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MULE DEER FORAGING PREFERENCE AMONG FIVE SAGEBRUSH (*ARTEMISIA* L.) TAXA

Carl L. Wambolt¹

ABSTRACT.—The hypothesis that sagebrush taxa are equally utilized by mule deer (*Odocoileus hemionus hemionus*) on winter range was tested. Five taxa were studied for 10 years at 2 locations. The taxa were *Artemisia tridentata* ssp. *tridentata* (basin big sagebrush), *A. t.* ssp. *wyomingensis* (Wyoming big sagebrush), *A. t.* ssp. *vaseyana* (mountain big sagebrush), *A. tripartita* ssp. *tripartita* (tall threetip sagebrush), and *A. arbuscula* ssp. *arbuscula* (low sagebrush). Possible mule deer preferences were determined each year individually for the 2 sites. Utilization was high enough to conclude all taxa are important forage, but not excessive enough to mask preference. *Artemisia tridentata* ssp. *vaseyana* (34.4%) and *A. arbuscula* ssp. *arbuscula* (35.6%) were preferred over *A. t.* ssp. *wyomingensis* (10.9%) and *A. t.* ssp. *tridentata* (6.8%) at the Ashbough site. At the Scudder site there were few differences in preference for *A. t.* ssp. *vaseyana* (32.1%), *A. t.* ssp. *wyomingensis* (28.8%), and *A. tripartita* ssp. *tripartita* (32.0%). While ungulates often demonstrate a preference among taxa, all sagebrush taxa are a potentially valuable forage source.

Key words: *Artemisia*, forage preference, Montana, mule deer, sagebrush.

Beetle (1960) estimated that sagebrush (*Artemisia* L.) taxa occur on as much as 109 million ha in the western United States. While developments, management, and fire in the region have considerably reduced this area, the importance of sagebrush taxa and the communities in which they occur is obvious for natural resource management (Wambolt 1998). Wambolt (1996) stated, “Consideration of sagebrush ecology, including forage values, is a necessity for judicious range management.”

Several studies have reported preference ratings of herbivores for various sagebrush taxa (Scholl et al. 1977, Sheehy and Winward 1981, Welch et al. 1981, 1983, Welch and McArthur 1986, Wambolt 1996). With the exception of Wambolt (1996), these studies based their conclusions on short-term projects with small numbers of tame animals under unnatural circumstances. Wambolt (1996) attempted to avoid anomalies that might occur under the previously described conditions by conducting a 10-year study under natural conditions to determine preferences of wild mule deer (*Odocoileus hemionus hemionus*) and elk (*Cervus elaphus nelsoni*) for 4 sagebrush taxa.

The purpose of this study was similar to that of Wambolt (1996). Similarities included conducting the study over a 10-year period to determine the preference of wild mule deer

for sagebrush taxa under natural conditions. Several differences also exist. This study does not have the complication of elk browsing along with mule deer. Also, the sagebrush taxa are somewhat different. This study examines *Artemisia tridentata* Nutt. ssp. *tridentata* (basin big sagebrush), *A. t.* ssp. *wyomingensis* Beetle and Young (Wyoming big sagebrush), *A. t.* ssp. *vaseyana* [Rydb.] Beetle (mountain big sagebrush), *A. tripartita* Rydb. ssp. *tripartita* (tall threetip sagebrush), and *A. arbuscula* Nutt. ssp. *arbuscula* (low sagebrush). Finally, the 2 study sites are separated by a large distance. The present study was conducted 200 km by air from the Wambolt (1996) investigation. In the present study the hypothesis was tested that sagebrush taxa are utilized equally as forage by mule deer on winter range. The test was made each year over a 10-year period under natural conditions for 5 taxa at 2 study sites.

METHODS

Study Area

The Ashbough and Scudder study areas are located approximately 86 km apart on Bureau of Land Management land in Beaverhead County, Montana. The Ashbough site (44°47'N, 112°38'W) is 50 km south of Dillon, and the

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Scudder site (45°18'N, 113°5'W) is 40 km west of Dillon. Both are at elevations of 1980 m, which is typical of elevations used by mule deer on winter range in southwestern Montana. Mule deer were the only ungulate of any significance to use these sites during the winters of the study. Average annual precipitation at the sites is approximately 380 mm, with half received as snow, although the peak occurs in May and June. Vegetative composition on both sites is dominated by an overstory of sagebrush taxa. At the Ashbough site *Artemisia tridentata* ssp. *vaseyana*, *A. t.* ssp. *wyomingensis*, *A. t.* ssp. *tridentata*, and *A. arbuscula* ssp. *arbuscula* comprise the overstory. At the Scudder site *A. t.* ssp. *vaseyana*, *A. t.* ssp. *wyomingensis*, and *A. tripartita* ssp. *tripartita* are dominants. The understory at both sites is dominated by *Agropyron spicatum* [Rydb.] Scribn. (bluebunch wheatgrass) and *Festuca idahoensis* Elmer (Idaho fescue). The sagebrush taxa at both study sites are present in nearly equal quantities (Table 1) and intermixed as a natural cafeteria for wintering mule deer due to a mosaic of microsites.

Sampling and Analysis

The preference of mule deer among the sagebrush taxa for use as winter forage was evaluated on the 2 deer winter ranges. The portions of the 2 winter ranges measured were confined to areas of 30 × 60 m that comprised each natural cafeteria. Sampling was conducted by establishing eight 1 × 30-m belt transects located parallel to each other at 8.6-m intervals within each browse cafeteria. All sagebrush plants rooted within the belt transects were permanently located and identified by taxon. Thus, the same plants were measured for winter utilization throughout the study.

Sagebrush plants that have been browsed develop a very twisted growth form. This was the situation on the 2 study sites, where a relatively high level of browsing had occurred in the past. Therefore, it was determined that an adequate sample of leaders measured for length, before and after browsing, could not be obtained. Because the study purpose was to determine relative preference of mule deer for the sagebrush taxa, it was decided to compare the proportion of leaders browsed among the taxa at each site. This procedure was not affected by the gnarled sagebrush crowns. A previous study (Guenther 1989) determined

TABLE 1. Percent canopy cover of 5 sagebrush (*Artemisia*) taxa at 2 study sites in 1982 at the beginning of the study. Data were determined by the line-intercept method on eight 30-m lines established along each of the belt transects used to sample sagebrush preference.

Taxon	Canopy cover (%)	
	Ashbough	Scudder
<i>A. tridentata</i> ssp. <i>vaseyana</i>	7.2	7.5
<i>A. tridentata</i> ssp. <i>wyomingensis</i>	7.9	8.0
<i>A. tridentata</i> ssp. <i>tridentata</i>	6.9	—
<i>A. tripartita</i> ssp. <i>tripartita</i>	—	8.3
<i>A. arbuscula</i> ssp. <i>arbuscula</i>	6.4	—
TOTAL ARTEMISIA	28.4	23.8

that the number of browsed leaders and total utilization obtained by measuring leader lengths were highly correlated ($r = 0.94$, $P \leq 0.0001$) for *Purshia tridentata* [Pursh] D.C. (bitterbrush). The percentage of *P. tridentata* leaders Guenther (1989) found removed by browsing at 18 locations was adequately predicted ($\pm 10\%$) by the proportion of leaders browsed. Because sagebrush leaders are shorter than those of *P. tridentata*, it is logical that results between the 2 methods for sagebrush would be similar.

Preceding the winter use period, each autumn between 1982 and 1991, a total of approximately 1350 and 1400 available leaders were tagged on 103 and 131 plants at the Ashbough and Scudder study sites, respectively. Sagebrush plants were each divided into segments from which randomly selected leaders were tagged. This procedure insured all portions of the sagebrush crown were sampled. The tagged leaders were reexamined each spring to determine the percentage of total leaders browsed the preceding winter.

The statistical analysis followed Wambolt (1996) and is repeated here for explanatory purposes:

A 1-way ANOVA with taxon as the factor was conducted each year individually for the 2 sites. This avoided year and location effects that could confuse the results. The observations in the ANOVA are a transformation on the proportion of utilized leaders. Because the proportions are based on relatively small sample sizes, a variance stabilizing arcsin transformation was used (Snedecor and Cochran 1980, Steel and Torrie 1980). This transformation is not used to remove inequalities in variance, but is used when the variation is purely binomial, often arising from unequal

denominators. The Least Significant Difference (LSD) method ($P \leq 0.05$) protected by a prior F-test ($P \leq 0.05$) was used for comparing treatment means (Snedecor and Cochran 1980).

RESULTS AND DISCUSSION

Browsing levels (Tables 2, 3) at both sites were in the utilization range considered desirable to detect possible foraging preferences (Wambolt 1996). Utilization was high enough to conclude that the taxa are important forage sources at the 2 sites. At the same time utilization was not so heavy that possible preferences might have been masked. During periods of deep snow accumulation, the availability of taxa might vary from normal and mask preferences. In the same manner, prolonged periods of severe temperatures, snow accumulation, and snow crusting might necessitate higher than normal consumption of all taxa that would have the same result. Because the study was conducted during a decade of below-average snowfall, no severe winters occurred that would have minimized preference differences. The 2 study sites should be considered individually because the sagebrush taxa present varied between the 2 locations.

The 4 taxa at the Ashbough site fell distinctly into 1 of 2 preference classes for mule deer (Table 2). *Artemisia tridentata* ssp. *vaseyana* and *A. arbuscula* ssp. *arbuscula* were clearly preferred over *A. t.* ssp. *wyomingensis* and *A. t.* ssp. *tridentata*. *Artemisia tridentata* ssp. *vaseyana* and *A. a.* ssp. *arbuscula*, with average utilization levels of 34.4% and 35.6%, respectively, were statistically the same 8 of 10 winters. The 2 winters that the taxa were not utilized equally were 1984–85, when browsing on *A. a.* ssp. *arbuscula* exceeded that on *A. t.* ssp. *vaseyana*, and 1991–92, when just the opposite occurred.

Artemisia tridentata ssp. *wyomingensis*, with a 10-year average utilization of 10.9%, and *A. t.* ssp. *tridentata*, with 6.8%, were distinctly less preferred than the other 2 taxa. On only 3 occasions (of 20 opportunities: 2 taxa \times 10 years), all during winters of light utilization, did the utilization level for either one of these taxa equal the browsing received by either *A. t.* ssp. *vaseyana* or *A. arbuscula* ssp. *arbuscula*.

Mule deer browsing at the Scudder site provided somewhat different results with the comparison between *Artemisia tridentata* ssp. *vase-*

yana and *A. t.* ssp. *wyomingensis*. In this case the 2 taxa were used at similar average levels of 32.1% and 28.8% during the entire study for *A. t.* ssp. *vaseyana* and *A. t.* ssp. *wyomingensis*, respectively (Table 3). The range of utilization levels of 9–59% for *A. t.* ssp. *vaseyana* and 10–52% for *A. t.* ssp. *wyomingensis* were also similar. Statistically over the study, the 2 taxa were browsed equally at the Scudder site. During the 4 winters a statistical difference ($P \leq 0.05$) was found; in 2 winters *A. t.* ssp. *vaseyana* was preferred over *A. t.* ssp. *wyomingensis*, while in the other 2 winters the opposite was true.

These data for *Artemisia tripartita* ssp. *tripartita* provide the 1st reported utilization levels for the taxon in a forage preference trial. *Artemisia tripartita* ssp. *tripartita* received an average utilization of 32.0% over the study. Interestingly, over that period *A. t.* ssp. *tripartita* had the greatest range of utilization values, from 8% to 74%. During the 10 years, browsing of *A. t.* ssp. *tripartita* significantly ($P \leq 0.05$) exceeded that of *A. tridentata* ssp. *vaseyana* 1 winter and was browsed less in 2 winters. Compared to *A. tridentata* ssp. *wyomingensis*, *A. t.* ssp. *tripartita* was twice used more and twice used less. Overall, little difference was found among utilization levels for the 3 taxa at the Scudder site; all taxa were browsed at similar levels to the preferred taxa at the Ashbough site.

Perhaps the greatest anomaly found in this study when results are considered with previous investigations (Scholl et al. 1977, Sheehy and Winward 1981, Welch et al. 1981, 1983, Welch and McArthur 1986, Wambolt 1996) of herbivore preferences for sagebrush taxa would be the acceptance by mule deer of *Artemisia tridentata* ssp. *wyomingensis* at the Scudder site. If the previous studies had a single point of agreement, it was that *A. t.* ssp. *vaseyana* was the preferred taxon. At the Scudder location browsing on the 2 taxa was essentially the same throughout the study.

This finding is also made relevant by the fact that the 3rd taxon at Scudder was *Artemisia tripartita* ssp. *tripartita*. Indeed, this taxon was preferred equally to the other 2 taxa by mule deer at the site. That implies that there was no shortage of preferred forage available that would lead to higher than usual consumption of *A. tridentata* ssp. *wyomingensis*. Also, the overall utilization levels were not

TABLE 2. Percentage of sagebrush leaders utilized during winter by taxon and year at the Ashbough study site. Means among taxa differ ($P \leq 0.05$) within date when followed by a different letter.

Year	<i>Artemisia tridentata</i> ssp. <i>vaseyana</i>	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i>	<i>Artemisia tridentata</i> ssp. <i>tridentata</i>	<i>Artemisia arbuscula</i> ssp. <i>arbuscula</i>
	----- % -----			
1982-83	46 ^a	8 ^b	2 ^b	60 ^a
1983-84	47 ^a	26 ^b	19 ^b	43 ^a
1984-85	15 ^b	3 ^c	15 ^b	38 ^a
1985-86	44 ^a	16 ^b	11 ^b	58 ^a
1986-87	25 ^a	4 ^b	0 ^b	18 ^a
1987-88	34 ^a	9 ^b	2 ^b	31 ^a
1988-89	28 ^a	13 ^b	10 ^b	38 ^a
1989-90	19 ^a	9 ^a	1 ^b	19 ^a
1990-91	25 ^a	5 ^b	3 ^b	32 ^a
1991-92	61 ^a	16 ^b	5 ^b	19 ^b

TABLE 3. Percentage of sagebrush leaders utilized during winter by taxon and year at the Scudder study site. Means among taxa differ ($P \leq 0.05$) within date when followed by a different letter.

Year	<i>Artemisia tridentata</i> ssp. <i>vaseyana</i>	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i>	<i>Artemisia tripartita</i> ssp. <i>tripartita</i>
	----- % -----		
1982-83	59 ^a	36 ^b	30 ^b
1983-84	39 ^a	38 ^a	43 ^a
1984-85	10 ^b	24 ^a	17 ^{ab}
1985-86	9 ^b	22 ^a	8 ^b
1986-87	24 ^a	23 ^a	27 ^a
1987-88	48 ^a	52 ^a	52 ^a
1988-89	23 ^a	25 ^a	10 ^b
1989-90	40 ^a	10 ^b	42 ^a
1990-91	40 ^b	38 ^b	74 ^a
1991-92	29 ^a	20 ^a	17 ^a

high enough to result in less selectivity by mule deer as found in another Montana study (Wambolt 1996). Utilization levels were often considerably higher on the northern Yellowstone winter range (Wambolt 1996), thereby tending to equalize the intakes of taxa during years of high ungulate populations or severe periods of weather.

Other investigators have determined that ungulate acceptance of a taxon for browsing varies among accessions (Welch et al. 1981, 1983, Welch and McArthur 1986, Welch et al. 1994). Thus, it seems likely that under natural conditions a given taxon might be more desirable to mule deer at one location than another. It appears that was the situation at the Scudder site when results there are compared to the Ashbough site and results of Wambolt (1996).

The variation in desirability of *Artemisia tridentata* ssp. *wyomingensis* as mule deer forage found at different locations emphasizes the importance of careful interpretation of limited information. This may be relevant to *A. tripartita* ssp. *tripartita* studied at the Scudder site. My data show that this taxon was utilized by mule deer to the same degree as *A. tridentata* ssp. *vaseyana*, a highly preferred taxon in all studies. However, it is reasonable to assume that this might vary at other locations, just as preference for *A. t.* ssp. *wyomingensis* has been found to vary between locations.

Both study sites are at elevations that in western Montana offer prime wintering opportunities for mule deer. They are high enough that conifer forest and topographical security and thermal cover are usually not far away. At

the same time they are low enough that snow depth usually does not significantly affect deer foraging. This is also the topographic position that generally has the most diversity of sagebrush taxa in western Montana. Thus, mule deer often have foraging options among sagebrush taxa on their western Montana winter ranges.

These results should improve understanding of sagebrush-ungulate relationships. Observed differences in foraging patterns are often questioned in making management decisions. This study and the others discussed lead to the general conclusion that while ungulates will demonstrate a preference among taxa, all sagebrush taxa are a potentially valuable forage source (Welch and McArthur 1979, Striby et al. 1987, Welch and Wagstaff 1992, Wambolt 1998).

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