DIET PREFERENCE OF CALIFORNIA BIGHORN SHEEP ON NATIVE RANGELAND IN SOUTH-CENTRAL BRITISH COLUMBIA

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INTRODUCTION

In 1954, the total population of California bighorn sheep (Ovis canadensis californiana) in North America numbered only slightly more than 1,600 animals (Spalding et al., 1970). Three of the largest herds, containing approximately 400 animals each, occurred in British Columbia, while a similar-sized herd occurred in the southern Sierra Nevada Mountains of California.

The Junction herd, located between the confluence of the Fraser and Chilcotin Rivers in the central interior of British Columbia, has been a primary source for reintroductions of these animals into historical sheep ranges throughout western North America, particularly Washington, Oregon, North Dakota and Idaho (Spalding et al., 1970). In fact, approximately 42% of all California bighorn sheep in North America in 1970 originated genetically from this Chilcotin River stock.

In 1970, the total California bighorn population was estimated to be 3,200 animals (Spalding et al., 1970), an increase of 53% in British Columbia and 153% in the United States. Since 1970, no further data have been published, but we, in British Columbia, believe the herds have remained relatively stable. Reputed low herd productivity and competition with domestic

livestock, plus alienation of winter ranges, have combined to prevent native and newly-established herds in British Columbia from increasing in size or extending their respective ranges. This situation emphasizes the need for knowledgeably-formulated management practices if bighorn sheep are to survive without the artificial aid of reintroduction.

Buechner (1960) stated that bighorn sheep are dependent more on vegetation than any other component of their environment. Many wildlife management programs have stressed, specifically, the importance of critical winter range, particularly in terms of limiting forage quality and quantity. Consequently, winter feeding of wildlife with alfalfa and grain is a technique commonly used to overcome presumed deficiencies on critical winter ranges. Winter feeding represents an artifical means for maintaining bighorn sheep population, however, and should not form the entire framework of long-term management practices.

Many researchers have investigated winter diet of California bighorn in B.C. (Sudgen, 1961; Blood, 1961; Blood, 1967; Demarchi, 1965; Morrison, 1972). However, few people have looked at diet throughout all seasons of the year, while even fewer studies have examined these diets in terms of forage preferences and selectivity. Specifically, animal diets must be carefully evaluated in terms of forage availability before conclusions about preferred or key plant species for management can be made. Furthermore, preferred plant species on the summer range can be just as important managerially as preferred plant species

on the winter range; perhaps even more so since spring and summer grazing, during periods of active plant growth, may lead to long-term botanical changes. Additionally, quality of summer diet affects the ability of animals to survive winter stress, as unthrifty animals at the beginning of winter are less likely to survive until spring even if winter conditions are relatively mild.

Low herd productivity and the need for more information on California bighorn provided the impetus for a joint study among the B.C. Fish and Wildlife Branch, the University of British Columbia (Departments of Plant and Animal Science), and Simon Fraser University at the Okanagan Game Farm near Penticton in south central British Columbia. We, in the Department of Plant Science, U.B.C., have been studying the impact of grazing by bighorn on the plant community. More specifically, our overall objectives are to determine: (1) the trend in range condition produced by year-round foraging, and (2) sheep diet and forage selectivity as influenced by plant phenology throughout the grazing year. The data presented here resulted from our first summer of field work. These data, based upon diet selection of California bighorn sheep, provide a useful base for discussing the interpretation of forage preferences exhibited by any grazing or browsing animal.

STUDY AREA

During April, 1977, 20 California bighorn were released

into a 42 hectare (104 acres) enclosure adjacent to the Okanagan Game Farm. The plant communities, typical of some bighorn habitat in the province, are characteristic of the lower grassland zones dominated by big sagebrush (Artemesia tridentata) and bluebunch wheatgrass (Agropyron spicatum), with browse species such as saskatoon (Amelanchier alnifolia) and snowberry (Symphoricarpus albus) in the draws at lower elevations. At higher elevations, Ponderosa pine (Pinus ponderosa) provides an overstory for rough fescue (Festuca scabrella), bluebunch wheatgrass, and mixed forbs. Aspect and drainage conditions profoundly influence vegetational patterns, with sagebrush occupying dry sites and bluebunch wheatgrass occurring primarily on more northerly aspects.

METHODS

Forage utilization and trends in range condition were assessed by sampling for herbage productivity and botanical composition both within and outside exclosures of 480 square meters (5,200 sq. feet). Bighorn sheep diet and selectivity were determined by comparing relative proportions of plant species available for use throughout the grazing year. Identification of botanical material in feces was determined with epiderminal cell slides prepared for 65 of the 83 plant species found on the study site. Monthly botanical composition was determined from 40-30 meter (100 ft.) loop-transects located systematically

throughout the study site.

RESULTS

Data in Table 1 indicate the importance to sheep diet of three forage classes in terms of animal preference and selectivity. Browse in the diet during the spring month of May equaled 18%, which is approximately proportional to the relative availability of these woody plant species. In contrast to browse, total forbs in spring were highly selected, contributing 40% to the diet even though only 17.7% of the botanical composition. Balsamroot (Balsamorhizza sagittata) was highly preferred, comprising 9% of the diet. This early-maturing perennial forb was actually selected at two different time periods, as sprouting plants were immediately eaten as they reappeared following initial grazing. Grasses in early spring, other than rough fescue, were typically selected against. The most abundant plant species on the study site was bluebunch wheatgrass (30.6%), which constitued only 9% of the diet. This relationship points out a pitfall of investigating only diet to determine animal forage preferences. Bluebunch wheatgrass was one of the most frequent plant species in the May diet, yet is obviously not nearly as preferred as rough fescue or balsamroot, which appeared approximately 86% more often in the diet as in the available forage, 9.0 compared to 5.2%.

Grasses as a forage group constituted the largest proportion

of the animal's diet during all four months. In fact, the portion of the diet comprised of grasses increased from 42% in early spring to 77% during the summer month of August. However, in May, June, and July, grasses were apparently selected against as, in all three of these months, the relative proportion of total grasses available on the range was more than the relative proportion of grasses appearing in the diet. Only in August did these two proportions equalize, indicating that grasses, particularly bluebunch wheatgrass and cheatgrass (Bromus Tectorum), were less preferred as forage than either browse or forbs.

Rough fescue provides a major exception to this previous generalization, as in August this plant species composed 21.5% of the diet, even though occurring less than 1% of the botanical composition. However, data indicating high selectivity must be evaluated carefully. Even though a highly preferred forage species, rough fescue occurred on the study site exclusively as an understory of ponderosa pine. This pine overstory was intensively utilized by the sheep for shade during the hot August weather. Therefore, the high proportions of rough fescue in the diet may be partially attributable to its presence in shade areas as much as its apparent palatability.

Forbs displayed opposite trends to grasses, as they comprised successively smaller portions of the diet from May through August, declining from 40.0 to 14.5%. However, in all four months, forbs constituted a preferred category of forage,

TABLE 1:
BIGHORN DIET IN RELATION TO BOTANICAL COMPOSITION OF RANGE

Month	May			June			July			August		
Species	Diet	Bot Comp	RSI	Diet	Bot Comp	RSI	Diet	Bot Comp	RSI	Diet	Bot Comp	RSI
GRASS												
Agropyron spicatum	9.0	30.6	0.29	11.5	31.0	0.37	15.5	32.1	0.48	16.0	32.4	0.49
Bromus tectorum	1.0	13.7	0.07	1.0	21.2	0.05	1.0	23.1	0.04	0.0	20.7	0.0
Stipa comata	4.0	3.5	1.14	6.0	7.9	0.76	7.5	8.9	0.84	12.5	6.4	1.95
Koeleria cristata	5.0	5.9	0.85	7.5	5.9	1.27	10.0	6.6	1.52	14.0	7.1	1.97
Festuca scabrella	10.0	T		9.5	T		10.0	T		21.5	T	
Other grasses	13.0	11.5	1.13	11.5	10.6	1.08	14.5	7.1	2.04	13.0	9.0	1.44
Total Grasses	42.0	65.2	0.64	47.0	76.6	0.61	58.5	77.8	0.75	77.0	75.6	1.01
FORBS												
Balsamorhiza sagittata	9.0	5.2	1.73	19.0	3.9	4.87	1.5	2.2	0.68	0.0	2.9	0.0
Achillea millefolium	1.5	3.0	0.5	1.0	1.3	0.77	1.0	T		0.0	T	
Lupinus sericeus	3.0	1.2	2.5	1.0	T		1.5	T		1.5	T	
Other forbs	26.5	8.3	3.19	20.5	4.0	5.13	25.0	1.8	13.89	13.0	4.5	2.89
Total Forbs	40.0	17.7	2.26	41.5	9.2	4.51	29.0	4.0	7.25	14.5	7.4	1.96
BROWSE												
Artemesia tridentata	1.5	11.4	0.13	1.4	9.7	0.14	0.0	13.3	0.0	0.0	12.3	0.0
Amelanchier alnifolia	2.5	T		4.0	T		2.5	T		1.5	T	
Prunus virginiana	2.0	T		1.0	T		2.0	T		1.0	T	
Eriogonum huracleoides	3.0	1.8	1.67	0.5	1.0	0.5	0.5	1.0	0.5	0.0	1.2	0.0
Eriogonum niveum	2.5	2.2	1.14	0.0	1.6	0.0	1.0	2.4	0.42	0.0	2.3	0.0
Other browse	6.5	1.4	4.64	6.0	1.1	5.5	6.5	0.8	8.13	6.0	1.2	5.0
Total Browse	18.0	16.8	1.07	11.5	13.4	0.86	12.5	17.5	0.71	8.5	17.0	0.5

RSI = Relative Selectivity Index = $\frac{\%\ \text{Diet}}{\%\ \text{Bot. Comp.}}$ T = Trace

as per cent forbs in the diet always exceeded per cent forbs available on the study site. Balsamroot in June composed 19% of the diet, while all forbs together comprised 41.5%. Beginning in July, when balsamroot withered in response to depleted soil moisture reserves, indian paintbrush (Castilleja thompsonii) (4.5%) and lemonweed (Lithospermum ruderale) (3.5%) became the most highly selected forbs. A late blooming summer species, brown-eyed susan (Gaillardia aristata), made up 2% of the diet in August, which placed this plant as the most preferred forb in late summer.

Browse as a forage class declined in the diet throughout these four months from 18.0 to 8.5%, and as a forage class was selected in approximately the same proportions as in the available forage. However, big sagebrush is an unpalatable woody species, and should not be managerially lumped with other browse species which were generally selected for, even during the dry summer months of July and August. Saskatoon, chokecherry (Prunus virginiana) and snowberry all produced selectivity indexes (% diet/% botanical composition) greater than one, suggesting that these browse plants are preferred forage species.

Once again, however, these data must be evaluated carefully. Judging the importance of a plant species, based solely upon proportions in the diet, or even selectivity indexes, may represent a hasty conclusion. Saskatoon has a relatively small selectivity index, approximately 2/1. However, this plant species may be nutritionally important in the animal's diet.

Utilization of this browse species equaled 65% from May to August. Forbs were also intensively utilized (80%), while bluebunch wheatgrass, which composed 32% of the forage and 16% of the diet from July to August, was utilized less than 1% in terms of total standing crop.

We wish to stress the importance of these utilization measures for proper management of bighorn sheep or any other wildlife species. Diet or selectivity data perhaps correlate with crude protein or other forage quality needs of the animal. However, diet and selectivity data do not impart any information regarding the potential impact of foraging animals on their own habitat in terms of range condition. Saskatoon was heavily hedged, and may not be available for spring use in subsequent years. Sumac (Rhus glabra)was severely browsed and may or may not resprout to satisfy spring browsing needs of these animals in coming years. Bluebunch wheatgrass composed a large proportion of the diet during all four months, yet is not being stressed by animal utilization. In other words, selectivity and utilization measurements must both be determined before sound animal and habitat management programs can be developed.

The relationship between forage quality and selectivity is complex. Relating grazing preference to a single forage parameter, such as crude protein, provides dubious conclusions. In April and May, for example, crude protein levels for all forage classes were relatively similar, and typically greater than levels required for adequate growth and maintenance. However,

the sheep still exhibited marked forage selectivity. Other studies on Rocky Mountain bighorn sheep have suggested that forage moisture content correlated with food preferences (Todd, 1972). This correlation may indeed be true. Certainly, in early spring, the sheep eagerly sought succulent new forbs, and nearly eliminated some of these plant species from the grazed areas. Again, however, forage selection is not determined solely by moisture content. Rather, forage selection is in response to many complex factors that are dynamically related to both plant nutrient cycles and animal dietary needs.

Even selectivity data, based on individual plant species, may be incomplete. Bighorn sheep tend to be highly selective in their grazing of plant parts. The sheep consistently selected leaves rather than stems of bluebunch wheatgrass, June grass (Koeleria cristata), Kentucky bluegrass (Poa pratensis), rough fescue, and needle and thread (Stipa comata). Similarly, in autumn, the sheep selected fall regrowth of bluebunch wheatgrass over old growth. Bluebunch wheatgrass responds to autumn rainfall in terms of total biomass more than any other grass species on the study site, and this regrowth provided a diet of 18% crude protein. Thus, while bluebunch wheatgrass was selected against in each summer month, this plant species may still be managerially important as a forage that can provide high crude protein levels at a time of the year when protein for many other forage species is generally below maintenance.

These subtle selectivity patterns and nutritional para-

meters are extremely important. Bighorn sheep habitat consists of a variety of plant species, all of which contribute to diet during different and specific portions of the foraging year. Proper habitat management techniques must consider and reflect this wide habitat/diet variability.

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