ATRIPLEX CANESCENS IMPACT ON UNDERSTORY VEGETATION UNDER DIFFERENT SEASONS OF GRAZING

R. H. Hart[1], A. F. Cibils[2], M. M. Ashby[1] and D. M. Swift[2]
[1]Agricultural Research Service, US Dept. of Agriculture, Cheyenne, WY 82009 and Nunn, CO 80658, respectively
[2]Natural Resources Ecology Laboratory, Colorado State University, Ft. Collins, CO 80523

ABSTRACT
Productivity and botanical composition of herbaceous plant communities were altered with distance (0 to 100 cm) from fourwing saltbush *(Atriplex canescens)* shrubs. Under winter grazing, production of western wheatgrass *(Pascopyrum smithii)* increased near saltbush while that of blue grama *(Bouteloua gracilis)* decreased. Shrub proximity had no effect on either species under summer grazing, but blue grama decreased sharply near saltbush in ungrazed exclosures. The effects were produced by grazing and possible interactions with snow catchment and competition.

KEYWORDS
Fourwing saltbush, *Atriplex canescens, Pascopyrum smithii, Bouteloua gracilis,* grazing season, competition, facilitation

INTRODUCTION
On pastures of fourwing saltbush-blue grama-western wheatgrass (*Atriplex canescens-Bouteloua gracili-Pascopyrum smithii*) rangeland in northern Colorado, western wheatgrass appeared to be more plentiful in the immediate vicinity of saltbush shrubs. Shrubs often provide "refuges" for plant species which, because of heavy grazing, have disappeared from the surrounding rangeland (Noy-Meir 1996). Differences in quantity and botanical composition of understory herbage have been reported with increasing distance from trees of *Juniperus, Pinus* and *Quercus* spp. (Engle et al., 1987; Armentrout and Pieper 1988; Dye et al., 1995; Frost and McDougald, 1989), but to our knowledge no such data existed for fourwing saltbush. We decided to locate similar areas with different grazing histories on which to test the hypotheses that (1) western wheatgrass is more plentiful in the immediate vicinity of saltbush shrubs than in the intervals between shrubs, and (2) this difference may be related to season of grazing.

EXPERIMENTAL
Two rangeland pastures, of approximately 65 ha each, had been grazed only in the winter from 1985-86 through 1994-1995. Two adjacent pastures of the same size had been grazed only in the summer from 1983 through 1994, but had not been grazed in the summer of 1995. Two exclosures in the winter-grazed area, each of about 1 ha, had not been grazed since they were established about 1940 and 1970, respectively. Thus rangeland with a history of grazing in winter or summer or not grazed was identified, none of which had been grazed during the 1995 growing season.

In September 1995, a 50-m transect was located in each pasture of the winter- or summer-grazed rangeland and in each exclosure. In each winter-grazed pasture, a 16-ha pasture to be used for late fall and early spring grazing was fenced off with a 50-m transect in each to provide baseline data for studying the effects of late fall-early spring grazing, which provided additional data on the long-term effects of winter grazing. This provided two transects each on summer-grazed and ungrazed rangeland and four on winter-grazed rangeland.

On each transect, stem diameter, height, and crown diameter of the saltbush shrub nearest each meter mark was measured, as well as the distance from the shrub to the meter mark (Cibils et al., 1997). At every fifth shrub (ten per transect), a 10 x 100 cm frame extending in a random direction from the shrub was placed with one end against a stem. This frame was sub-divided into five 10 x 20 cm sections. Vegetation in each section was clipped to ground level, dried at 60° C, separated by plant species, and weighed. Data was analyzed by analysis of variance as a completely randomized design with two replications, and significant differences ($P<0.05$) among means were separated with Tukey's Honestly Significant Difference (Tukey 1953).

RESULTS AND DISCUSSION
In the winter-grazed pastures, production of western wheatgrass decreased as distance from saltbush shrubs increased, while that of blue grama sometimes increased (Table 1). No such effect was observed in summer-grazed pastures. In the exclosures, production of western wheatgrass was much greater than under grazing, and no effect of distance from saltbush could be detected, but production of blue grama was less than under grazing, and less near shrubs than at a greater distance. Other graminoids, plains pricklypear (*Opuntia polyacantha*), other forbs, and half-shrubs were minor constituents; they produced 0.4, 9.5, 6.8, and 6.0 g m^{-2}, with no differences among seasons of use.

The different responses between grazed pastures and ungrazed exclosures reflect the greater size and density of saltbush in the exclosures. Average crown volume was 0.25, 0.21 and 0.42 m^3 in summer-grazed, winter-grazed and exclosures, respectively; density was 4850, 3540 and 7500 plants ha^{-1} (Cibils et al 1997). The greater population of larger saltbush shrubs in the exclosures stimulated growth of western wheatgrass, perhaps by increasing snow catch and soil moisture in early spring, when western wheatgrass begins to grow while blue grama is still dormant. The increased competitiveness of western wheatgrass and shade from saltbush suppresses growth of blue grama near saltbush.

The different responses of western wheatgrass and blue grama under summer and winter grazing reflect an interaction between season of grazing and proximity to saltbush. On shortgrass prairie, heavy summer grazing reduces herbage production and suppresses cool-season grasses such as western wheatgrass (Ashby et al., 1992). Under summer grazing, the influence of grazing obscured any effects of distance from saltbush. In winter, grazing effects were minimal and the positive influence of saltbush on western wheatgrass produced greater growth of western wheatgrass the following spring and a modest suppression of blue grama near saltbush.

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Table 1
Production of western wheatgrass and blue grama at five distances from saltbush shrubs in pastures grazed summer or winter or in ungrazed exclosures.

Grazing history	Distance from saltbush, cm 0-20	20-40	40-60	60-80	80-100	Std. error of mean
	Western wheatgrass, g m^{-2}					
Summer	44.0 a	40.8 a	42.5 a	54.2 a	32.5 a	9.1
Winter	67.0 a	51.4 ab	40.8 b	32.4 b	30.5 b	9.3
Ungrazed	164.5 a	118.8 a	172.8 a	132.2 a	133.2 a	25.0
	Blue grama, g m^{-2}					
Summer	43.0 a	54.5 a	44.8 a	44.5 a	61.0 a	9.1
Winter	50.6 b	71.2 a	68.0 ab	72.2 a	67.9 ab	5.5
Ungrazed	5.8 c	18.5 bc	40.8 ab	42.8 ab	48.5 a	4.5

a, b Means in the same row followed by different letters are different, $P<0.05$.