Relationship of Range Quality to Range Condition in the Chilcotin Region, British Columbia

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Highlight: *Bluebunch wheatgrass and needleandthread plants were clipped from three different condition classes and six different growing periods in a wheatgrass/bluegrass association. The collected samples were chemically analyzed for crude protein, total ash, calcium, and phosphorous. The results were tested against the condition classes. There were no statistical differences for the components in needleandthread; however, bluebunch wheatgrass showed highly significant differences in the crude protein levels of ungrazed and overgrazed plants. It was also determined that even though the overgrazed wheatgrass had the highest percentage protein, the total weight of protein per unit area was much greater in ungrazed wheatgrass plants.*

One of the preferred forages in the Lower Chilcotin River region of British Columbia is bluebunch wheatgrass (*Agropyron spicatum*). Undoubtedly it was the most abundant forage plant prior to the introduction of livestock to the area. Heavy grazing has caused bluebunch wheatgrass to decline and needleandthread (*Stipa comata*) to increase with a consequent decline in the grazing value of this range.

Bluebunch wheatgrass can be considered a valuable but fragile resource. This grass is larger than needleandthread and is more readily available under winter snows. The fruits of needleandthread have a long, wiry awn and a sharp callus which aids the grass in seedling establishment but which also can cause mechanical injury to grazing ungulates. Therefore, compared to bluebunch wheatgrass, needleandthread is relatively poor forage for summer as well as winter.

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The grasslands of the riverbreaks and terraces in the Lower Chilcotin River region support a population of 350 to 400 California bighorn (*Ovis canadensis californiana*). Sugden (1961) postulated that this population has fluctuated over the years with a major low about 1915. Unlike most other bighorn herds which make annual migrations between summer and winter ranges, The Chilcotin population occupies the same general area at all seasons.

At present, three ranches are grazing domestic livestock on this range. Two ranches use their holdings along the Fraser River for wintering approximately 500 brood cows. The other ranch winters about 2,000 yearling steers on the Fraser Plateau along the Chilcotin and Fraser Rivers.

If wildlife and livestock resources are to continue to exist in this area, a better understanding of the effects of grazing on the grassland and the two dominant grasses, bluebunch wheatgrass and needleandthread, is needed.

The purpose of this study was to determine the chemical composition of bluebunch wheatgrass and needleand-

Table 1. Canopy cover (%) of major plant species at study sites in three plant communities in the wheatgrass/bluegrass zone.

	Wheatgrass/bluegrass			Needlegrass/wheatgrass bluegrass			Needlegrass/bluegrass		
Study site	1A[a]	1B	1C	2A	2B	2C	3A	3B	3C
Grasses									
Bluebunch wheatgrass	40	27	33	7	6	10	1	4	6
Junegrass	2	8	14	–	1	2	–	t[b]	1
Needleandthread	21	–	t	30	14	25	60	24	30
Sandberg bluegrass	7	13	12	13	1	2	6	–	2
Shrubs									
Big sagebrush	6	–	–	–	–	–	1	–	–
Pasture sage	13	8	7	4	8	2	4	6	2
Forbs									
Bastard toadflax	7	–	3	–	–	2	5	t	–
Lambs-quarters	1	–	–	2	t	3	3	1	–
Pricklypear cactus	–	–	–	t	t	t	1	t	t
Dwarf pussytoes	–	–	1	1	t	3	1	t	t
Pink pussytoes	1	4	4	3	t	1	t	t	t

[a] Study site.
[b] t Trace (<0.5%).

thread and relate this to range condition.

Study Methods

In order to relate the chemical composition of the two grasses to range condition, three plant communites had to be identified. Prior to the field study, aerial photographs of the area were studied. Vegetation types were identified by means of tonal and textural differences in the photos. Potential sample sites were located on the aerial photographs, and final selection of the sample sites was made in the field following a general reconnaissance.

It was predetermined that statistical analysis of the collected data would be a split-plot-in-time design. Thus three areas were chosen to represent blocks; within each block one each of three levels of range condition or plant community succession were to be found. The three blocks occurred within the wheatgrass/bluegrass zone, and the three plant communities within each block were presumed to represent differences brought about by grazing.

Within each of the nine study sites the following information was collected: the canopy-coverage of the plants; the density of bluebunch wheatgrass and needleandthread; ungulate fecal droppings; soil profile descriptions; and samples of bluebunch wheatgrass and needleandthread for chemical analyses.

The nine sites were studied intensively using the macroplot technique of Poulton and Tisdale (1961). The macroplots were modified from 30 by 100 ft to 15 by 30 m with five randomly selected, parallel, 15-m transects located in each. At 1½-m intervals along each transect, a tenth of m^2 frame was employed to determine the canopy-coverage according to the method of Daubenmire (1959 and 1968). Densities of bluebunch wheatgrass and needleandthread were recorded in 1-x 15-m strips along each transect in each macroplot. The macroplots and transects were parallel to the contours of the terrain surrounding the study sites.

Ungulate fecal droppings were counted in each macroplot to assess the relative amount of grazing use of each plant community. The fecal counts were conducted within three 100-m^2 circles (5.64 m in radius) in each macroplot. All fecal groups that were at least 50% inside the circles were recorded.

Fecal groups were related to ungulate units, based on the relative weight of the species. One bighorn sheep equals one; one cow equals six ungulate units (Stoddart and Smith, 1955: 192).

Soil profiles were described at nine of the ten study sites. Description and classification of the profiles were conducted according to the methods adopted by the National Soil Survey Committee of Canada (1965).

Two plant species, bluebunch wheatgrass and needleandthread, were sampled for chemical composition. Bluebunch wheatgrass was sampled only in the excellent and fair condition sites, while needleandthread was sampled in the fair and poor condition sites. Bluebunch wheatgrass was almost nonexistent in the poor condition sites and needleandthread did not occur in the excellent condition sites.

In order to obtain the seasonal chemical change in the plants, the sampling dates were based on the phenological development of the grasses. Sampling was conducted in: late May, 1968, leaf stage; early June, 1968, flowering heads out; late June, 1968, seeds ripe; late July, 1968, seeds disseminated; middle October, 1968, plants cured; late March, 1969, plants weathered.

The number of plants sampled varied for each species as the earlier clippings did not provide enough material for analyses. For the late May clipping only four plants per species per site were clipped. This was increased to six, eight or ten bluebunch wheatgrass plants and to ten, 20, or 40 needleandthread plants per site per clipping date. All plants were clipped to ground level and only the growth from the 1968 growing season was kept. The plants were bulked to constitute one sample for each species at each plot for each sampling date.

The plant samples were weighed, air dried in the field; in the fall of 1968 they were transported to the University of Idaho Range Sciences Laboratory, where they were oven dried at 55°C, ground in a Wiley mill, and passed through a 40-mesh screen. (Samples collected in October, 1968, and March, 1969, were taken to the University of Idaho within 1 week of being clipped.) The samples were analyzed according to the methods of the Agricultural Official Association of Chemists (1960) for crude protein, total ash, calcium, and phosphorus. Results were based on the weight of material measured at an oven-dry temperature of 105°C. (Chemical analyses were conducted during the winter of 1968-69 and spring of 1969).

Study Areas

The area chosen for study is situated near the northern limit of grasslands in central British Columbia. Specifically, the study area is the river break and terraced area lying west of the Fraser River and north of the Chilcotin River below the edge of the Fraser Plateau, approximately 1,006 m (3,300 ft) elevation.

The vegetation in the Lower Chilcotin River region consists mainly of grasslands and coniferous forests. The grasslands are well established on the south-facing slopes and terraces, while coniferous forests occur on northerly exposures. A smaller community dominated by big sagebrush (*Artemisia tridentata*, subsp. *tridentata*) occupies only the lower terraces above both rivers and some steep, windswept slopes.

Although certain habitat factors of this region were relatively constant, the grazing use of each plant community was not uniform. Access was the main cause for this discrepancy of use. Gullies, ridges, and fences blocked access to cattle on several of the slopes and terraces. While this limitation was not of serious consideration to the bighorn, they were limited in their distribution by lack of escape terrain and habitual avoidance of certain areas. Because of these differences in the use of certain areas, the wheatgrass/bluegrass zone does not have a uniform plant community in this region.

Orthic Dark Brown Chernozemic Soils were described for nine sites in the Lower Chilcotin River region. This soil is derived from Aeolian material that overlies basal till. Much of the parent material has been modified by movement of the till down the slopes. The soils had an Ah horizon that varied in thickness from 4.5 to 9.5 inches. This horizon was a very dark greyish brown when moist. The boundary between this horizon and the next, the Bm horizon, was clear. The Bm horizon varied from 5 to 9 inches in thickness and was a dark greyish brown when moist. At two sites this horizon was strongly lithologic. The boundary between the Bm horizon and the next, the Cca horizon, was clear. The Cca horizon began from 12 to 21 inches below the surface and was brown when moist. There was a $CaCO_3$ coating on the underside of stones in this horizon. At three sites this horizon was strongly lithologic.

Wheatgrass/bluegrass Community

The wheatgrass/bluegrass association was dominant on isolated terraces and steep slopes. The community was described at three sites. The dominant plant species in this association were bluebunch wheatgrass and Sandberg bluegrass (*Poa sandbergii*) (Table 1). Common species included Junegrass (*Koeleria cristata*), pasture sage (*Artemisia frigida*) and pink pussytoes (*Antennaria rosea*). In addition to these species, one site contained big sagebrush, needleandthread, and bastard toadflax (*Comandra umbellata*). The latter two species were represented by high canopy coverage values, due in part to relatively recent use of the area by cattle. This one site was no doubt not in pristine condition. However, it was not in the degraded condition of other communities. In this community bluebunch wheatgrass had an average density of 8.8

plants per m^2 (Table 2). The density of needleandthread was almost zero although one site had 10.4 plants per m^2.

Needlegrass/wheatgrass/bluegrass Community

The needlegrass/wheatgrass/bluegrass community formed the dominant community on areas that had animal grazing on accessible gentle slopes. This community was described at three sites. Dominant plant species in this community were needleandthread, bluebunch wheatgrass, and Sandberg bluegrass (Table 1). Associated plant species were Junegrass, pasture sage, dwarf pussytoes (*Antennaria dimorpha*), pink pussytoes, lambs quarters (*Chenopodium album*), peppergrass (*Lepidium densiflorum*), and pricklypear cactus (*Opuntia fragilis*). Bluebunch wheatgrass had an average density of 4.2 plants per m^2 (Table 2). The density of needleandthread averaged 22.5 plants per m^2, although one site only had 9.0 plants per m^2.

Needlegrass/bluegrass Community.

The needleandthread/bluegrass community formed the dominant community over the majority of the grasslands in the Lower Chilcotin River region. This community was found on gently rolling hills and the broad extensive terraces common to the region and was described at three sites. Dominant plant species in this community were needleandthread and Sandberg bluegrass (Table 1). Associated plant species were bluebunch wheatgrass, pasture sage, dwarf pussytoes, pink pussytoes, lambs quarters, and pricklypear cactus. One site also contained big sagebrush and bastard toadflax. Bluebunch wheatgrass had an average density of 2.2 plants per m^2 (Table 2). The average density of needleandthread was 32.4 plants per m^2.

Animal Distribution

Fecal group counts in the nine macroplots indicated that the grazing intensity of cattle and bighorn varied in each community. The highest ungulate unit values per m^2 for bighorn were found in the wheatgrass/bluegrass and needlegrass/wheatgrass/bluegrass communities (Table 3). The ungulate unit values per m^2 for cattle were highest in the needlegrass/bluegrass community and successively lower in the needlegrass/wheatgrass/bluegrass and wheatgrass/bluegrass communities. This trend was consistent, except for one site in the wheatgrass/bluegrass community where recent increased use by cattle had occurred.

Table 3. The use (fecal groups per m^2 weighted by metabolic rate of the ungulate) of sites in three plant communities in the wheatgrass/bluegrass zone by cattle and bighorn.

Animal	Wheatgrass/bluegrass			Needlegrass/wheatgrass bluegrass			Needlegrass/bluegrass		
	1A[a]	1B	1C	2A	2B	2C	3A	3B	3C
Cattle	1.00	0.32	0.32	0.52	0.82	0.60	0.94	1.02	0.54
Bighorn	0.06	0.08	0.14	0.27	0.09	0.07	0.07	0.04	0.08
Total	1.06	0.40	0.46	0.79	0.91	0.67	1.11	1.06	0.61

[a]Study site.

Results

Percentages of crude protein and phosphorous of the bluebunch wheatgrass and needleandthread in all three condition classes of the wheatgrass/bluegrass association were highest in the leaf stage (late May and early June) and declined with advancing maturity (Table 4). Percentages of total ash in both species were moderate in the leaf stage but declined slightly in the seed setting stage and increased in the weathered stage.

These results are similar to those of other investigators who have analyzed bluebunch wheatgrass or needleandthread plants from various habitats (Demarchi, 1968; Johnston and Bezeau, 1962; McIlvanie, 1942; McLean and Tisdale, 1960; and Smoliak and Bezeau, 1968).

Grazing affected the chemical composition of bluebunch wheatgrass plants. The results of an analysis of variance for all chemical analyses of bluebunch wheatgrass revealed highly significant differences ($P<0.01$) in crude protein percentages. The plants from sites in fair condition had the highest percentages of crude protein. No significant differences were found between either bluebunch wheatgrass or needleandthread for the other two condition classes of each species. Percentage crude protein differences were highly significant between needleandthread plants and bluebunch wheatgrass plants from the excellent condition sites. However, differences between needleandthread and bluebunch wheatgrass from the fair condition sites were not significant. Bluebunch wheatgrass plants from the excellent condition sites had the lowest crude protein percentages.

Grazing had an effect on the weights of bluebunch wheatgrass plants (Table 5). Analysis of variance showed that differences between bluebunch wheatgrass plants in excellent and fair condition sites were significant ($P<0.05$). Differences between needleandthread plants from the two different sites were not significant. Differences for percent total ash were highly significant ($P<0.01$) between species. Bluebunch wheatgrass plants had higher percentages of total ash than did the needleandthread plants. Differences for calcium were significant ($P<0.05$). Again bluebunch wheatgrass plants had the higher percentages. Tests for differences between species for percent phosphorous were not significant.

Table 2. Density (plants per m^2) of bluebunch wheatgrass and needleandthread at study sites in three plant communities in the wheatgrass/bluegrass zone.

Species	Wheatgrass/bluegrass			Needlegrass/wheatgrass/ bluegrass			Needlegrass/bluegrass		
	1A	1B	1C	2A	2B	2C	3A	3B	3C
Bluebunch wheatgrass	8.1	7.7	9.5	4.5	3.0	5.1	0.9	2.4	3.3
Needleandthread	10.4	0.0	0.3	28.4	9.0	30.0	43.5	17.2	38.2

Discussion and Conclusions

Grazing appeared to have a beneficial effect on the nutrient content of bluebunch wheatgrass. However, the overgrazed plants were smaller than those which had been lightly grazed. These results are similar to those observed by Cook, Stoddart and Kinsinger (1958). Working with crested wheatgrass (*Agropyron desertorum*) they found that early and close clipping resulted in high quality herbage, but the quantity declined rapidly each year the plants were harvested.

A possible explanation for the higher percentages of crude protein in the overgrazed bluebunch wheatgrass plants is that these had a greater proportion of leaves than did the lightly grazed plants. Clarke and Tisdale (1945) found that Junegrass and needleandthread in the cured stage had twice as much crude protein in the leaves as in the culms. Whittingham (1965) says that nitrogen is taken up through the plant to the leaves in the inorganic from and is converted to the organic form in the leaves. From here the organic nitrogen moves to other parts

Table 4. Chemical composition (%) of bluebunch wheatgrass and needleandthread by range condition classes of the wheatgrass/bluegrass zone.

Component	Growth stage	Bluebunch wheatgrass by condition class		Needleandthread by condition class	
		Climax	Fair	Fair	Poor
Crude protein	Leaf	12.7	15.1	15.8	14.7
	Flowering heads out	9.5	12.7	13.2	12.0
	Seed-ripe	6.8	9.4	9.8	9.2
	Seeds disseminated	5.5	6.7	8.2	7.1
	Plants cured	2.6	3.3	4.5	4.3
	Plants weathered	2.7	2.8	4.7	4.4
Total ash	Leaf	8.3	8.3	6.4	7.1
	Flowering heads out	7.6	7.8	5.8	6.6
	Seed-ripe	6.7	7.2	5.5	6.0
	Seeds disseminated	5.7	6.6	4.8	4.9
	Plants cured	10.3	10.7	8.3	7.9
	Plants weathered	9.9	11.0	7.1	7.9
Calcium	Leaf	0.33	0.43	0.40	0.37
	Flowering heads out	0.33	0.38	0.39	0.27
	Seed-ripe	0.35	0.40	0.31	0.27
	Seeds disseminated	0.32	0.37	0.30	0.24
	Plants cured	0.51	0.54	0.39	0.41
	Plants weathered	0.46	0.55	0.39	0.37
Phosphorous	Leaf	0.22	0.22	0.18	0.19
	Flowering heads out	0.17	0.18	0.16	0.20
	Seed-ripe	0.13	0.12	0.14	0.15
	Seeds disseminated	0.08	0.08	0.10	0.10
	Plants cured	0.03	0.03	0.05	0.04
	Plants weathered	0.03	0.03	0.04	0.05

of the plant. This would tend to concentrate the nitrogen in the leaves.

As a result of the depleted bluebunch wheatgrass plants having relatively more leafy material and a higher percentage of crude protein these plants may be subjected to yet heavier grazing. This would perpetuate the overgrazed condition of the plant. Also this may increase the carbohydrate utilization in the plant and further reduce the size.

While the relative values of crude protein were lower in bluebunch wheatgrass from excellent condition sites than from fair condition sites, the absolute values were opposite (Table 5). Values of crude protein expressed as g/m^2 were much lower in bluebunch wheatgrass from fair condition sites than from either bluebunch wheatgrass from excellent condition sites or needleandthread. Needleandthread from the fair condition sites produced more crude protein per unit area than did bluebunch wheatgrass from the excellent condition sites. Needleandthread from the poor condition sites produced slightly less crude protein per unit area than did bluebunch wheatgrass from the excellent condition sites. When the crude protein production per unit area for bluebunch wheatgrass and needleandthread was combined, the plants on sites in fair condition produced a greater amount of crude protein per unit area than did bluebunch wheatgrass on the excellent condition sites.

Although bluebunch wheatgrass from the climax condition sites did not produce more crude protein than needleandthread on sites in fair condition, the quality of the range must be judged with regard to the foragers. Needleandthread has a mechanically injurious fruit in early summer and the plant is relatively unavailable under winter snows. Thus, bluebunch wheatgrass, which provides yearround grazing, must be considered a better species for bighorn sheep. This judgement is enhanced by the fact that overgrazing by livestock caused the decrease in bluebunch wheatgrass and not some other factor. That action by grazing ungulates is interpreted as a preference for that grass over needleandthread.

Table 5. Weight (g, oven dry) of individual plants of bluebunch wheatgrass and needleandthread and of crude protein of these plants per m² from three condition classes of the wheatgrass/bluegrass zones.

Species and range condition	Plant weight at growth stage[a] 1	2	3	4	5	6	Crude protein at growth stage 1	2	3	4	5	6
Bluebunch wheatgrass												
Climax	6.5	7.7	7.0	8.6	7.6	4.2	6.5	5.6	3.9	3.8	1.6	0.9
Fair	2.3	3.0	5.4	4.0	3.6	1.4	1.6	1.6	2.3	1.1	0.5	0.2
Needleandthread												
Fair	2.2	1.8	2.6	1.8	1.6	0.9	7.9	5.3	5.9	3.1	1.4	0.9
Poor	1.1	1.2	1.6	1.6	1.1	0.9	5.2	4.6	4.6	3.5	1.4	1.1

[a]Growth stages: 1-leaf; 2-flowering heads out; 3-seed-ripe; 4-seeds disseminated; 5-plants cured; and, 6-plants weathered.

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