Variation in Utilization of Big Sagebrush Accessions by Wintering Sheep

BRUCE L. WELCH, E. DURANT MCARTHUR, AND RONALD L. RODRIGUEZ

Abstract

We observed the effects of accessions of big sagebrush *(Artemisia tridentata)* on big sagebrush utilization by wintering domestic sheep. The sheep had continuous access to high quality alfalfa hay and were fed 0.28 kg of rolled barley per head per day. Utilization was expressed as a percent of the current year's vegetative growth consumed by the sheep and also as grams of dry matter eaten per stem. Utilization of accessions varied from 0 to 98% over 3 sites and from 0 to 7.112 g of dry matter per stem. The sheep tended to remove significant (60 to 70%) amounts of current growth from the more preferred accessions before removing even small (15%) amounts of less preferred accessions. If this is typical grazing behavior, preferred big sagebrush plants may be lost in areas subject to repeated grazing.

Key Words: palatability, *Artemisia tridentata,* preferred diet (sheep)

Observations of diet selection have shown that several species of wild herbivores discriminate among big sagebrush *(Artemisia tridentata)* accessions, preferring to feed on some types, while rejecting others (Smith 1950, Stevens and McArthur 1974, Welch et al. 1981, White et al. 1982, Remington 1983, Welch and McArthur 1986a). This discrimination suggests that big sagebrush shows variable palatability; such variation could be useful in improving range plants for domestic animals. Because studies of preference of domestic animals for big sagebrush are rare (Sheehy and Winward 1981), we investigated the influence of big sagebrush accession on big sagebrush utilization by domestic sheep.

Materials and Methods

Three uniform gardens were established in 1977 at Springville, Utah; 3 km east of Nephi, Utah (Salt Creek Canyon); and 15 km west/southwest of Helper, Utah (Gordon Creek Wildlife Management Area). The Springville site at 1,402 m is a basin big sagebrush (*(A.t.* ssp. *tridentata)* habitat type. Soil is of the Pleasant Grove series (Pleasant Grove gravelly loam, 6 to 10% slope). This series consists of deep, well-drained, gravelly or cobbley alluvial soils. Weathered limestone is the parent material. Soil permeability is moderate to rapid. Roots can penetrate to a depth of 1.5 m or more. About 9 cm of available water is held by this soil to a depth of 1.5 m. Soil pH ranges from 7.4 to 7.9. Average annual precipitation is 35 to 45 cm. The mean annual temperature is 8.9 to 11.1° C and the frost-free period is 130 to 170 days (Swenson et al. 1972).

The Salt Creek Canyon site at 1,676 m is a basin big sagebrush habitat type with 4 to 15% slopes. Soil is a Rofiss gravelly clay loam, deep and well-drained. Parent material is Arpien shale. Soil permeability is moderately slow. Soil pH ranges from 8.2 to 8.6. Effective annual precipitation is 20 to 35 cm. The mean annual temperature is 7.2 to 8.3° C, and the frost-free period is 100 to 140 days (Trickler and Hall 1984).

Authors are principal research plant physiologist, project leader, and soil conservationist, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, located at the Shrub Sciences Laboratory, 735 North 500 East, Provo, Utah 84601.

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The Gordon Creek Wildlife Management Area site at 2,130 m is a Wyoming big sagebrush *(A.t.* ssp. *wyomingensis)* habitat type with 1 to 6% slopes. Soil is of the Atrac series (Atrac is a very fine sandy loam). This series consists of deep, well-drained soils. Parent material is sandstone. Effective rooting depth is 1.5 m or more. Soil pH ranges from 6.6 to 8.0. Average annual precipitation is 30.5 to 35.6 cm. The mean annual temperature is 7.2 to 8.3° C, and the frost-free period is 100 to 120 days (USDA, SCS 1981).

Vegetation at each site was killed by disking and the sites were kept weed free by hand and mechanical means. The gardens were enclosed with deer-proof fences to enclose sheep and exclude deer. Containerized stock of 21 accessions of big sagebrush was planted in spring of 1978 at each site. Each accession was represented by 10 plants per site. The resulting 210 plants in each set were placed at random on a 3 by 3 m grid for each site. Table 1 lists the locations of seed collection sites for the accessions. The 3 common subspecies of big sagebrush were represented in this study: 10 accessions were *A.t.* ssp. *vaseyana,* 7 were *A.t.* ssp. *tridentata,* and 4 were *A.t.* ssp. *wyomingensis.*

Table 1. Locations of collection sites for 21 accessions of big sagebrush used in this study to determine utilization by wintering domestic sheep.

Subspecies	Accession	County & State	Elevation (m)
vaseyana	Colton	Utah, UT	2260
	Sardine Canyon	Cache, UT	1800
	Benmore	Tooele, UT	1900
	Petty Bishop's Log	Sanpete, UT	2380
	Durkee Springs	Sevier, UT	2270
	Salina Canyon	Sevier, UT	2350
	Clear Creek Canyon	Sevier, UT	2130
	Pinto Canyon	Washington, UT	1850
	Indian Peaks	Beaver, UT	2140
	Hobble Creek	Utah, UT	1500
tridentata	Clear Creek Canyon	Sevier, UT	1720
	Brush Creek	Uintah, UT	1830
	Loa	Wayne, UT	2140
	Dove Creek	Dolores, CO	2070
	Evanston	Uinta, WY	2020
	Wingate Mesa	San Juan, UT	2060
	Dog Valley	Juab, UT	1700
wyomingensis	Evanston	Uinta, WY	2130
	Kaibab	Coconino, AZ	2340
	Trough Springs	Humboldt, NV	1400
	Milford	Beaver, UT	1540

Utilization of the accessions was measured as follows: 15 annual vegetative leaders per plant were randomly selected through the entire crown and measured to the nearest centimeter in November 1983. These measurements were used to calculate a mean annual leader length per plant before browsing. Plants were remeasured using 15 randomly selected leaders during April 1984. A mean annual leader length after browsing was calculated. Utilization was calculated by dividing the mean leader length after browsing by the mean leader length before browsing, multiplying by 100, and subtracting from 100. Welch et al. (1981) reported a precision error of 4% for this method.

A second method of expressing utilization among the accessions was used. This consisted of multiplying the accessional mean per-

cent of vegetative leader eaten (data from this study) by the accessional mean length of the vegetative leader (data from Welch and McArthur 1986b) by the accessional mean total leader weight expressed as g/cm (data from Davis and Stevens (1986)). Results would rank the utilization of the accessions in terms of the mean number of grams eaten per leader. This method would take into account differences in growth rates among the accessions (Welch and McArthur 1986b). Unfortunately, only 10 of 21 accessions used in this study were studied by Davis and Stevens (1986). For the other 11 accessions, the heaviest reported value for the subspecies was used except for the Wyoming big sagebrush accessions, where the second heaviest was used. This was done because the Trough Springs accession has been treated as Wyoming big sagebrush but is not typical for that taxon and is being described as a new taxon (Winward et al. in review). Statistical analysis of this data set was not possible.

Five domestic sheep were obtained from a private operator. These sheep were open ewes about 4 to 6 years old. They were range-experienced sheep that had been exposed to the 3 subspecies of big sagebrush being tested. The 5 sheep were taken directly off the native range and placed in the Springville garden on 9 Dec. 1983; in the Nephi garden on 9 Jan. 1984; and the Gordon Creek garden on 9 Feb. 1984. While in the gardens, the sheep had continuous access to high quality alfalfa hay and 0.28 kg of rolled barley per head per day. This gave the sheep the choice to eat or not eat big sagebrush.

Differences in utilization as expressed on a percent basis among accessions were tested by one way analysis of variance with the sites as replications and plants within sites as subsamples (SPSS Inc. 1983). The Student-Newman-Keuls multiple range comparison test ($P<0.05$) was used to evaluate which accessions differed. Data collected were transformed by the arcsine percentage function for analysis and then returned to the percent values for final presentation (Snedecor and Cochran 1967).

Results and Discussion

Accessions of big sagebrush influenced utilization by sheep

Table 2. Variation in the utilization of 21 big sagebrush *(Artemisia tridentata)* accessions by wintering domestic sheep. Data expressed as percentage of current years vegetative growth eaten. Gardens are reps with 10 plants per accession per garden serving as subsamples.

Accessions	Percent of current years vegetative growth eaten			
	Gardens			Overall
	Spring-ville	Nephi	Gordon Creek	
Kaibab(w)[1]	97.1	97.8	100.0	98.3[a2]
Colton (v)	87.5	96.0	93.5	92.3[a]
Trough Springs (w)	91.0	85.5	96.8	91.1[a]
Wingate Mesa (t)	90.5	88.5	78.8	85.9[ab]
Milford (w)	86.7	84.5	76.8	82.7[ab]
Brush Creek (t)	79.0	83.5	82.5	81.7[ab]
Hobble Creek (v)	78.0	84.1	79.6	80.6[ab]
Pinto Canyon (v)	81.2	70.5	78.4	76.6[b]
Sardine Canyon (v)	53.5	59.6	61.3	58.1[c]
Petty Bishops Log (v)	55.3	48.9	42.2	48.3[c]
Evanston (w)	52.5	33.8	46.3	44.2[cd]
Indian Peaks (v)	38.3	45.9	35.1	39.8[cde]
Clear Creek Canyon (v)	21.6	24.6	18.7	21.6[de]
Benmore (v)	20.6	18.5	11.1	16.7[de]
Durkee Springs (v)	14.7	21.4	12.3	16.1[ef]
Salina Canyon (v)	10.4	12.3	9.9	10.9[f]
Dog Valley (t)	8.1	5.2	0.0	4.4[f]
Clear Creek Canyon (t)	1.7	3.9	0.0	1.9[f]
Evanston (t)	0.0	1.5	0.0	0.5[f]
Loa (t)	0.0	0.0	0.0	0.0[f]
Dove Creek (t)	0.0	0.0	0.0	0.0[f]
Gardens means	46.1	46.0	44.0	

[1]v = *Artemisia tridentata* ssp. *vaseyana*,
t = *A.t.* ssp. *tridentata*
v = *A.t.* ssp. *wyomingensis*.
[2]Means sharing the same superscript are not significantly different at the 5% level.

Table 3. Variation in the utilization of 21 big sagebrush accessions by wintering domestic sheep. Data expressed as accessional mean number of grams eaten per vegetative leader.

Accession	Mean[1] of vegetative leader eaten %	×	Mean length of vegetative leader cm	×	Mean total leader weight g/cm	=	Mean number of grams eaten per leader g
Hobble Creek (v)[2]	80.6		23.1		0.382		7.112
Colton (v)	92.3		17.2		447[3]		7.096
Kaibab (w)	98.3		20.7		.344[3]		7.000
Wingate Mesa (t)	85.9		20.9		.386[3]		6.930
Trough Springs (w)	91.1		15.5		379		5.352
Pinto Canyon (v)	76.7		23.2		.276		4.911
Sardine Canyon (v)	58.1		20.2		.359		4.213
Indian Peaks (v)	39.8		22.4		.447[3]		3.985
Milford (w)	82.7		17.2		.250		3.556
Petty Bishops Log (v)	48.4		15.3		.447[3]		3.337
Brush Creek (t)	81.7		16.7		.236		3.220
Evanston (w)	44.2		15.8		.344[3]		2.402
Clear Creek Canyon (v)	21.6		20.1		.447[3]		1.941
Durkee Springs (v)	16.1		20.6		.447[3]		1.483
Benmore (v)	16.7		18.8		.447[3]		1.403
Salina Canyon (v)	10.9		23.0		.316		0.792
Dog Valley (t)	4.4		33.0		.283		0.411
Clear Creek Canyon (t)	1.9		30.8		.386		0.226
Evanston (t)	0.5		30.9		.386[3]		0.060
Loa (t)	0.0		33.1		.386[3]		0.000
Dove Creek (t)	0.0		41.4		.286		0.000
Data source	This study		Welch & McArthur 1986b		Davis & Stevens 1986		by calculation

[1]Mean is for the accession.
[2]v = *Artemisia tridentata* ssp. *vaseyana*
t = *A. t.* ssp. *tridentata*
w = *A. t.* spp. *wyomingensis* (Trough Springs has been treated as ssp. *wyomingensis* but is not typical and is being described as a new taxon - Winward et al. in review).
[3]Due to the lack of specific accessional information, these values are in the case of *Artemisia tridentata* ssp. *vaseyana* ssp. *tridentata* the heaviest reported for the subspecies (Davis and Stevens 1986). Because Trough Springs is being described as a new taxon - Winward et al. in review - the second heaviest value is used for *A. t.* ssp. *wyomingensis*.

($P<0.05$, Table 2). Highest levels of utilization were seen in Kaibab, Colton, Trough Springs, Wingate Mesa, Milford, Brush Creek, and Hobble Creek accessions.

Wingate Mesa and Brush Creek accessions are *A.t.* ssp. *tridentata*. In general, subspecies *tridentata* is the least preferred by wintering mule deer (Stevens and McArthur 1974, Welch et al. 1981, Welch and McArthur 1986a). The preference domestic sheep showed for these accessions of subspecies *tridentata* was surprising. Both of these accessions differ from the other 5 accessions of subspecies *tridentata* in plant size and chromosome number. The Wingate Mesa and Brush Creek accessions are significantly smaller plants (McArthur and Welch 1982, Welch and McArthur 1986b). These accessions are tetraploids (2n = 36), whereas the larger and mostly uneaten subspecies *tridentata* accessions are diploids (McArthur et al. 1981). All the accessions in the most preferred array are tetraploids with the exception of Hobble Creek, which is basically diploid but also includes occasional tetraploids (McArthur and Sanderson, unpublished). All the accessions in the least preferred array are large-statured diploids with the exception of Salina Canyon, which is mostly a tetraploid mixture. Although tetraploid accessions are generally preferred by sheep, the role of ploidy in determining sheep preference for accessions of big sagebrush is unknown.

We observed differences in animal (sheep versus deer) browsing preference as demonstrated by the data presented here (Table 2) and in a companion study (Welch and McArthur 1986a) involving the same sagebrush plants. Although deer showed definite preferences (28.3 to 57.5% use per accession), they were not as discriminating in preference as sheep were (0.0 to 98.3% use per accession). Some accessions, most notably the Hobble Creek and Colton accessions of ssp. *vaseyana,* were highly preferred by both sheep and deer but many showed widely different use patterns, e.g., Kaibab ssp. *wyomingensis* (98.3% use by sheep with the top ranking versus 33.5% use by deer with the 16 ranking); Trough Springs ssp. *wyomingensis* (91.1% use by sheep with the 3 ranking versus 30.1% use by deer with the 20 ranking), and Salina Canyon ssp. *vaseyana* (10.9% use by sheep with a 16 ranking versus 41.7% use by deer with a 6 ranking). A notable overall use difference by sheep versus deer was sheep preference for Wyoming big sagebrush in contrast to deer.

Amount of vegetative current year's growth eaten by sheep was large. One third of the accessions had 80% or more of their current year's growth eaten. The sheep had continuous access to high-quality alfalfa hay and 0.28 kg rolled barley per head per day. There was no need for these range-experienced sheep to consume any big sagebrush except by choice. The sheep tended to remove most vegetative current growth from the more utilized accessions before removing even small amounts from less utilized accessions. If this is typical grazing behavior, preferred big sagebrush plants may be lost in areas subject to repeated heavy grazing.

When utilization was expressed on a mean number of grams per leader eaten basis, the highest 7 accessions were Kaibab, Colton, Trough Springs, and Hobble Creek, with Pinto Canyon and Sardine Canyon replacing the smaller accessions Milford and Brush Creek (Table 3).

In general, the 2 methods of expressing utilization agree. It has been our contention in the past (Welch and McArthur 1979) and continues to be our contention (Welch and McArthur 1986a and this study) that the Hobble Creek accession of big sagebrush is the most preferred accessions of big sagebrush for wintering mule deer and domestic sheep. Because of the high utilization we observed in the study, we are preparing to release Hobble Creek through the Soil Conservation Service's plant material program as a superior accession of big sagebrush for use on mule deer and domestic sheep winter ranges. For those areas where Hobble Creek can be established, grown, and stands maintained, it will provide a palatable, nutritious winter forage (Behan and Welch 1986, Davis and Welch 1986, Welch et al. 1986).

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