Add Three More to the List of Big Sagebrush Eaters

Bruce L. Welch

Abstract—This paper challenges the notion that big sagebrush (*Artemisia tridentata*) is a range plant of low value. Present data that documents the consumption of big sagebrush seeds by dark-eyed junco (*Junco hyemalis*), horned lark (*Eremophila alpestris*), and white-crowned sparrow (*Zonotrichia leucophrys*), and shows the nutritive value of the consumed seeds to be high in energy, crude protein, and phosphorus.

A number of years ago I gave a speech to the Utah Section of The Society for Range Management on the superiority of big sagebrush (*Artemisia tridentata)* as a winter forage for wild ungulates and domestic sheep. Emphasis was given to its higher digestibility, higher crude protein, higher phosphorus, and higher carotene content than other winter forages (Welch 1989). The essence of that speech is in table 1. After I completed the presentation, a seasoned range conservationist of 25-plus years got up and said: "Dr. Welch you make sagebrush sound real good—too bad nothing eats it." A lack of appreciation for big sagebrush as a forage plant is not uncommon. Big sagebrush is a competitor to grass (Vallentine 1989). But a statement of such profound unenlightenment caused me to be speechless for a moment. Then I enumerated to my range conservationist friend the animals I have watched eating big sagebrush (table 2).

Where does this lack of appreciation for big sagebrush as a forage plant come from? I believe I have a partial answer—Range Management text books (Heady 1975; Heady and Child 1994; Holechek and others 1989; Stoddart and others 1975; Vallentine 1989, 1990). Sixty-eight percent of comments made concerning big sagebrush in these six text books are of a negative nature. These comments included: "unpalatable to livestock," "high levels of volatile oils," "invader," "undesirable," "reduces the production of better plants," "causes rumen disorders," "uses up water," "woody," "noxious," "poisonous," "low value," "little used," "control," "eradicate," "convert," "suppressed grasses," and the list goes on. Only 9% of the comments on big sagebrush were positive. These comments included: "provide mule deer (*Odocoileus hemionus hemionus*), pronghorn antelope (*Antilocapra americana*), and domestic sheep (*Ovis aries*) with winter feed," "food for jack rabbits(*Lepus californicus*)," "food for sage grouse (*Centrocerus urophasianus*)," and "nesting sites for Brewer's sparrow (*Spizella breweri*)." Perhaps in his zeal to defend the faith—killing big sagebrush to produce more grass—my range conservationist friend forgot these few but positive comments. Unfortunately, he is not alone.

Listed in table 2 are 12 animals I have watched eating big sagebrush. Three of those animals were new to me and had not been documented in the literature: Dark-eyed junco

Table 1—Winter nutritive values of selected range plants (after Welch 1989).[a]

Species	In vitro digestibility	Crude protein	Phosphorus
Shrubs			
Artemisia tridentata			
Big Sagebrush	57.8	11.7	0.18
Cercocarpus montanus			
Mountain mahogany	26.5	7.8	0.13
Chrysothamnus nauseosus			
Rubber rabbitbrush	44.4	7.8	0.14
Juniperus osteosperma			
Utah juniper	44.1	6.6	0.18
Purshia tridentata			
Antelope bitterbrush	23.5	7.6	0.14
Grasses			
Agropyron desertorum			
Crested wheatgrass	43.7	3.5	0.07
Festuca idahoensis			
Idaho fescue	46.1	3.8	0.08
Hilaria jamesii			
Galleta	48.2	4.6	0.08
Oryzopsis hymenoides			
Indian ricegrass	50.5	3.1	0.44
Stipa comata			
Needle-and-thread	46.6	3.7	0.07

[a]Nutritive value based on vegetative tissue, not seeds.

Table 2—List of animals that the author has watched eating big sagebrush (*Artemisia tridentata*).

Black-tailed jack rabbit	*Lepus californicus*
Dark-eyed junco	*Junco hyemalis*
Domestic sheep	*Ovis aries*
Horned lark	*Eremophila alpestris*
Pronghorn antelope	*Antilocapra americana*
Pygmy rabbit	*Brachylagus idahoensis*
Rocky Mountain cottontail	*Sylvilagus nuttalli*
Rocky Mountain elk	*Cervus elaphus nelsoni*
Mule deer	*Odocoileus hemionus hemionus*
Sage grouse	*Centrocerus urophasianus*
Uinta ground squirrel	*Spermophilus armatus*
White-crowned sparrow	*Zonotrichia leucophrys*

In: McArthur, E. Durant; Ostler, W. Kent; Wambolt, Carl L., comps. 1999. Proceedings: shrubland ecotones; 1998 August 12–14; Ephraim, UT. Proc. RMRS-P-11. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Bruce L. Welch is Principal Research Plant Physiologist, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Shrub Science Laboratory, 735 N 500 E, Provo, UT 84606.

(Junco hyemalis), horned lark (*Eremophila alpestris*), and white-crowned sparrow (*Zonotrichia leucophrys*). All were eating the seeds of big sagebrush. The purpose of this report is to document the consumption of big sagebrush seeds and to determine the nutritive value of the seeds.

Methods

I first observed dark-eyed juncos pecking at big sagebrush inflorescences near Paul Bunyon's Woodpile, a point of interest about 56 km northeast of Delta, Utah.

Shortly after that initial observation, four dark-eyed juncos were collected near the site to verify actual consumption of big sagebrush seeds. Digestive systems were removed from the esophagus to the gizzard and placed in small plastic bags. The bags were transported in a cooler filled with ice to a laboratory freezer. Then the digestive systems were thawed and the contents removed. Next, the ingesta were placed inside of a 200-mesh sieve and washed with deionized water. After the washing, the contents were separated into three piles: grit, big sagebrush seed, and other foods. Big sagebrush seed piles and other food piles were placed on preweighed filter paper circles and dried to constant weight in a convention oven at 100°C. Percent of big sagebrush seeds on a dry-matter basis was calculated.

Big sagebrush seeds were collected from 30 plants in the area where the birds were harvested. Seeds were cleaned as outlined by Booth and others (1997); Welch (1995); Welch and Nelson (1995). After cleaning, the seeds were ground to a fine powder inside the mortar of a steel, motorized mortar and pestle. Liquid nitrogen was used to precool the mortar and pestle and then more liquid nitrogen was poured over the seeds and the seeds ground. Next, the powder was placed in plastic bottles fitted with airtight caps and stored at 0°C. I analyzed the ground seeds for in vitro digestibility, crude protein, phosphorus, and crude fat.

Ground seeds were digested using Pearson's (1970) in vitro digestibility method, except 1.0 g of fresh weigh was placed in the digestion tubes. The dry matter content was determined for the ground seeds. Inoculum was obtained from a slaughterhouse steer that was fed a ration of alfalfa and corn. Welch and others (1983) studied the ability of different rumen inocula to digest range forages. Steers on fattening ration digested range forages as well as inoculum from other sources (also Striby and others 1987). The CO_2-injected inoculum was processed 45 minutes after removal from the rumen (Milchunas and Baker 1982). Data was expressed as percent of dry matter digested.

Crude protein level was determined by the Kjeldahl method (Association of Official Analytical Chemists 1980) and expressed as a percent of dry matter. Phosphorus content was determined by spectrographic means (Association of Official Analytical Chemists 1980) and expressed as a percent of dry matter. Crude fat level was determined by the anhydrous ether method (Association of Official Analytical Chemists 1980) and expressed as a percent of dry matter.

Results

Results of the four food analyses expressed as a percent of total food, dry matter basis, were 64, 69, 71, and 76% big sagebrush seed for a mean of 70. In vitro digestion for four big sagebrush seed samples were 71.2, 72.7, 73.6, and 74.0% for a mean of 72.9. Crude fat levels for four samples were 28.2, 28.5, 29.1, and 29.8% for a mean of 28.9%. Crude protein level (one sample) was 28.8%. Phosphorus level was 0.545%.

Discussion

The results of this study clearly show that big sagebrush seeds were eaten by wintering dark-eyed juncos and at that time constituted about 70% of their diet.

One thing that appeared remarkable to me was, while searching the ingesta of the four birds, I did not find one seed bract. Considering the small size of the seed—2 million or more for 0.454 kg—and the more numerous but equal in size bracts shows a great amount of dexterity on the part of the birds, especially when all the birds I watched that day were swinging up and down and back and forth on the inflorescences. Big sagebrush inflorescences are not stiff enough to support the weight of the feeding birds without movement.

During this initial observation period, I noticed small footprints around many of the big sagebrush plants and trails going from one plant to another (fig. 1). This situation is very similar to a sage grouse wintering range except in miniature. In addition, seeds and seed bracts were found on the snow surface. Birds were walking around pecking in those areas, presumably, picking up seeds that had fallen.

Since this initial observation, I have watched dark-eyed juncos eat big sagebrush seeds at 36 different wildland sites. These sites encompassed an area from The Fort Hall Indian Reservation, Idaho, in the north, to Salina, Utah, in the south, from Lynndyl, Utah, in the west, to Helper, Utah, in the east. In addition, I have observed the eating of big sagebrush seed by horned larks (7 wildland sites) and white-crown sparrows (11 wildland sites) (fig. 2). The eating of big sagebrush seed by dark-eyed juncos and at least two other birds in the wild appears to be a widespread phenomenon.

I filled a backyard bird feeder with big sagebrush seeds and watched not only dark-eyed juncos (fig. 3) feeding on the seeds, but house finches (*Carpodacus mexicanus*), black-capped chickadees (*Parus atricapillus*), and house sparrows (*Passer domesticus*).

In May of 1992, I observed dark-eyed juncos flying in and out of an open shed that was being used at the time to dry big sagebrush inflorescences that were collected the previous winter. Inside the shed, the birds were scratching and pecking around, among, and through the inflorescences (fig. 4). The whole scene reminded me of watching domestic chickens feeding in a barn yard. A pile of big sagebrush seeds (about 50 g) was placed near the layers of drying inflorescences. In less than a day, the entire pile was consumed by the dark-eyed juncos.

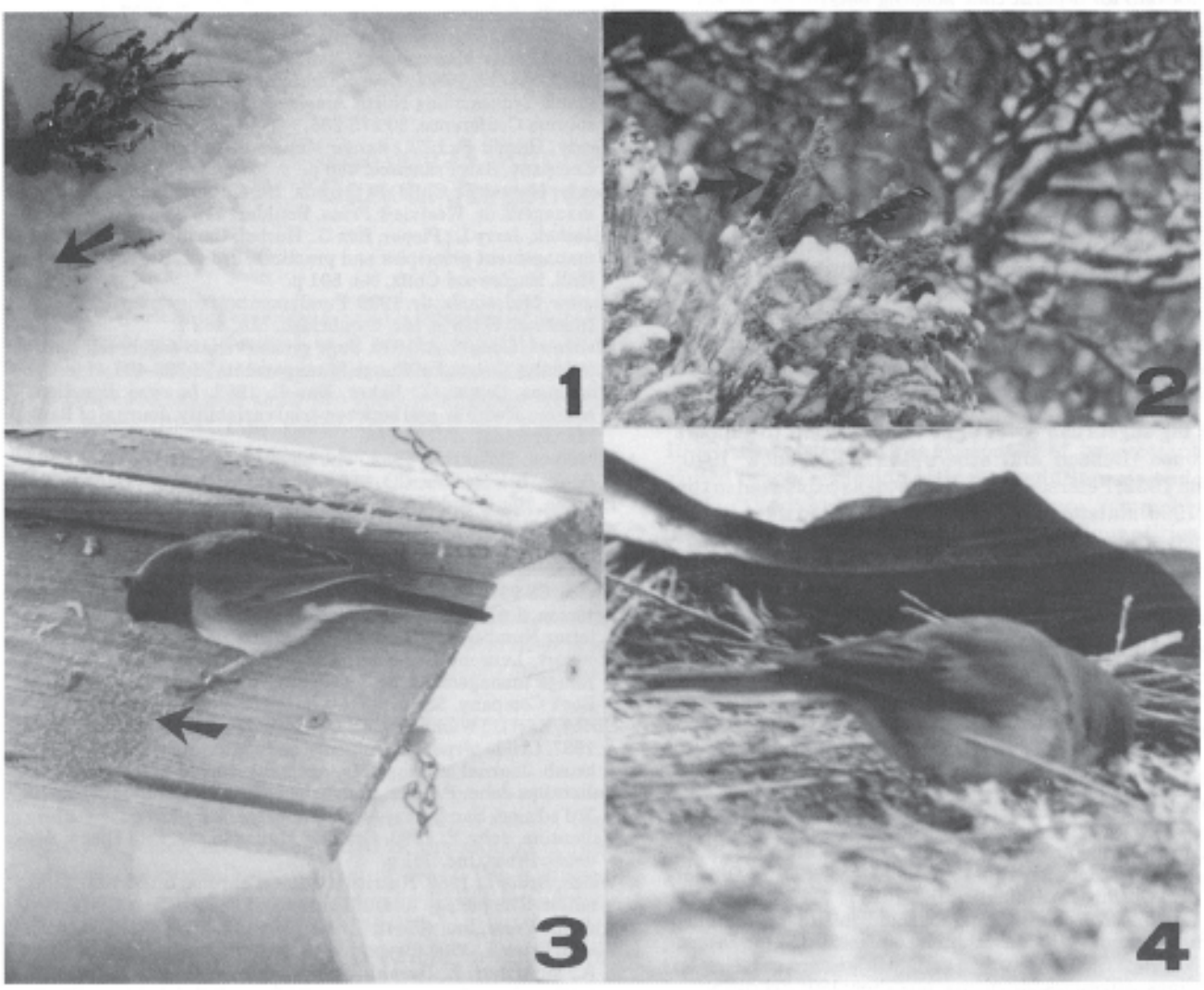

Figure 1—Footprints in snow of dark-eyed juncos feeding on big sagebrush seeds. Arrow pointing to big sagebrush seeds and seed bracts.
Figure 2—White-crown sparrows feeding on big sagebrush seeds. Arrow pointing to a bird feeding on seeds. All three birds were observed at some time eating seeds.
Figure 3—Dark-eyed junco eating big sagebrush seeds spilled on the roof of a backyard bird feeder. Arrow pointing to big sagebrush seeds.
Figure 4—Dark-eyed junco feeding on big sagebrush seed among drying big sagebrush inflorescences in May.

It is unknown how much of the yearly diet of dark-eyed juncos, horned larks, and white-crowned sparrows consists of big sagebrush seeds. Data presented in this study suggest that at times it may be a substantial amount. Probably more important than the absolute amount eaten on a yearly basis is the timing when the birds are eating the seeds. After fresh snow, big sagebrush seed may be the only food available to these birds. Perhaps there are times when big sagebrush is a keystone species (Hunter 1996) to not only these wintering birds but to others animals as well. Also, evidence was given in this study that dark-eyed juncos will consume big sagebrush seeds at times other than winter.

Energy, phosphorus, and protein are most limiting in the winter diet of animals (Dietz 1965). High in vitro digestion (72.9%) and high crude fat content (28.9%) of big sagebrush seeds are evidence that this food could furnish high levels of energy to the consuming animal. Crude protein level at 28.8% and phosphorus level at 0.545% further shows that big sagebrush seeds are rich in these needed nutrients. These levels would exceed the levels needed for maintenance of range birds (grouse, pheasant, quail, turkey) (Welch 1989). Interesting enough, Beck and Braun (1978) reported that wintering sage grouse gain weight during the winter, a time when their diet is nearly 100% big sagebrush leaves

and short shoots (Klebenow 1970; Patterson 1952; Peterson 1970). Not bad for a plant that nothing eats!

However, negativeness still persists, for example, Baxter in 1996 states in the publication "Sharing Common Ground on Western Rangelands: Proceedings of a Livestock/Big Game Symposium:"

> Dr. Alma Winward is a Plant Ecologist for the Intermountain Region of the U.S. Department of Agriculture, Forest Service, and a leading authority on the sagebrush-grass ecosystem. His opinion is that more acres of sagebrush-grass lands in the Western United States were held in low ecological status the past decade due to abnormally high sagebrush cover and density than currently occurring due to livestock grazing. He notes that when big sagebrush cover reaches 12 to 15 percent, the understory production of other plants decreases as canopy increases. This results in increased bare ground and reduction of forage for livestock and wildlife.

It takes big sagebrush cover of 20 to 40 percent to support sage grouse (Benson and others 1991; Klebenow 1970; Patterson 1952; Peterson 1970). If the ideas expressed in the Baxter (1996) statement were fully implemented there would be no sage grouse habitat and no sage grouse.

Not all Rangeland Management Specialists share this narrow and biased view. A statement from Heady and Child (1994-301 p.)—a range management text book—gives hope that big sagebrush is gaining some respect as a forage plant "One *example, Artemisia spp.* in thick stands are generally undersirable for livestock but furnish food and cover for wildlife species."

References

Association of Official Analytical Chemists. 1980. Official methods of analysis. W. Horwitz, ed., 13th Ed. Association of Official Analytical Chemist, Washington, DC. 1018 p.

Baxter, Garth. 1996. Improving rangeland health by thinning sagebrush stands with Tebuthiuron (spike 20 p). In: Evans, Keith E., comp. Sharing common ground in western rangelands: proceedings of livestock/big game symposium; 1996 February 26-28; Sparks, NV. Gen. Tech. Rep. INT-GTP-343. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 60-62.

Beck, Thomas D. I; Braun, Clait E. 1978. Weights of Colorado sage grouse. Condor. 80:241-243.

Benson, Lee A.; Braun, Clait E.; Leining, Wayne C. 1991. Sage grouse response to burning in the big sagebrush type. In: Comer, Robert D.; Davis, Peter R.; Roster, Susan Q.; (and others), eds. Proceedings national symposium issues and technology in the management of impacted wildlife; 1991 April 8-10; Snow Mass Resort, CO. Boulder, CO: Thorne Ecological Institute. 97-104.

Booth, D. Terrance; Bai, Yuguang; Roos, Eric E. 1997. Preparing sagebrush seed for market: effects of debearder processing. Journal of Range Management. 50:51-54.

Dietz, Donald R. 1965. Deer nutrition research in range management. Transactions North American Wildlife and Natural Resources Conference. 30:275-285.

Heady, Harold F. 1975. Range Management. McGraw-Hill Book Company, San Francisco. 460 p.

Heady, Harold F.; Child, R. Dennis. 1994. Rangeland ecology and management. Westview Press, Boulder. 519 p.

Holechek, Jerry L.; Pieper, Rex D.; Herbel, Carlton H. 1989. Range management principles and practices, 3rd ed. Regents/Prentice Hall, Englewood Cliffs, NJ. 501 p.

Hunter, Malcolm L., Jr. 1996. Fundaments of conservation biology. Blackwell Science, Inc. Cambridge, MA. 482 p.

Klebenow, Donald. A. 1970. Sage grouse versus sagebrush control in Idaho. Journal of Range Management. 23:396-400.

Milchunas, Daniel G.; Baker, Dan L. 1982. *In vitro* digestion—sources of within- and between-trial variability. Journal of Range Management. 35:199-203.

Patterson, Robert L. 1952. The sage grouse in Wyoming. Sage Books, Inc. Denver, CO. 455 p.

Pearson, Henry A. 1970. Digestibility trials: *in vitro* techniques. In: Paulsen, H. A.; Reid, E. H.; Parker, K. W., eds. Range and wildlife habitat evaluation—a research symposium. Misc. Publ. 1147. Washington, DC: U.S. Department of Agriculture, Forest Service. 85-92.

Peterson, Joel. 1970. Gone with the sage. Montana Outdoor Newsletter Number 9 September. 3 p.

Stoddart, Laurence A.; Smith, Arthur D.; Box, Thadis W. 1975. Range management, 3rd edition. San Francisco: McGraw-Hill Book Company. 532 p.

Striby, Karl D.; Wambolt, Carl L.; Kelsey, Rick G.; Havstad, Kris M. 1987. Crude terpenoid influence on in vitro digestibility of sagebrush. Journal of Range Management. 40:244-248.

Vallentine, John. F. 1989. Range development and improvements, 3rd edition. San Diego: Academic Press, Inc. 524 p.

Vallentine, John F. 1990. Grazing Management. San Diego: Academic Press, Inc. 531 p.

Welch, Bruce L. 1989. Nutritive value of shrubs. In: McKell, C. M., editor. The biology and utilizations of shrubs. San Diego: Academic Press, Inc. 405-424.

Welch, Bruce L. 1995. Beyond 12 percent purity. In: Roundy, Bruce A.; McArthur, E. Durant; Haley, Jennifer, S.; Mann, David K., comps. Proceedings: wildland shrub and arid land restoration symposium. Gen. Tech. Rep. INT-GTR-315. Ogden, Utah: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 126-129.

Welch, Bruce L.; Pederson, Jordan C.; Clary, Warren P. 1983. Ability of different rumen inoculum to digest range forages. Journal of Wildlife Management. 47:873-877.

Welch, Bruce L. Nelson, David L. 1995. Black stem rust reduces big sagebrush seed production. Journal of Range Management. 48: 398-401.