PLANT NUTRIENT LEVELS ON TWO SUMMER RANGES IN THE RIVER OF NO RETURN WILDERNESS AREA, IDAHO

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Abstract.— Monthly percent nutrient and moisture levels of plant species on two summer ranges in the River of No Return Wilderness Area of Idaho were determined. *Festuca idahoensis* exhibited the highest average crude protein content of graminoids on both study areas. *Achillea millefolium* and *Balsamorhiza saggittata* at Rush Point and *Trifolium* spp. and *Achillea millefolium* at Cold Meadows possessed the highest mean crude protein content of the forbs examined. Grasses exhibited greater average seasonal levels of crude fiber, and forbs generally contained significantly larger levels of Ca, P, and moisture.

Nutrient data for summer range plants in the mountainous region of south central Idaho are lacking. Claar (1973) presented information concerning winter nutrient trends for browse species in the River of No Return Wilderness Area (formerly the Idaho Primitive Area) but, to our knowledge, no data exist for this area relative to graminoids and forbs on summer ranges.

The quality of summer forage has been demonstrated to have an effect on body condition and reproductive capacity of wild herbivores (Verme 1963, Snider and Asplund 1974, Pederson and Harper 1978). Deficiencies in available plant nutrients are common on western ranges (Cook and Harris 1968) and have led to studies of the nutritional properties of forage plants (Skovlin 1967). Such information can be used to estimate the seasonal nutritional adequacy of plants in animal diets and can be used to implement better management practices.

Study Sites

The study was conducted in the Big Creek Ranger District, River of No Return Wilderness Area, Idaho. A description of the Big Creek drainage is provided by Hornocker (1970). Two types of summer range utilized by wild ungulates were examined.

The Cold Meadows (elev. 2142 m) site was an example of the mountain meadow range type. Meadow vegetation appears to have developed through normal processes of hydroseral succession, with the soils being maintained in a saturated or near saturated condition (Wing 1969). Vegetation within the meadow exhibited a predominance of sedges, with a wide variety of grasses and forbs. Hydromorphic and alluvial soils predominate, but sandy loams occur along the outer meadow edges (Hayden-Wing 1980).

The Rush Point (elev. 1890 m) site represented the sagebrush (*Artemisia tridentata*)-bunchgrass association typical of the southeast-facing slopes used by wild ungulates in the area. Perennial plants dominated the biotic community and occupied soils derived from basalt, granite, sedimentary deposits, and metamorphosed variations of these materials (Mueggler and Harris 1969).

Methods

The botanical communities of the two study sites were compared using Jaccard's (1912) community coefficient. The resulting index value of 22% indicated each site exhibited little similarity in plant composition.

Each study area was visited according to a monthly schedule: Cold Meadows 12–19 June, 17–24 July, and 14–21 August; Rush Point 1–8 June, 1–8 July, and 1–8 August 1977. Plant biomass was determined monthly

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at each area using the calibrated weight-estimate method (Tadmor et al. 1975). Preliminary sampling in 1976 indicated 10, 90 m transects at Cold Meadows and 14 transects at Rush Point were required to be 95% certain the vegetation biomass sampling mean was within 20% of the true mean for the single most abundant plant species at each site (Subcommittee on Range Research Methods of the Agricultural Board 1962:230). A 50 x 50 cm frame was placed every 9 m along a sampling transect; this plot size was used to reduce the "edge effect" encountered when sampling in tall vegetation (Tadmor et al. 1975).

After every 10 plots, samples of each plant species that had occurred in amounts of one gram or more per plot were estimated by weight, clipped, weighed to the nearest gram, stored, and returned to the laboratory. All plants were oven dried at 64 C for 72 hrs, weighed, and assessed for moisture content. The plant samples were then pooled, by individual species, for each month and analyzed for nutrient content.

Plant nitrogen content was determined using the Kjeldahl technique (AOAC 1970); this value was multiplied by 6.25 and crude protein was calculated (AOAC 1970). Crude fiber was determined using the Van Soest (1963) method; phosphorus (P) and calcium (Ca) levels were obtained using the dry ashing procedure (Middleton and Stucky 1954). Analyses were performed at the Plant and Soil Analysis Laboratory, Brigham Young University, Provo, Utah. Average nutrient levels, by month, for each plant "group" (grasses and forbs) within a study area were statistically compared using unpaired t-tests (Steel and Torrie 1980). The measure of significance tested for was $P = 0.05$.

Results and Discussion

The average (± S.D.) monthly percent nutrient and moisture levels of the 10 plant species exhibiting the highest frequency (75%) of occurrence at Cold Meadows and Rush Point are shown in Tables 1 through 4. The average biomass (kg/ha ± S.D.) available on each site was: Cold Meadows 1870 ± 69, Rush Point 1140 ± 77.

At Cold Meadows the group average crude fiber content of grasses was significantly greater than forb levels in all months (Tables 1 and 2). Group mean crude protein levels were not statistically different during June and July, but August protein content of forbs was significantly greater than grasses. Group average forb Ca, P, and moisture levels were significantly greater than grasses for the entire summer period.

Rush Point grasses exhibited significantly greater group mean crude fiber levels in June and July but were equivalent to forbs in August (Tables 3 and 4). Group average crude protein was the same for both plant categories in July and August, but forbs were

Table 1. Average (± S.D.) monthly percent nutrient and moisture content of grass species exhibiting the highest frequency of occurrence at Cold Meadows, River of No Return Wilderness, 1977–1978.

Species	Crude fiber	Crude protein	Ca	P	Ca:P	Moisture
			June			
Agropyron caninum	25 ± 0.2	9 ± 2.0	0.14 ± 0.1	0.06 ± 0.02	2.3:1	61 ± 2
Festuca idahoensis	28 ± 0.1	15 ± 3.4	0.25 ± 0.1	0.09 ± 0.001	2.8:1	60 ± 3
Phleum alpinum	28 ± 0.4	17 ± 2.3	0.18 ± 0.02	0.08 ± 0.02	2.3:1	64 ± 2
Group mean (± S.D.)	27.0 ± 1.7	13.7 ± 4.2	0.19 ± 0.1	0.08 ± 0.02	2.4:1	61.7 ± 2.1
			July			
Agropyron caninum	33 ± 1.4	11 ± 1.9	0.14 ± 0	0.07 ± 0.01	2.0:1	59 ± 1.5
Festuca idahoensis	36 ± 1.0	13 ± 1.3	0.19 ± 0.01	0.07 ± 0.003	2.7:1	59 ± 3
Phleum alpinum	34 ± 0.7	9 ± 1.0	0.17 ± 0.04	0.07 ± 0.002	2.4:1	54 ± 2
Group mean	34.3 ± 1.5	11.0 ± 2.0	0.17 ± 0.03	0.07	2.4:1	57.3 ± 2.9
			August			
Agropyron caninum	35 ± 0.4	8 ± 1.2	0.14 ± 0.01	0.04 ± 0.01	3.5:1	50 ± 2
Festuca idahoensis	37 ± 0.2	10 ± 1.1	0.20 ± 0.01	0.07 ± 0.002	2.9:1	31 ± 1
Phleum alpinum	34 ± 0.1	7 ± 0.9	0.20 ± 0.2	0.09 ± 0.001	2.2:1	27 ± 2
Group mean	35.3 ± 1.5	8.3 ± 0.03	0.18 ± 0.03	0.07 ± 0.03	2.6:1	36.0 ± 12.3

significantly higher in June. Group average calcium content was significantly higher in forbs in July and August. Group mean P levels were significantly higher in forbs in June, grasses in July, and equivalent in August. Group average moisture content was significantly greater in forbs throughout the summer.

The group average Ca:P ratios for grasses on both study sites were generally consistent throughout the summer. The June Ca:P ratio for Rush Point was dramatically inflated by the 1.15% Ca level reported for *Agropyron spicatum*. This value may be unrealistically high, but no material remained after the initial analysis; hence a reanalysis of the sample was not possible. Calcium:P ratios for forbs generally increased throughout the summer.

The principle wild ungulates observed using the two study areas were bighorn sheep (*Ovis canadensis*) at Rush Point and elk (*Cervus elaphus*) at Cold Meadows. Elk cows and calves were especially prevalent on Cold Meadows.

The summer diet of elk on five mountain meadows in the Cottonwood Creek watershed (of which Cold Meadows is a part) have been reported to consist primarily of forbs, sedges second, grasses third, and shrubs least (Hayden-Wing 1980). Frequency of use of most grass and shrub species were less than 10%, but exceeded 10% for most forb and sedge species. No grass species exceeded 26% frequency of utilization, but several species of forbs, sedges, and shrubs reportedly exceeded 40% (Hayden-Wing 1980).

Forbs composed 44% of the summer (June–August) diet of Big Creek bighorn sheep; shrubs and grasses made up 36% and 20%, respectively. *Agropyron spicatum* (11%), *Achillea millefolium* (11%), *Balsamorhiza saggittata* (10%), *Cercocarpus ledifolius* (9%), *Physocarpus malvalceous* (8%), and *Lupinus sericeus* (6%) were the major species proportionately evident in the diet (J. Bennett pers. comm.).

The adequacy of the nutritional plane in the vegetation will be considered in relation

TABLE 2. Average (± S.D.) monthly percent nutrient and moisture content of forb species exhibiting the highest frequency of occurrence at Cold Meadows, River of No Return Wilderness, 1977–1978.

Species	Crude fiber	Crude protein	Ca	P	Ca:P	Moisture
			June			
Achillea millefolium	22 ± 2.0	20 ± 1.6	0.51 ± 0.16	0.19 ± 1.63	2.7:1	78 ± 5
Erigeron speciosus	18 ± 0.3	19 ± 0.4	0.56 ± 0.13	0.16 ± 0.06	3.5:1	75 ± 3
Fragaria virginiana	17 ± 0.7	16 ± 0.7	0.68 ± 0.13	0.10 ± 0.09	6.8:1	72 ± 3
Penstemon spp.[1]	26 ± 0.7	15 ± 2.0	0.57 ± 0	0.15 ± 0.003	3.8:1	72 ± 2
Potentilla gracilis	19 ± 1.4	20 ± 2.3	0.65 ± 0.1	0.18 ± 0.05	3.6:1	75 ± 3
Senecio serra	22 ± 0.4	14 ± 1.4	0.62 ± 0.04	0.15 ± 0.07	4.1:1	78 ± 2
Trifolium spp.[2]	15 ± 0.7	27 ± 1.2	1.70 ± 0.5	0.44 ± 0.02	3.9:1	70 ± 2
GROUP MEAN (± S.D.)	19.9 ± 3.7	18.7 ± 4.4	0.76 ± 0.4	0.20 ± 0.1	3.8:1	74.3 ± 3.1
			July			
Achillea millefolium	24 ± 1.8	17 ± 0.3	0.90 ± 0.04	0.20 ± 0.01	4.5:1	64 ± 2
Erigeron speciosus	20 ± 1.4	16 ± 0.9	0.65 ± 0.10	0.16 ± 0.03	4.1:1	69 ± 3
Fragaria virginiana	28 ± 16.3	13 ± 1.3	0.85 ± 0.05	0.18 ± 0.03	4.7:1	66 ± 1
Penstemon spp.	33 ± 3.5	9 ± 1.3	0.58 ± 0.03	0.13 ± 0.02	4.5:1	68 ± 3
Potentilla gracilis	17 ± 1.4	16 ± 1.6	0.69 ± 0.25	0.18 ± 0.01	3.8:1	65 ± 2
Senecio serra	29 ± 0.7	10 ± 0.2	0.78 ± 0.17	0.19 ± 0.05	4.1:1	75 ± 5
Trifolium spp.	20 ± 0.9	22 ± 1.2	1.30 ± 0.11	0.40 ± 0.05	3.3:1	55 ± 2
			August			
Achillea millefolium	25 ± 1.2	14 ± 0.9	1.05 ± 0.10	0.20 ± 0.04	5.3:1	58 ± 3
Erigeron speciosus	24 ± 1.0	13 ± 0.4	1.03 ± 0.10	0.20 ± 0.04	5.2:1	58 ± 4
Fragaria virginiana	16 ± 9.0	12 ± 0.5	0.83 ± 0.06	0.18 ± 0.03	4.6:1	52 ± 1
Penstemon spp.	31 ± 2.1	10 ± 0.9	0.92 ± 0.03	0.14 ± 0.002	6.6:1	47 ± 1
Potentilla gracilis	19 ± 1.1	12 ± 1.5	1.07 ± 0.11	0.19 ± 0.01	5.6:1	58 ± 3
Senecio serra	30 ± 0.3	8 ± 0.5	0.91 ± 0.13	0.21 ± 0.04	4.3:1	50 ± 1
Trifolium spp.	27 ± 0.6	14 ± 0.9	1.05 ± 0.06	0.34 ± 0.03	3.1:1	35 ± 3
GROUP MEAN	24.6 ± 5.5	11.9 ± 2.2	0.98 ± 0.1	0.21 ± 0.1	4.7:1	51.1 ± 8.4

[1]Includes *Penstemon procerus* and *P. rydbergii*.
[2]Includes *Trifolium repens* and *T. longipes*.

to the ungulate species observed using the forage. The nutritional requirements of bighorn sheep and elk were equated with the nutritional demands of a domestic sheep (*Ovis* spp.) and a steer (*Bos* spp.), respectively. This comparison may seem questionable, but it provides a qualitative method with which to assess the adequacy of forage plants in meeting the nutritional needs of the wildlife species.

Rush Point

The National Research Council (NRC 1975:44) recommends a minimum 8.9% crude protein in the diet for growth in domestic sheep. On this basis, both forbs and grasses contained sufficient protein to meet requirements during June and July but were declining in August. The NRC (1975:44) recommends a ration containing 0.25–0.30% Ca and 0.24–0.38% P for maintenance in domestic sheep. The forbs and grasses generally exceeded the required Ca levels, but neither group consistently met the P recommendation.

Cold Meadows

Thorne et al. (1976) noted cow elk responded to different levels of nutrition much as do domestic ruminants. Early attainment of large size was postulated to be important in preparing free-ranging elk calves for winter. In their experiment, the only group of elk to gain weight were fed diets containing 13.4–14.5% crude protein. This corresponds closely with the crude protein levels (12.7–16.2%) Papageorgiou (1978) found in forage preferred by red deer in Greece. Forbs at Cold Meadows maintained similar protein levels throughout the summer, but graminoids were deficient. Calcium and P levels, based on NRC (1976:28) requirements for a 300 kg steer (P = 0.18–0.34%, Ca = 0.18–0.42%), were variable—sufficient levels of Ca in forbs and grasses but deficient levels of P in both categories.

Maynard et al. (1979:224) indicated an acceptable ratio of Ca:P to be from 1:1 to 2:1 for farm animals other than poultry. When the proportion reaches about 10:1 problems occur. An excess of Ca interferes with the efficient assimilation of P (Maynard et al. 1979:224). The Ca:P ratios for all plant categories on both sites exceeded the 2:1 ratio but generally never approached the problem level of 10:1.

Chemical analysis indicated grasses exhibited greater average seasonal levels of crude fiber, and forbs generally contained significantly larger levels of Ca, P, and moisture. Crude protein levels declined over the summer but were at sufficient levels during the critical early summer months that are important for newborn, as well as maturing, sheep and elk. Like other herbivores in temperate environments, elk and bighorn sheep must

TABLE 3. Average (± S.D.) monthly percent nutrient and moisture content of grass species exhibiting the highest frequency of occurrence at Rush Point, River of No Return Wilderness, 1977–1978.

Species	Crude fiber	Crude protein	Ca	P	Ca:P	Moisture
			June			
Agropyron spicatum	36 ± 4.9	15 ± 2.5	1.15 ± 1.24	0.11 ± 0.04	10.5:1	61 ± 2
Festuca idahoensis	35 ± 1.4	13 ± 0.1	0.36 ± 0.09	0.12 ± 0.001	3.0:1	61 ± 2
Koeleria cristata	38 ± 1.2	11 ± 0.5	0.12 ± 0.04	0.08 ± 0.02	1.5:1	57 ± 1
GROUP MEAN (± S.D.)	36.3 ± 1.5	13.0 ± 2.0	0.54 ± 0.5	0.10 ± 0.02	5.4:1	59.7 ± 2.3
			July			
Agropyron spicatum	38 ± 3.1	12 ± 2.4	0.51 ± 0.33	0.09 ± 0.01	5.7:1	41 ± 2
Festuca idahoensis	32 ± 7.4	13 ± 3.7	0.21 ± 0.09	0.18 ± 0.08	1.2:1	43 ± 1
Koeleria cristata	40 ± 3.1	9 ± 1.2	0.20 ± 0.03	0.06 ± 0.01	3.3:1	38 ± 2
GROUP MEAN	36.7 ± 4.2	11.3 ± 2.1	0.31 ± 0.2	0.11 ± 0.1	2.8:1	40.7 ± 2.5
			August			
Agropyron spicatum	36 ± 3.0	7 ± 2.0	0.41 ± 0.05	0.06 ± 0.01	6.8:1	36 ± 2
Festuca idahoensis	34 ± 1.1	12 ± 2.9	0.48 ± 0.01	0.16 ± 0.04	3.0:1	42 ± 3
Koeleria cristata	47 ± 1.2	3 ± 0.2	0.17 ± 0.03	0.06 ± 0.01	2.8:1	8 ± 2
GROUP MEAN	39.0 ± 7.0	7.3 ± 4.5	0.35 ± 0.2	0.09 ± 0.1	3.9:1	28.7 ± 18.2

Table 4. Average (± S.D.) monthly percent nutrient and moisture content of forb species exhibiting the highest frequency of occurrence at Rush Point, River of No Return Wilderness, 1977–1978.

Species	Crude fiber	Crude protein	Ca	P	Ca:P	Moisture
			June			
Achillea millefolium	29 ± 6.0	16 ± 1.4	0.96 ± 0.21	0.25 ± 0.07	3.8:1	70 ± 2
Balsamorhiza saggittata	29 ± 2.1	20 ± 3.2	2.45 ± 1.15	0.26 ± 0.06	9.4:1	81 ± 3
Eriogonum umbellatum	27 ± 0.4	16 ± 3.9	0.79 ± 0.32	0.22 ± 0.07	3.6:1	66 ± 5
Frasera montana	22 ± 6.3	17 ± 0.3	0.42 ± 0.01	0.16 ± 0.01	2.6:1	78 ± 2
Hieracium albertinum	25 ± 1.5	18 ± 0.3	0.45 ± 0.29	0.22 ± 0.01	2.1:1	77 ± 3
Lithospermum ruderale	34 ± 4.9	19 ± 2.3	1.71 ± 0.67	0.19 ± 0.004	9.0:1	73 ± 2
Lupinus sericeus	24 ± 2.0	19 ± 1.3	1.58 ± 0.15	0.35 ± 0.01	4.5:1	74 ± 4
Mean (± S.D.)	27.1 ± 3.9	17.9 ± 1.6	1.19 ± 0.8	0.24 ± 0.1	4.9:1	74.1 ± 5.1
			July			
Achillea millefolium	30 ± 1.8	14 ± 0.6	0.76 ± 0.47	0.23 ± 0.07	3.3:1	60 ± 2
Balsamorhiza saggittata	31 ± 6.4	14 ± 1.0	1.57 ± 0.83	0.21 ± 0.11	7.5:1	63 ± 3
Eriogonum umbellatum	27 ± 0.7	13 ± 2.4	1.66 ± 1.29	0.15 ± 0.05	11.1:1	56 ± 1
Frasera montana	27 ± 0.8	13 ± 0.7	1.11 ± 0.76	0.17 ± 0.06	6.5:1	60 ± 4
Hieracium albertinum	27 ± 4.4	11 ± 1.2	1.08 ± 0.29	0.20 ± 0.04	5.4:1	63 ± 2
Lithospermum ruderale	30 ± 0.4	14 ± 1.7	1.95 ± 2.04	0.25 ± 0.07	7.8:1	57 ± 2
Lupinus sericeus	26 ± 1.5	17 ± 1.0	1.09 ± 0.82	0.21 ± 0.02	5.2:1	62 ± 3
Mean	28.3 ± 1.9	13.7 ± 1.8	1.32 ± 0.4	0.2 ± 0.03	6.6:1	60.1 ± 2.8
			August			
Achillea millefolium	31 ± 0.85	12 ± 2.3	1.13 ± 0.10	0.20 ± 0.02	5.7:1	53 ± 2
Balsamorhiza saggittata	29 ± 3.4	10 ± 1.8	1.48 ± 0.76	0.19 ± 0.03	7.8:1	52 ± 2
Eriogonum umbellatum	31 ± 1.4	8 ± 0.9	0.87 ± 0.04	0.15 ± 0.02	5.8:1	43 ± 3
Frasera montana	28 ± 0.7	8 ± 0.4	0.36 ± 0.08	0.10 ± 0.02	3.6:1	38 ± 1
Hieracium albertinum	32 ± 4.6	8 ± 2.6	1.10 ± 0.14	0.13 ± 0.01	8.5:1	57 ± 3
Lithospermum ruderale	30 ± 1.4	9 ± 0.6	2.03 ± 1.65	0.16 ± 0.08	12.7:1	49 ± 2
Lupinus sericeus	35 ± 1.2	8 ± 1.1	0.97 ± 0.05	0.12 ± 0.02	8.1:1	59 ± 3
Mean	30.9 ± 2.3	9.0 ± 1.5	1.1 ± 0.5	0.15 ± 0.04	7.5:1	50.1 ± 7.5

adjust foraging strategies to seasonal changes in the quality of food resources.

Even in wilderness areas it is important to understand the nutritional and dietary planes of native herbivores. Management strategies such as prescribed and wild fires, using natural meadows as camp sites and aircraft landing sites, and seasonal hunting of big game all involve decisions that can benefit from the nutritional evaluation of vegetation and dietary strategies of resident wild ungulates. More data of this nature as well as further studies on population dynamics and behavior of resident herbivores will contribute to the essential understanding of the relatively pristine ecosystem included within the River of No Return Wilderness Area.

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