Diets of Ungulates Using Winter Ranges in Northcentral Montana

WAYNE F. KASWORM, LYNN R. IRBY, AND HELGA B. IHSLE PAC

Abstract

Dietary comparisons based on fecal analysis of mule deer, elk, bighorn sheep, and cattle using mule deer winter ranges along the east slope of the Rocky Mountains indicated that elk, bighorn, and cattle diets were much more similar to each other than to mule deer diets. The greatest overlap between elk, bighorns, and mule deer occurred during late winter when creeping juniper became an important dietary item for all 3 species. Rank-order comparisons indicate that rankings of items in the graminoid and forb forage classes for diets of the 4 ungulate species were significantly correlated with availability of these items. Correlations between availability and diet rank-order were poor for items in the woody forage class. Differences in the diets of the 4 ungulate species were more pronounced at the forage class level than at the plant species/genus level.

Resource management along the East Front of the Rocky Mountains in northcentral Montana is becoming one of the most important land use issues in the state. The 10-km-wide strip where the prairie and mountains meet encompasses winter ranges for wild ungulates summering in the Bob Marshall Wilderness, supports a viable cattle industry, and has recently become the center of intense oil and gas exploration activity. Development of oil and gas reserves in the area could alter the existing relationship between livestock and game species by converting rangeland to well sites, roads, or storage facilities and by increasing disturbance and harvest of native ungulates. To contend with these changes in land use, range mangers will require more precise knowledge of the manner in which native and domestic ungulates use available forage than was necessary in the past. This study compares diets of mule deer *(Odocoileus hemionus)*, elk *(Cervus elaphus)* bighorn sheep *(Ovis canadensis)*, and cattle from sites where concentrations of native ungulates winter. A partial assessment of dietary selectivity is included.

Study Area

The study area, located approximately 110 km northwest of Great Falls, Mont. (Fig. 1), was characterized by shortgrass prairie intergrading with a narrow foothill region of fescue (*Festuca* sp.)–wheatgrass (*Agropyron* sp.) grassland and limber pine *(Pinus flexilis)* woodland/savannah. Mule deer, elk, and bighorn sheep winter along the foothill zone from December through May. Most cattle grazing in the foothills occurs from May through October on private, U.S. Forest Service, and Bureau of Land Management holdings.

The climate of the area is characterized by long cold winters and warm summers. Chinook winds periodically reduce snow cover in the mountain foothills zone throughout the winter. Weather conditions were approximately average during the early winter of 1980

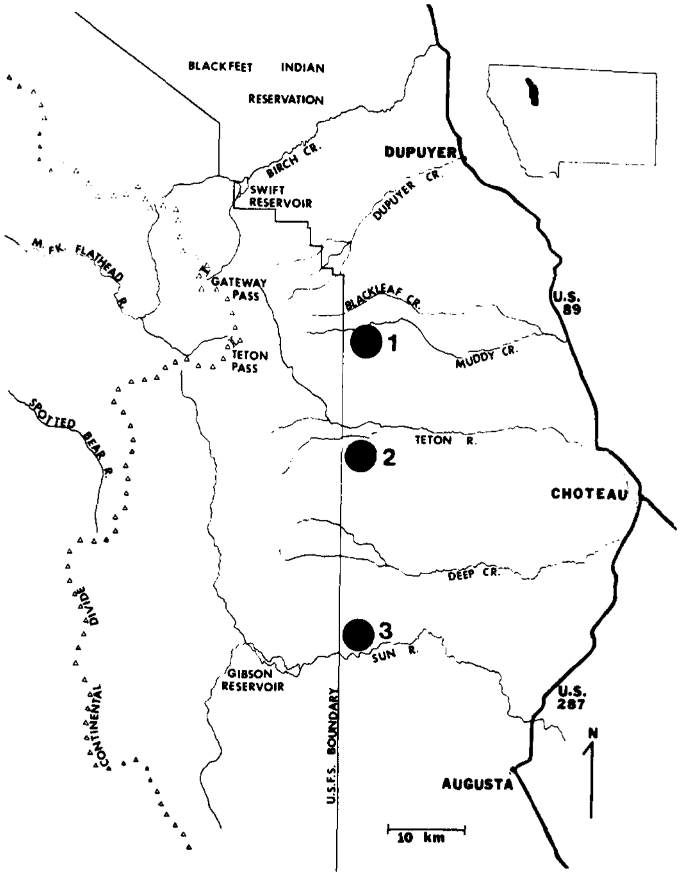

Fig. 1. *Map of the East Front study area showing major features. Collection sites for fecal samples were: the Blackleaf Game Range (1), Ear Mountain Game Range (2), and the Sun River (3).*

but were warmer and wetter than average during late winter. If vegetation in the area followed the pattern observed on range sites in western Montana by Mueggler and Stewart (1981), productivity should have been lower than average during the moderately dry April–July periods of 1979 and 1981 and greater than average in 1980 (U.S. Department of Commerce 1979–1981).

Methods

Fecal Analysis

Fecal samples were collected from 3 winter ranges (Fig. 1). The Sun River site represented a winter range where deer concentrated in high density (≅40/km² in 1980–1981) that was used concurrently

Authors Kasworm and Ihsle Pac were graduate research assistants in the Biology Department, Montana State University, Bozeman 59717, at the time of the study. Both are currently employed by the Montana Department of Fish, Wildlife, and Parks, Rt. 1, Box 1455, Libby 59923 and 610 S. 7th, Bozeman 59715. Irby is an assistant professor in the Biology Department, Montana State University, Bozeman
This study was funded through the Montana Department of Fish, Wildlife, and Parks under Bureau of Land Management contract YA-512-CT9-33. Thanks for assistance are due Dr. R. Mackie, J. Jones, W. Elliott, J. McCarthy, G. Olson, and the land owners who allowed us access to their property.
Manuscript received August 19, 1982.

by bighorn sheep and elk. Fecal samples from all 3 wild ungulates (5–20 pellets/sample) were collected at this site. Blackleaf represented a more mesic site with a lower deer density (≅6/km^2). Bighorn and elk use of the Blackleaf site was low at the time of the study (Kasworm 1981, Ihsle 1982) so only mule deer samples were collected. Cattle feces (≅100g/sample) were collected from the Ear Mountain winter range, a site occupying an intermediate position in vegetative character and deer density (≅10/km^2) relative to the Sun River and Blackleaf sites, to obtain general information on the diets of the dominant domestic ungulate using wild ungulate winter ranges in the area.

Five fecal samples from mule deer, elk, and bighorn sheep were collected at 2-week intervals from mid-January through early April 1980. All samples were collected following observed defecations to insure correct assignment to species and time period. Twenty cattle fecal samples were collected between June 15 and August 21, 1981. Each sample was air-dried, ground to 1- mm particle size using a Wiley mill, and soaked in household bleach (sodium hypochlorite) for 20–30 minutes to remove pigments. One slide was prepared per individual sample. Twenty fields were systematically located on each slide and examined at 100x magnification using a phase contrast microscope. Frequency conversion techniques outlined by Sparks and Malechek (1968) were employed in obtaining estimates of the percentages of identifiable plant items in the samples. Big game data were pooled by early (January–February) and late (March–April) winter periods. Cattle samples were considered a single summer sample.

Spearman's Rank Correlations (Siegel 1956) were used to assess similarities between diets. Only those identifiable plant categories that comprised 3% or more of the diet of any animal species during a single sampling period were included in these tests. Student's *t*-tests (Steele and Torrie 1960) were used to assess changes in graminoid, forb, and shrub contributions to diets between time periods.

Vegetation Measurement

Time and funding limits precluded detailed measurement of vegetative production, but an index of plant availability (canopy coverage) was developed from data collected during the summers of 1979–1981 on five mule deer winter ranges encompassing 79 km^2 along the mountain front (Kasworm 1981, Ihsle 1982). Eleven major upland cover types were delineated in 1979 using a modification of habitat types described by Pfister et al. (1977) and Mueggler and Stewart (1980). Over 1,150 0.1-m^2 plots were sampled in 1980 using a modified (a seventh coverage class, 0–1% was added) Daubenmire technique (Daubenmire 1959) to assess canopy coverage of individual species in the ground stratum (herbaceous and woody vegetation <30 cm in height). Mid stratum (woody vegetation 30–180 cm in height) canopy coverage estimates were obtained from 650 points using the point-centered-quarter technique (Cottam and Curtis 1956) during 1979–1980. Sampling intensity in upland types was roughly proportionate to the total area covered by each type and varied from 10–390 plots per type for all cover types and from 10–200 points per type for those types with shrubs or trees. Canopy cover estimates for dominant species in aspen *(Populus tremuloides)* and riparian/swamp communities were based on a modified (only plants with ≧1% canopy coverage were noted, and trees were not divided into diameter classes) Pfister plot technique (Pfister et al. 1977) used in 24 and 6 stands, respectively, during 1980–1981.

Estimates of mean canopy coverage for each species in a specific cover type were derived by averaging all values recorded for sample units (plots and/or points) within that cover type. Estimates of total canopy coverage for individual species in the ground and mid strata were calculated for each winter range by weighting the mean canopy coverage for each species in a cover type by the proportionate occurrence of that type.

To facilitate comparisons between diets and canopy coverage, plant species were combined, when necessary, into categories (genus, family, or species group) corresponding to those identifiable through fecal analysis. Spearman's Rank Correlations were used to assess similarities between ranked canopy coverage and ranked occurrence of plant categories in ungulate diets. Tests were limited to plant categories with an estimated canopy coverage of 0.5% or more. Identifiable items within each forage class (graminoids, forbs, woody species) were tested separately to reduce the effects of radically different growth forms on our index of relative availability (Daubenmire 1959).

Rank correlation tests were conducted using the MSUSTAT (Lund 1978) and SPSS (Nie et al. 1975) statistical packages on a Honeywell Series 60 computer.

Results

Food Habits

Browse was the dominant forage component in mule deer diets at both sample sites for the early and late winter periods (Table 1). Total browse in the diet ranged from 67-91%. Mule deer at both sites consumed less browse in late than in early winter (*t*-test, $p<0.01$). Forbs and graminoids combined made up 10–16% of the diet in early winter and 22–33% in late winter. Juniper (probably creeping juniper, *Juniperus horizontalis,* since this species constituted 98% of the juniper canopy coverage) was the most important single item in mule deer diets for both sites throughout the winter. Other important browse items in fecal samples from both sites were fringed sagewort *(Artemisia frigida), Populus* sp. (probably aspen), and Douglas-fir *(Pseudostuga menziesii).* Mountain big sagebrush *(A. tridentata vaseyana)* was important at the Sun River site but was unavailable at the Blackleaf site (Table 2). Oregon grape *(Berberis repens)* and pine (probably limber pine) were important items in the Blackleaf samples but contributed little to Sun River diets. Wheatgrasses, sedges (*Carex* sp.), and fescues were the most important graminoids in samples from both sites. Only one forb genus, *Phlox,* made a significant contribution to winter diets.

Grasses were the most important component in bighorn sheep diets at the Sun River site throughout the winter (Table 1), but they declined in importance from 65% in early winter to 47% in late winter (*t*-test, $p<0.05$). Important graminoids were wheatgrasses, fescues, and junegrass *(Koelaria cristata).* Browse utilization increased from 23% in early to 42% in late winter (*t*-test, $p<0.05$). Most of the increase consisted of juniper and Douglas-fir taken during March. Fringed sagewort, the only other important browse item, was utilized throughout the winter. Percentages of forbs in bighorn diets were low ($\bar{x}$=12%) throughout the winter. The only heavily used items in the forb class were roots of biscuitroot (*Lomatium* sp.) or balsamroot (*Balsamorhiza* sp.). Although roots from the 2 genera could not be separated microscopically, observations of sheep pawing roots suggested that balsamroot constituted the majority of this item.

Elk diets were similar to bighorn diets (Table 1). Graminoids constituted 84% of the diet in early winter and 65% during late winter. Mean percentages of browse in the diet for early and late winter samples were 12 and 29%, respectively. Most of the apparent increase (*t*-test, $p<0.07$) was attributable to greater juniper consumption during early March. Important items in the diet were the same as those noted for bighorns.

Summer cattle diets in 1981 consisted of 84% grass, 12% forbs, and 4% browse. Important forage items included fescues, wheatgrasses, bromes (*Bromus* sp.), junegrass, and bluegrasses (*Poa* sp.).

Dietary Comparisons

Sixteen forage items that constituted at least 3% of the diet of one or more ungulate species were used in dietary comparisons. Spearman's Rank Correlations (r_S) between early and late winter diets were significant for mule deer, bighorns, and elk (r_S range < 0.70–0.88, $p<0.01$). Correlations between mule deer diets on the Sun River and Blackleaf ranges were significant ($p<0.05$) for early (r_S=0.50) and late (r_S=0.52) winter. Elk and bighorn diets were similar throughout the winter (r_S=0.92 and 0.82 for early and late winter, respectively; $p<0.01$). Mule deer had the lowest dietary overlap with other native ungulates at the Sun River site (r_S = −0.25 to 0.08, $p>0.35$). Summer cattle samples from Ear Mountain showed a negative (r_S range = −0.01 to −0.28) correlation with mule deer winter diets and positive correlations with bighorn and elk diets, but the only significant ($p<0.05$) correlations were between elk and cattle (r_S = 0.63 and 0.50 for early and late winter, respectively).

Diet versus Relative Forage Availability

Estimated canopy coverage for individual plant categories in each sample site are given in Table 2. Fescues, sedges, wheat grasses, and bluegrasses were the highest ranking graminoids at all sites. The highest ranking forb categories for all sites were unidentifiable composites (13 genera that could be identified as composites in fecal analysis but no more precisely), *Phlox* sp., northern bedstraw *(Galium boreale)*, silky lupine *(Lupinus sericeus)*, and balsamroot. Juniper (predominantly creeping juniper) was the

Table 1. Mean percentages and standard deviations (in parentheses) for forage items identified in fecal samples from mule deer, bighorn sheep, and elk during winter 1980 and cattle during summer 1981. Samples were collected in mule deer winter ranges along the East Front of the Rocky Mountains in northcentral Montana.

	Mule Deer Jan.-Feb. SR[a] N=15	Mule Deer Mar.-Apr. SR N=15	Mule Deer Jan.-Feb. BL N=15	Mule Deer Mar.-Apr. BL N=15	Bighorn Jan.-Feb. SR N=15	Bighorn Mar.-Apr. SR N=15	Elk Jan.-Feb. SR N=15	Elk Mar.-Apr. SR N=15	Cattle Jun.-Aug. EM N=20
Agropyron sp.	2.5 (2.9)	3.1 (2.0)	1.0 (1.4)	1.6 (1.6)	20.7 (4.5)	15.0 (7.9)	24.7 (5.0)	21.1(12.9)	23.9 (3.5)
Bromus sp.	.6 (1.1)	1.2 (1.6)	.4 (.8)	.7 (1.2)	2.9 (1.9)	2.8 (3.4)	2.9 (1.8)	3.0 (3.9)	5.9 (3.0)
Carex sp.	.4 (1.1)	5.2 (5.8)	2.3 (2.5)	4.1 (3.0)	3.5 (2.9)	2.1 (2.2)	3.4 (1.8)	5.9 (3.7)	2.9 (3.1)
Festuca sp.	.9 (1.3)	2.9 (2.3)	1.0 (1.4)	3.2 (1.9)	17.6 (4.7)	11.6 (8.4)	31.2 (4.6)	20.1(13.7)	31.3 (5.2)
Koeleria cristata	.7 (1.2)	.3 (.6)	.1 (.5)	1.1 (1.8)	6.9 (4.3)	5.7 (3.8)	9.3 (4.1)	5.3 (2.9)	6.7 (3.0)
Poa sp.	.5 (1.4)	.1 (.5)	.1 (.5)	.3 (.7)	.1 (.5)	1.1 (1.7)	.4 (.8)	.8 (1.7)	3.7 (2.8)
Stipa sp.	0	.2 (.6)	.1 (.5)	.4 (1.1)	3.2 (2.9)	2.0 (3.1)	3.2 (2.0)	1.7 (1.5)	3.5 (2.2)
Unknown grass	2.0 (2.5)	4.8 (2.5)	1.4 (1.8)	3.3 (1.3)	10.9 (1.8)	6.8 (2.8)	9.3 (1.8)	7.7 (2.8)	7.2 (1.4)
Total grass	7.1 (7.2)	17.6 (9.0)	6.2 (4.4)	13.7 (5.1)	65.3(12.5)	46.7(24.7)	83.9 (5.1)	65.4(34.7)	84.3 (6.4)
Achillea millefolium	0	1.5 (2.7)	.1 (.5)	0	0	.5 (1.0)	.1 (.5)	.3 (.7)	1.7 (2.2)
Antennaria sp.	.2 (.6)	0	0	0	0	0	0	0	0
Arenaria sp.	.1 (.5)	.3 (.9)	.4 (1.1)	.5 (1.4)	0	.1 (.5)	0	0	.5 (.9)
Astragalus sp.	.1 (.5)	.5 (1.3)	0	.1 (.5)	.1 (.5)	0	0	0	.2 (.6)
Balsamorhiza sp.	1.4 (2.4)	2.9 (3.1)	0	.7 (1.3)	2.4 (3.2)	1.6 (1.8)	.7 (1.0)	.3 (.7)	.1 (.4)
Cirsium sp.	0	0	0	0	0	0	0	0	.1 (.4)
Compositae (Unidentified)	.9 (1.8)	1.3 (2.2)	.1 (.5)	.1 (.5)	.3 (.7)	.1 (.5)	0	.4 (.8)	.5 (1.1)
Comandra umbellata	0	.1 (.4)	.1 (.5)	.3 (.7)	0	0	0	0	.2 (.6)
Cruciferae	.1 (.3)	.1 (.5)	0	0	.1 (.5)	.3 (.9)	0	0	0
Eriogonum sp.	0	.1 (.3)	0	0	0	.7 (1.9)	0	0	0
Galium boreale	0	.1 (.5)	.1 (.5)	0	.3 (.7)	.3 (.7)	0	0	.6 (1.1)
Hedysarum sulphurescens	0	0	.1 (.5)	0	0	0	0	0	.9 (1.8)
Lomatium sp.	0	0	0	0	0	0	0	0	.2 (.6)
Lupinus sericeus	.5 (.8)	.7 (1.1)	.1 (.5)	.5 (.9)	0	0	.5 (.7)	.1 (.5)	.4 (.8)
Phlox sp.	3.5 (3.1)	1.8 (1.7)	.8 (1.5)	2.1 (2.5)	.4 (1.1)	1.1 (1.8)	.1 (.5)	.7 (1.2)	1.0 (1.4)
Root	0	0	0	1.1 (1.7)	3.9 (4.3)	3.3 (3.2)	1.1 (2.1)	1.5 (2.2)	0
Thermopsis rhombifolia	0	0	0	0	0	0	.1 (.3)	0	.1 (.4)
Trifolium sp.	0	0	0	0	0	0	0	0	.6 (.9)
Vicia americana	0	0	0	0	0	0	0	0	1.0 (1.5)
Unknown forb	2.7 (1.9)	6.0 (2.4)	1.9 (2.5)	3.8 (2.3)	4.8 (2.1)	4.1 (1.8)	2.1 (1.7)	2.8 (1.6)	4.4 (1.7)
Total forbs	9.1 (4.1)	15.3 (8.6)	3.7 (4.0)	8.7 (6.3)	11.9 (7.0)	11.7 (7.4)	4.8 (3.3)	5.7 (3.2)	11.5 (5.8)
Acer glabrum	0	.1 (.5)	.3 (.9)	.1 (.5)	0	0	0	0	0
Amelanchier alnifolia	2.6 (3.5)	.9 (2.3)	1.0 (1.8)	.7 (1.2)	.1 (.5)	1.2 (2.3)	.3 (.7)	1.1 (3.1)	.1 (.4)
Artemisia frigida	3.8 (4.5)	7.5 (4.6)	3.5 (2.1)	5.7 (2.5)	12.9 (6.2)	13.1 (8.8)	7.2 (3.5)	2.3 (4.0)	.7 (1.2)
Artemisia tridentata	4.2 (4.2)	4.3 (3.5)	0	0	2.3 (2.6)	1.9 (2.4)	1.0 (1.6)	3.0 (3.8)	0
Arctostaphylos uva-ursi	1.2 (1.9)	0	0	0	0	.6 (1.4)	0	0	0
Berberis repens	.7 (1.7)	0	7.0 (4.8)	3.5 (4.6)	0	0	.1 (.5)	0	.2 (.9)
Betula occidentalis	0	0	.4 (.8)	0	0	0	0	0	0
Juniperus sp.	53.7 (6.8)	45.0 (6.8)	51.5 (9.5)	51.5 (7.3)	2.4 (3.2)	13.5(15.6)	1.7 (1.4)	17.1(23.9)	.9 (1.7)
Pinus flexilis	.7 (1.4)	.6 (1.0)	4.7 (4.3)	5.4 (4.5)	.7 (1.6)	1.0 (2.2)	0	.7 (1.3)	.7 (1.0)
Potentilla fruticosa	0	0	.1 (.5)	0	0	0	0	.1 (.5)	0
Populus sp.	3.5 (5.4)	1.5 (3.1)	9.8(12.8)	3.6 (5.3)	.5 (1.2)	.7 (1.6)	.1 (.5)	.8 (1.8)	.5 (1.1)
Prunus virginiana	1.7 (3.7)	.9 (2.3)	1.4 (1.6)	.9 (1.6)	.4 (.8)	.4 (1.1)	.3 (1.0)	.8 (1.3)	.1 (.4)
Pseudotsuga menziesii	7.0 (6.4)	3.4 (3.8)	6.4 (5.7)	5.7 (4.4)	.9 (1.8)	7.4 (9.2)	.7 (2.6)	2.5 (3.8)	0
Rhus trilobata	.7 (1.3)	0	0	0	0	0	0	.1 (.5)	0
Ribes sp.	.2 (.6)	.1 (.3)	0	0	0	0	0	0	0
Rosa sp.	.1 (.5)	0	.1 (.5)	0	0	0	0	0	0
Salix sp.	.4 (1.3)	0	0	0	0	0	0	0	0
Shepherdia canadensis	.9 (3.6)	.8 (1.4)	.2 (.8)	0	.1 (.5)	.3 (.7)	0	0	0
Symphoricarpos sp.	.4 (.9)	.1 (.3)	0	0	0	0	0	0	0
Unknown browse	1.8 (1.3)	2.2 (1.6)	4.3 (2.3)	1.8 (1.7)	2.4 (2.0)	1.7 (1.8)	.7 (1.4)	1.0 (1.3)	1.1 (1.7)
Total browse	83.7 (7.2)	67.3 (9.1)	90.5 (7.3)	77.7 (9.5)	22.7 (8.3)	41.7(24.2)	11.7 (3.6)	29.2(32.5)	4.2 (3.5)

[a]SR = Sun River, BL = Blackleaf, EM = Ear Mountain.

dominant woody genus at all sites. Most differences in ranked canopy coverages between winter ranges were associated with the absence of mountain big sagebrush habitat types and the abundance of swamp/riparian types at the Blackleaf site. Consequently, plants associated with mesic or wet habitats were more abundant at the Blackleaf site than at the Sun River or Ear Mountain sites.

Spearman's Rank Correlations between diet and our index of availability for the graminoid forage class were based on 8 (Blackleaf) or 10 (Sun River and Ear Mountain) plant categories. Correlations were significant for all ungulate species at all sites during all time periods tested (r_S range = 0.71 – 0.8, p<0.001 – 0.02). Fescues and wheatgrasses, the graminoides with the highest canopy coverage ranks, consistently ranked high in the graminoid component of diets. Bromes, rushes (*Juncus* sp.), and needlegrasses (*Stipa* sp.) were ranked low in canopy coverage and usually had mid to low ranks in diets.

Comparisons in the forb class were based on 17, 19, and 27 plant categories in the Sun River, Ear Mountain, and Blackleaf sites, respectively. Mule deer and bighorn diets were positively correlated with ranked forb canopy coverage throughout the winter (r_S range = 0.41 – 0.76, p<0.001 –0.02). Late winter elk samples showed a significant relationship to canopy rankings (r_S = 0.62, p<0.001), but early winter samples did not (r_S = 0., 31 p<0.12). Summer cattle diets had a low rank correlation with our availability index (r_S = 0.25, p<0.15). The forb categories that ranked highest in native ungulate diets tended to be common forbs that were large and/or resistant to winter deterioration such as balsamroot and phlox. The high dietary rankings of some forbs with low canopy coverages, such as clover (*Trifolium* sp.) and vetch (*Vicia americana*), indicated that cattle were selectively feeding on palatable legumes.

Correlations between diet and canopy coverage ranks in the shrub class were based on 9, 10, and 12 plant categories for the Ear Mountain, Sun River, and Blackleaf sites, respectively. All rank correlations were nonsignificant (r_S range = –0.23 to 0.39, p<0.13 – 0.43). Of the browse categories tested, some, such as fringed

Table 2. Estimated percent canopy coverage of plant categories identifiable through fecal analysis in three mule deer winter ranges (BL = Blackleaf, SR = Sun River, EM = Ear Mountain).

	Canopy coverage (%)				Canopy coverage (%)		
Plant category	BL	SR	EM	Plant category	BL	SR	EM
Graminoids				Forbs (cont.)			
Agropyron sp. (85% *A. spicatum*)	4.3	4.5	5.4	*Astragalus* sp.	1.1	1.2	1.1
Bromus sp.	1.0	0.4	0.9	*Balsamorhiza* sp. (95% *B. sagittata*)	1.3	1.2	1.8
Carex sp.	5.3	4.2	3.8	*Besseya wyomingensis*	0.2	0.1	0.2
Danthonia intermedia	0.9	0.6	1.2	*Bupleurum americanum*	0.3	0.2	0.2
Deschampsia elongata	0.1	0.0	0.1	*Cerastium arvense*	0.8	0.5	0.1
Festuca sp. (39% *F. idahoensis,*				*Cirsium* sp.	0.1	0.1	0.2
61% *F. scabrella*)	7.6	7.3	9.6	*Clematis* sp.	0.1	Tr	0.1
Juncus sp.	1.0	0.7	0.6	*Collinsia parviflora*	Tr	0.1	0.1
Koelaria cristata	1.5	1.4	2.0	*Collomia linearis*	0.1	0.1	0.1
Phleum pratense	1.8	Tr	0.8	*Comandra umbellata*	0.6	0.5	0.8
Poa sp.	4.1	1.8	2.5	*Douglasia montana*	0.2	0.2	0.1
Stipa sp.	1.0	0.5	1.3	*Eriogonum* sp.	0.1	0.1	0.2
Unidentifiable and unknown graminoids	3.3	2.5	2.3	*Frageria virginiana*	0.8	0.2	0.4
				Galium boreale	2.7	1.7	2.6
Forbs				*Geranium* sp.	0.6	0.2	0.4
Achillea millefolium	1.3	0.7	1.1	*Hedysarum sulphurescens*	0.3	0.3	0.4
Allium textile	0.2	0.2	0.2	*Iris missouriensis*	0.5	0.4	0.4
Anemone sp.	1.0	0.6	0.9	*Linum perenne*	0.2	0.2	0.2
Antennaria sp.	1.4	1.1	1.7	*Lupinus sericeus*	2.2	1.3	2.9
Apocynum medium	Tr	0.1	Tr	*Melilotus officinalis*	Tr	0.1	Tr
Arenaria sp.	0.6	0.8	0.8	*Monarda fistulosa*	0.6	0.3	0.5
Artemisia campestris/ludoviciana	0.5	0.4	0.4	Woody plants			
Opuntia polyacantha	0.1	0.1	0.1	*Acer glabrum*	Tr	0.0	Tr
Oxytropis sp.	0.9	0.7	1.4	*Amelanchier alnifolia*	0.5	0.2	0.5
Pedicularis sp.	Tr	Tr	0.1	*Arctostaphylos uva-ursi*	3.0	1.2	2.1
Penstemon sp.	0.4	0.2	0.4	*Artemisia frigida*	2.0	2.7	2.9
Petalostemon sp.	0.2	0.2	0.3	*A. tridentata*	0.0	0.5	0.2
Phacelia linearis	0.1	0.1	0.1	*Berberis repens*	Tr	0.0	0.0
Phlox sp.	2.3	2.2	3.1	*Betula occidentalis*	0.5	0.4	0.2
Sedum lanceolatum	0.2	0.2	0.2	*Eleagnus commutata*	0.1	Tr	0.1
Smilacina sp.	0.1	Tr	0.1	*Juniperus* sp. (98% *J. horizontalis*)	8.0	14.4	7.5
Thalictrum occidentale	0.2	0.0	Tr	*Pinus* sp. (84% *P. flexilis*)	1.4	1.2	0.6
Thermopsis rhombifolia	0.9	0.6	1.1	*Populus* sp. (99% *P. tremuloides*)	0.6	0.2	0.1
Trifolium sp.	0.6	Tr	0.5	*Potentilla fruticosa*	4.6	2.3	3.3
Vicia americana	0.7	0.5	0.8	*Prunus virginiana*	0.3	0.2	0.3
Zigadenus sp.	0.5	0.4	0.6	*Pseudostuda menziesii*	0.1	0.2	0.1
				Rhus trilobata	Tr	0.1	0.1
Boraginaceae	0.6	0.6	0.7	*Ribes* sp.	0.1	0.3	0.1
Geum triflorum/Potentilla gracilis/P.	0.7	0.7	1.0	*Rosa* sp.	2.6	1.2	1.9
Lomatium sp./*Musineon divaricatum*				*Salix* sp.	1.7	1.6	0.7
Unidentifiable composites (includes 13	1.0	0.4	0.8	*Shepherdia canadensis*	0.8	0.8	0.4
Compositae genera)	0.4	0.4	0.5	*Spirea betuifolia*	0.4	0.4	0.1
Unidentifiable and unknown forbs				*Symphoricarpos* sp.	2.3	1.2	1.5
Compositae genera)	4.0	3.3	4.1				
Unidentifiable and unknown forbs	2.0	1.8	2.2				

[a]Estimated canopy coverage less than 0.05%.

sagewort and juniper, ranked high in canopy coverage and in diets of native ungulates. Others, including rose (*Rosa* sp), shrubby cinquefoil *(Potentilla fruticosa),* snowberry (*Symphoricarpos* sp.), and willow (*Salix* sp.) were common plants but contributed little to diets. Big sagebrush was evidently a preferred forage for wild ungulates when available. Several species that were potentially preferred foods, such as Douglas-fir and Oregon grape, were excluded from tests because they did not meet minimum canopy coverage requirements. The proportion of browse in summer cattle diets was low (4%), but the pattern of species use was similar to that observed for native ungulates. Juniper, pine, and fringed sagewort comprised 74% of the identifiable browse in cattle samples.

Discussion

Our data indicate that the greatest overlap in diets of native ungulates on East Front winter ranges during an average winter (U.S. Department of Commerce. 1980) occurred between bighorns and elk in early winter. The extent of overlap decreased in late winter as bighorns decreased their grass consumption and increased intake of browse. Mule deer fed primarily on browse throughout the winter in 2 sites which were representative of the extremes of currently occupied wintering areas along the East Front. If the 1981 cattle samples were representative, cattle food habits in summer were similar to elk and bighorn winter food habits. Reviews by Buechner (1960), Capp (1968), Mackie (1981), Nelson (1982), and Nelson and Leege (1982) indicate that dietary overlaps reported in this study were within the range of values reported in other studies.

Although canopy coverage is at best a crude index of relative forage availability (National Academy of Sciences 1962), comparisons of diets with ranked canopy coverages demonstrated that all ungulate species included in the tests used plants within the graminoid forage class in a similar manner: they either ate graminoids in proportion to relative availability or selectively fed on the most abundant graminoids available. Wild ungulates used essentially the same sets of forbs and shrubs in winter. Cattle were evidently more selective in forb use, possibly because they had access to forbs which were unavailable to wild ungulates in winter due to deterioration following the growing season, but used many of the same shrubs as game species. The major differences between diets were in the proportions of each forage class used rather than which species within a forage class were consumed. This pattern is not surprising considering the relatively high palatability of dominant graminoids on the study sites (Mueggler and Stewart 1980), the limited number of forb items with high canopy coverages (a selection even more limited in winter), and the low relative availability of browse species rated as highly palatable (Mueggler and Stewart 1980).

The importance of juniper to wintering ungulates deserves special note. During an average winter, juniper constituted half of the diet of mule deer and approximately 1/6 of the late winter diets of elk and bighorns. Studies of food habits in the East Front area (Schallenberger 1966, McCarthy et al. 1978) and studies in other areas of Montana in which creeping juniper is found (Lovass 1958, Martinka 1968) support the idea that juniper is an important staple winter food rather than an emergency alternative used when nothing else is available as the low palatability rating assigned by Mueggler and Stewart (1980) would suggest.

Literature Cited

Buechner, H.K. 1960. The bighorn sheep in the United States, its past, present and future. Wildl. Monogr. 4.

Capp, J.C. 1968. Bighorn sheep, elk, mule deer range relationships: a review of the literature. Rocky Mountain Nat. Ass. and Colorado State Univ., Fort Collins.

Cottom, G., and J.T. Curtis. 1956. The use of distance measures in phytosociological sampling. Ecology 37:451-460.

Daubenmire, R. 1959. A canopy-coverage method of vegetational analysis. Northwest Sci. 33:43-64.

Ihsle, Helga B. 1982. Population ecology of mule deer with emphasis on potential impacts of gas and oil development along the east slope of the Rocky Mountains, northcentral Montana. M.S. Thesis, Montana State Univ., Bozeman.

Kasworm, W.F. 1981. Distribution and population characteristics of mule deer along the East Front, northcentral Montana. M.S. Thesis, Montana State Univ., Bozeman.

Lovaas, A.L. 1958. Mule deer food habits and range use, Little Belt Mountains, Montana. J. Wildl. Manage. 22:275-282.

Lund, R.E. 1978. MSUSTAT - an interactive statistical analysis system. Dep. Mathematics, Montana State Univ., Bozeman.

Mackie, R.J. 1981. Interspecific relationships. p. 487-507. *In:* O.C. Wallmo (ed.). Mule and black-tailed deer of North America. Wildlife management Institute, Univ. Nebraska Press.

Martinka, C.J. 1968. Habitat relationships of white-tailed and mule deer in northern Montana. J. Wildl. Manage. 32:558-565.

Mueggler, W.F., and W.L. Stewart. 1980. Grassland and shrubland habitat types of western Montana. U.S. Forest Serv. Intermountain Forest and Range Exp. Sta. Gen. Tech. Rep. INT-66.

Mueggler, W.F. 1981. Forage production on important rangeland habitat types in western Montana. J. Range Manage. 34:347-353.

National Academy of Sciences. 1962. Basic problems and techniques in range research. Pub. No. 890, Washington, D.C.

Nelson, J.R. 1982. Relationships of elk and other large herbivores. p. 415-441. *In:* J.W. Thomas and D.E. Toweill (eds.), Elk of North America. Wildlife Management Institute, Stackpole Books, Harrisburg, Pa.

Nelson, J.R., and T.A. Leege. 1982. Nutritional requirements and food habits. p. 323-367. *In:* J.W. Thomas and D.E. Toweill (eds.), Elk of North America. Wildlife Management Institute, Stackpole Books, Harrisburg, Pa.

Nie, N.H., C.H. Hull, J.G. Jenkins, K. Steinbrenner, and D.H. Bent. 1975. SPSS, statistical package for the social sciences, 2nd ed. McGraw-Hill, New York.

Pfister, R.D., B.L. Kovalchik, S.F. Arno, and R.C. Presby. 1977. Forest habitat types of Montana. U.S. Forest Serv. Intermountain Forest and Range Exp. Sta. Tech. Rep. INT-34.

Siegel, S. 1956. Nonparametric statistics for the behavioral sciences. McGraw-Hill, New York.

Sparks, D.R., and J.C. Malechek. 1968. Estimating percentage dry weight in diets using a microscopic technique. J. Range Manage. 21:264-265.

Steele, R.G.D., and J.H. Torrie. 1960. Principles and procedures of statistics. McGraw-Hill, New York.

U.S. Department of Commerce. 1979-1981. Climatological data for Montana. Nat. Oceanic Atmos. Admin. Environ. Data Serv., Asheville, North Carolina. Vol. 82-84.