Desert mule deer use of grazed and ungrazed habitats

KIM E. RAGOTZKIE AND JAMES A. BAILEY

Abstract

We studied use of pastures and habitats in relation to moderate cattle grazing for 19 radio-collared desert mule deer *(Odocoileus hemionus crooki)* in a southeastern Arizona grass-shrubland. For each deer, use of grazed or ungrazed pastures and habitats in relation to their availability within the deer's home range was tested on a seasonal and annual basis. Deer, especially females during summer, tended to use currently ungrazed portions of their home range and dry wash habitats more than expected. Most deer showed a strong preference for ungrazed dry wash habitats, followed by grazed dry washes and ungrazed uplands. Although deer used grazed uplands less than expected based on availability, deer were still observed frequently in this abundant type. Deer use of currently ungrazed habitats may have been due to absence of cattle or to effects of recent cattle grazing in these habitats. During 2 years of favorable precipitation and forage conditions deer appeared to be adjusted to moderate rest-rotation cattle grazing. Leaving some areas periodically ungrazed might also provide a contingency for deer against impacts of cattle grazing during drought.

Key Words: habitat use, deer-cattle relationships, cattle grazing, semidesert grass-shrublands, *Odocoileus hemionus crooki*

The influence of cattle grazing on deer and their habitat has long interested ecologists and resource managers. Leopold noted the interdependence of game and livestock management in 1928 (Flader 1974:28). The subject has been reviewed by Urness (1976), Mackie (1981), and Severson and Medina (1983). Biologists have reported effects of cattle grazing on deer and their habitat (Bowyer and Bleich 1984, Austin and Urness 1986, Loft et al. 1987, Wallace and Krausman 1987), on deer abundance (McCulloch 1955), and on survival of deer fawns (Horejsi 1982). Except where ranges have been extremely overgrazed, there are few generalizations regarding functional interactions between cattle grazing and deer. Observed relationships have varied with site, season, livestock management practices, and species of deer.

Desert mule deer have been adjusting to the presence of cattle since before 1700 (Wagoner 1952). Cattle grazing contributed to the mesquite *(Prosopis juliflora)* invasion of desert grasslands (Humphrey 1958). Many of these areas may be more suitable for mule deer today than 100 years ago (Urness 1976).

We investigated desert mule deer use of grazed and ungrazed pastures in a semidesert grass-shrub range in southeast Arizona. Objectives were to determine if deer used (1) grazed and ungrazed pastures, (2) habitats, and (3) grazed and ungrazed habitats in proportion to their availabilities within deer home ranges.

Study Area

Research was conducted on the 20,250-ha Santa Rita Experimental Range (SRER), southeast of Tucson, Ariz. At the time of the study the SRER was administered by the U.S. Forest Service. Elevations range from 884 m on the west to 1,372 m where the SRER abuts the Santa Rita Mountains to the east. Most of the Range is a gently sloping alluvial fan cut by numerous dry washes. Precipitation increases with elevation and averages 375 mm annually, more than half occurring July through September. Precipitation was above average during this study (+64%, 1984; +35%, 1985). Mean monthly temperatures range from 10° C in January to 26° C in July, with occasional highs above 35° C in summer.

Vegetation is characterized by a mesquite *(Prosopis juliflora)* overstory, numerous shrubs and cacti, and perennial grasses. Predominant deer habitats are upland mesquite grass-shrublands (UMGS) and dry washes, comprising 60% and 29% of the SRER, respectively. Upland mesquite habitats have a relatively open canopy of mesquite trees. Burroweed *(Haplopappus tenuisectus)* is the most common shrub and Lehmann lovegrass *(Eragrostis lehmanniana)* is the principal herbaceous species. Woody vegetation, especially mesquite and catclaw acacia *(Acacia greggii)* tend to be dense along dry washes, where there is also a greater diversity of plant species. The remaining 11% of the Range consists of slope habitats (5%), open grasslands (4%), and stands of creosote-bush *(Larrea tridentata)* (2%). The SRER and its mule deer habitats were described by Martin and Reynolds (1973), and by Ragotzkie (1988), respectively.

Cattle (primarily Herefords) grazed about 60% of the Range at any time. Pastures were grazed yearlong or on a 3-pasture rest-rotation basis. Under the Santa Rita Grazing System (Martin 1978), rotation pastures were rested 12 months prior to each 4–8 month grazing period. Blocks of 3 rotation pastures and 1 yearlong pasture were located at low, middle, and high elevation areas of the SRER. At the time of this study, the Santa Rita Grazing System had been in effect for 12 years (Martin and Severson 1988). One pasture was never grazed during this study. Stocking levels were moderate (5–60 ha/AU), with the higher elevation/precipitation areas being stocked most heavily. Cattle in the rotation pastures were moved during March and again in early November.

Methods

Nineteen radio-collared desert mule deer (10 females, 9 males) were visually observed during daylight hours in a predetermined sequence over 2 years (April 1984–March 1986). Reobservations of each deer were separated by about 1 week to minimize autocorrelation of the data (Swihart and Slade 1985). Four deer were alive with functioning transmitters for 24 months, while 11 additional deer were alive during a 13-month period. All 19 deer were alive with functioning transmitters during a 3-month period. Attempts to locate a deer were abandoned for the day if the deer moved in response to the observer. Remote telemetric locations were obtained at night, but those data were too imprecise for these analyses (Ragotzkie 1988). For each observation, location, habitat, and pasture were noted.

Because deer, especially females are social and do not move independently (Geist 1981), validity of inferences from radio-collared deer to the population on the SRER depended upon independence of deer when captured. Deer were captured separately from a helicopter with a net gun in 2 periods >1 year apart. Locations of radio-collared deer were not used to locate additional deer for capture.

The home range of each radio-collared deer was plotted using the minimum convex polygon method (Mohr 1947). Average

Ragotzkie is former graduate student, Bailey professor, Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins 80523. Ragotzkie is currently wildlife biologist, U.S. Forest Service, Clearwater National Forest, Powell Ranger Station, Lolo, Montana 59847.

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home-range size was 1,240 ± 401 (SD) ha for females, and 3,868 ± 2,981 (SD) ha for males. Deer habitats on the SRER were mapped, and the area of each habitat within each pasture and within a deer's home range was calculated. All habitats and pasture areas were considered available to a deer if within its home range. The implications of this assumption have been discussed by Johnson (1980). Availabilities of grazed or ungrazed pastures and habitats changed whenever cattle were moved, usually twice yearly.

Use of pastures and habitats was analyzed separately for each deer, and variation among deer was used to evaluate trends. Observations were analyzed yearlong and for each of 3 seasons: dry summer (April–June), wet summer (July–October), and winter (November–March). Data subsets with 1 deer during 1 season (a deer-season) were the primary analysis units. In these analyses, only current grazing status was considered. Past grazing treatment and grazing system (yearlong or rest-rotation) were not incorporated.

For each of 54 deer-seasons and 19 deer-years, deer use of grazed and ungrazed pastures was analyzed with goodness-of-fit procedures (Zar 1984). Seasonal analyses were not done if there were <5 observations for a deer-season, thus 3 deer-seasons were discarded. Relative pasture availability within the deer's home range determined expected frequencies of observations. It was assumed that missing observations were distributed the same as observations used in these analyses. Deer use of pastures and habitats was not thought to be related to missing observations, therefore the use of goodness-of-fit procedures was reasonable. Use of habitats, regardless of grazing status, was similarly tested. Each deer had 2–4 habitats within its home range. Habitats comprising <5% of a deer's home range were combined with the relatively diverse UMGS type. Lastly, habitats in grazed and ungrazed pastures were treated as different, and goodness-of-fit tests were used to evalaute whether deer used grazed and ungrazed habitats in proportion to availabilities. Contingency tables were used to assess interdependence of deer use of habitats with deer use of grazed or ungrazed pastures. All statistical tests were conducted at an alpha level of 0.05. These significance levels apply to single tests of a deer-season or a deer-year.

Radio-collared deer were observed 1,201 times. Number of observations per deer ranged from 22–107 ($\bar{x}$ = 64). Only 1,189 observations were available for analyses of habitat use as we were able to determine use of a pasture but not a habitat for 12 observations. On 115 occasions, ≥2 radio-collared deer were observed in a group (22.5% of deer observations). Nevertheless, as deer were captured independently, and patterns of pasture and habitat use were different among several of the more frequently associated deer, all data were retained for analysis.

Results

Grazed and Ungrazed Pastures

Based on 54 deer-seasons, deer tended to use the currently ungrazed portions of their home ranges (Table 1). In 37 of the 54 deer-seasons (69%), deer used ungrazed pastures more than expected, compared to an expected 27 deer-seasons (50%) under the null hypothesis. Deer used ungrazed pastures significantly (P<0.05) more than expected in 13 of the 54 deer-season (24%). Grazed pastures were used significantly more than expected in only 1 deer-season. The tendency to prefer ungrazed pastures was consistent across 3 seasons for females and across 2 summer seasons for males (Table 1). At 1 season or another, 8 different deer used ungrazed pastures significantly more often than expected. When tested on a yearlong basis, 14 deer selected ungrazed pastures more than expected, significantly more for 7 of these deer.

Habitats

On a yearlong basis, 12 of 19 deer used habitats within their home ranges different (P<0.05) from expected based on availabilities of types (Table 2). Significant differences were more frequent among females than among males. These differences were primarily due to consistently greater use of dry wash habitats (Table 2) and less use of UMGS habitats.

Table 1. Use of ungrazed pastures by radio-collared desert mule deer on the Santa Rita Experimental Range, 1984–86. Observations of deer are compared to expected frequencies based on pasture availabilities within deer home ranges.

	Females			Males		
		Percent using ungrazed pastures			Percent using ungrazed pastures	
Season	No. deer[a]	Signif. >avail.[b]	>Avail.[c]	No. deer[a]	Signif. >avail.[b]	>Avail.[c]
Dry summer	10	30	80	8	13	63
Wet summer	10	10	80	8	38	75
Winter	10	30	70	8	25	38
Yearlong	10	30	80	9	44	67

[a]Number of observations/deer/season ranged from 5–49 ($\bar{x}$ = 22.3), and for yearlong from 22–107 ($\bar{x}$ = 63.6).
[b]Percent of deer using ungrazed pastures significantly more (P<0.05) than expected, based on goodness-of-fit tests. Under the null hypothesis, these values are expected to be 5%.
[c]Percent of deer using ungrazed pastures more than expected, regardless of statistical significance. Under the null hypothesis, these values are expected to be 50%.

Table 2. Use of habitat types by radio-collared desert mule deer on the Santa Rita Experimental Range, 1984–86. Observations of deer are compared to expected frequencies based on habitat availabilities within deer home ranges.

	Females			Males		
		All types	Dry washes		All types	Dry washes
Season	No. deer[a]	Use ≠ avail. (%)[b]	Use > avail.(%)[c]	No. deer[a]	Use ≠ avail.(%)[b]	Use > avail.(%)[c]
Dry summer	10	60	100	8	25	75
Wet summer	10	30	100	8	0	88
Winter	10	60	80	8	0	75
Yearlong	10	90	100	9	33	100

[a]Number of observations/deer/season ranged from 5–49 ($\bar{x}$ = 21.9), and for yearlong from 22–107 ($\bar{x}$ = 62.6).
[b]Percent of deer for which goodness-of-fit tests indicated significant (P<0.05) differences between observed and expected use of habitat types. Under the null hypothesis, these values are expected to be 5%.
[c]Percent of deer using dry washes more often than expected, regardless of statistical significance. Under the null hypothesis, these values are expected to be 50%.

Females tended to be less selective of habitats during wet summer, which is the season of fawning and of most forage growth. Yearlong, with larger samples from combining across seasons, 9 of 10 females used habitats significantly different from expected (Table 2). Although all radio-collared males were sexually mature and were often found with females during the winter rut, males were not as selective for habitats as were females at that time. As with females, patterns of habitat use by males were more discernible with larger samples attained by pooling data on a yearlong basis.

Open grassland habitats, which comprised up to 24% of 5 doe home ranges, were always used less than expected based on availability. Slope habitats, available in 8 deer home ranges, were used in proportion to availability or somewhat more. Creosote-bush habitats were used occasionally but were too uncommon in deer home ranges to draw inferences regarding deer preference.

Grazed and Ungrazed Habitats

Concurrent tendencies of deer to select for ungrazed pastures (Table 1) and dry wash habitats (Table 2) suggest that deer may select grazed and ungrazed habitats differently. Thus when habi-

Table 3. Use of grazed and ungrazed habitat types by radio-collared desert mule deer on the Santa Rita Experimental Range, 1984–86. Observations of deer are compared to expected frequencies based on grazed and ungrazed habitat availabilities within deer home ranges.

	Females				Males			
		All types	Ungrazed washes	Grazed UMGS[a]		All types	Ungrazed washes	Grazed UMGS[a]
Season	No. deer[b]	Use ≠ avail(%)[c]	Use > avail(%)[d]	Use < avail(%)[e]	No. deer[b]	Use ≠ avail(%)[c]	Use > avail(%)[d]	Use < avail(%)[e]
Dry summer	10	70	90	80	8	25	75	88
Wet summer	10	50	100	100	8	25	75	88
Winter	10	40	90	90	8	38	88	50
Yearlong	10	90	100	90	9	44	89	89

[a]UMGS = Upland mesquite grass-shrub habitat.
[b]Number of observations/deer/season ranged from 5–49 ($\bar{x}$ = 21.9), and per year from 22–107 ($\bar{x}$ = 62.6).
[c]Percent of deer for which goodness-of-fit tests indicated significant ($P<0.05$) differences between observed and expected use among grazed and ungrazed habitats.
[d]Percent of deer using ungrazed dry wash habitats more than expected, regardless of statistical significance. Under the null hypothesis, these values are expected to be 50%.
[e]Percent of deer using grazed UMGS habitats less than expected, regardless of statistical significance. Under the null hypothesis, these values are expected to be 50%.

tats were partitioned into grazed and ungrazed types, 9 females and 4 males used these types significantly differently from expected based on availabilites (Table 3). Significant differences were most frequent among females, especially during dry summer.

The tendency for deer to use dry wash habitats more than expected was strongest in ungrazed pastures. Conversely, the tendency for deer to use UMGS habitats less than expected was more pronounced in grazed pastures. The general pattern is illustrated by pooling observed and expected numbers of observations across all deer and seasons (Fig. 1). Although grazed UMGS habitats were used far less than expected, the most observations were in this

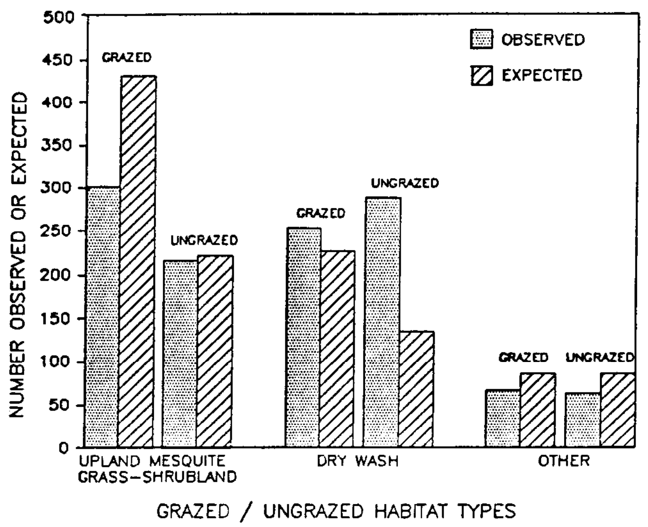

Fig. 1. Observed and expected frequencies of observations of desert mule deer in grazed and ungrazed habitat types on the Santa Rita Experimental Range, 1984–86. Observations, and expected values based on habitat availabilities within home ranges, are pooled across 3 seasons and 19 deer, with 22–107 observations per deer ($\bar{x}$ = 62.6).

abundant habitat. Based on contingency table analyses, a significant interaction between selection for pasture grazing status and habitat was indicated in only 6 of 54 deer-seasons (11%).

Deer occupied the same home-range areas yearlong, though use of areas within a home range varied seasonally and with changes in the distribution of cattle among pastures. Inspection of maps with plots of observed locations of each deer revealed areas of concentrated use within home ranges. For 9 of 10 females, these areas were located in pastures grazed on rotation schedule and grazed only 1 of the 2 summers. When this pasture (not the same pasture for all 9) was not grazed, use was concentrated in this pasture. During the grazed summer, use was more dispersed into adjacent pastures which were either currently ungrazed or grazed on a yearlong basis. However, deer did not abandon currently grazed rotation pastures. For males, movements within home ranges appeared to be more related to winter rut than to changes in grazing status. There was no apparent influx of deer into a pasture excluded from grazing the entire study period. Many radio-collared deer had home ranges incorporating portions of this pasture, but none displayed a strong preference for it.

Discussion

This study was done during a period of unusually high precipitation on the SRER. Forage was abundant and cattle likely consumed less than the recommended 40% of grass production (pers. comm., S.C. Martin, Univ. Ariz., Tucson). These conditions could influence deer responses to cattle grazing. Our results cannot be extrapolated to drought conditions.

The availability and location of water did not appear to influence deer distribution on the SRER, as it has elsewhere in the arid Southwest (Hervert and Krausman 1986). Livestock water tanks were well dispersed over the SRER and most were kept full yearround. Within deer home ranges, few areas were >1 km from water.

We found that, while deer used grazed pastures, they preferred ungrazed pastures (Table 1). Deer preference for ungrazed pastures may have been due to avoidance of cattle or a more attractive forage base in ungrazed pastures. The importance of each of these possibilities remains unclear.

Our observations suggested that direct interference competition was minimal, as only one incident of direct interaction between deer and cattle was observed. Competition for forage may also have been minimal during this study, as forage was abundant due to moisture conditions. Deer and cattle diets have little overlap in many regions (Mackie 1970, Currie et al. 1977), although Short (1977) felt that a potential for dietary overlap exists on the SRER when cattle use browse during drought.

Cattle grazing may enhance forage availability to deer. Willms et al. (1979) reported increased spring deer use of a pasture grazed the previous fall. On 2 adjacent ungrazed pastues in central Arizona, Wallace and Krausman (1987) found higher deer densities in the pasture that was grazed the previous year. White-tailed deer *(O. virginianus)* have also preferred recently grazed pastures (Gavin et al. 1984).

Preference of deer on the SRER for dry washes (Table 2) is supported by other studies of desert mule deer (Rodgers et al. 1978, Krausman et al. 1985). These "xeroriparian" habitats provide thermal cover during summer and have an abundance of shrubs palatable to deer (Short 1977). Deer use of riparian habitats, even when grazed by cattle, was also reported by Loft et al. (1986) in

California. Upland mesquite habitats also provided food and cover for deer, but in a more dispersed arrangement. On the SRER, the only habitat avoided by deer was the Lehmann lovegrass-dominated open grassland, a tendency previously suggested by Germano et al. (1983). Longhurst et al. (1977) noted that monotypic habitats generally do not attract deer.

Dry summer is the season of greatest stress for desert mule deer (Anthony 1976). Although some shrubs are flowering and developing new foliage, most plants are dormant at this time. In addition, female deer are experiencing nutritional demands of late gestation. These stresses could create an increased degree of habitat selection among female deer. Generally, this occurred on the SRER, as the greatest number of statistically significant patterns of habitat selection (Tables 1-3) occurred in dry summer.

Male deer on the SRER showed less consistent selection for habitats or pastures than did females (Tables 1-3). Female deer are probably more exacting in their requirements for habitat due to the forage and cover needs generated by pregnancy, lactation, caring for fawns, and living in larger groups. Ordway and Krausman (1986) also reported differential patterns of habitat use by male and female desert mule deer.

Although deer on the SRER used grazed and ungrazed habitats differently, tending to favor ungrazed dry washes, there was no indication that moderate cattle grazing negatively impacted the deer. Fawning success was at least average both years of this study (Ragotzkie 1988). In semidesert environments, deer populations are dependent on precipitation and forage production (Swank 1958, Short 1979, Smith and LeCount 1979). Impacts of drought, not observed in this study, would be compounded if both deer and cattle were dependent on the same limited forage base. We recommend that some areas be left periodically ungrazed, as they were on the SRER, as a contingency for deer against possible impacts of cattle grazing during drought.

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