule deer use steeper slopes compared to females (Schwarzkoph 1973). My results show that males used more open areas (nonmountainous vegetative associations) than females. This was also found to be true for Rocky Mountain mule deer and black-tailed deer (Dasmann and Taber 1956, Robinette et al. 1977, King and Smith 1980). In the desert, use of areas with different aspects is not a function of snow accumulation as is true for Rocky Mountain mule deer habitat (Wilkins 1957, Mackie 1970, Nicholson 1973, Schwarzkoph 1973). Desert mule deer males most commonly used flat areas without an exposure; when on slopes both males and females preferred northern exposures over southern exposures. Areas with northern exposures provide a more mesic environment along with greater thermal cover which is especially important during the high temperatures of the summer seasons. Truett (1972) and Koerth (1981) found similar results working with desert mule deer.

Bowyer (1984) suggests that sexual segregation in southern mule deer (O.h. fuliginatus) may be the result of higher water demands by lactating does. Hervert and Krausman (unpublished data) demonstrated that females do water more frequently than males. However, males have larger rumens which allow fewer visits to water sources to meet their water demands. During early and late summer, distances to the nearest available water source for collared deer were significantly closer than

when compared to distances for the wet cool seasons, winter and spring. Also, in early summer, the driest season, both male and female use were greatest in the PSB vegetative association where the most reliable water sources (big game catchments) are located. Similar observations showing deer use to be greater in proximity to water sources have been shown by Clark (1953), Swank (1958), Mackie (1970), Wood et al. (1970), and Truett (1972).

Habitat management emphasis for desert mule deer populations should be directed mainly toward the areas in and proximal to desert mountain ranges as these areas are vital to the female segment of the population. Loss or deterioration of these areas will have detrimental effects on the productivity of desert mule deer populations. However, measures must also be taken to maintain the open areas distal to desert mountain ranges to provide habitat for mature males during the nonbreeding period of the year. Of major importance in these open areas are the desert washes and associated vegetation. These washes provide cover, forage, and travel routes.

Table 1. Habitat availability in the Picacho Mountains, Arizona, January 1981-July 1982, determined by a nonmapping technique^a.

Habitat Component	No. of random points	Proportion (%) of study area
Vegetative Association		
Paloverde-saguaro north slope	29	7.5
Paloverde-saguaro south slope	27	7.0
Paloverde-saguaro bajada	77	20.0
Paloverde-saguaro-jojoba	9	2.3
Juniper-grass	5	1.3
Paloverde-saguaro flats	30	7.8
Creosote-mesquite	172	44.7
Washes	32	8.3
Between washes	140	36.4
Creosote-ironwood	26	6.8
Mesquite bosque	<u>10</u>	<u>2.6</u>
	n = 385 ^b	100.0
Slope Position		
Bottoms and flats (< 25% slope)	319	82.9
Slopes and ridges	<u>66</u>	<u>17.1</u>
	n = 385	100.0
Slope class		
0-10%	298	77.4
11-25%	21	5.5
26-50%	26	6.8
51-75%	37	9.6
> 76%	<u>3</u>	<u>0.8</u>
	n = 385	100.1
Aspect		
North	45	11.7
South	42	10.9
Level (< 10% slope)	<u>298</u>	<u>77.4</u>
	n = 385	100.0

^a Marcum and Loftsgaarden (1980).

^b Error of estimation ≤ 0.05 ; alpha = 0.05.

Table 2. Vegetative characteristics for vegetative associations in the Picacho Mountains, Arizona, January 1981-July 1982.

Vegetative Component	Vegetative Association			
	Paloverde-Saguaro North Slope	Paloverde-Saguaro South Slope	Paloverde-Saguaro Bajada	Paloverde-Saguaro Jojoba
Tree density ^a	80	103	30	62
" species	2	2	1	1
" H' ^b	0.0263	0.0264	0	0
Shrub density	2733	3366	2559	2707
" species	44	40	21	31
" H'	2.7629	1.8469	0.5358	2.1963
Grass density	100	53	5	73
" species	9	7	1	6
" H'	1.4162	1.5197	0	1.4773
Succulent density	157	278	292	196
" species	9	10	8	8
" H'	1.6507	1.5182	1.5203	1.6243
Forage density	1609	2051	180	1916
" species	20	18	12	15
" H'	2.2619	1.4776	2.0750	1.9620
Total density	3069	3800	2886	3038
" species	64	59	31	46
" H'	3.0528	2.2252	1.0258	2.5460
Thermal cover (%)	18.19	12.08	15.33	12.98

(Table 2 continued)

Vegetative component	Vegetative Association				
	Juniper Grass	Paloverde-Saguaro Flats	Creosote-Mesquite	Creosote-Ironwood	Mesquite Bosque
Tree density	22	8	2	31	401
" species	3	1	1	2	1
" H'	0.5764	0	0	0.2392	0
Shrub density	3219	1242	299	834	844
" species	42	10	4	6	8
" H'	2.7017	0.84886	0.2613	0.8422	0.6776
Grass density	1965	0	0	0	0
" species	8	0	0	0	0
" H'	1.4352	-	-	-	-
Succulent density	373	86	0	7	8
" species	7	8	0	4	3
" H'	1.4454	1.7187	-	1.1537	0.7356
Forage density	2173	175	2	115	407
" species	16	8	1	4	4
" H'	1.8222	1.1654	0	0.6945	0.0896
Total density	5579	1336	301	872	1253
" species	60	15	5	12	12
" H'	3.0508	1.1746	0.2995	1.0232	1.1242
Thermal cover (%)	11.37	12.62	5.24	14.39	28.73

^a Density = # plants/0.4 ha.

^b H' - Shannon and Weaver (1949) Diversity Index.

Table 3. Preference by desert mule deer for habitat components in the Picacho Mountains, Arizona, January 1981 - July 1982.

Habitat Component	Spring	Preference ^a		
		Early Summer	Late Summer	Winter
Vegetative Association				
Paloverde-saguaro north slope	M/F ^b	F	M/F	M/F
Paloverde-saguaro south slope	M/F	F	F	F
Paloverde-saguaro bajada		M/F		
Paloverde-saguaro-jojoba	M/F	M/F	M/F	M/F
Juniper-grass	M			M
Paloverde-saguaro flats				
Creosote-mesquite				
Washes	M		M	M
Between washes				
Creosote-ironwood				
Mesquite bosque			M	
Slope position				
Bottoms and flats (<25% slope)				
Slopes and ridges	M/F	F	M/F	M/F
Slope class				
0-10%				
11-25%	F	M/F	F	M
26-50%	M/F	M/F	M/F	M/F
51-75%	M/F	F	F	M/F
≥ 76%	F			M
Aspect				
North	M/F	M/F	M/F	M/F
South	M/F	F	F	F
Level (<10% slope)				

^a Preference indicates use > availability; $P \leq 0.05$.

^b M = male; F = female.

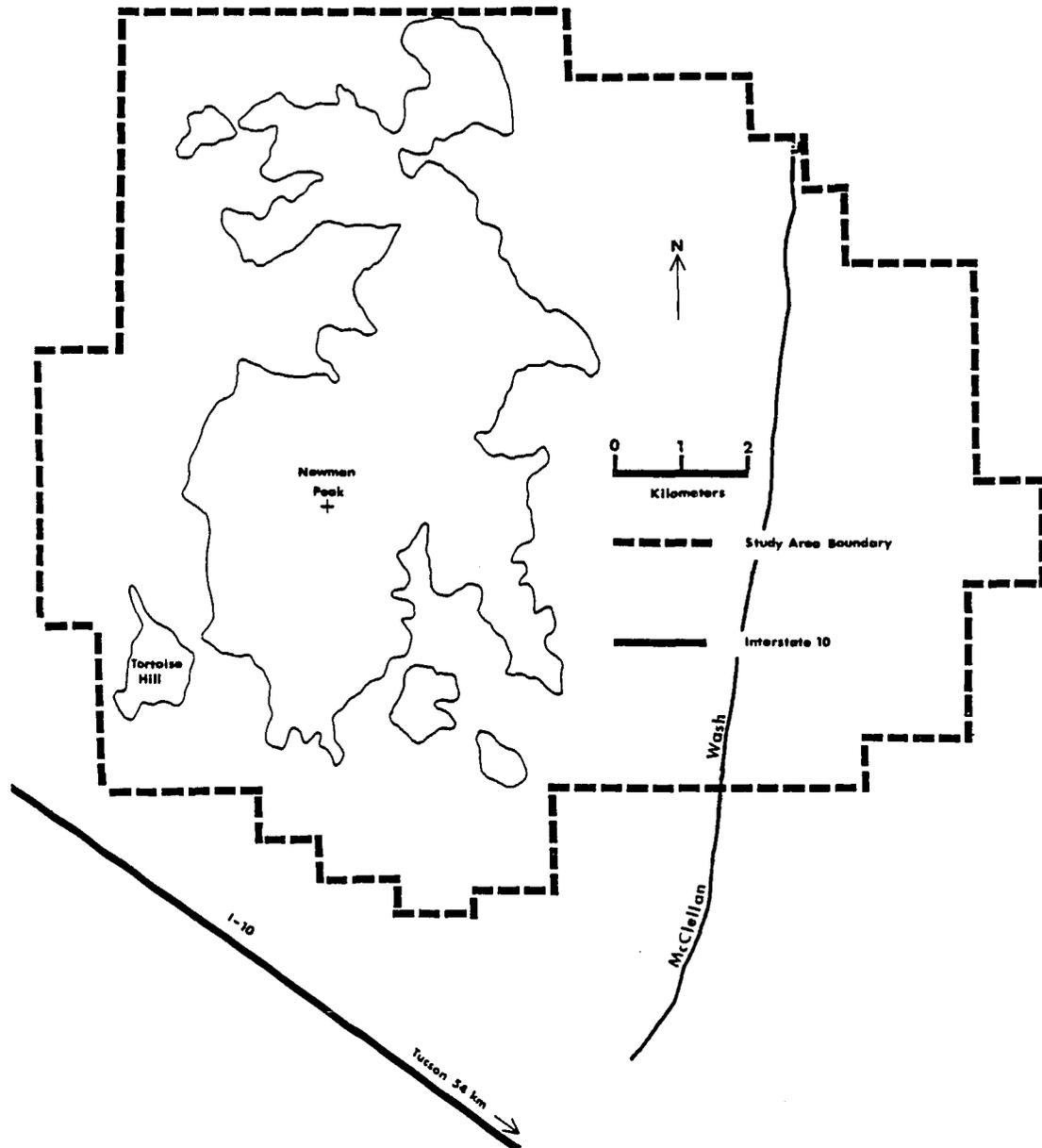


Figure 1. Location of Picacho Mountains study area, Arizona.

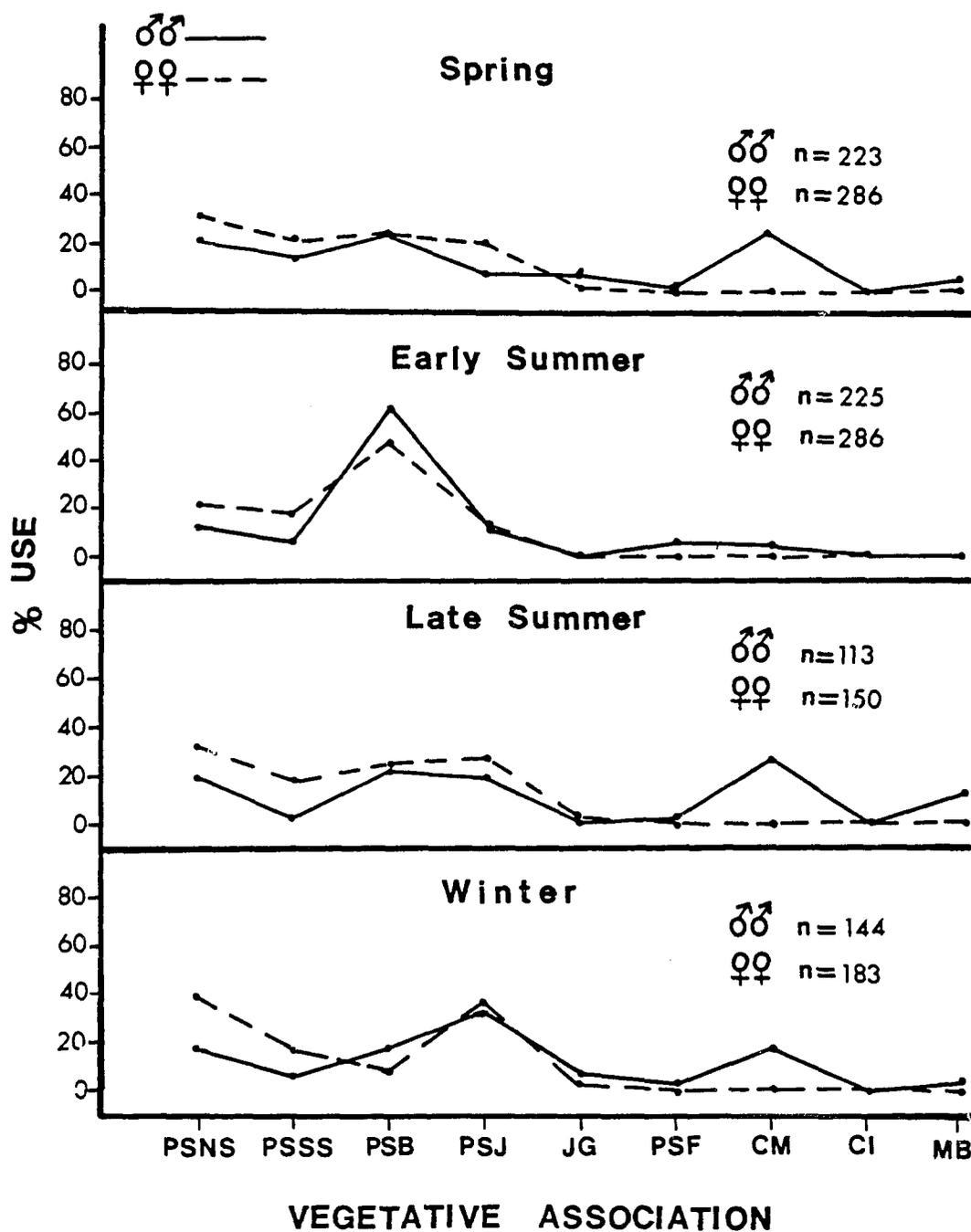


Figure 2. Seasonal use of vegetative associations by male and female desert mule deer in the Picacho Mountains, Arizona, January 1981 - July 1982. PSNS = paloverde-saguaro north slope, PSSS = paloverde-saguaro south slope, PSB = paloverde-saguaro bajada, PSJ = paloverde-saguaro-jojoba, JG = juniper-grass, PSF = paloverde-saguaro flats, CM = creosote-mesquite, CI = creosote-ironwood, MB = mesquite bosque.

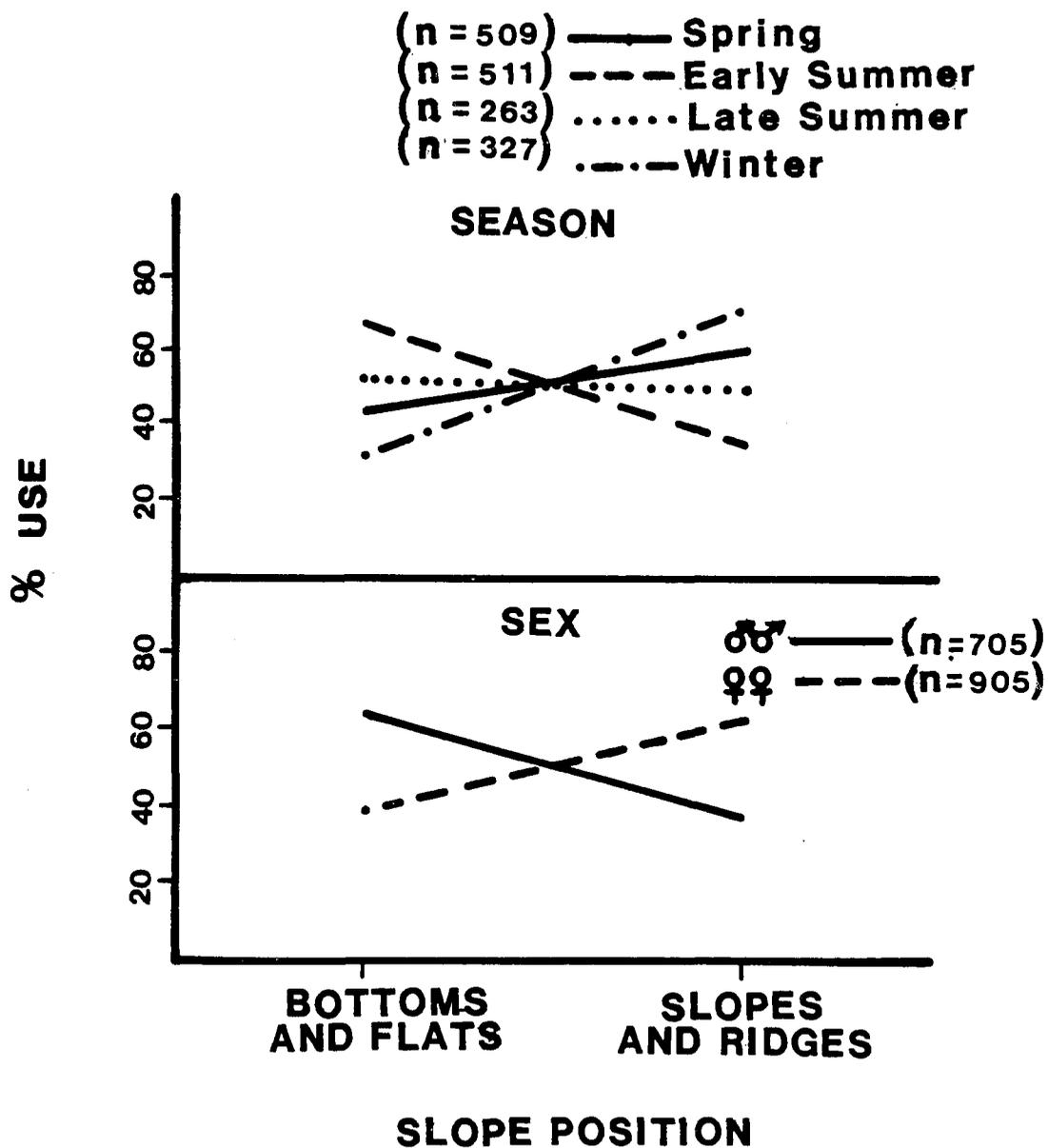


Figure 3. Use of slope positions by season and sex for desert mule deer in the Picacho Mountains, Arizona, January 1981 - July 1982.

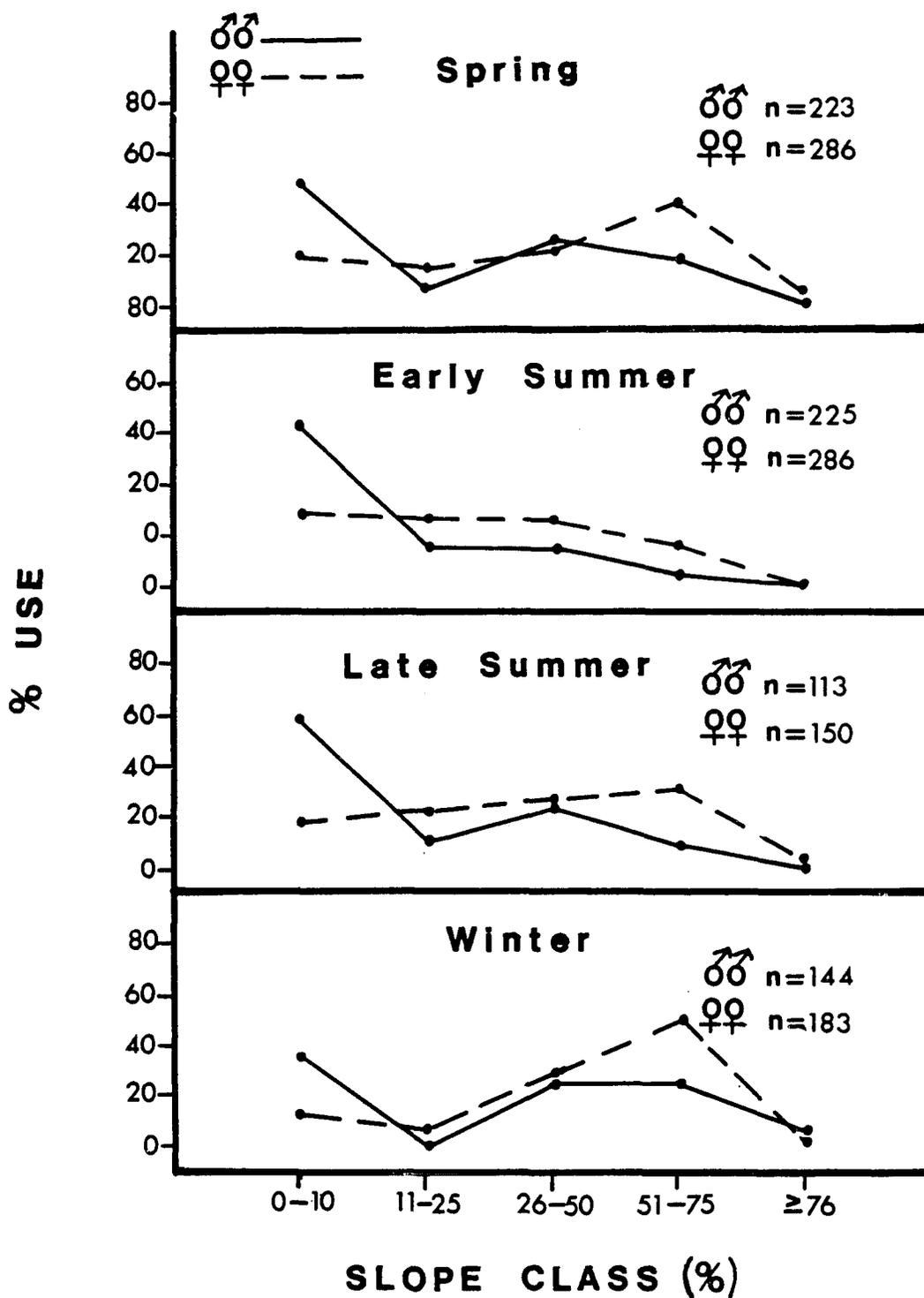


Figure 4. Seasonal use of slope classes by male and female desert mule deer in the Picacho Mountains, Arizona, January 1981 - July 1982.

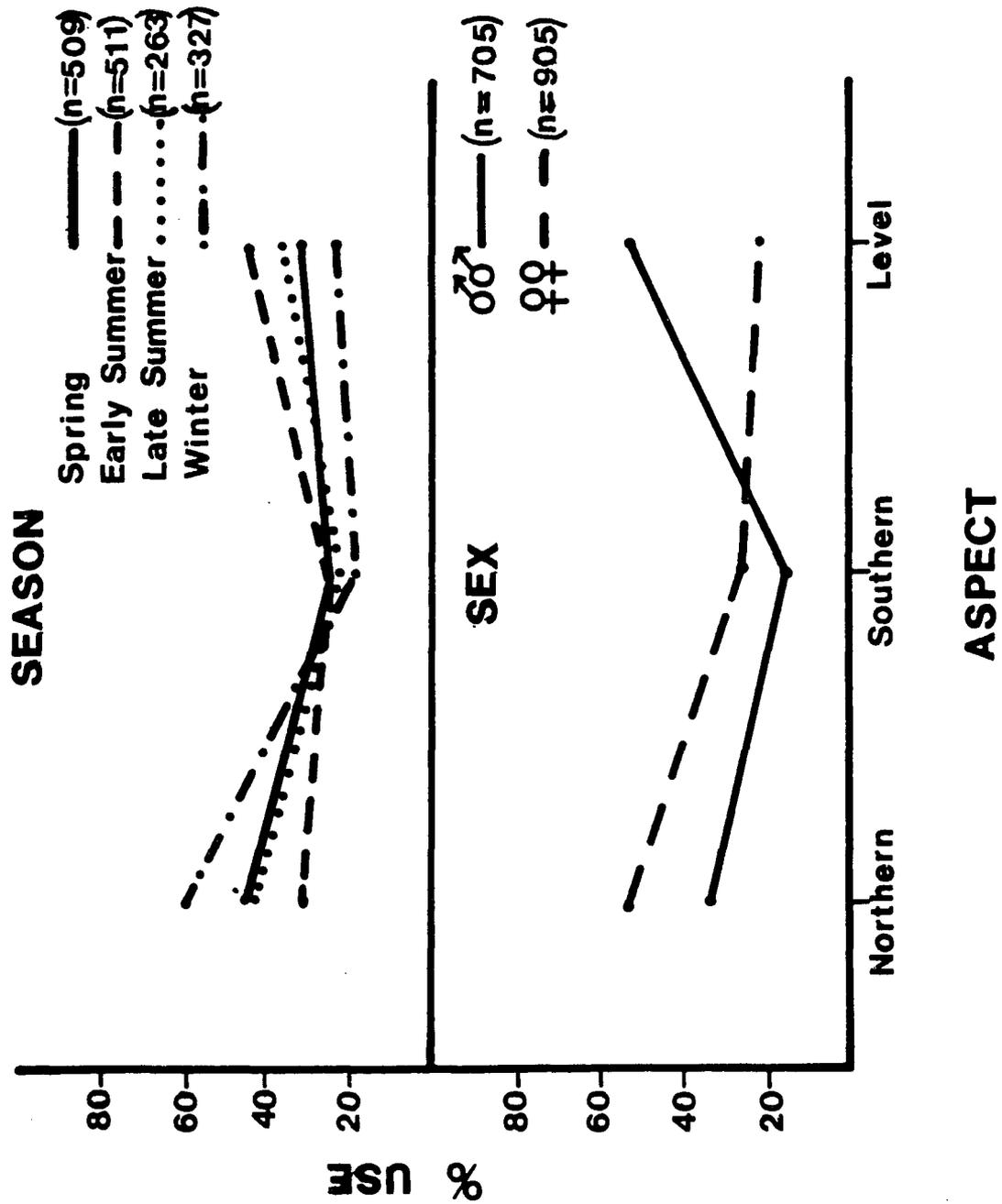


Figure 5. Use of aspects by season and sex for desert mule deer in the Picacho Mountains, Arizona, January 1981 - July 1982.

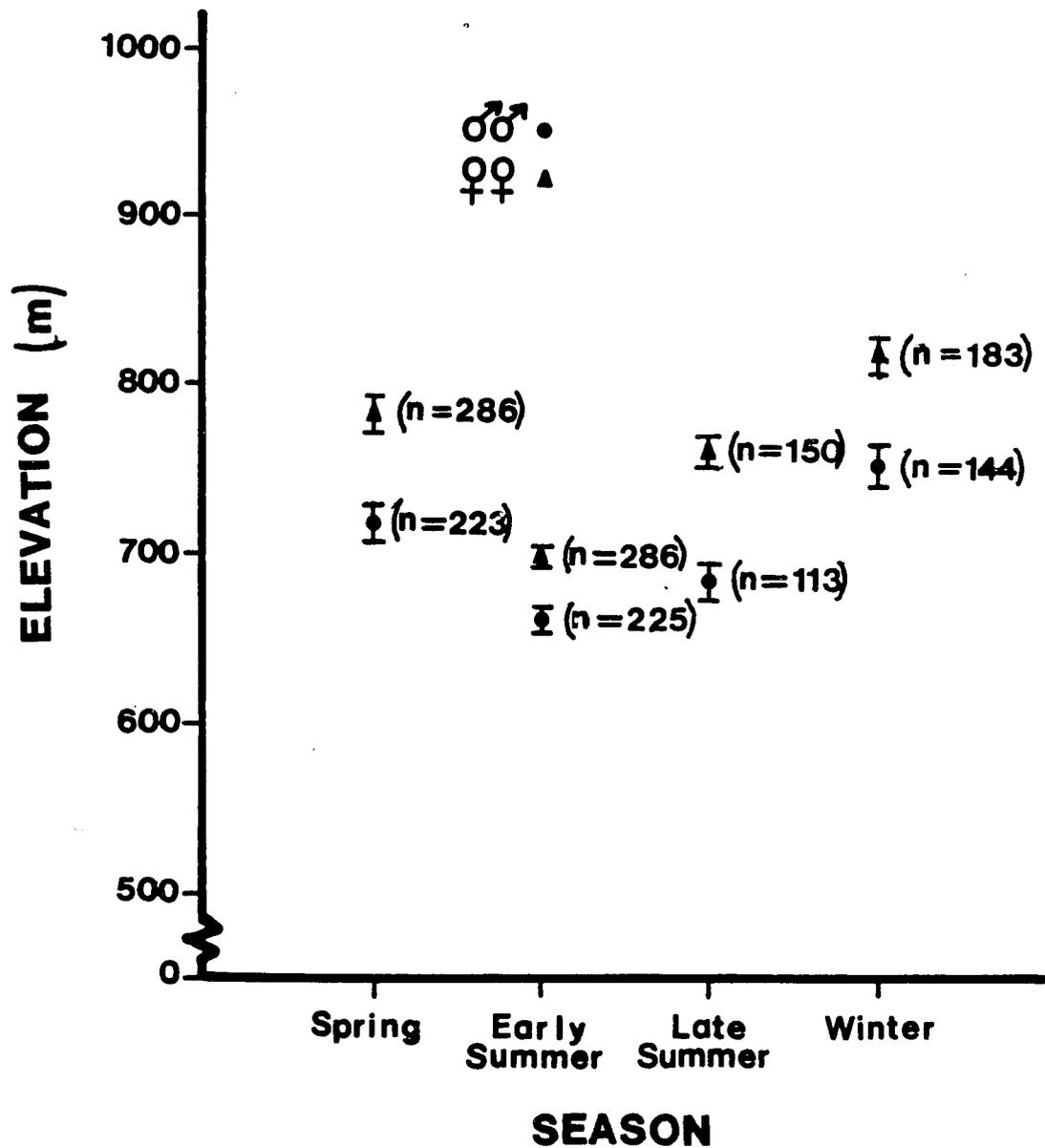


Figure 6. Seasonal elevation (m) means \pm SE for male and female desert mule deer in the Picacho Mountains, Arizona, January 1981 - July 1982.

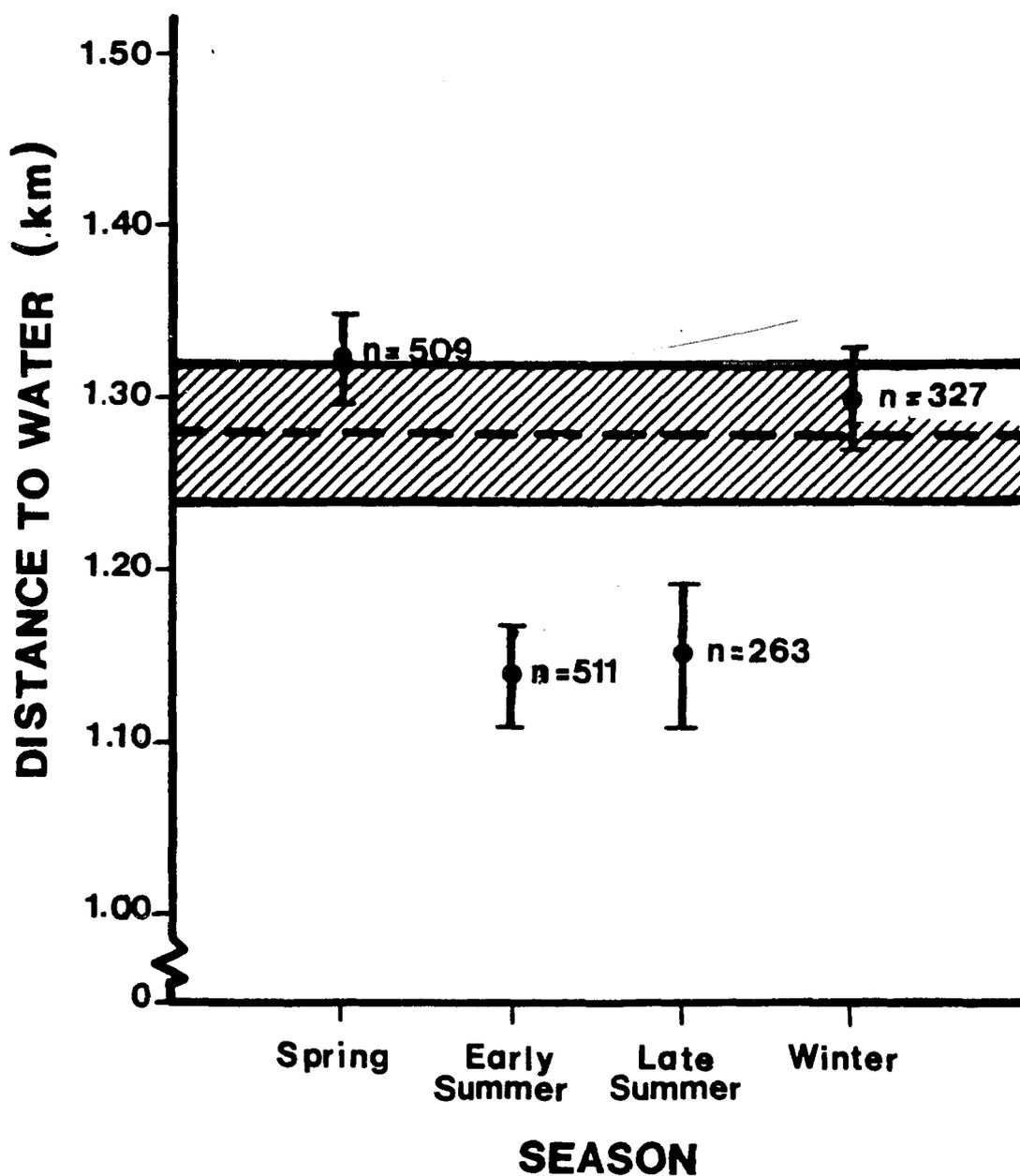


Figure 7. Seasonal mean distances (km) to nearest available water \pm SE for desert mule deer compared to the mean random distance (km) to water \pm SE in the Picacho Mountains, Arizona, January 1981 - July 1982.

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