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CHANGES IN FORAGE QUANTITY AND QUALITY WITH CONTINUED CATTLE GRAZING IN A MOUNTAIN RIPARIAN PASTURE

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ABSTRACT: The objective of this study was to evaluate changes in the quantity, quality, and moisture of available forage in a riparian pasture, and shrub utilization by cattle during a 30-d late summer grazing period. A riparian pasture (44.7 ha) in northeast of Oregon was grazed with 30 yearlings (419 kg, BCS = 5.05) and 30 mature cows with calves (499 kg, BCS = 4.65) from early August to early September in 2001, and from late July to late August in 2002. Sampling dates were d 0, d 10, d 20, and d 30. The forage availability before grazing was 1058 kg/ha and declined to 323 kg/ha at the end of the grazing period ($P < 0.10$). Grasses dominated the pasture, followed by forbs, grass-likes (sedges and/or rushes), and shrubs. Kentucky bluegrass was the most prevalent forage species followed by timothy, sedges, and common snowberry. The highest percent disappearances of forage species was (83.7 - 92.7%) observed with quackgrass, western fescue, California brome, redtop, and heartleaf arnica, though their initial contributions to the available forage were less than 5%. Timothy, elk sedge, red clover, and common snowberry were also preferred species and major components of the available vegetation. High levels of shrub utilization were observed from d 20 through the end of the grazing period (45% for willow and 59% for alder). Forbs and shrubs did not vary in moisture content over the 30 d grazing period and across the years averaging 59% and 61%, respectively ($P > 0.10$). In contrast, the moisture content of grasses were over 50% at the beginning of the grazing period and declined to 34% by d 20. Likewise, forbs and shrubs were higher than grasses in CP (11, 14, and 6%, respectively) and IVDMD (58, 49, and 42% respectively). In summary, our results suggest that cattle grazing late summer riparian pastures will switch to intensive shrub utilization when grasses decline in quality and quantity, and forbs decline in quantity.
Key words: riparian areas, cattle, utilization

Introduction

Grazing animals have long been associated with alteration of productivity, cover, and species composition of plant communities (Stoddart et al., 1975). Changes in forage nutritional quality are related to advancing plant phenology. Therefore, optimizing livestock production means coordinating it to the forage resources so that the most efficient use is made of the short periods when forages are at their highest quality (Vavra and Raleigh, 1976). A knowledge of dietary shifts in response to seasonal advance and precipitation induced forage regrowth should help managers optimize use of specific range types for improved grazing management and livestock production (Holechek et al. 1982). Information on variations in the quality and quantity of available herbage, as well as a better understanding of what drives cattle grazing in riparian zones to shift their diets from grass dominated to shrub dominated will be important to sustainable and productive uses of riparian areas. The objectives of this study, therefore, were to determine changes in herbage quantity, quality, species composition, and utilization in riparian areas grazed during the late summer.

Materials and Methods

The study site was located within the Catherine Creek riparian area, on Oregon State University's Hall Ranch, about 19 km southeast of Union, Oregon. Elevation ranges from 1,050 to 1,250 m. Mean annual precipitation is 35 cm, with majority coming between October and June. Average July and August rainfall totals 3.94 cm (Porath et al. 2002).

The pasture utilized in the study comprised 44.7 ha along Catherine Creek, that runs for a length of 2.5 km through the area and is confined by steep hills on the east side and a state highway on the west. The downstream portion of the study area consisted of an open grassland, while the upper area contained more shrubs and trees (Laliberte et al. 2001). Dominant grasses in riparian communities included timothy (*Phleum pratensis* L.), Kentucky bluegrass (*Poa pratensis* L.), redtop (*Agrostis alba* L.), wheatgrasses (*Agropyron spp.*) and bromes (*Bromus spp.*). Sedges (*Carex spp.*) and rushes (*Juncus spp.*) were also present. Numerous forbs, including cinquefoil (*Potentilla spp.*), fleabanes (*Erigeron spp.*), western yarrow (*Achillea millefolium* L.), and lupines (*Lupinus* spp.) occurred in these communities. The overstory typically consisted of hawthorn (*Crataegus douglasii* Lindl.), ponderosa pine (*Pinus ponderosa* Dougl.), snowberry (*Symphoricarpus albus* L.), wild rose (*Rosa gymnocarpa* Nutt.), alders (*Alnus spp.*) and willows (*Salix spp.*). Ponderosa pine was the dominant tree species (Porath et al. 2002).

The study was conducted as a completely random design with repeated measures. Treatments were based on age class of the cattle and were: 1) thirty yearling heifers, and 2) thirty mature cows with calves. The grazing was initiated August 07 and ended September 07 in 2001, and was from July 31 to August 31 in 2002. The cows grazed together in one herd in the same pasture. In Year 2, mature cows from Year 1 that were still in the herd and within the

age requirements were used again. A new group of yearling heifers were used each year.

The cattle performance variables measured were cow weight change, body condition score change and calf ADG at the beginning and end of the grazing period. Body weights were obtained after an overnight shrink (16 h). Condition score was an average of the scores assigned from two independent observers.

Herbage mass of available forage was estimated at four times (d 0, d 10, d 20, and d 30). A 0.25 m^2 plot was placed every 30 m along five transects across the pasture at each sampling date. Current years forage growth was clipped to ground level, separated by species, oven-dried in a 50^o C forced air oven, and weighed.

Samples from 14 major forage species, which included seven grasses and grasslikes, four forbs, and three shrub species were collected at each sampling date. For each plant species, a composite sample of approximately 40 grams (dry weight) was collected at random throughout their respective distributions in the study area by hand plucking. The samples were weighed, oven-dried at 50ºC, and reweighed to determine moisture content. Samples of the common forage species were used for analysis of CP (AOAC, 1990), NDF using a Filter Bag Method developed by ANKOM Technology Corporation (Fairport, NY), IVDMD, and IVOMD (Tilley and Terry 1963).

Shrub utilization was evaluated by the photographic technique (Reynolds, 1999; Damiran et al., 2003) at each sampling date on two different shrub species (8 willows and 8 alders) that were randomly selected across the study site.

Data were analyzed using GLM procedures of SAS (1996). Time series data were analyzed as a repeated measures design. Treatment means were separated using LSmeans procedures of SAS (1996) and were considered different at the ($P < 0.10$) level.

Results and Discussion

Yearling heifers gained more ($P < 0.05$) BW than mature cows in both years of the study. In Year 1, yearling heifers and mature cows had similar ($P > 0.10$) initial BCS (5.0 and 4.9 respectively), however, in Year 2 yearling heifers had greater ($P < 0.05$) initial BCS than mature cows (5.1 and 4.4 respectively). Average daily gain of calves was similar ($P > 0.10$) across years and averaged 0.96 kg/d.

Precipitation and average daily temperatures during the trial did not differ between years. Total precipitation was below average during both years and precipitation during the trials was 1.02 cm for 2001 and 1.27 cm for 2002. Average daily temperatures were recorded at 20.1^o C and 19.6^o C for the study period in 2001 and 2002, respectively.

Herbage standing crop in the pasture was not different ($P > 0.05$) between years and averaged 1057.8 kg/ha before grazing, but declined ($P < 0.10$) continuously throughout the grazing period averaging 323 kg/ha after grazing (Fig. 1). The similar weather conditions during the trials may have contributed to the similar results in quantity of available forage between the study years. The standing crop of herbage in August on continuously grazed plots in north-central Oregon was determined to be 1200 kg/ha by Gillen et al. (1985), while Parsons et al. (2000) estimated forage availability in northeast Oregon during late season grazing (mid August - mid September) to be 1726 kg/ha. The estimated forage availability in our study was below these values, which could be explained by the drought conditions experienced. The rate of decline in the standing crop was similar between years and averaged at 32.5% ($P > 0.10$) over the 10 d sampling intervals. Intensive utilization of available forage was observed from d 20 (51%) to the end of grazing (69.4%). At the initiation of grazing, grasses comprised 44.5%, forbs 30.7%, grasslikes 15.9%, and shrubs 8.8% of the available herbaceous vegetation. As the season progressed grasses and forbs decreased ($P < 0.10$) in herbage mass over the dates ($P > 0.10$). No differences between the sampling dates were detected for grasslikes and shrubs ($P > 0.10$; Fig. 2).

Kentucky bluegrass comprised almost 11% of the total herbage and was the major portion of the available forage, timothy and sedges were the next greatest components (about 10%). However, the highest percent disappearances (84-93%) were found for quackgrass (*Agropyron repens* (L.) Beauv.), western fescue (*Festuca occidentalis* Hook.), California brome (*Bromus carinatus* Hook.) and redtop, although their availability on d 0 did not exceed 5%. In addition to herbage removal by cattle, advancing maturity and (or) senescence due to drought may have also contributed to the extensive disappearing of these species. Red clover (*Trifolium pratense* L.) and western yarrow were the primary forb components in the herbage mass, but red clover and heartleaf arnica were the most utilized forb species (85-90%). Holechek et al. (1982) observed that western yarrow and heartleaf arnica were utilized throughout the grazing period because both species remained green and succulent until October in most years. Utilization of common snowberry had reached 72% by the end of the grazing season.

Although forages were expected to decline in moisture content with the season advancement, our data indicate that the most forages sustained a similar ($P > 0.10$) moisture content throughout the grazing period. Only grasses declined ($P < 0.05$) in the moisture from 48.5% on d10 to 33.5% on d20 during the study (Fig. 3). California brome and western fescue had the largest moisture losses, declining to 23.0 and 25.5% moisture by the end of the grazing season. In contrast, forbs averaged 72% moisture on d 0, and declined to 59.5% ($P > 0.10$) by the end of the grazing season, while shrubs did not change ($P > 0.10$) (65.4 to 60.9 %) throughout the grazing season.

The CP content was similar ($P > 0.10$), throughout the grazing season and across years for forbs and shrubs. Forbs contained 11% CP, and shrubs contained 14% CP. In contrast, grasses were lower ($P < 0.10$) in CP content in Year 1 (4.5%) than in Year 2 (7.3%). Presumably, the difference in protein content for grasses between the years was due to a week earlier start of the trial in Year 2 and regrowth observed for a couple of grass species late in the grazing season in Year 2. Quackgrass, California brome, and western fescue declined numerically in CP early in the trial, from 8.4 to 9.9% on d 0 to 3.5 to 5.4% on d 10, although they did not change further. The CP content for the other grasses ranged from 3.8 to 6.5% on d 0 and 5.3 to

9.1% on d 30. Regrowth in Kentucky bluegrass and timothy was observed late in the grazing season, which is likely to have resulted in an increase in their CP contents on d 30. In contrast to the grasses, elk sedge retained its CP level at 7.3% throughout the grazing season. Skovlin (1967) noted that elk sedge maintained its crude protein content later in the grazing season and showed less seasonal and annual variation as compared to grasses. The highest CP content among forbs was red clover (16.8% CP), which was similar to that of shrubs, whereas other forbs ranged from 8.1 to 9.6% CP.

Patterns of NDF content and in vitro digestibility of forages was similar to that of CP, in that they did not differ ($P > 0.10$) between the dates and across the years, except for grasses. In grasses, NDF was greater ($P < 0.05$), and digestibility lower ($P < 0.05$) in Year 1 as compared to Year 2. Overall, NDF content was highest in grasses (66.2%), intermediate in forbs (35.2%) and lowest in shrubs (29.9%). Conversely, forbs had the greatest IVDMD (58.4%), shrubs were intermediate (49.5%), and grasses had the lowest IVDMD (42.0%) during the trial. Our data generally concurs with Parsons et al. (2000) on nutritive quality of riparian vegetation in northeast Oregon during late season grazing (mid August to mid September) who found DM to be 68.2, NDF 68.4, and CP 4.5%. In our study heartleaf arnica was characterized by the most digestibility among forage species (72.3% IVDMD). From the shrubs alder was lower in digestibility (42.9% IVDMD) as compared to willow and snowberry which were similar, averaging 52.8 and 52.9% IVDMD, respectively.

Shrub utilization measured on the two common shrubs (alder and willow) in the area indicated that it intensifies as grazing progresses, and it did not differ ($P > 0.10$) between years (Fig. 4). Alder use by cattle increased ($P < 0.10$) through the grazing season during the study, except one date in 2002, where the change was not significant ($P > 0.10$) on d 30. Willow demonstrated similar utilization patterns to that of alder in that utilization increased ($P < 0.05$) throughout the grazing season in both years, except on d 30 ($P > 0.05$) of 2002. The data revealed that in a riparian pasture cattle browsing activity was increased starting from d 20 (around mid August), where it ranged 45-53% for willow and 56-59% for alder and remained higher to the end of the trial, accounting for 51-63% and 67.1-81.1%, respectively ($P < 0.05$). The rise in shrub use by cattle is likely to have been dictated by the diminishing quality and availability of the other forages. This would indicate that cows must shift to a browse dominated diet in order to satisfy their protein and/or energy needs. Our findings agree with Vavra (1983) who reported shrub use increases in riparian community as the grazing season progressed, which was in response to herbaceous vegetation maturing and becoming less palatable and/or declining in availability. Also, Vavra (1983) indicated that forage quality on the pastures at EOARC's Hall Ranch deteriorates below required levels by late August, while shrubs contain higher levels of crude protein later in the grazing season than herbaceous species. Holechek et.al. (1982) observed that on the forested rangelands, in the latter half of the grazing season, cattle responded to weather conditions by shifting their diets away from grasses to browse when green regrowth, due to summer precipitation, was not available. Overall shrub utilization was an average of 17% higher with alder than that of willow throughout the study years, which may be related to alder being higher in CP than willow (17.4% vs 13.7%), and more abundant and evenly distributed in the pasture.

Implications

Our data revealed that maturation and drying of grasses and consequent decline in the quality can occur as early as in the first half of the late summer grazing, while forbs and shrubs remain higher in quality, although forb abundance declines in late summer. This would suggest that in response to changes in the quantity and quality of grasses and forbs, cattle grazing late summer riparian pastures will switch to intensive shrub utilization. Sustainable management of riparian pastures needs to balance uniform use of forage resources with optimal production. Our data suggest that late summer grazing should be light, or avoided if grasses have senesced. In addition, further investigation on foraging habits of cattle grazing riparian pastures in relation to forage availability and quality is needed.

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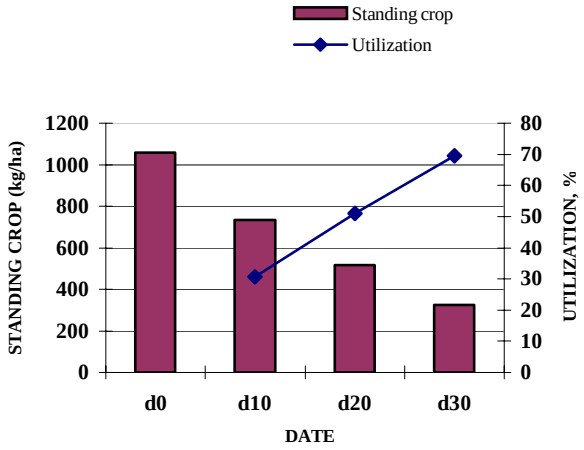

Fig. 1. Standing crop of total herbage and utilization in late summer grazing in Catherine Creek riparian area (averaged over the years 2001 and 2002)

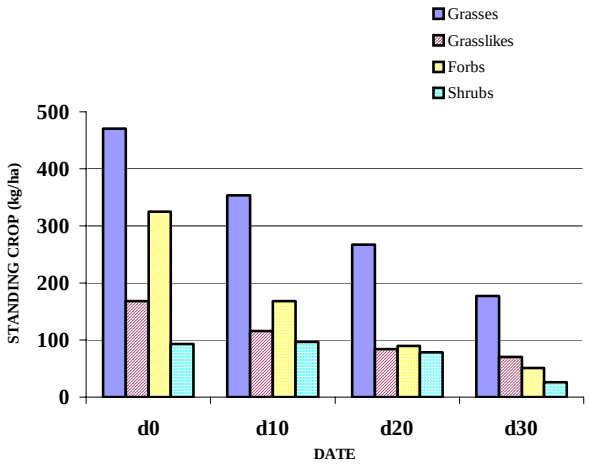

Fig. 2. Herbage standing crop by growth forms in late summer grazing in Catherine Creek riparian area (averaged over the years 2001 and 2002)

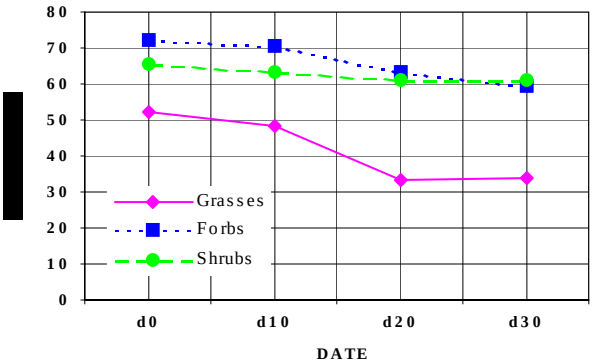

Fig. 3. Moisture content of forages in late summer grazing in Catherine Creek riparian area (averaged over the years 2001 and 2002)

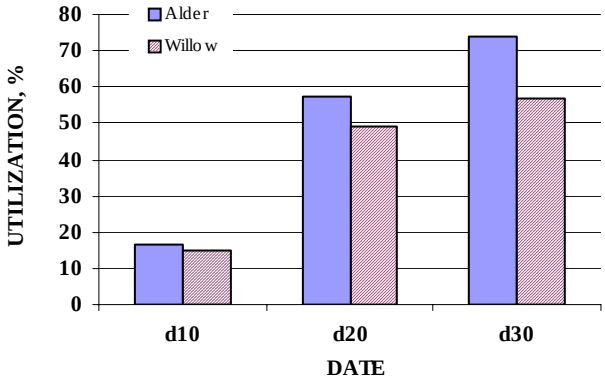

Fig. 4. Shrub utilization in late summer grazing in Catherine Creek riparian area (2001)