

EFFECTS OF CATTLE GRAZING ON SELECTED HABITATS OF SOUTHERN MULE DEER ¹

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Comparisons of cattle ranges and areas without cattle were made from May-August 1979 in montane regions of San Diego County, California. Spotlight transects found significantly fewer southern mule deer, *Odocoileus hemionus fuliginatus*, in meadows where cattle grazing occurred than in similar areas where cattle were prohibited. Deer pellet groups were found significantly more often on ranges without cattle than on ranges with them. Vegetative sampling indicated that total cover of plants was significantly greater in meadows where cattle were absent. The diet of cattle substantially overlapped that of deer. Three important deer forage species were absent from cattle ranges, and others present exhibited significantly more use than in meadows without cattle. Cattle grazing also may limit deer numbers by reducing dense patches of *Muhlenbergia rigens* used for cover during the fawning period.

INTRODUCTION

The importance of competition between mule deer, *Odocoileus hemionus*, and cattle has been the subject of considerable debate (Urness 1976). Many authors have contended that only slight competition occurred (Stoddart and Rasmussen 1945; Julander 1955; Swank 1958; Skovlin, Edgerton, and Harris 1968), whereas others reported considerable overlap in the diet of these herbivores (Dixon 1934, Martinson 1960, Tueller and Monroe 1975). Overlap in forage preference may be unimportant on lightly-stocked cattle ranges (Leopold *et al.* 1951, Mackie 1970, Dusek 1975), but heavy cattle grazing has the potential to adversely affect deer populations (Longhurst, Leopold, and Dasman 1952; Mackie 1981). However, as Mackie (1976) noted, quantitative data necessary to assess the effects of competition between cattle and deer often are lacking.

Subjective observations made along roadways from 1977-1979 and during a helicopter flight in spring 1979 revealed a conspicuous absence of nonmigratory southern mule deer, *O. h. fuliginatus*, on cattle ranges in montane San Diego County, California, but deer were plentiful on nearby areas without cattle. Thus, a quantitative investigation of similar deer and cattle ranges was undertaken during late spring to mid-summer (May-Aug.) to test for differences in forage utilization on these areas and to compare the number of deer found on each type of range.

STUDY AREA

Four natural meadows in the Laguna and Cuyamaca Mountains were selected

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as typical cattle ranges. Seven similar meadows within Cuyamaca Rancho State Park were chosen as representative areas without cattle. Two meadow systems where cattle were pastured adjoined Park land, and none were more than 20 km from the Park. Elevations of the meadows ranged from 1400–1670 m. Soils were alluvial sandy loams derived from schist parent materials (Oberbauer 1978). The mean annual temperature at 1418 m in the Park was 12°C; annual precipitation averaged 88 cm (Bowyer 1981).

Meadows were characterized by annual grasses and forbs, including *Bromus tectorum*; *B. diandrus*, *Avena barbata*, *Festuca octoflora*, *Erodium cicutarium*, *Ambrosia psilostachya*, and *Eriogonum gracile*. Oberbauer (1978) and Bowyer and Bleich (1980) provide a more complete description of meadows and surrounding vegetative types of this area. Longhurst *et al.* (1952) rated cattle ranges in this area as "overgrazed," and based on vegetative and soil conditions we rated them as poor. Public hunting was prohibited on all areas, but some cattle ranges may have been hunted by private landowners.

METHODS

Standardized spotlight transects (Progulske and Duerre 1964, McCullough 1982) were conducted from sundown to 0100 hours PST during June–August 1979 on cattle ranges and similar areas without cattle to determine deer use. The time at which a given meadow was spotlighted was rotated with each sampling effort to help neutralize the influence of temporal changes in deer and cattle activity patterns on estimates of animal abundance.

A modification of the step-point method (Evens and Love 1957) was used to sample percent cover and percent relative frequency of meadow vegetation during June 1979. Starting points were selected using a random numbers table and grid; initial direction of travel was determined by flipping a coin twice, and transects were aligned with a compass. The distance between step-points was five paces (approximately 4 m), and transects were located 20 paces (approximately 16 m) apart. Biases from foot placement were avoided by having samplers keep their eyes on the horizon and not look downward until their foot was in place for each sample. Personal errors in point sampling are only important in tall vegetation (Kershaw 1964). This problem was not important on our study areas because forbs and grasses were typically low-growing. To reduce sampling time, a line drawn on the toe of a boot was used in place of a pin. One drawback to point sampling is that estimates of abundance are exaggerated as pin diameter is increased (Kershaw 1964). We minimized this bias by using a thin line (< 1 mm). Percent cover was determined by noticing the first portion of a plant "hit" by this thin line on the boot. Frequency was tabulated only for those "hits" that struck the base of herbaceous plants. Where absolute measures of cover are required, an optical cross-wire apparatus must be used (Kershaw 1964). However, as long as size is held constant, small points provide reliable estimates of abundance for comparisons between areas (Kershaw 1964).

Deer and cattle utilization of meadow vegetation was determined by estimating the amount of forage available on a given plant and noting the actual number of "bites" already removed (Mackie 1970). Wallmo *et al.* (1979) found that hand-plucked samples of simulated "bites" varied little from relative intake based on measurements of bites removed by feeding deer. Each plant "hit" by a step-point was examined for animal use, thereby providing an estimate of the

percent of total plants utilized as well as the percent of each plant removed. The only forage species counted were those that showed utilization by cattle and deer. Those not used were designated "other species".

Wallmo *et al.* (1973) reported that feeding-site inspections did not produce appreciably different estimates from bites removed by grazing deer for frequently occurring forage species, but that the use of less common plants was estimated poorly. They also suggested the most important source of error in their sampling was the inability to distribute their feeding-site sample plots in a proper relationship to the distribution of deer grazing. This may have occurred because samplers followed arbitrarily chosen deer trails within an enclosure and located a 30 × 30 cm plot at three pace intervals. This design clearly will not provide random samples and, by their own admission, inadequate sample sizes probably resulted in errors for some species. A major source of error in their data came from rare shrubs with uneven distributions. Another factor not discussed was the selection of quadrat size, which is known to have a profound influence on frequency data (Kershaw 1964).

Fortunately, herbaceous meadow vegetation on our study areas exhibited a relatively even distribution when compared with shrubs that resulted in errors in other data sets (Wallmo *et al.* 1973). Samples were collected only in mesic portions of meadows. We overcame problems of distribution by randomized sampling, and errors associated with quadrat size were avoided by plotless step-point samples. Adequate sample sizes were insured for forage species in each meadow by stabilizing their means (Kershaw 1964).

It was not possible to distinguish between grazing by cattle and deer on cattle ranges. However, deer occurred on these ranges so infrequently that this source of error was minimal. Although our estimates of forage removal by deer and cattle may vary from actual amounts removed by grazing animals, they do provide a standardized methodology for a relative comparison of different ranges.

Forage preference ratings were calculated in the manner described by Petrides (1975). Additionally, a record of the number of deer pellet groups encountered during vegetation sampling was used as a relative index to the abundance of deer. A two-sample Z-test for proportions was used to compare frequency data, and a t-test was used for comparing means (Remington and Schork 1970).

RESULTS

One hundred seventy one ha of cattle range from four meadow systems and 233 ha from seven meadows without cattle were spotlighted between four and six times each. Three deer and 166 cattle were found on cattle ranges, whereas 212 deer were tallied during spotlight counts of meadows where cattle were prohibited. Mean densities of two deer ($SD = 1$, range = 0–12) and 97 cattle ($SD = 69$, range = 0–684) per 100 ha were found for cattle ranges, while a mean of 22 deer ($SD = 10$, range = 0–217) per 100 ha occurred on areas without cattle. A significant difference existed between the mean number of deer in meadows where cattle grazing was permitted and meadows where it was not ($t = 8.89$, $P < 0.001$, 53 d.f.). Deer pellet groups were significantly less frequent ($Z = 14.04$, $P < 0.001$, 1 d.f.) on cattle ranges ($N = 3$) than on areas without cattle ($N = 205$).

Twelve hundred sixty three plants were examined for signs of utilization on

cattle ranges, and 2434 plants were inspected on meadows without cattle. Either percent cover or percent relative frequency for deer forage species was significantly lower on cattle ranges than on meadows where cattle were absent (Table 1). Summations of percent cover ($Z = 11.88$, $P < 0.001$, 1 d.f.) and percent relative frequency ($Z = 15.36$, $P < 0.001$, 1 d.f.) of deer forage species were significantly greater on areas without cattle. Additionally, total percent cover and frequency were lower on cattle ranges than on areas without cattle (Table 1). A 50% overlap occurred in the plant species utilized by deer and cattle in meadows. Three forbs important in the diet of deer (*Gilia caruifolia*, *Lactuca serriola*, and *Sisymbrium altissimum*) were absent from cattle ranges and may have been eliminated by grazing. If this was the case, the diet of cattle overlapped that of deer by 100%. Additionally, a significantly greater percentage of all *Erodium cicutarium*, an important forage species for both deer and cattle, and a larger proportion of each plant were utilized on cattle ranges than on areas without cattle (Table 1).

TABLE 1. Percent Cover, Relative Frequency, and Utilization of Forage Plants in Mountain Meadows With and Without Cattle in San Diego County, California, June, 1979. S = $P < .05$ (Z-test).

Deer Forage Species	Percent cover			Percent relative frequency			Percent of each species showing utilization			Percent of each plant utilized		
	With cattle	Without cattle	P	With cattle	Without cattle	P	With cattle	Without cattle	P	With cattle	Without cattle	P
<i>Bromus tectorum</i>	9.7	19.7	S	1.0	7.6	S	1.1	0.2		35.7	<0.1	S
<i>Corethrogyne filaginifolia</i>	0.6	1.7	S	0.2	1.0	S	6.7	1.2		33.3	15.0	
<i>Erodium cicutarium</i>	6.3	6.8		0.7	2.7	S	32.4	14.9	S	43.3	21.2	S
<i>Gilia caruifolia</i>	0.0	0.3	S	0.0	0.1		0.0	18.2		0.0	58.3	S
<i>Lactuca serriola</i>	0.0	0.5	S	0.0	0.2	S	0.0	4.8		0.0	8.3	
<i>Sisymbrium altissimum</i>	0.0	2.2	S	0.0	0.8	S	0.0	39.6	S	0.0	47.6	S
Subtotal	16.62	31.2		1.9	12.4							
Cattle												
Forage Species												
<i>Astragalus</i> sp.	0.8	<0.1	S	0.1	<0.1		12.5			40.0		S
<i>Carex</i> sp.	1.2	1.2		0.3	0.3		24.0		S	57.0		S
<i>Ranunculus</i> sp.	0.5	0.0	S	<0.1	0.0		11.1			11.8		
<i>Sidalcea malvaeflora</i>	1.6	0.2	S	<0.1	0.1		32.1		S	25.7		S
Subtotal	4.1	1.4		0.6	0.5							
Other Species	52.4	47.8		24.3	24.0							
No Vegetation	26.9	19.5	S	73.2	63.1							
Total	100.0	100.0		100.0	100.0							
N	1728	3024		1728	3024		1263	2434		1263	2434	

Some variation in cover and frequency of forage species between areas with and without cattle may be a function of site factors rather than cattle grazing. However, results of vegetative sampling from a single meadow, divided into grazed and ungrazed portions by a 4-strand fence (Table 2), showed that the same three species important as forage for deer were absent from cattle range, and that the cover and relative frequency of *Bromus tectorum* and *E. cicutarium* were significantly lower on cattle range than on areas without cattle. Additionally, deer pellet groups occurred more frequently on the portion of this meadow

without cattle than on the portion where cattle grazing was permitted ($Z = 4.38$, $P < 0.001$, 1 d.f.).

TABLE 2. Differences in Composition of Deer Forage Species on the Same Meadow Divided into Areas With and Without Cattle by a Fence, San Diego, County, California, June 1979. $S = P < .05$ (Z-test).

Plant species	Percent cover			Percent relative Frequency		
	With Cattle	Without Cattle	P	With Cattle	Without Cattle	P
<i>Bromus tectorum</i>	6.0	22.0	S	0.9	5.8	S
<i>Corethrogyne filaginifolia</i>	1.9	0.9		0.9	0.9	
<i>Erodium cicutarium</i>	0.5	7.2	S	<0.1	2.1	S
<i>Gilia caruifolia</i>	0.0	1.6	S	0.0	0.2	
<i>Lactuca serriola</i>	0.0	0.9	S	0.0	0.5	
<i>Sisymbrium altissimum</i>	0.0	2.2	S	0.0	0.8	
Other Species	61.0	37.2	S	21.6	14.5	S
No Vegetation.....	30.6	28.0		76.6	75.2	
N.....	432	432		432	432	

Quantitative ratings of forage preference and importance (Table 3) indicated *Carex* sp. received the highest preference rating for cattle while *G. caruifolia* and *S. altissimum* were highly preferred by deer. Species with preference ratings above 1.00 were those sought by deer or cattle as forage; those with ratings below 1.00 were avoided (Petrides 1975). *S. altissimum* and *E. cicutarium* received high importance ratings for deer in areas without cattle, whereas *E. cicutarium*, *Carex* sp., and *Sidalcea malvaeflora* were the most important forage species on cattle range. The absence of *S. altissimum* from cattle ranges, combined with the heavy use of *E. cicutarium* on these areas, may explain the low use of cattle ranges by deer.

DISCUSSION

Extremely low densities of southern mule deer on ranges where cattle were pastured in spring and summer, and an abundance of deer on similar ranges without cattle, suggest that cattle use of mountain meadows may limit deer numbers. One explanation of this phenomenon is that cattle grazing reduced or eliminated important forage species for deer. The absence of three forbs preferred by deer, and heavy utilization of *E. cicutarium* on cattle ranges, support this contention (Tables 1-3).

Although mule deer often are thought of as browsers, they require succulent forage for optimum growth and productivity, especially during spring (Short 1981). Visual evidence of heavy cattle grazing on succulents in meadows and riparian zones is apparent throughout the Laguna and Cuyamaca mountains. The same observation was made over 30 years ago (Longhurst *et al.* 1952).

Cattle may limit deer populations by means other than direct competition for food. Photographs documenting cattle grazing in Cuyamaca Rancho State Park in the mid-1950's indicated that stands of *Muhlenbergia rigens*, used by deer for concealment were badly damaged, but recovered once cattle were removed and further cattle use prohibited (Bowyer and Bleich 1980). Parturient does and newborn fawns were found consistently in and around tall (1-1.5 m) stands of *M. rigens* during June and July (Bowyer and Bleich 1980). Dense stands of *M.*

TABLE 3. Utilization, Preference Rating, and Importance Rating for Forage Plants in Mountain Meadows With and Without Cattle, San Diego County, California, June 1979.

Plant species	Cattle ranges				Ranges without cattle				Importance rating ⁴
	% of species removed ¹	% of each species removed as related to all species removed	% of each species available as related to all species available	Preference rating ³	% of species removed ¹	% of each species removed as related to all species removed	% of each species available as related to all species available	Preference rating ³	
<i>Astragalus</i> sp.....	5.00	10.9	3.9	2.79	0.00	0.0	0.02	0.00	0.00
<i>Bromus tectorum</i>	0.39	0.9	46.9	0.02	0.03	0.1	60.42	0.01	0.59
<i>Carex</i> sp.	13.68	30.0	5.8	5.17	0.00	0.0	3.68	0.00	0.00
<i>Corethrogyne filaginifolia</i>	2.23	4.9	2.9	1.69	0.18	0.6	5.21	0.12	0.31
<i>Erodium cicutarium</i>	14.81	32.4	30.4	1.07	3.16	9.5	20.86	0.46	21.49
<i>Gilia carubolia</i>	-	-	-	-	10.61	31.9	0.92	34.67	3.18
<i>Lactuca serriola</i>	-	-	-	-	0.40	1.2	1.53	0.78	0.20
<i>Ranunculus</i> sp.	1.31	2.9	2.4	1.21	-	-	-	-	-
<i>Sidaea malvaeflora</i>	8.25	18.0	7.7	2.34	-	-	-	-	-
<i>Sisymbrium altissimum</i>	-	-	-	-	18.85	56.7	6.75	8.40	41.47

¹ % of species removed = % of each species showing utilization X proportion of each plant utilized (from Table 1).
² Available = % cover (from Table 1).
³ Preference Rating = % of each species removed as related to all species removed/% of each species available as related to all species available.
⁴ Importance Rating = % of species removed X % cover.

rigens found within Cuyamaca Rancho State Park are absent from cattle ranges in the Laguna and Cuyamaca mountains, and we contend that cattle grazing probably eliminated valuable cover for does with fawns. Holl (1976) suggested that an absence of suitable cover on key summer ranges resulted in increased predation of neonate fawns which may have suppressed recruitment in a herd of California mule deer, *O. h. californicus*. Salwasser, Holl, and Ashcraft (1978) hypothesized that although coyotes, *Canis latrans*, were the principal agent of death for fawns in the North Kings herd, the effect of predation on deer was intensified by factors related primarily to habitat quality. Stocking levels of livestock also are known to influence deer productivity. McKean and Bartmann (1971) and Mackie (1976) reported that fawn mortality was significantly higher on heavily grazed pastures than on those receiving moderate use.

We never observed deer and cattle together. Deer are thought to actively avoid cattle in some areas (Mackie 1981), but the role of social interactions in effecting the near absence of deer on cattle ranges in San Diego County is uncertain. Current cattle stocking rates, which contribute to the removal of important forage and cover plants for deer, may be sufficient to explain reduced deer use of cattle range in these mountain meadows. Although reliable information on the number of cattle using meadows was unavailable, cattle numbers recorded in spotlight counts apparently were high enough to limit deer use of cattle range.

Whatever the cause, southern mule deer occurred in comparatively small numbers on cattle ranges while they were abundant on nearby areas without cattle. Clearly, more research is needed to develop livestock management practices that will alleviate the adverse effects of cattle on deer and their habitat. This is a critical necessity for the successful management of southern mule deer as large amounts of public land are leased for cattle grazing in San Diego County.

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