

Effects of Cattle Grazing Upon Chemical Constituents Within Important Forages for Elk¹

Abstract

On many western rangelands, cattle and elk use the same forages but during different seasons. This can place these species into indirect competition or amensalism. The objective of this study was to examine the effects of summer grazing by cattle upon the winter forage quality for elk. Individual plants of bluebunch wheatgrass (*Agropyron spicatum*), rough fescue (*Festuca scabrella*), and Idaho fescue (*Festuca idahoensis*) were monitored for phenological stage when summer grazed by cattle on a Rocky Mountain elk (*Cervus elaphus nelsoni*) wintering range in the Elkhorn Mountains, Montana. Assessment of winter chemical composition of these three key forage species indicated no deleterious effects of summer grazing by cattle stocked at 3.7 ha/AUM upon the winter forage quality. In general, rough fescue and Idaho fescue had lower average fiber fractions and higher crude protein than bluebunch wheatgrass. Under deferred rotation cattle management, the primary winter elk forage management concern appears to be forage quantity rather than quality.

Introduction

In the Elkhorn Mountains of west-central Montana, up to 62% of elk winter diets was composed of Idaho fescue (*Festuca idahoensis*), rough fescue (*Festuca scabrella*) and bluebunch wheatgrass (*Agropyron spicatum*), the most abundant bunchgrasses on the winter range (DeSimone *et al.* pers. comm.). Other studies from Montana also reported that these three caespitose species comprise 50 to 90% of elk winter and spring diets (Gordon 1968, Stevens 1965).

Dietary components of cattle grazing summer ranges in the Pacific Northwest indicate similar reliance on these dominant bunchgrasses as key forage species (Holechek *et al.* 1982). Apparently use by cattle and elk of the same forages and nutrient supply at different times may create situations of indirect competition or amensalism. Although questions of dietary overlap have been addressed concerning these two species (Hansen and Reid 1975), this assessment has not been directed toward individual plants and the effect of grazing upon the resulting forage quality of the grazed plant.

The objective of this study was to quantify the effects of summer cattle grazing at various phenological stages of three key forage species upon resulting winter forage quality for elk.

Study Area and Methods

The study site was within the Muddy Lake and Jenkin's Gulch drainages, tributaries of Crow Creek located on the southeastern end of the

Elkhorn Mountains in the Helena National Forest, Montana. This area comprises the South Crow cattle allotment, a rolling grassland with steep conifer filled draws and broader cottonwood dominated bottoms. Slopes and ridge tops have stony, loamy soils. Vegetation on the upland sites is dominated by bunchgrasses. Idaho fescue is nearly ubiquitous. Rough fescue occurs on slightly moister sites and bluebunch wheatgrass on most drier sites. The climate in the region is modified continental with large annual and daily temperature variations (DiSimone *et al.* pers. comm.). Elevation and annual precipitation range from 1464 m to 2100 m and 51 cm to 76 cm, respectively.

Approximately 200 elk have wintered in the study area since the 1960s (DeSimone *et al.* pers. comm.). Generally the area is used by elk from December to June. The South Crow cattle allotment (9300 ha) has been grazed with a three pasture, deferred rotation, grazing system since 1970. There are approximately 2500 animal unit months (AUM) allocated to 600 cows with calves (Anonymous USDA-Forest Service rep.). In 1983 the cattle grazing season was June 10 to October 15.

Defoliation responses of individual plants were quantified using permanent 10 m line transects marked by fixed end points (Gammon and Roberts 1978). Twenty-four transects were established on the study area with transects in five groups with three to six transects per group. Each group was subjectively located to include the three major forage plants and evidence of both

elk and cattle use. An average of six bluebunch wheatgrass plants, twenty-three Idaho fescue plants, and six rough fescue plants were contained within each transect. Line intercept of plant canopy determined inclusion of a plant in the sample population.

Transects were established in the spring, 1983, and sampled biweekly from June through October. Phenological stage and evidence of utilization of the three grass species were recorded. Eight phenological stages were identified: vegetative, boot (swelling visible in sheath to seedhead 50% out of the sheath), emerging seedheads (seedheads greater than 50% out of the sheath to fully emerged, but not filling), anthesis (any visible anthers regardless of condition), mature flowers (from seedheads filling to fully developed), seed shatter (any indication of disarticulation), mature foliage (seedheads completely empty and leaves dull green through brown), and fall regrowth (any new vegetative growth). Mature foliage was the overwintering stage. During March, 1984, all plants along the transects with known utilization histories from the previous summer were collected by removing the entire aboveground biomass from the sample population. Only plants which had been utilized once during the previous summer or were ungrazed were used for chemical analyses. Repeated defoliation of an individual plant was rarely observed.

Plant nitrogen and fiber related fractions were selected as the most useful for reflecting forage quality. Twenty percent of the individually-collected samples were randomly selected for chemical analyses using the AOAC (1980) procedures for crude protein (CP) and ash (ASH) and the procedures of Goering and Van Soest (1970) for neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL). The remaining 80% of the samples were analyzed for CP, ASH, NDF, ADF and ADL by near-infrared spectrophotometry (NIR) as outlined by Norris *et al.* (1976) and Schenk *et al.* (1981). NIR calibration was achieved using the wet chemistry data obtained from 20% of the samples collected. Additionally, cellulose (CELL) and hemicellulose (HC) content was calculated as $CELL = ADF - ADL$ and $HC = NDF - ADF$ (Goering and Van Soest 1970). Analysis of variance was used to compare chemical constituent data between plant species and phenological

stage when summer grazing had occurred. For constituents with significant F-values, the species means were separated using Least Significant Differences.

Results and Discussion

The phenological stage when either rough fescue or bluebunch wheatgrass had been grazed by cattle did not affect ($P > .05$) winter chemical composition (Table 1). Furthermore, grazed and ungrazed plants could not be distinguished by chemical analyses. For Idaho fescue, only NDF and ADF fiber fractions exhibited a response to the phenological stage when grazing occurred (Table 1). When grazed at seed shatter stage, Idaho fescue exhibited a reduction ($P < .05$) in both winter NDF and ADF contents compared to ungrazed plants and plants grazed during the vegetative or boot stages. Since other chemical constituents did not respond to summer grazing, these reductions in NDF and ADF percentages would not indicate a significant alteration of the winter forage quality of Idaho fescue.

An insufficient number of plants of each species were grazed during either the anthesis or mature flowers phenological stages to provide adequate samples for chemical analyses. Possible explanations for the absence of a negative response in forage quality to summer grazing include a single defoliation event for sampled plants, late spring defoliation as the earliest grazing event, and minimal tissue removal when summer grazed. All three explanations are probably correct to a degree.

McLean and Wikeem (1985a) indicated that injury to bluebunch wheatgrass was minimized when defoliation was either terminated early in the growing season allowing replenishment of depleted carbohydrate reserves, was infrequent, or avoided significant meristematic tissue. Similar observations were reported for rough fescue (McLean and Wikeem 1985b). In the Elkhorns cattle grazing was not initiated until mid-June and defoliation would have occurred only after the vulnerable early spring vegetative stage. The deferred rotation livestock grazing system and light cattle stocking rate (approximately 3.7 ha/AUM) would also minimize both defoliation events and meristematic tissue removal.

Mean values of winter chemical composition across all phenological stages demonstrated

TABLE 1. Winter (1984) chemical composition,¹ reported as percentage dry weight, of bluebunch wheatgrass (AGSP), Idaho fescue (FEID), and rough fescue (FESC) in relation to phenological stage when grazed, summer, 1983. Means in the same row followed by the same letter do not differ significantly ($P > .05$).

	PHENOLOGICAL STAGE						
	Vegetative	Boot	Seedheads Emerging	Seed Shatter	Mature Foliage	Fall Regrowth	Ungrazed
AGSP							
CP	5.1	3.6	3.6	4.0	3.4	NA	2.7
NDF	79.4	78.8	83.4	81.7	81.5	NA	82.4
ADF	50.3	53.2	57.3	53.8	53.9	NA	54.4
ADL	4.3	5.2	6.0	5.8	5.5	NA	5.5
CELL	46.0	48.0	51.3	48.0	48.4	NA	48.5
HC	29.1	25.6	26.1	27.9	27.6	NA	28.0
ASH	8.3	7.0	7.4	7.5	7.5	NA	7.3
FEID							
CP	6.0	5.4	5.8	6.2	6.5	6.0	6.2
NDF	77.8 ^b	76.1 ^b	71.8 ^{ab}	66.3 ^a	73.2 ^{ab}	72.4 ^{ab}	76.8 ^b
ADF	46.8 ^b	47.5 ^b	46.0 ^b	38.4 ^a	46.7 ^b	43.2 ^{ab}	46.2 ^b
ADL	3.7	3.6	3.7	5.7	4.6	3.8	4.4
CELL	43.1	43.9	42.3	32.7	42.1	39.4	41.8
HC	31.0	28.6	25.8	27.9	26.5	29.2	30.6
ASH	10.2	6.5	8.2	7.9	7.6	8.0	8.6
FESC							
CP	5.4	4.0	3.9	5.0	4.8	4.0	5.0
NDF	75.1	79.1	80.1	78.8	79.3	82.0	77.5
ADF	47.9	46.8	49.6	49.7	49.6	49.4	48.7
ADL	2.6	3.6	3.5	3.4	3.6	3.9	2.7
CELL	45.3	43.2	46.1	46.3	46.0	45.5	46.0
HC	27.2	32.3	30.5	29.1	29.7	32.6	28.8
ASH	8.4	6.2	7.0	10.0	8.8	7.4	8.2

¹CP = crude protein, NDF = neutral detergent fiber, ADF = acid detergent fiber, ADL = acid detergent lignin, CELL = cellulose, HC = hemicellulose, and ASH = ash.

species differences (Table 2). Bluebunch wheatgrass, reported as the least preferred by elk of these three species (Gordon 1968), represented a typical dormant winter grass with low CP and high ADF and ADL composition. Nowak and Caldwell (1984) have reported winter photosynthetic activity by bluebunch wheatgrass in a cold steppe environment but that activity was minimal and was substantially reduced by cold temperature. The absence of fall regrowth by this species (Table 1) is not unusual (Quinton *et al.* 1982).

The lack of succulent leaf tissue and resulting lower preference by elk were reflected in the winter chemical composition. Bluebunch wheatgrass had the lowest ($P < .05$) average CP content in this study. Its CP content was below the generally accepted minimum of 5-6% required for rumen microbial function (Robbins *et al.* 1975).

Rough fescue, the most preferred grass on the South Crow winter range (Gordon 1968), had the lowest lignin values of the three forage species.

TABLE 2. Mean winter (1984) values for chemical constituent fractions as a percentage of dry weight for bluebunch wheatgrass (AGSP), Idaho fescue (FEID) and rough fescue (FESC). Means in the same row followed by the same letter do not differ significantly ($P > .05$).

CHEMICAL CONSTITUENT ¹	SPECIES		
	AGSP	FEID	FESC
CP	4 ^c	6 ^a	5 ^b
NDF	81 ^a	74 ^b	79 ^a
ADF	54 ^a	45 ^c	49 ^b
ADL	5 ^a	4 ^b	3 ^c
CELL	49 ^a	41 ^c	46 ^b
HC	27 ^a	29 ^a	30 ^a
ASH	7 ^a	8 ^a	8 ^a

¹CP = crude protein, NDF = neutral detergent fiber, ADF = acid detergent fiber, ADL = acid detergent lignin, CELL = cellulose, HC = hemicellulose, and ASH = ash.

Low lignin values and intermediate levels of CP and other fiber constituents indicated some level of winter photosynthetic activity. Fall floral primordia initiation and slow winter development have been reported in rough fescue (Johnston and McDonald 1967).

Idaho fescue was apparently physiologically active through the winter. Fall initiation of floral primordia has also been reported in Idaho fescue (Johnston and McDonald 1967), and study site plants were observed with many greenish winter leaves. Winter CP content was similar to reported midsummer values (McCall 1939). An explanation for relatively lower structural carbohydrates (reflected in the CELL content) during the winter is that more easily metabolized carbohydrates are used in maintenance level respiration. Winter photosynthetic activity would provide some highly available carbohydrates, reducing tissue catabolism and preventing increased concentrations of CELL and ADL in the winter fiber component. For both fescues the apparent winter photosynthetic activity would generate greater tissue succulence contributing to the observed higher winter preference by elk (Gordon 1968) for these caespitose species.

Smith (1977) suggested that livestock grazing

is the major factor restricting western wildlife production. Though management concerns surrounding dual use of rangelands by cattle and elk extend beyond questions of forage utilization, a key consideration is the impact one grazing species has on the forage quality available to the other. Operating primarily as grazers, cattle and elk in the northern Rockies extensively utilize caespitose grasses, especially wheatgrasses and fescues, though often during different seasons. In the Elkhorn mountains of west-central Montana cattle grazing is principally under the administration of the U.S. Forest Service and livestock rotation grazing systems are normally utilized. Within this setting it was observed that one summer cattle grazing event had no harmful effects upon the forage quality of the main key species of elk winter range. This observation would imply that under the current, deferred rotation grazing system, the primary consideration for winter forage allocation would be the quantity of available forage rather than its quality.

Notes

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