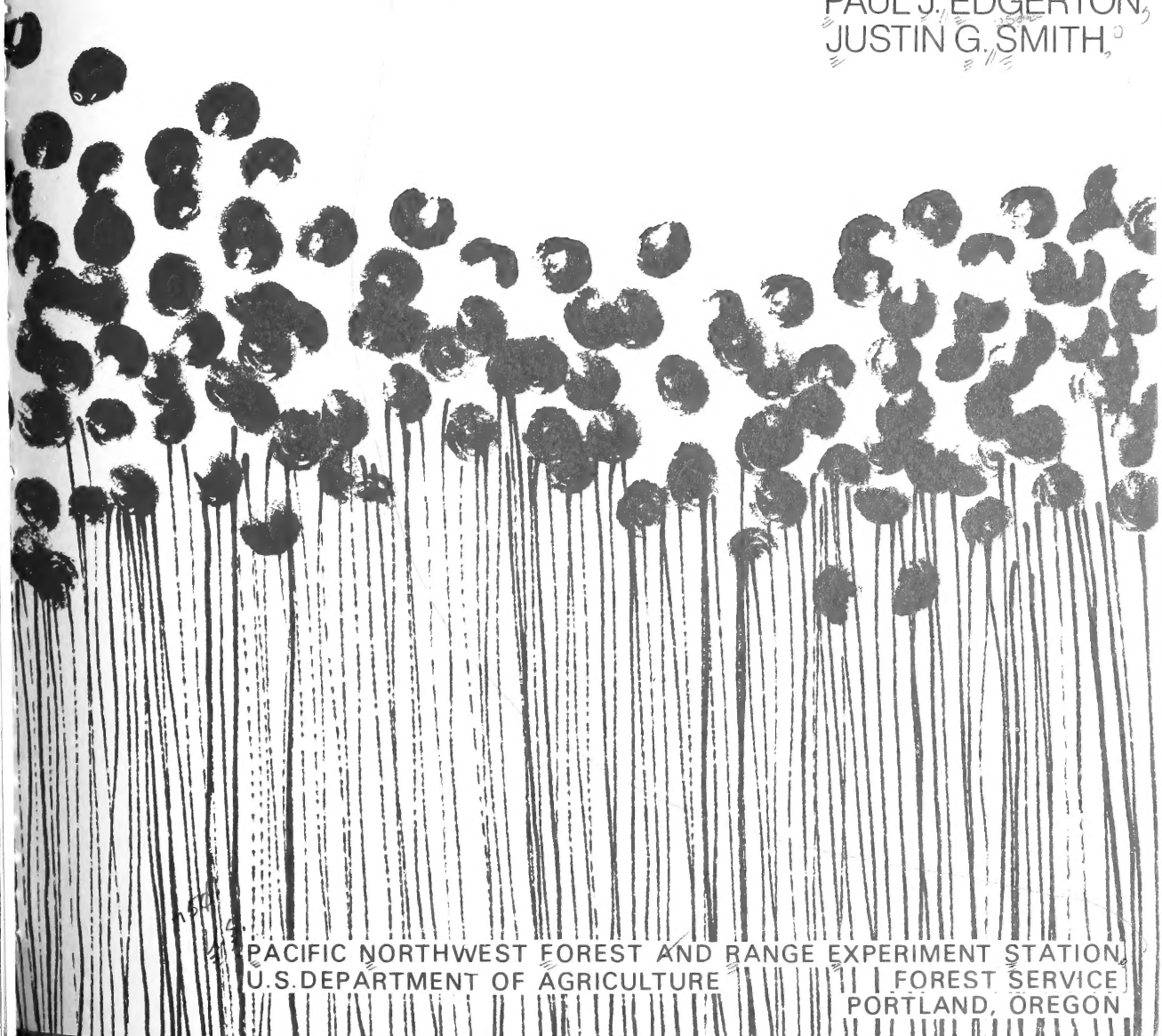
1971
USDA FOREST SERVICE RESEARCH PAPER PNW-112

SEASONAL FORAGE USE BY DEER AND ELK ON THE STARKEY EXPERIMENTAL FOREST AND RANGE, OREGON

PAUL J. EDGERTON
JUSTIN G. SMITH



PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE | FOREST SERVICE
PORTLAND, OREGON

ABSTRACT

Seasonal forage use by mule deer (Odocoileus hemionus hemionus) *and Rocky Mountain elk* (Cervus canadensis nelsoni) *was determined in the three major habitats--open forest, dense forest, and grassland--that characterize the ponderosa pine-Douglas-fir* (Pinus ponderosa-Pseudotsuga menziesii) *vegetation type of the Blue Mountains of eastern Oregon. Food grades derived from data on diet and forage abundance were used to compare the habitats as sources of forage. Open forest land rated highest in spring, summer, and fall. This habitat had a season-long abundance of forage, particularly elk sedge* (Carex geyeri), *a highly preferred grasslike plant. Grassland rated second in the spring when succulent forbs were abundant but dropped to third during the summer and fall periods when grassland plants were largely dry and unpalatable. Deer and elk then sought food as well as cover in the forest habitats. Although low-growing shrubs contributed most to the dense forest food grade, that habitat was probably more important as cover than as a source of food.*

Keywords: Forage plants, habitats, food habits, mule deer *(Odocoileus hemionus hemionus)*, Rocky Mountain elk *(Cervus canadensis nelsoni)*, elk sedge *(Carex geyerii)*, Starkey Experimental Forest and Range, Oreg.

A knowledge of local wildlife preferences for food and cover is prerequisite to the effective management of the animals and their habitat. It is particularly important to administrators of public lands for which the management objective is to enhance or maintain suitable habitat while minimizing conflicts with other resources.

Mule deer (*Odocoileus hemionus hemionus*) and Rocky Mountain elk (*Cervus canadensis nelsoni*) spend 8 or more months of the year on midelevation ranges in the ponderosa pine-Douglas-fir (*Pinus ponderosa-Pseudotsuga menziesii*)[1/] type of the Blue Mountains of eastern Oregon.

Interactions of deer and elk use with livestock grazing, logging, and other resource uses are frequent and far-reaching. Yet, despite a need for better coordinated management, the local habitat needs of big game have not been extensively studied. The only published information available is that of Skovlin et al. (1968). However, because they studied big game-cattle relationships, their findings were limited to forage species and habitats important to cattle.

This paper presents the results of a 3-year study of seasonal forage use by deer and elk on a portion of the Starkey Experimental Forest and Range, an area representative of the central Blue Mountains.

DESCRIPTION OF THE STARKEY EXPERIMENTAL FOREST AND RANGE

In the Starkey Range in the central Blue Mountains near La Grande, Oregon, undulating uplands are dissected by moderate to steeply walled drainages; elevations range from 3,500 to 5,000 feet. Annual precipitation averages 20 inches, of which nearly half is snow. The soils and vegetation have been described by Strickler (1966); soils originated from basalt and pumicite. The vegetation is closely associated with soil type and depth, and habitats have developed in a mosaic pattern. Three distinct types of habitats--open forest, dense forest, and grassland--have been classified.

The open forest is the most extensive habitat, covering almost half the area (fig. 1). It consists of ponderosa pine and Douglas-fir intermixed in open stands on ridgetops and moderately sloped south exposures. Principal understory plants include bunchgrasses, elk sedge (*Carex geyeri*), and low-growing shrubs. Heartleaf arnica (*Arnica cordifolia*), lupines (*Lupinus* spp.), and several other forbs are abundant in spring and summer.

The dense forest is found on north and east exposures on deep pumice soils (fig. 1). It includes mature stands of mixed conifers, mainly Douglas-fir, grand fir (*Abies grandis*), and western larch (*Larix occidentalis*); and seral stands dominated by lodgepole pine (*Pinus contorta*). Huckleberries (*Vaccinium* spp.), twinflower (*Linnaea borealis*), and pyrolas (*Pyrola* spp.) are among the most abundant understory plants.

[1/] Scientific names for grasses and sedges are according to Hitchcock (1950); for forbs and shrubs, Hitchcock et al. (1955-69); for trees, Little (1953). Common names are according to Garrison et al. (1967).

Figure 1.--*Major habitats of the Starkey Experimental Forest and Range: open forest (top), dense forest (middle), grassland (bottom).*

Grassland openings are intermingled with the forest habitats (fig. 1). Bunchgrasses such as bearded bluebunch wheatgrass (*Agropyron spicatum*), Sandberg bluegrass (*Poa secunda*) and onespike danthonia (*Danthonia unispicata*) form the principal plant cover. However, composition varies greatly with season. During the spring and early summer while the shallow soils are wet, many species of succulent forbs are abundant. Among the more important ones are common camas (*Camassia quamash*), serrated balsamroot (*Balsamorhiza serrata*), and bicolor biscuitroot (*Lomatium leptocarpum*).

Deer, elk, and cattle share the range. Cattle are grazed approximately 4 months each summer. Skovlin et al. (1968) reported that deer use averaged 2.8 days per acre and elk use averaged 1.5 days per acre annually. The seasonal length of big game use varies and is determined by weather conditions, particularly snow accumulation. In most years deer and elk inhabit the area from early April through late December. Numbers of deer seem to remain relatively constant during the period of use. The elk population, however, is highest during May and June and again in November when a part of the elk herd is migrating across the area to or from adjacent summer ranges.

METHODS

The Study Area

The study was conducted during 1964 through 1966 in an area of experimental range from which cattle were excluded. Open forest comprised 47 percent of the area; grassland, 41 percent; and dense forest, 12 percent. Water was available on or adjacent to the study area at all seasons.

Measurements

Deer-elk diet was calculated from estimates of forage production and utilization. Data were taken three times a year in each type to follow changes in use brought about by seasonal changes in forage availability and palatability. The first measurements were made in June while spring forbs were abundant. The elk population was usually at its peak at that time. Summer measurements were taken in mid-August after grass and shrub growth was complete. Fall measurements were made in late November or early December just before snow forced deer and elk to move to their winter ranges.

Herbage production was estimated by species on clusters of permanent plots randomly located within each habitat. Each cluster consisted of 10 plots regularly spaced along a 100-foot line. A total of 450 plots were examined each season. Individual plots covered a rectangular area of 1.92 square feet. Production was determined by the weight-estimate method of Pechanec and Pickford (1937b). Only herbage considered potentially palatable was included in the estimate. For example, the dry, cured portions of grasses and the older, woody stems of shrubs were excluded. The summer production estimate minus summer forage use was taken as the fall estimate since little growth occurred between the two sampling dates. The small amount of grass regrowth that occurred in the grassland during the fall was estimated and added to the fall production estimate.

Utilization was estimated on circular plots of 6 square feet positioned concentrically over the production plots. The ocular-estimate-by-plot method (Pechanec and Pickford 1937a) was used. Although it is probable that the actual diet included a few additional species not sampled, it is unlikely that any of these missed made up an appreciable part of the diet. Occasional light use by small herbivores such as rabbits, mice, and squirrels when noted was not included in the utilization estimates.

Forage ratios and food grades (Hess and Swartz 1940) were calculated for forage species and habitats. These indexes allow comparison of individual food items and habitats as sources of forage. The forage ratio of a given species is the ratio of its percentage of the diet to its percentage of the total forage available. For example, in a given habitat at a given season, suppose that species X made up 10 percent of the total amount of all species eaten and that it made up 5 percent of the total amount of all species available, then its forage ratio would be $10/5 = 2.0$. A ratio greater than 1 indicates a preference; a ratio of less than 1 suggests the species was eaten but not sought out. The food grade is the result of weighting herbage production according to the forage ratio. Those species with a forage ratio of 1 or more are given their full production value; those with a forage ratio of less than 1 are given a value equal to the forage ratio times herbage production. For example, if species X had a forage ratio of 2.0, as above, and produced 20 pounds of available forage per acre, its food grade value would be 20. If, however, its forage ratio had been 0.8 instead of 2.0, its food grade value would be $0.8\ (20) = 16$. The sum of these values for species making up 1 percent or more of the diet constitutes the seasonal food grade for the habitat. Thus, the food grades represent the effective production of food species. Food grades and production estimates are all expressed in pounds (dry weight) per acre.

RESULTS

Forage availability and animal use varied during the 3-year study period. The fluctuations were related to yearly differences in seasonal precipitation and temperature. The results presented here are 3-year averages.

Use was recorded on 73 species, including 15 grasses and grasslike plants, 46 forbs, and 12 shrubs. Most forage use was concentrated on a few species but none were heavily used. Five species made up more than one-half of the total diet for combined seasons and habitats.

Spring

The spring period showed the greatest variety and abundance of forage species. Many forbs and grasses were available, or palatable, only during the spring and early summer. Forage production averaged 336 pounds per acre in grassland, 324 in open forest, and 155 in dense forest. Forage use was highest in the grassland, lowest in the dense forest.

Forbs were the most important plant group in the spring diet, accounting for more than half of the forage eaten and almost half of that available (table 1). Twenty-two of 29 species used in the grassland and 22 of 38 species used in the open forest were forbs. The most important forbs were common camas and bicolor biscuitroot in the grassland, and heartleaf arnica in the open forest. Forbs were not important in the dense forest diet.

Table 1.--*Spring diet of deer and elk and forage availability in three habitats on the Starkey Experimental Forest and Range, Oregon*

(In percent)

Species[1]	Grassland		Open forest		Dense forest		Combined habitats[2]	
	Diet	Available forage	Diet	Available forage	Diet	Available forage	Diet	Total available forage
Grasses:								
Carex geyeri	--	0	30	29	--	1	14	14
All grasses	9	41	32	50	2[3]	4	18	43
Forbs:								
Arnica cordifolia	--	0	17	10	--	3	8	5
Balsamorhiza serrata	9	10	--	<1	--	0	--	4
Camassia quamash	38	6	--	<1	--	0	17	3
Geum triflorum	--	0	5	1	--	0	--	<1
Lomatium leptocarpum	14	11	--	<1	--	0	6	5
Lomatium nudicaule	7	1	--	<1	--	0	--	<1
Lupinus spp.	--	0	6	8	--	0	--	4
Microseris nutans	5	5	--	<1	--	0	--	2
Sidalcea oregana	6	<1	--	0	--	0	--	<1
All forbs	91	59	46	38	3[3]	41	63	47
Shrubs:								
Spiraea betulifolia	--	0	6	3	--	1	--	1
Symphoricarpos albus	--	0	12	3	--	<1	6	2
Vaccinium membranaceum	--	0	--	0	14	7	--	<1
Vaccinium scoparium	--	0	--	0	72	18	6	1
All shrubs	--	0	22	12	95	55	19	10

[1] Species listed constituted at least 5 percent of the diet in a habitat; a dash indicates less than 5 percent.

[2] Data for each habitat were weighted by the acreage of the habitat, then combined.

[3] Neither the forage class nor any species constituted 5 percent of the diet; the class percentage is shown for comparison with the other classes.

The remainder of the diet was equally divided between grasses and shrubs. Grasses were almost as abundant as forbs but made up less than 20 percent of the diet. Most use was observed on elk sedge, a grasslike species, in the open forest. Shrubs were available only in the forest habitats. Huckleberries (*Vaccinium scoparium* and *V. membranaceum*) dominated the dense forest diet. Common snowberry (*Symphoricarpos albus*) was used most heavily in the open forest.

Even though forage use was lowest in the dense forest, more elk pellet groups were observed there than elsewhere, indicating that elk probably used it primarily for cover.

Summer

As spring forbs dried and shattered, forage availability changed quickly. Animal diets indicated a response to these changes since the proportion of forbs in the diet dropped sharply and grasses and shrubs increased (table 2).

The greatest change took place in the grassland openings, where grasses as well as forbs became dry and unpalatable. The few succulent plants present during the summer period were mostly stemmy, aromatic species such as low gumweed (*Grindelia nana*). By mid-August usable grassland forage dropped to less than 100 pounds per acre. Accordingly, summer forage use was less than 25 percent of the spring average. Light use was recorded on 15 species including seven grasses and eight forbs. The most heavily used species was Oregon checkermallow (*Sidalcea oregana*); although not abundant, it made up 40 percent of the grassland diet.

In the open forest, the loss of spring forbs was largely offset by the rapid growth of other species, particularly elk sedge. Production dropped slightly to 287 pounds per acre. Although the number of species eaten decreased to 27, forage consumption increased as deer and elk shifted from the grassland to the forest habitats. Elk sedge was the principal food item. Its increased use, coupled with the decrease in forbs, accounted for the dominance of grasses in the summer diet.

Summer forage production in the dense forest reached a high of 180 pounds per acre. Use also increased. Forbs were abundant, but shrubs continued to dominate the diet. Adenocaulon (*Adenocaulon bicolor*) was the only forb accounting for more than 5 percent of the diet.

Fall

Diet and forage availability for the fall period are summarized in table 3. The major portion of the diet was grasses and elk sedge. Elk sedge continued to be the most important item in the open forest and the entire study area. Several grasses were also used in the grassland. Although these species were mostly dry and unpalatable during the summer, fall precipitation, coupled with mild temperatures, stimulated a small quantity of regrowth. This regrowth was very attractive to big game, particularly deer, and accounted for 98 percent of the grassland diet. Sandberg bluegrass was fed upon more than any other of the eight species on which use was recorded. As expected, forbs were a minor item, and the proportion of shrubs increased.

Table 2.--*Summer diet of deer and elk and forage availability in three habitats on the Starkey Experimental Forest and Range, Oregon*

(In percent)

Species[1/]	Grassland		Open forest		Dense forest		Combined habitats[2/]	
	Diet	Available forage	Diet	Available forage	Diet	Available forage	Diet	Total available forage
Grasses:								
Carex geyeri	--	0	62	46	--	1	45	30
Danthonia unispicata	16	28	--	0	--	0	--	5
Koeleria cristata	6	3	--	1	--	0	--	1
Sitanion hystrix	20	<1	--	0	--	0	--	<1
All grasses	44	37	64	72	5	6	52	58
Forbs:								
Adenocaulon bicolor	--	0	--	0	9	1	--	<1
Polygonum douglasii	5	18	--	0	--	0	--	3
Sidalcea oregana	40	1	--	0	--	0	5	<1
All forbs	56	63	13	14	13	41	19	27
Shrubs:								
Ribes lacustre	--	0	--	0	6	1	--	<1
Rosa spp.	--	0	7	<1	--	2	5	<1
Spiraea betulifolia	--	0	8	3	--	1	6	2
Symphoricarpos albus	--	0	8	4	--	<1	6	3
Vaccinium membranaceum	--	0	--	0	20	5	--	<1
Vaccinium scoparium	--	0	--	0	42	16	6	2
All shrubs	--	0	23	14	82	53	29	15

[1/] Species listed constituted at least 5 percent of the diet in a habitat; a dash indicates less than 5 percent.

[2/] Data for each habitat were weighted by the acreage of the habitat, then combined.

Table 3.--*Fall diet of deer and elk and forage availability in three habitats on the Starkey Experimental Forest and Range, Oregon*

(In percent)

Species[1]	Grassland		Open forest		Dense forest		Combined habitats[2]	
	Diet	Available forage	Diet	Available forage	Diet	Available forage	Diet	Total available forage
Grasses:								
Agropyron spicatum	10	3	--	<1	--	0	--	<1
Calamagrostis rubescens	--	0	6	19	--	3	--	13
Carex geyeri	--	0	50	46	--	1	34	30
Danthonia unispicata	24	27	--	0	--	0	6	6
Koeleria cristata	26	3	--	<1	--	0	6	<1
Poa secunda	34	4	--	0	--	0	8	<1
All grasses	98	39	59	72	[3]2	6	64	58
Forbs	2	61	--	14	5	41	1	27
Shrubs:								
Chimaphila umbellata	--	0	--	0	8	18	--	2
Pachistima myrsinites	--	0	--	<1	33	5	--	<1
Spiraea betulifolia	--	0	15	3	--	1	6	2
Symphoricarpos albus	--	0	22	4	--	<1	8	2
Vaccinium membranaceum	--	0	--	0	20	5	--	<1
Vaccinium scoparium	--	0	--	0	26	16	--	2
All shrubs	--	0	41	14	93	53	35	15

[1] Species listed constituted at least 5 percent of the diet in a habitat; a dash indicates less than 5 percent.

[2] Data for each habitat were weighted by the acreage of the habitat, then combined.

[3] Neither the forage class nor any species constituted 5 percent of the diet; the class percentage is shown for comparison with other classes.

Forage Ratios and Food Grades

The seasonal values listed in table 4 give added meaning to the information presented on forage availability and diet. For example, in the grassland during the spring, the forage ratio of common camas was 6.2; thus, it was preferred over serrated balsamroot rated at 0.9. However, because it was less abundant than the latter species, its food grade value was lower (20.3 vs. 28.8). The importance of elk sedge is further emphasized by these indexes. Because it was both sought out and abundant at all seasons, it made up a large share of the total food grade for the season. In fact, during the summer and fall periods, the food grade for elk sedge alone was greater than that for all grassland and dense forest species combined.

Largely owing to elk sedge, the open forest received the highest food grade in each season. The grassland rated second in the spring while succulent forbs were available but dropped to third during the summer and fall when grassland plants were mostly dry and unpalatable. The slight rise in the fall value for the grassland reflected the availability and use of grass regrowth. Shrubs accounted for most of the total food grade for the dense forest in each season.

DISCUSSION

Seasonal trends were apparent in deer and elk use of habitats and forage classes. They resulted from the interaction of many factors, the most important of which was the availability of preferred forage. Thus, during the spring, deer and elk fed mostly in the grassland and open forest where succulent forbs were available. The abundance of forage in those habitats was reflected in their high food-grade values. However, later, as the preferred forbs matured, deer and elk shifted almost entirely to the forest habitats for food as well as cover. Accordingly, summer and fall food grades for the grassland were low. Those for the open forest also dropped, but not greatly, because elk sedge and several kinds of shrubs were available to take the place of the spring forbs. On the other hand, the dense-forest food grade was highest in the fall when shrubs reached their greatest importance in the diet. Similar seasonal shifts in habitat use have been reported by Smith (1952), Stevens (1966), and others.

Use was recorded on many species, but regardless of season, only a few made up the bulk of the diet. The staple forage species was elk sedge. This plant is also an important forage on other ranges (Murie 1951; Young and Robinette 1939). It is important because it remains palatable as well as abundant throughout the grazing season. Perhaps its palatability is also enhanced by the relatively high nutrient content that it maintains throughout the growing season (Skovlin 1967).

Several species were very abundant but rarely eaten. Some were apparently unpalatable, and others were little used because of the availability of more preferred species. For example, Douglas stonecrop (*Sedum douglasii*) was abundant in the grassland and in parts of the open forest but was not eaten. Twinflower made up nearly half of the forage available in the dense forest, but few plants were utilized, although DeNio (1938) found it commonly used on winter range in Idaho. The effect of vegetal composition on diet was also well illustrated by the use of bunchgrasses. Deer and elk have been observed

Table 4.--*Seasonal forage ratios and food grades for three habitats on the Starkey Experimental Forest and Range, Oregon*

Species[1/]	Forage ratio			Food grade (pounds per acre)		
	Spring	Summer	Fall	Spring	Summer	Fall
Grassland:						
Agropyron spicatum	0.2	0.8	3.5	--	2.3	3.0
Danthonia unispicata	.2	.6	.9	8.5	14.6	24.5
Koeleria cristata	.9	2.2	10.0	--	2.5	2.6
Poa secunda	.1	0	9.4	--	--	3.6
Achillea millefolium	.6	.2	.1	8.6	2.3	--
Balsamorhiza serrata	.9	.5	0	28.8	2.3	--
Camassia quamash	6.2	0	0	20.3	--	--
Grindelia nana	.3	.3	.3	--	2.2	--
Lomatium leptocarpum	1.3	0	0	36.8	--	--
Microseris nutans	1.0	0	0	16.0	--	--
Polygonum douglasii	0	.3	0	--	4.5	--
Total for the type[2/]	--	--	--	153.1	33.6	36.9
Open forest:						
Calamagrostis rubescens	<.1	<.1	.3	--	--	16.6
Carex geyeri	1.0	1.4	1.1	94.2	131.7	129.2
Arnica cordifolia	1.7	3.6	0	32.1	--	--
Lupinus spp.	.8	1.7	0	18.7	--	--
Spiraea betulifolia	2.4	2.4	4.9	--	9.2	8.9
Symphoricarpos albus	3.7	2.1	5.9	11.0	10.9	10.6
Total for the type[2/]	--	--	--	197.1	172.8	173.9
Dense forest:						
Pyrola spp.	0	0	1.0	--	--	5.0
Chimaphila umbellata	.2	.2	.5	4.5	7.2	14.7
Pachistima myrsinites	.5	.5	7.1	3.1	3.9	8.3
Rosa spp.	.8	1.6	.4	--	4.5	--
Vaccinium membranaceum	2.1	3.8	3.8	10.3	9.7	9.6
Vaccinium scoparium	3.9	2.6	1.7	28.7	29.0	27.6
Total for the type[2/]	--	--	--	53.7	64.0	73.4

[1/] Species listed constituted at least 5 percent of the seasonal food grade; a dash indicates the food grade was less than 5 percent.

[2/] Includes all species that constituted 1 percent or more of the seasonal diet for the habitat.

to graze bunchgrasses heavily during the winter and early spring on winter ranges adjacent to the study area. Yet, they grazed grasses little when they reached this area in late spring, apparently because more preferred forbs were also available. For the same reason, they relished the regrowth of grasses in the fall when forbs were not available.

Although many of the forage species used by big game on the study area are shared with cattle on adjacent ranges, the lack of excessive use on any species found by this study corroborates the conclusion of Skovlin et al. (1968) that no direct competition for forage exists on the Starkey Range. Nevertheless, competition may occur on similar ranges that are overstocked with either cattle or big game. It is most likely to develop in the open forest in the summer and fall when both cattle and game are using that habitat. Elk sedge and shrubs would be the key plants in demand. Because of its comparative size, as well as the potential for competitive forage use, the open forest should receive the greatest consideration in management plans for dual-use ranges in the central Blue Mountains.

The dense forest has the greatest potential for habitat improvement. At present, the understory of mature stands produces relatively little palatable forage for either big game or livestock. But this amount can be greatly increased by a coordinated harvest of merchantable trees. Selective or patch cuttings can create seral plant communities with a great number of forage species, many of which remain palatable throughout the grazing season. As this study previously pointed out, these stands are important cover, particularly for elk. Hence, portions of stands suitable as cover should be left available, but their optimum size and distribution have not yet been determined.

LITERATURE CITED

DeNio, R. M.
1938. Elk and deer foods and feeding habits. N. Amer. Wildlife Conf. Trans. 3: 421-427.

Garrison, George A., Jon M. Skovlin, and Charles E. Poulton.
1967. Northwest range-plant symbols. USDA Forest Serv. Res. Pap. PNW-40, 121 p. Pac. Northwest Forest & Range Exp. Sta., Portland, Oreg.

Hess, A. D., and Albert Swartz.
1940. The forage ratio and its use in determining the food grade of streams. N. Amer. Wildlife Conf. Trans. 5: 162-164.

Hitchcock, A. S.
1950. Manual of the grasses of the United States. U. S. Dep. Agr. Misc. Publ. 200, 1051 p.

Hitchcock, C. Leo, Arthur Cronquist, Marion Ownbey, and J. W. Thompson.
1955-69. Vascular plants of the Pacific Northwest. 5 vols. Seattle: Univ. Wash. Press.

Little, Elbert L., Jr.
1953. Check list of native and naturalized trees of the United States (including Alaska). U.S. Dep. Agr. Handb. 41, 472 p.

Murie, Olaus, J.
1951. The elk of North America. 376 p. Stackpole Co., Harrisburg, Pa., and Wildlife Manage. Inst., Washington, D. C.

Pechanec, J. F., and G. D. Pickford.
1937a. A comparison of some methods used in determining percentage utilization of range grasses. J. Agr. Res. 54: 753-765.

Pechanec, Joseph F., and G. D. Pickford.
1937b. A weight estimate method for the determination of range or pasture production. J. Amer. Soc. Agron. 29: 894-904.

Skovlin, Jon M.
1967. Fluctuations in forage quality on summer range in the Blue Mountains. USDA Forest Serv. Res. Pap. PNW-44, 20 p. Pac. Northwest Forest & Range Exp. Sta., Portland, Oreg.

_____, Paul J. Edgerton, and Robert W. Harris.
1968. The influence of cattle management on deer and elk. N. Amer. Wildlife & Natur. Resour. Conf. 33: 169-181.

Smith, Justin G.
1952. Food habits of mule deer in Utah. J. Wildlife Manage. 16: 148-155.

Stevens, David R.
1966. Range relationships of elk and livestock, Crow Creek Drainage, Montana. J. Wildlife Manage. 30: 349-363.

Strickler, Gerald S.
1966. Soil and vegetation on the Starkey Experimental Forest and Range. Soc. Amer. Forest. Proc. 1965: 27-30.

Young, V. A., and W. L. Robinette.
1939. A study of the range habits of elk on the Selway Game Preserve. Univ. Ida. Bull. 34(16), Sch. Forest. Bull. 9, 48 p.

Edgerton, Paul J., and Justin G. Smith.
1971. Seasonal forage use by deer and elk on the Starkey Experimental Forest and Range, Oregon. USDA Forest Serv. Res. Pap. PNW-112, 12 p., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Forage use in open and dense forest and grassland habitats was greatly influenced by the seasonal availability of preferred forage plants. Habitat ratings showed that open forest was the most important at all seasons; elk sedge was the staple forage plant.

Keywords: Forage plants, habitats, food habits, mule deer *(Odocoileus hemionus hemionus)*, Rocky Mountain elk *(Cervus canadensis nelsoni)*, elk sedge *(Carex geyerii)*, Starkey Experimental Forest and Range, Oreg.

Edgerton, Paul J., and Justin G. Smith.
1971. Seasonal forage use by deer and elk on the Starkey Experimental Forest and Range, Oregon. USDA Forest Serv. Res. Pap. PNW-112, 12 p., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Forage use in open and dense forest and grassland habitats was greatly influenced by the seasonal availability of preferred forage plants. Habitat ratings showed that open forest was the most important at all seasons; elk sedge was the staple forage plant.

Keywords: Forage plants, habitats, food habits, mule deer *(Odocoileus hemionus hemionus)*, Rocky Mountain elk *(Cervus canadensis nelsoni)*, elk sedge *(Carex geyerii)*, Starkey Experimental Forest and Range, Oreg.

Edgerton, Paul J., and Justin G. Smith.
1971. Seasonal forage use by deer and elk on the Starkey Experimental Forest and Range, Oregon. USDA Forest Serv. Res. Pap. PNW-112, 12 p., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Forage use in open and dense forest and grassland habitats was greatly influenced by the seasonal availability of preferred forage plants. Habitat ratings showed that open forest was the most important at all seasons; elk sedge was the staple forage plant.

Keywords: Forage plants, habitats, food habits, mule deer *(Odocoileus hemionus hemionus)*, Rocky Mountain elk *(Cervus canadensis nelsoni)*, elk sedge *(Carex geyerii)*, Starkey Experimental Forest and Range, Oreg.

Edgerton, Paul J., and Justin G. Smith.
1971. Seasonal forage use by deer and elk on the Starkey Experimental Forest and Range, Oregon. USDA Forest Serv. Res. Pap. PNW-112, 12 p., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Forage use in open and dense forest and grassland habitats was greatly influenced by the seasonal availability of preferred forage plants. Habitat ratings showed that open forest was the most important at all seasons; elk sedge was the staple forage plant.

Keywords: Forage plants, habitats, food habits, mule deer *(Odocoileus hemionus hemionus)*, Rocky Mountain elk *(Cervus canadensis nelsoni)*, elk sedge *(Carex geyerii)*, Starkey Experimental Forest and Range, Oreg.

The mission of the PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION is to provide the knowledge, technology, and alternatives for present and future protection, management, and use of forest, range, and related environments.

Within this overall mission, the Station conducts and stimulates research to facilitate and to accelerate progress toward the following goals:

1. Providing safe and efficient technology for inventory, protection, and use of resources.
2. Development and evaluation of alternative methods and levels of resource management.
3. Achievement of optimum sustained resource productivity consistent with maintaining a high quality forest environment.

The area of research encompasses Oregon, Washington, Alaska, and, in some cases, California, Hawaii, the Western States, and the Nation. Results of the research will be made available promptly. Project headquarters are at:

College, Alaska	Portland, Oregon
Juneau, Alaska	Roseburg, Oregon
Bend, Oregon	Olympia, Washington
Corvallis, Oregon	Seattle, Washington
La Grande, Oregon	Wenatchee, Washington

The FOREST SERVICE of the U.S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — as directed by Congress — to provide increasingly greater service to a growing Nation.