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HABITAT SELECTION BY SOUTHERN MULE DEER [1]

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Habitat selection by southern mule deer, *Odocoileus hemionus fuliginatus,* was studied at Cuyamaca Rancho State Park, San Diego County, California from June 1977–January 1979. Direct observations, spotlight transects, and track counts indicated meadows were most preferred by active deer followed by stands of oaks, and pine; deer avoided dense brushfields of chaparral. Deer bedding at midday exhibited a marked preference for the oak plant community. Because meadows were used extensively by feeding deer, this habitat was subdivided into an additional seven vegetative types. Deer preference ratings were highest for the deer grass type, followed by mustard, cheat grass, rose, wild oat, chokecherry, and buckwheat types. No significant variation occurred in the preferences of deer for vegetative types between seasons. Further, few differences occurred among sex and age classes of deer in their preferences for vegetative types; however, newborn fawns made extensive use of deer grass habitat. Deer occurred most often on west-facing slopes, probably because of the palatable foods that occurred on these areas; preferences of deer for different slope exposures did not vary significantly among seasons. Deer occurred most often at distances of 41–50 m from concealment cover. Most deer were found within 1 km of free water during summer. Deer distribution was correlated significantly with the availability of *Sisymbrium altissimum,* a preferred forage.

INTRODUCTION

Southern mule deer, *Odocoileus hemionus fuliginatus,* are thought to occupy primarily chaparral regions of extreme southern California (Cowan 1956, Wallmo 1981). This subspecies, however, possesses a dark, sooty-colored pelage uncharacteristic of most mule deer that occur in chaparral or other arid environments (Bowyer and Bleich 1984*a,* Cowan 1956). Habitat preferences of southern mule deer have not been described fully, and accounts that indicated chaparral habitat was preferred often lacked quantification. Indeed, until recently (Bowyer and Bleich 1980, Bowyer and Bleich 1984*b,* Bowyer 1984) little was known of the ecology of these deer. Further, the southern mule deer is an important game species in southern California (Bowyer 1981), and information concerning habitat selection would be useful in its management.

The purpose of this study was to quantify seasonal changes in habitat preferences of various sex and age classes of southern mule deer. Components of habitat important in the ecology of California deer (Leopold et al 1951, Taber and Dasmann 1958) that were assessed in this research include: i) diel changes in the use of vegetative types; ii) the concealment cover provided by vegetative types and the distances deer occurred from escape cover; iii) seasonal variation in the use of differing slope exposures; iv) the distribution of deer relative to free water during summer; and v) the influence of preferred forage on deer distribution.

STUDY AREA

Location and Climate

Research was conducted at an elevation of 1520 m on 1250 ha of East Mesa, Cuyamaca Rancho State Park, San Diego Co., California (32° 59′ N, 116° 35′ W).

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The Park is located 65 km east of San Diego and 40 km north of Mexico in the Cuyamaca Mountains of California's Peninsular Range.

Annual precipitation averages 88 cm; most precipitation occurs between November and April. Snowfall averages 92 cm per year. December–March is the period of greatest snowfall. Snow does not accumulate but usually melts within several weeks.

The mean annual temperature is 12° C; while summer maxima seldom exceed 38° C and winter minima rarely fall below −10° C. The hottest period is June–September and the coldest December–March. Monthly variation in temperature during the study approximated the 50-year mean.

Prevailing winds are from the southwest, but Santa Ana winds (extremely hot, dry winds originating in the Great Basin) come from the northeast. Santa Ana conditions are most prevalent from September through early December, but may occur in any month.

Flora and Fauna

East Mesa was dominated by upland meadows (619 ha) interspersed with stands of oak (149 ha) or pine (241 ha) and surrounded by old-growth chaparral (241 ha) (Figure 1). Percent cover for species typifying the chaparral community was *Quercus wislizenii* (17.8%), *Cercocarpus betuloides* (17.3%), *Adenstoma fasciculatum* (11.2%), *Ceanothus palmeri* (2.9%), *Eriogonum fasciculatum* (2.9%), *Rhamnus crocea* (1.8%), and *Salvia apiana* (1.7%) (see Methods for sampling details).

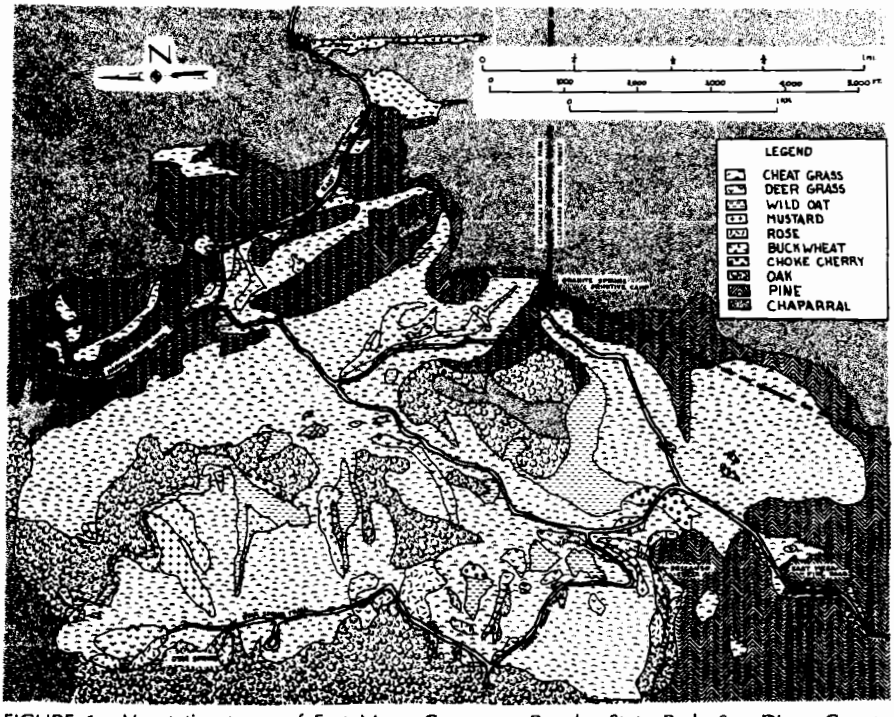

FIGURE 1. Vegetative types of East Mesa, Cuyamaca Rancho State Park, San Diego County, California, 1977–1979.

Percent cover for trees of the pine community was: *Pinus jeffreyi* (3.4%), *Quercus kelloggi* (1.9%), *Q. agrifolia* (1.6%), *Pinus ponderosa* (0.1%), and *P. coulteri* (0.1%). The dominant understory shrub was *Arctostaphylos pungens* (0.3%). Other common species in the understory were *Bromus diandrus* (5.9%), *Festuca octoflora* (5.7%), *Bromus tectorum* (3.2%), and *Leptodactylon pungens* (2.4%).

Percent cover of trees in the oak community was *Quercus kelloggi* (4.6%), *Q. agrifolia* (2.8%), and *Q. wislizenii* (0.9%). Common understory shrubs included *Rhus trilobata* (2.5%) and *Rhamnus californica* (0.8%). Understory grasses were predominantly *Bromus diandrus* (18.2%), *B. tectorum* (5.8%) and *B. marginatus* (4.5%).

Feeding deer occurred frequently in meadows, consequently this community was divided into seven vegetative types that formed relatively discrete patches and were distinquished easily in the field. The most common type was cheat grass (509 ha). Percent cover for common species was: *Bromus tectorum* (18.4%), *Festuca octoflora* (10.7%), *Erodium citutarium* (6.7%), *Ambrosia psilostachya* (3.2%), *Bromus diandrus* (3.1%), and *Sisymbrium altissimum* (1.9%).

Percent cover for common species in the wild oat type (37 ha) was: *Avena barbata* (23.7%), *Eriogonum nudum* (6.6%), *E. davidsonii* (2.3%), *Ambrosia psilostachya* (2.1%), *Erodium cicutarium* (1.8%), and *Gutierrezia californica* (1.2%).

Percent cover for species in the deer grass type (36 ha) was: *Carex* sp. (27.8%), *Muhlenbergia ridgens* (22.9%), *Festuca octoflora* (5.6%), *Bromus tectorum* (4.3%), *Eriogonum nudum* (2.5%), and *Juncus xiphoides* (1.4%).

The buckwheat type encompassed 15 ha and percent cover for common species was: *Eriogonum fasciculatum* (29.2%), *Rhus trilobata* (6.7%), *Bromus tectorum* (5.6%), and *Festuca octoflora* (4.4%).

Percent cover for species typical of the rose type (11 ha) was: *Symphoricarpos mollis* (17.7%), *Rosa californica* (12.7%), *Eriogonum nudum* (5.8%), *Bromus tectorum* (5.8%), *Festuca octoflora* (4.9%), and *Prunus virginiana* (1.4%).

The mustard type totaled 7 ha and percent cover for characteristic species was: *Bromus diandrus* (22.1%), *B. tectorum* (13.9%), *Sisymbrium altissimum* (11.8%), and *Erodium cicutarium* (1.6%).

The chokecherry type (5 ha) was dominated by *Prunus virginiana* (25.9%), *Bromus tectorum* (20.8%), and *Ambrosia psilostachya* (1.4%). Plant nomenclature follows to Munz (1974).

An unhunted population of approximately 250 nonmigratory southern mule deer inhabited East Mesa. Predators including coyote, *Canis latrans,* and bobcat, *Lynx rufus,* were common. Further descriptions of the flora and fauna of this area are available elsewhere (Bowyer and Bleich 1980, Bowyer et al 1983, Bowyer and Bleich 1984*b,* Bowyer 1984)

METHODS

Direct Observations

Deer were observed on 268 days from June 1977–January 1979 with the unaided eye, 7 X binoculars or a 20–45 X spotting scope from a vehicle or on foot over distances of 5–800 m. Observations were made primarily during the

three to four hours about sunrise and sunset when deer were most active. Some sampling also was conductd at midday to determine the habitat preferences of bedding deer. Observation periods of 24 h were undertaken when weather permitted. Nighttime observations were dependent upon clear, moonlit conditions.

A fixed transect of 8.2 km typically was driven once each morning and evening when roads on East Mesa were passable. The portion of East Mesa sampled first was alternated with each sampling effort from eastern to western areas to help neutralize the influence of time of day on deer activity. A 7.5-km, fixed transect was walked when snow or mud prevented driving on East Mesa.

Data were collected only from groups of deer that were undisturbed by my presence. If any member of a group exhibited alert or alarm postures at my approach, data collection was terminated. Care was taken to assure a complete count and accurate identification of deer in each group. No data were recorded unless I was confident that deer were not hidden by hills, gullies, or vegetation. Extra time was spent with groups in dense habitats to assure all group members were counted. Sampling of habitat use by active deer was determined, in part, by the location of roads on East Mesa. From spring through autumn 625 ha were sampled for deer use, whereas 557 ha were sampled during winter. Overall, meadows composed 88.8% of the area sampled, followed by oak (5.2%), pine (3.4%), and chaparral (2.6%) plant communities. Sampling effort within meadow types was most intense in cheat grass (73.3%), followed by wild oat (5.9%), deer grass (4.7%), buckwheat (2.3%), mustard (1.2%), rose (1.1%), and chokecherry (0.5%).

Sex and age of deer in each group also were recorded. Categories recognized were bucks (adult males older than two years of age), male yearlings, does (adult females older than two years of age), female yearlings, and fawns (deer of either sex less than one year of age). All categories were distinguished easily for most of the year from body size and form or antler development.

Locations of deer were determined using an aerial photograph divided into grids equivalent to 25 m^2. Whenever deer were encountered, data on vegetative type, slope exposure, distance from escape cover (cover sufficient to conceal a standing deer from view), distance from free water (in summer), and activity patterns (standing, feeding, bedding) were collected using scan sampling procedures (Altmann 1974).

Spotlight and Track Counts

Weather permitting, monthly spotlighting transects (Progulske and Duerre 1964, McCullough 1982) were conducted on East Mesa. Transects were arranged so there was no chance of double counting deer, and the area sampled was determined by multiplying the length of the transect in each plant community by the mean distance the spotlight beam penetrated the vegetation. The area sampled for each plant community was: meadow (60.8 ha), oak (14.1 ha), pine (7.3 ha), and chaparral (13.0 ha). A more complete description of this procedure is provided by Bowyer and Bleich (1984*b*).

Track counts were conducted monthly along a 2.5-km section of East Mesa's road system. Fresh tracks were used to assess deer use of vegetative types by noting the number of tracks entering and leaving various plant communities. Meadows composed 61.0% of the area sampled, oak 22.7%, pine 10.6% and chaparral 5.7%.

Vegetation Sampling

A modification (Bowyer and Bleich 1984*b*) of the step-point method (Evans and Love 1957) was used to determine percent cover of plant species. Starting points and direction of travel were selected randomly and samples were stratified by vegetative type and season. Percent cover corresponded with the proportion of times a thin line (< 1 mm) on the toe of a boot struck a plant species. A total of 20,631 step-points were used to describe vegetative types on East Mesa.

Measures of concealment cover were made with a 1.2 m by 1.2 m board divided into 100 squares. Sample points were located with a random numbers table and grid. The board was held perpendicular to the ground and observed from a distance of 15 m from four cardinal directions at each location. If a square on the board was 50% or more covered, it was recorded as concealed; if less than 50% was covered by vegetation, it was not counted. Adequate sample sizes were determined by stabilizing means (Kershaw 1964:29); a total of 1440 samples were collected. Brush fields of chaparral were too thick to enter with a sampling board, thus data were collected on the more open periphery of these stands.

Data Analyses

Most data were analyzed using the MIDAS statistical package at the University of Michigan. The degree of kurtosis, skewness and other assumptions concerning statistical inference were evaluated and the most appropriate test applied. Statistical tests used in these analyses included the *G*-test of independence (Sokal and Rohlf 1969), Kolmogorov-Smirnov test, Mann-Whitney *U*-test, Kruskal-Wallis one-way analysis of variance, Friedman two-way analysis of variance, and Spearman rank correlation (Siegel 1956). Preference ratings were calculated according to Petrides (1975). Although differences in the total number of deer observed occurred between the first and second year of the study, no significant ($P > 0.40$) difference was found in their preferences for vegetative types. Thus, data from both years were pooled.

RESULTS

Selection of Vegetative Types

Differences in diel activities strongly influenced the use of vegetative types by southern mule deer. Deer found bedded at midday preferred stands of oak and pine over open meadows or dense brush fields of chaparral (Table 1). Deer bedded in a significantly ($G = 135.90$, $P < 0.001$, 3 *d.f.*) different pattern than would have been expected from the availability of vegetative types. All undisturbed groups encountered at midday were bedded, but their precipitous flight after detecting my presence prevented any meaningful analyses of group composition or size.

The occurrence of active (standing) mule deer in different vegetative types was assessed by direct observations, spotlight transects and track counts. All three procedures indicated deer occurred most often in meadows, followed by oak, pine, and chaparral communities (Table 2). Preference ratings for vegetative types exhibited a similar pattern; however, track counts rated oaks slightly above meadows, perhaps because this technique included the movements of deer to stands of oak where they typically bedded. Nonetheless, a Friedman

two-way analysis of variance showed no significant difference (X^2, = 2.62, $P > 0.20$, 2 *d.f.*) among the techniques used to evaluate preference. Thus, direct observation was as reliable as the other methods for evaluating habitat selection by southern mule deer.

TABLE 1. Selection of Vegetative Types of 110 Groups of Bedded Southern Mule Deer at Midday, East Mesa, Cuyamaca Rancho State Park, San Diego County, California, 1977–1979.

Vegetative Type	*N*	*% Groups*	*Preference rating*
Meadow	22	20.0	0.2
Oak	83	75.5	14.5
Pine	5	4.5	1.3
Chaparral	0	0.0	0.0

TABLE 2. Selection of Vegetative Types by Active Southern Mule Deer Observed on East Mesa, Cuyamaca Rancho State Park, San Diego County, California, 1977–1979.

	Direct Observations (N = 9,260 Deer)		*Spotlight Tranects (N = 369 Deer)*		*Track Counts (N = 522 sets of tracks)*	
Vegetative Types	*%*	*Preference Rating*	*%*	*Preference Rating*	*%*	*Preference Rating*
Meadow	94.8	1.1	85.9	2.0	77.8	1.3
Oak	3.6	0.7	8.9	0.3	16.3	1.4
Pine	1.4	0.4	4.9	0.3	5.6	0.5
Chaparral	0.2	0.1	0.3	<0.1	0.4	0.1

Direct observations indicated the distribution of 9,260 active deer differed significantly ($G = 348.86$, $P < 0.001$, 3 *d.f.*) from expected values based on the availability of vegetative types. A Friedman two-way analysis of variance indicated no significant difference (X^2, = 2.77, $P > 0.50$, 3 *d.f.*) in deer preferences for vegetative types among seasons (Table 3). Meadows generally were most preferred followed by oak, pine, and chaparral; this overall pattern of deer preference was highly significant (X^2, = 12.45, $P < 0.001$, 3 *d.f.*).

Because meadows were highly preferred, and nearly 95% of active deer were observed in this habitat, meadows were subdivided into an additional seven vegetation types (Table 4). As before, the Friedman two-way analysis of variance showed season had little influence (X^2, = 2.01, $P > 0.50$, 3 *d.f.* on the preferences of deer for these meadow types. Over all seasons, deer tended to prefer deer grass most often, followed by mustard, cheat grass, rose, wild oak, chokecherry, and buckwheat types (Table 4); this pattern was significant (X^2, = 15.62, $P < 0.02$, 6 *d.f.*).

No significant (X^2, = 1.60, $P > 0.80$, 4 *d.f.*) difference in preferences among different sex and age classes of deer occurred for meadow, oak, pine, or chaparral vegetative types (Table 5). Likewise, no significant difference was found among the preferences of deer sex and age classes for the seven meadow types (X^2, = 3.46, $P > 0.30$, 4 *d.f.*). During the fawning season in late June through early July, however, neonates exhibited a marked preference for deer grass, oak, and rose vegetative types (Figure 2). Although the sample size was small (N=26), a Kolmogorov-Smirnov test showed that young fawns were distributed in vegetative types in a significantly ($D = 0.46$, $P < 0.01$) different pattern than would have been expected from the availability of those types.

TABLE 3. Seasonal Changes in the Use of Vegetative Types by Active Southern Mule Deer Observed on East Mesa, Cuyamaca Rancho State Park, San Diego County, California, 1977–1979.

Vegetative Type	Spring (N = 1,831)		Summer (N = 2,234)		Autumn (N = 3,628)		Winter (N = 1,567)	
	%	Preference Rating	%	Preference Rating	%	Preference Rating	%	Preference Rating
Meadow	93.4	1.1	92.6	1.0	96.1	1.1	96.9	1.0
Oak	3.4	0.7	5.5	1.1	3.0	0.6	2.3	0.4
Pine	3.1	0.8	1.5	0.4	0.8	0.2	0.8	<0.1
Chaparral	0.1	<0.1	0.4	0.1	0.1	<0.1	0.0	0.0

TABLE 4. Seasonal Variation in the Use of Seven Meadow Vegetative Types by Active Southern Mule Deer Observed on East Mesa, Cuyamaca Rancho State Park, San Diego County, California, 1977–1979.

Meadow Types	Spring (N = 1,831)		Summer (N = 2,234)		Autumn (N = 3,628)		Winter (N = 1,567)	
	%	Preference Rating	%	Preference Rating	%	Preference Rating	%	Preference Rating
Cheat Grass	59.3	0.8	61.3	0.9	72.9	1.0	70.4	0.9
Deer Grass	27.0	5.4	18.7	3.7	13.3	2.7	13.4	3.6
Wild Oat	3.1	0.5	4.6	0.8	3.3	0.6	7.9	1.4
Mustard	3.2	2.8	3.3	2.9	5.2	4.6	4.0	3.1
Rose	0.7	0.7	3.2	3.0	1.0	1.0	0.0	0.0
Buckwheat	0.0	0.0	0.0	0.0	0.4	0.2	1.2	0.6
Chokecherry	0.1	0.2	1.5	3.4	0.0	0.0	0.0	0.0

TABLE 5. Selection of Vegetative Types by Different Sex and Age Classes of Southern Mule Deer Observed on East Mesa, Cuyamaca Rancho State Park, San Diego County, California, 1977–1979.

Vegetative types	*Sex and age class*									
	Buck (N = 1,388)		*Male yearling (N = 553)*		*Doe (N = 5,937)*		*Female yearling (N = 246)*		*Fawn (N = 1,110)*	
	%	*Preference rating*	%	*Preference rating*	%	*Preference rating*	%	*Preference rating*	%	*Preference rating*
MEADOW	93.5	1.1	88.4	1.0	95.7	1.1	93.5	1.1	95.1	1.1
Cheat Grass	59.7	0.8	68.4	0.9	69.9	0.9	51.0	0.7	68.6	0.9
Deer Grass	22.4	4.8	16.5	3.5	15.8	3.4	41.2	8.8	16.8	3.6
Wild Oak	5.3	0.9	3.6	0.6	3.9	0.7	3.9	0.7	3.6	0.6
Mustard	4.8	4.1	4.5	3.8	4.2	3.6	3.9	3.3	3.5	3.0
Rose	0.4	0.4	1.1	1.0	1.3	1.2	0.0	0.0	2.1	1.9
Buckwheat	0.3	0.1	0.0	0.0	0.4	0.2	0.0	0.0	0.5	0.2
Chokecherry	0.6	1.3	0.5	1.1	0.2	0.4	0.0	0.0	0.0	0.0
OAK	3.9	0.8	8.3	1.6	3.4	0.7	4.9	1.0	4.6	0.9
PINE	2.4	0.7	3.3	1.0	0.8	0.2	1.6	0.5	0.3	0.1
CHAPARRAL	0.2	0.1	0.0	0.0	0.1	<0.1	0.0	0.0	0.0	0.0

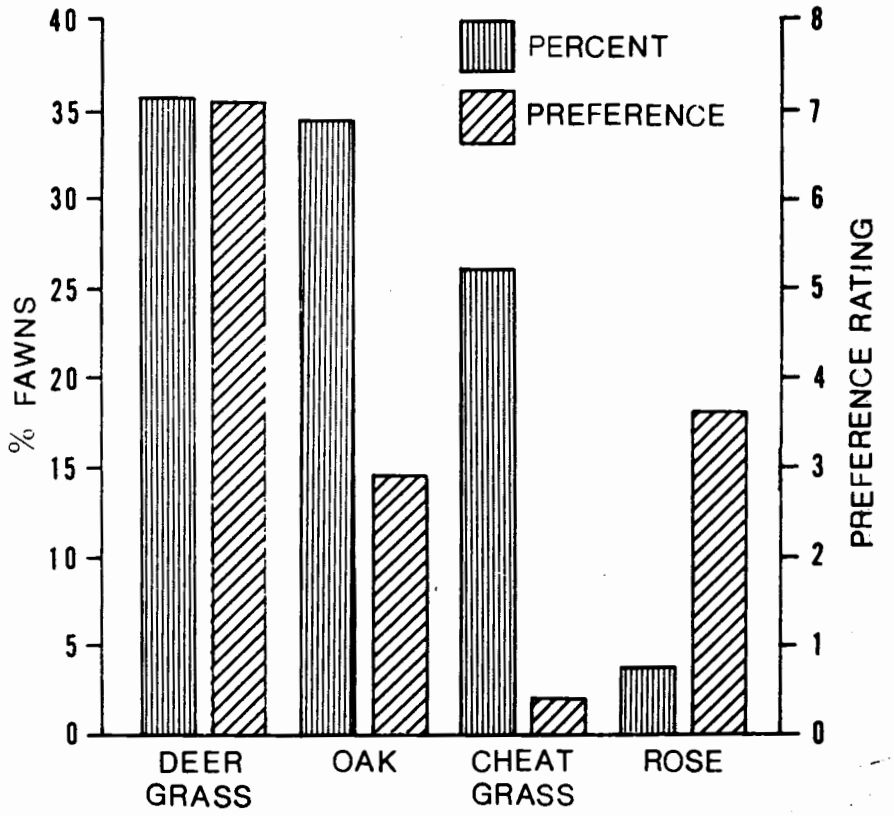

FIGURE 2. Preference and percent occurrence of 26 neonate fawns for vegetative types on East Mesa, Cuyamaca Rancho State Park, San Diego County, California during June through July.

Selection of Slope Aspect

Slope exposures on East Mesa faced predominantly east (20%) and west (31%); most deer occurred on west-facing slopes (Table 6). The occurrence of deer on all slope aspects was significantly different than if deer were distributed randomly over the study area during spring ($G = 298.80$, $P < 0.001$, 8 *d.f.*), summer ($G = 357.88$, $P < 0.0001$, 8 *d.f.*), autumn ($G = 1078.36$, $P < 0.001$, 8 *d.f.*), and winter ($G = 626.48$, $P < 0.001$, 8 *d.f.*). Deer exhibited a clear preference for west facing slopes (Table 6); no significant difference occurred among seasons in the preference of deer for various slope exposures (X^2, $= 1.97$, $P > 0.50$, 3 *d.f.*).

Concealment Cover

Chaparral provided the greatest concealment cover (100% for all seasons) of any plant community. Southern mule deer, however, consistently avoided the dense brush fields of chaparral that surrounded East Mesa. I often herded groups of deer in front of my vehicle where the road passed through chaparral. Deer typically followed the road to the next meadow or more open stand of oak or pine rather than fleeing into nearby old-growth chaparral. Pine had the next highest value for concealment cover, followed by oak and meadow plant communities (Figure 3).

TABLE 6. Seasonal Variation in Selection of Slope Exposures by Southern Mule Deer Observed on East Mesa, Cuyamaca Rancho State Park, San Diego County, California, 1977–1979.

Slope aspect	Spring (N = 1,831)		Summer (N = 2,234)		Autumn (N = 3,628)		Winter (N = 1,567)		Total (N = 9,260)	
	%	Preference rating	%	Preference rating	%	Preference rating	%	Preference rating	%	Preference rating
North	1.8	0.3	5.4	0.8	3.8	0.6	1.2	0.3	3.4	0.6
Northwest	0.5	0.4	3.5	2.5	0.6	0.4	0.7	0.7	1.3	1.0
West	52.0	1.7	54.1	1.8	64.1	2.1	70.8	2.3	60.5	2.0
Southwest	5.7	0.4	7.2	0.5	5.6	0.4	6.2	2.6	6.1	0.4
South	5.8	0.5	7.9	0.7	8.2	0.8	5.2	0.5	7.1	0.7
Southeast	7.9	0.9	2.9	0.3	2.5	0.3	3.5	0.4	3.8	0.4
East	13.4	0.6	13.7	0.7	14.2	0.7	12.5	0.6	13.6	0.7
Northeast	3.2	2.5	2.3	1.8	0.8	0.6	0.0	0.0	1.5	0.2
None	9.9	1.5	3.0	0.4	0.1	<0.1	0.0	0.0	2.7	0.4

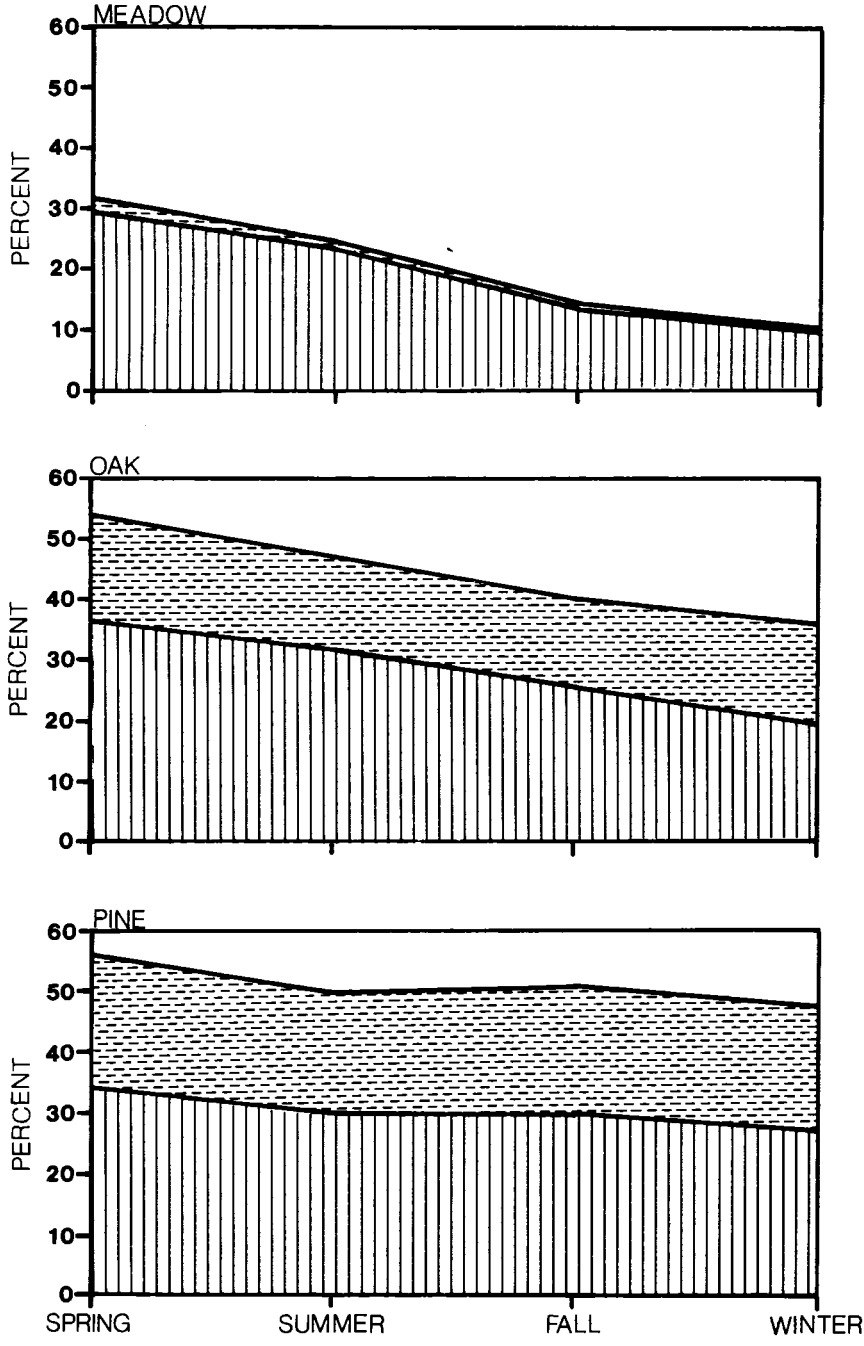

FIGURE 3. Seasonal changes in percent concealment cover of vegetative types at heights of 0–0.61 m (continuous vertical lines) and 0.61–1.22 m (broken horizontal lines) above the ground, East Mesa, Cuyamaca Rancho State Park, San Diego County, California.

Concealment cover for deer declined from spring through winter with this trend being most pronounced in meadows. Concealment cover in the predominant meadow types (Figure 4) exhibited similar seasonal patterns; deer grass furnished the greatest cover, followed by wild oat, and cheat grass types. Additionally, rose declined from 44% cover below and 5% beyond 0.61 m in height during autumn to 30% below and 1% beyond 0.61 m in winter. Buckwheat (41% within and 4% beyond 0.61 m) and chokecherry (48% below and 48% beyond 0.61 m) were sampled only during autumn.

Approximately 30–40% concealment cover at heights below 0.61 m was sufficient to hide a bedded deer; an additional 15–20% cover at heights of 0.61–1.22 m was necessary to obscure a standing deer from view.

The selection of trees or shrubs for escape cover by alarmed deer was determined by recording the plant species into which deer fled and became completely concealed from view. The use of trees and shrubs by 122 deer fleeing from predators, primarily coyote and bobcat, included *Quercus agrifolia* (43.5%), *Q. kelloggii* (12.3%), *Pinus jeffreyi* (12.3%), *Prunus virginana* (7.4%), *Rhamnus californica* (4.9%), *Salix lasiandra* (4.9%), *Sambucus caerulea* (4.9%) and *Cercocarpus betuloides* (2.5%). Alarmed deer made significantly ($G = 13.12$, $P < 0.001$, 1 *d.f.*) greater use of *Q. agrifolia* than would have been predicted by chance. Lateral branches of *Q. agrifolia* extended to ground level except in old trees, and alarmed deer often ran behind or beneath this dense cover. Although deer often concealed themselves by bedding in deer grass, they did not seek shelter in this vegetative type when pursued by predators.

The mean distance that 2,639 groups of active southern mule deer occurred from escape cover was 34.6 m (SD = 28.8 m, range = 0–300 m); 75% of all groups were found within 50 m of cover, but the highest percentage of deer was found 41–50 m from concealment cover (Figure 5). The Kruskal-Wallis one-way analysis of variance showed no significant difference ($H = 6.68$, $P > 0.05$, 3 *d.f.*) in the distances deer occurred from escape cover in spring ($\bar{X} = 33.7$ m, SD = 29.6 m), summer ($\bar{X} = 29.4$ m, SD = 22.0 m), autumn ($\bar{X} = 42.8$ m, SD = 36.3 m), or winter ($\bar{X} = 29.2$ m, SD = 21.9 m).

Because many groups contained more than one sex and age class, lone deer were used to evaluate how far active individuals in each sex and age class would venture from cover. Bucks and male yearlings were found the farthest whereas fawns occurred the closest to concealment cover (Table 7). The Mann-Whitney U – test showed significant ($P < 0.05$) differences in distances from cover for all sex and age class pairings except buck-male yearling, and doe-female yearling. The distance that fawns occurred from cover was small because neonates composed a substantial proportion of observations for lone fawns. Nonetheless, the tendency for fawns to remain closer to cover was evident for groups of two; does with fawns ($\bar{X} = 24.3$ m, SD = 19.8) occurred significantly ($P < 0.05$) nearer cover than does without them ($\bar{X} = 36.0$, SD = 22.7).

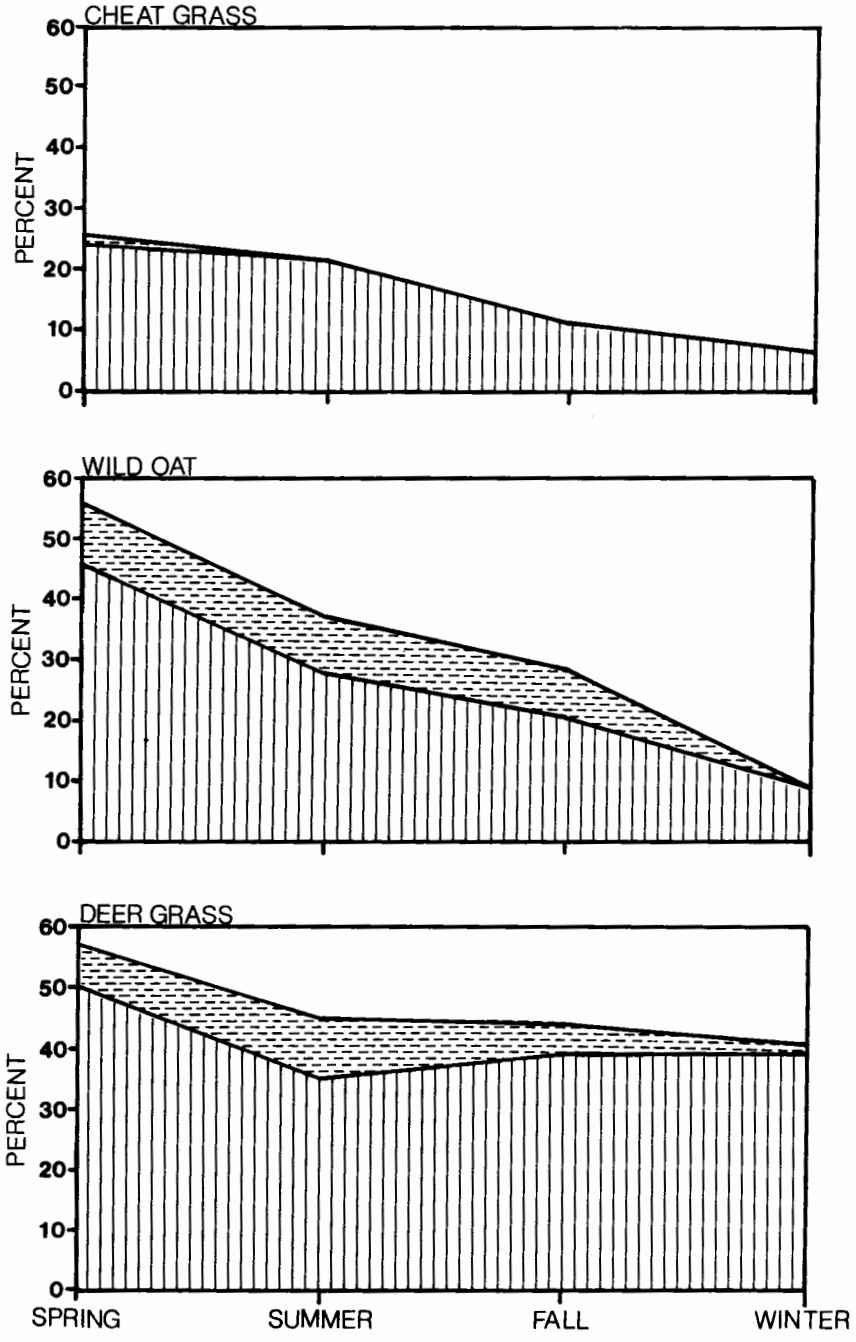

FIGURE 4. Seasonal changes in concealment cover of selected meadow types at heights of 0–0.61 m (continuous vertical lines) and 0.61–1.22 m (broken horizontal lines) above the ground, East Mesa, Cuyamaca Rancho State Park, San Diego County, California.

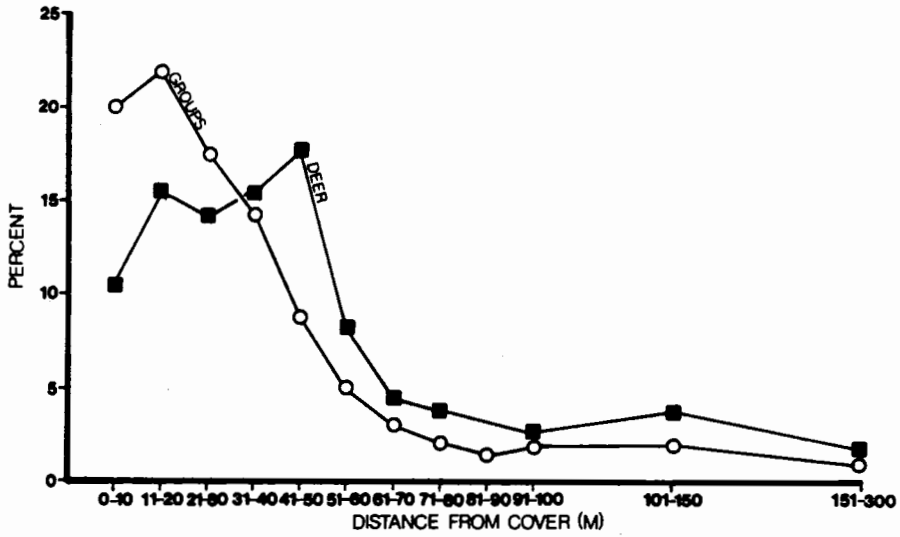

FIGURE 5. Distances 2,639 groups totaling 9,260 individual southern mule deer were observed from escape cover (cover sufficient to conceal a standing deer from view) on East Mesa, Cuyamaca Rancho State Park, San Diego County, California. 1977–1979.

TABLE 7. Sex and Age-class Differences in the Distances Lone Southern Mule Deer Were Observed from Concealment Cover on East Mesa, Cuyamaca Rancho State Park, San Diego County, California, 1977–1979.

Sex and age class	*Distance from cover (m)*			
	N	$\bar{X}$	*SD*	*Range*
Bucks	224	29.8	25.8	0–200
Male Yearlings	119	29.8	25.0	1–150
Does	554	25.0	22.7	0–150
Female Yearlings	27	25.1	19.5	1–60
Fawns	13	9.2	7.6	0–25

Free Water

During the wet portion of the year (November–April), water was readily available throughout the study area. Small creeks and seeps occurred even in areas that were exceptionally dry in summer. With the onset of drier, hotter weather in June, however, sources of water became limited and remained so until replenished by autumn rains. Of 3,053 southern mule deer observed during the dry months of June–September, 97% occurred within 1 km of free water. The mean distance deer occurred from free water during this dry period was 380 m (Bowyer 1984). Moreover, bucks occurred furthest from free water, followed by male yearlings, does, female yearlings, and fawns (Bowyer 1984).

Preferred Forage

The distribution of southern mule deer was influenced by the availability of preferred foods. Direct observations of 4,960 feeding deer indicated they ingested vegetation with herbaceous stems (grazing) more often than those with

woody stems (browsing); < 5% of all deer were observed browsing throughout the study. The importance of palatable forbs, especially *Sisymbrium altissimum,* in the ecology of southern mule deer has been substantiated previously (Bowyer and Bleich 1980, 1984*b*; Bowyer 1984). The influence of *S. altissimum* on the distribution of deer was demonstrated by significant correlations between deer density and the percent cover of this forb in each of the nine vegetative types on East Mesa, and for the eight meadow systems on East Mesa (Bowyer 1984).

DISCUSSION

Southern mule deer avoided dense stands of chaparral during periods of activity and when bedding at midday even when this vegetation was readily available. Perhaps the thick brush made it difficult for deer to elude predators. Fleeing deer never were observed to seek cover in chaparral, even when this habitat was nearby. The extensive use of oaks by alarmed deer, and the preference of bedding deer for this vegetation suggest it provided both concealment and thermal cover.

Taber and Dasmann (1958) reported that the nutritive value of shrubs in old stands of chaparral was low. Nonetheless, mule deer in northern and central California occurred at low densities even in old-growth chaparral (Taber and Dasmann 1958, Biswell 1961). This is one respect in which southern mule deer differ from other California subspecies; their use of chaparral was sporadic at best. Southern mule deer are primarily a species of meadows, oaks and pines; their morphology, including their dark pelage, is adapted to these habitats.

The most efficacious management for southern mule deer must include meadows. Nearly 95% of all active deer were observed in this vegetative type. Levels of cattle stocked on public lands in San Diego County, however, were sufficiently high to nearly eliminate southern mule deer from preferred meadow habitats outside the Park (Bowyer and Bleich 1984*b*). Moreover, heavy cattle grazing reduced the availability of deer grass (Bowyer and Bleich 1984*b*). Deer grass was used extensively by fawns for concealment cover on East Mesa. Salwasser et al. (1978) suggested that an absence of suitable fawning habitat may have increased the mortality rate of neonates in a herd of California mule deer, *O. h. californicus.*

Taber and Dasmann (1958) suggested that Columbian black-tailed deer, *O. h. columbianus,* made greater use of cooler north-facing slopes in summer and shifted their distribution to warmer southerly exposures in winter. Southern mule deer showed no significant differences in their preferences for various slope exposures among seasons. Mackie (1970) reported similar results for Rocky Mountain mule deer, *O. h. hemionus.* The preference of southern mule deer for west-facing slopes probably related to the availability of preferred forbs on westerly exposures on East Mesa.

Manipulation of chaparral has benefited mule deer in central and northern California (Biswell et al. 1952, Taber 1953, Taber and Dasmann 1958). Fire or the mechanical removal of brush produces successional changes that improve deer forage by increasing its protein content; however, such increases are temporary (Dasmann and Dasmann 1963). Modification of chaparral also may enhance habitat for southern mule deer. Bowyer (1981) reported a marked increase in deer harvested in San Diego County following the Laguna fire in 1970.

Nevertheless, the types of manipulation that will benefit southern mule deer may be more restricted than for other deer that occur at greater densities in chaparral.

The proximity of treated areas to other vegetative types preferred by southern mule deer may be a critical factor in determining the response of deer populations to alterations in old-growth chaparral. Short-lived increases in forage quality in areas with few deer will do little to promote population growth. Thus, to be effective, habitat modifications should adjoin meadow, oak, or pine vegetative types that are not heavily stocked with cattle. Further, oaks, which provided cover for bedded deer, were used to escape pursuing predators, and also provided fawning habitat. Acorns were a highly preferred food of these deer (Bowyer and Bleich 1980). The presence of *Quercus kelloggii* or *Q. agrifolia* on or near manipulated areas would improve these localities for southern mule deer.

The size of the opening produced by manipulating brushlands also may affect its use by southern mule deer. Deer made optimum use of areas 41–50 m from cover; they occurred infrequently at great distances from cover, and vast open areas are of little use to this subspecies.

The availability of free water during summer is a major factor regulating the distribution of southern mule deer. Sexual segregation in southern mule deer begins during the fawning season and then wanes with the approach of rut (Bowyer 1984). Bucks occurred predominantly on dry areas with little water, whereas does and fawns were concentrated on ranges with more succulent vegetation and some free water (Bowyer 1984). Areas farther than 1 km from free water received limited summer use by southern mule deer. Further, areas without sources of summer water typically were devoid of fawns (Bowyer 1984). Thus, habitat manipulations greater than 1 km from free water are unlikely to increase populations of southern mule deer. Clearly, an understanding of relationships among vegetation types, the foods and cover such habitats provide, the proximity of summer water, and how deer distribute themselves with respect to these variables is essential to the sound management of this important game species.

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