Mule Deer Fecal Group Counts Related to Site Factors on Winter Range[1]

ALLEN E. ANDERSON, DEAN E. MEDIN,[2] AND DAVID C. BOWDEN

Wildlife Researchers, Research Center, Colorado Division of Game, Fish and Parks, Fort Collins; and Assistant Professor, Department of Statistics, Colorado State University, Fort Collins.

Highlight

Measurements of 32 site factors on 931, 100 ft², circular plots systematically distributed among lower, middle and upper Cache la Poudre, Colorado winter range study areas of about 500 surface acres each, were related to cumulative mule deer (*Odocoileus hemionus*) fecal groups counted on those plots (1963–65). Single and multiple linear regression and Chi-square analyses indicated that vegetative measurements, particularly antelope bitterbrush (*Purshia tridentata*) parameters, were the site factors most closely related to fecal group counts. These site factors accounted for about 10–13 percent in single linear regressions, and 8–20 percent in multiple linear regressions of the significant variation (R^2) in fecal group counts.

The distribution patterns of deer fecal groups counted on sample plots are commonly used as indices of: (1) deer distribution within adjacent habitats (Julander, 1955; White, 1960; Reynolds, 1962a, 1966, 1969; McCaffery and Creed, 1969); and (2) deer response to habitat modification (Taber and Dasmann, 1958:69; Bramble and Byrnes, 1958; Reynolds, 1962b, 1964; Neff, 1968; Shafer and Liscinsky, 1968; Anderson, 1969; Krefting and Hansen, 1969; McCulloch, 1969; Patton, 1969; Wallmo, 1969). The validity of fecal group distribution patterns as an index to deer habitat preferences has not been experimentally verified and available data are in conflict. Direct, diurnal observations of mule deer distribution were found by White (1960) and Loveless (1967) to generally support, and by Leckenby (1968) to refute, results obtained by fecal group counts. The efficient design of experiments to test discrete hypotheses relative to the validity of the technique would seem to require more detailed information on site factor-mule deer fecal group count relationships than presently available.

The objective of this exploratory study was to identify the site factors most strongly related to counts of mule deer fecal groups on individual plots.

Methods

Three study areas of about 500 acres each, were selected to include the elevational sequence of the major topographic and vegetative features of the lower (Area 1), middle (Area 2), and upper (Area 3) winter range of mule deer on the north side of the Cache la Poudre River within Roosevelt National Forest, northcentral Colorado.

Sampling was systematic. Mule deer fecal groups were counted and removed on each of 960, 100-ft², circular plots by two observers. Our sampling design, fecal group search methods, fecal group criteria, and some statistical attributes of the fecal group counts are described in Bowden et al. (1969). The cumulative (1963–65) counts of mule deer fecal groups were used herein (Table 1).

The following measurements of abiotic and biotic site factors were made on, or immediately adjacent to, each of 960 fecal group plots.

Abiotic Site Factors

Plot elevations were read to the nearest 100 ft from topographic maps (1 inch = 500 ft, 20 ft contour intervals) constructed for this study by a commercial engineering firm. Slope exposure was read to the nearest degree from true north with a Brunton compass. Slope gradient was read to the nearest percent with an Abney level. Radiation index is a theoretical quantity of solar irradiation and was read from the measured slope exposure and gradient of each plot as tabulated for lat 40 N by Frank and Lee (1966). Slope position was obtained by subjectively assigning and scoring each plot position as being in the lower (1), middle (2), and upper (3), one-third of its respective slope. Soil depth was subjectively judged and scored on the basis of ground surface characteristics as to whether developed soil depths were shallow (1), moderate (2), or deep (3). Soil texture was subjectively judged and scored on the basis of ground surface characteristics as to whether textures were coarse (1), medium (2), or fine (3).

Biotic Site Factors

Percent ground cover.—Defined as the proportion of the ground surface occupied by the vertical projection of live plant parts, both basal and aerial, plus that occupied by non-living matter such as litter, rock and dead plants. These components were sampled with vertical point quadrats (Fayle, 1959).

Shrub density.—All living shrubs, four or more inches in crown diameter and rooted within the 100-ft², circular fecal group plots were counted by species. Semi-woody species were not included in these counts.

Browse yields.—Oven-dry weights of forage were predicted directly from the estimated green weights of true mountainmahogany (*Cercocarpus montanus*), antelope bitterbrush (*Purshia tridentata*) and big sagebrush (*Artemisia tridentata*) (Hilmon, 1959; Blair, 1959). Forage was considered to be the current annual twig growth of true mountainmahogany, current annual twig growth and attached leaves for antelope bitterbrush, apparent annual twig growth and all leaves but ex-

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[2] Present address: U. S. Forest Service, Intermountain Forest and Range Experiment Station, Boise, Idaho.

Table 1. Basic data relative to the mule deer fecal group counts, and concurrent estimates of browse yield and utilization.

Study areas	Surface acres and elevation (ft)	End dates of each sampling		Time interval (days)
1	490.1 acres	10-13-63	5-27-64	227
	5,710–7,230	5-27-64	10-6-64	132
		10-6-64	5-17-65	223
2	509.2 acres	10-21-63	5-21-64	213
	6,710–7,840	5-21-64	11-5-64	168
		11-5-64	5-13-65	189
3	495.0 acres	11-15-63	5-27-64	194
	7,440–8,800	5-27-64	11-6-64	163
		11-6-64	5-27-65	202

cluding the flowering parts for big sagebrush. All such forage below a 5-ft height was estimated by species within the 100-ft^2, circular, fecal group plots. Estimates made on individual, tagged plants were summed for each 100-ft^2 fecal group. Sampling dates are given in Table 1.

Browse utilization.—Winter use of forage by deer was estimated in the late spring for the individual, tagged, true mountainmahogany, antelope bitterbrush, and big sagebrush plants using the ocular-estimate-by-average-of-plants methods of Pechanec and Pickford (1937). We assessed the percentage removal by weight for each plant with the "use-class" technique (Clark, 1944). Sampling dates are given in Table 1.

Additional site factors.—The presence or absence of plants, number of plants, percent ground cover, grams oven-dry yield, grams utilization, and percent utilization were derived from the vegetative measurements on a per plot basis for true mountainmahogany, antelope bitterbrush, and big sagebrush. The percent ground cover of fringed sage (*Artemisia frigida*), percent ground cover of cheatgrass (*Bromus tectorum*), number of shrub genera, and the number of herbaceous genera were similarly obtained. Thirty-two site factors were measured on each plot.

Statistical Analyses

Site factor measurements were complete for 360 plots on area 1, 298 plots on area 2, and 273 plots on area 3. Simple correlation coefficients (r) were calculated for all site factors (X_i) measured on each of these plots versus their corresponding mule deer fecal group counts (Y). Because of the large number of correlation coefficients calculated, inferences are made at $P < 0.001$ to avoid spuriously significant relationships. Stepwise, multiple linear regression analyses were used to estimate the relative importance of sample plot site factor measurements (X_i) as influents on mule deer fecal group counts on these plots (Y). For those 12 site factors which could be adequately categorized, Chi-square contingency tables were used to detect significant ($P < 0.05$) differences among the category frequency distributions of mule deer fecal group counts.

Results

Simple correlation coefficients which differed significantly ($P < 0.001$) from zero correlation are listed in Table 2. Antelope bitterbrush density and percent utilization accounted for the maximum variation (R^2 = 10–13 percent) in fecal group counts. The results of the stepwise multiple linear regression analyses are listed by area in Table 3. Combinations of site factors accounted for 8–20 percent of the variation (R^2) in fecal group counts.

Chi-square analyses revealed that elevation, slope gradient, slope exposure, soil depth, bare soil, density of antelope bitterbrush, and density of all shrub species were significantly ($P < 0.05$) related to the frequency distributions of mule deer fecal group counts. Maximum fecal group densities were significantly ($P < 0.05$) associated with higher elevations on the lower winter range study area and lower elevations on the upper winter range study area. Southeasterly slope exposures, 20–60 percent slope gradients, shallow or moderate soil depths, 50–60 percent bare soil, 1–6 antelope bitterbrush plants per plot, and 11–15 shrubs of all species per plot were each significantly ($P < 0.05$) associated with maximum mean fecal group densities on one or more study areas. Antelope bitterbrush densities of 1–6 shrubs per plot and southeasterly exposures were both associated with the maximum mean fecal group densities of 2 groups per plot.

Conclusions

Both parametric and non-parametric analyses indicate that antelope bitterbrush in particular, and vegetation in general, were most closely related to mule deer fecal group counts. Significantly, current studies show that antelope bitterbrush was the major food item in stomach content samples from Cache la Poudre mule deer collected from the winter range at ap-

Table 2. Simple correlation coefficients of those counts of mule deer fecal groups (Y) related to site factors (X).

Study area	Site factors	Correlation coefficients
3	Number of bitterbrush plants (per 100-ft^2)	0.33
3	% utilization of bitterbrush	0.36
2	% utilization of bitterbrush	0.32

Table 3. Multiple correlation coefficients of winter range mule deer fecal group counts (Y) significantly ($P < 0.01$) related to that combination of site factors (X) in which all the partial regression coefficients were significant ($P < 0.05$).

Study area	Multiple correlation coefficient	Independent site factors
1	0.40	elevation (ft)
		soil texture
		% ground cover of bitterbrush
		% of ground cover of cheatgrass
		% utilization of bitterbrush
2	0.37	radiation index
		Grams utilization of mountainmahogany
		Grams utilization of bitterbrush
		No. shrub genera
3	0.45	bare soil (%)
		Grams utilization of mountainmahogany
		Grams yield of bitterbrush
		% utilization of sagebrush

proximate weekly intervals, 1961–65.

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