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# Impact of Cattle Grazing on Three Perennial Grasses in South-Central Washington

W. H. RICKARD, D. W. URESK, and J. F. CLINE

**Highlight:** *Grazing by yearling steers in a sagebrush-bluebunch wheatgrass community resulted in a reduction of growth and reproductive performance of the most important forage grass. Cusick's bluegrass was sparsely represented, but it was the most palatable and nutritious grass. It also showed the large reductions in growth of leaves and reproductive performance. Bluebunch wheatgrass and Thurber's needlegrass were not as adversely affected by grazing as Cusick's bluegrass.*

Quantitative information concerning the effects of grazing by cattle on important range forage plants is needed for successful long-term use of western rangelands. For a given species of plant, controlled grazing may actually improve the quantity and nutritional quality of available forage; however, undesirable effects, such as reduction of growth and reproductive vigor, may occur. If palatable forage plants are weakened by excessive grazing, they are likely to be replaced by aggressive, less palatable species.

The influences of grazing on aboveground herbage have often been simulated by hand-clipping and the results extrapolated to usage by grazing animals. Recent literature reviews concerning grazing and clipping impacts are presented by Ellison (1960) and Jameson (1963). Bluebunch wheatgrass (*Agropyron spicatum*), an important forage on western rangelands, has been investigated by several workers: Stoddart (1946), Blaisdell and Pechanec (1949), Heady (1950), Branson (1956), Wilson et al. (1966), and Mueggler (1972). Little data are available for the most abundant forage grasses growing in association with bluebunch wheatgrass.

This paper presents the results of a 3-year investigation concerning the gross effects of moderate spring grazing by steers in a sagebrush-bluebunch wheatgrass community in the semiarid steppe region of south-central Washington.

## The Study Area

The study site is the Arid Lands Ecology Reserve located on the United States Atomic Energy Commission's Hanford Reservation. This is one of several widely scattered study areas in the steppe regions of the United States which have been incorporated into the International Biological Program Grassland Biome studies. Topographically, the site is located on gentle, east-facing slopes of the Rattlesnake Hills at an elevation of about 1300 ft above mean sea level. The vegetation is representative of the *Artemisia tridentata*/*Agropyron spicatum* association (Daubenmire, 1970). Texturally, the soil is a silt loam with very few stones in the upper meter of the soil profile. October to May precipitation averaged 23 cm over the past 3 years. Prior to the initiation of the studies reported here, there had been little or no cattle grazing since 1943.

Four adjoining pastures, each 9 hectares in area, were established within a homogenous plant community with a long history of no grazing (Fig. 1). The pastures were similar in slope, exposure, elevation, soil type, and chemical properties, and were exposed to the same weather conditions (Rickard et al., 1972). An old, unused dirt road and several water-washed gullies up to a meter in depth and several meters wide are present but occupy only a small part of the area.

Two pastures were enclosed with a four-strand barbed wire fence with a common watering tank placed between them; the two adjoining pastures were not fenced, although steel fence posts were installed at the same 5-meter spacing to facilitate locating sampling plots within pastures. In April, 1971, 15 yearling steers were used as a grazing stress within the fenced pastures. The grazing season lasted for 58 days, alternating between pastures at weekly intervals. In 1972 the same stocking rate and alternate weekly use of pastures was maintained for 41 days. In 1973 grazing was excluded from one fenced pasture which hereafter is referred to as the grazing-release pasture. Steers were removed when it was visually estimated that about half of the new growth of bluebunch wheatgrass had been removed.

## Sampling Design

Pre-treatment harvests were made on all four pastures in the early spring of 1971 for species composition and plant biomass. Sampling was distributed over 9 hectares in each pasture—using 6 replicated areas each 15 X 30 meters, randomly selected within each pasture (Rickard et al., 1972). Harvest plots, 0.5 $m^2$, were also selected at random from within each replicate. In 1973 one previously grazed pasture was not grazed and the performance of vegetation was compared to its adjacent ungrazed control area.

In 1973 eight replicated areas were located at random in the grazing-release pasture and the adjacent ungrazed control pasture. Replicates that fell across dirt roads or the deeper gullies were rejected. Thereafter, all biomass sampling was confined to the replicates. Aboveground biomass harvests

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**Fig. 1.** *Comparison of the grazed pasture (*left*) prior to being released from grazing and the ungrazed control pasture (*right*) on the ALE site.*

consisted of hand clipping 32 circular plots at 3-week intervals throughout the spring growing season in control and grazing-release pastures. As the growing season progressed, it was apparent that measurements other than live biomass would be needed to adequately describe the impact of past grazing. Individual grass clumps were selected by species and measured for length of leaves and flowering culms, length of the flowering spike, the number of flowering culms, and clump area (length X width). Two randomly chosen points were made in each replicate, and a 2 $m^2$ circular hoop was laid down tangent to a point. A maximum of six clumps of bluebunch wheatgrass in each circle was chosen for measurements. If more than six clumps were encircled, clumps were selected at random.

Cusick's bluegrass (*Poa cusickii*) and Thurber's needlegrass (*Stipa thurberiana*) were sparsely scattered over the pastures. The first six clumps encountered within each replicate and the immediate area were chosen for measurements. A single clump of each of the three species from each replicate was clipped at ground level for chemical analysis.

It was not practical in terms of time and effort to measure the myriad of leaves in each clump; therefore, leaf length measurements were made at systematic intervals around the margin of each crown and in the crown interior until twelve leaves were measured.

Live biomass was hand separated from dead material for each species and weighed separately from the crown tissues. All material was oven-dried, weighed, and processed according to the procedures of the A.O.A.C. (1965). Plant samples for the live category were combined by clumps over two replicates within pastures, reducing the sample size to four for chemical analyses. The dead category was combined by clumps for each species over four replicates, reducing the sample size to two. Analyses include: crude protein, crude fat, crude fiber, nitrogen free extract (NFE), total digestible nutrients (TDN), and ash.

## Results

Pre-grazing biomass harvested on two dates in 1971 indicates that the four pastures were much alike (Table 1). Bluebunch wheatgrass, the major cattle forage species, was similar in biomass ($\alpha = 0.05$) for all pastures on two early harvest dates when tested by a two-way analysis of variance. The pastures showed some differences on the first harvest ($\alpha = 0.05$) during the early stages of growth for Sandberg bluegrass (*Poa secunda*) and total biomass of all herbaceous species. Bluebunch wheatgrass and Sandberg bluegrass comprised 57% of the total biomass. Replicates within pastures were similar ($\alpha = 0.05$) indicating a relatively homogenous plant community.

Three perennial bunchgrasses provided essentially all of the herbaceous forage for cattle. These were Cusick's bluegrass, Thurber's needlegrass, and bluebunch wheatgrass (Table 2). Although ubiquitously distributed, Sandberg bluegrass provided little forage for cattle. The standing dead herbage associated with these three perennial grasses was reduced by approximately 50% in the grazing-release pasture (Table 2).

Biomass yields for bluebunch

**Table 1. Average herbaceous plant biomass ($g/m^2$ ± standard error) on four pastures prior to the introduction of cattle, spring 1971.**

| Date and species | Pasture 1 control | Pasture 2 to be grazed | Pasture 3 control | Pasture 4 to be grazed |
|---|---|---|---|---|
| March 22 | | | | |
| *Agropyron spicatum* | 1.9 ± 0.5 | 1.6 ± 0.4 | 3.2 ± 0.9 | 2.6 ± 0.7 |
| *Poa secunda* | 2.5 ± 0.3 | 3.2 ± 0.3 | 4.2 ± 0.5 | 2.9 ± 0.3 |
| All vegetation | 5.7 ± 0.9 | 6.8 ± 0.7 | 11.7 ± 1.7 | 8.0 ± 1.4 |
| April 8 | | | | |
| *Agropyron spicatum* | 6.0 ± 1.5 | 3.8 ± 0.5 | 4.5 ± 1.1 | 5.7 ± 1.1 |
| *Poa secunda* | 3.6 ± 0.5 | 3.3 ± 0.4 | 4.1 ± 0.5 | 3.2 ± 0.6 |
| All vegetation | 11.2 ± 2.4 | 8.4 ± 1.1 | 13.6 ± 1.8 | 14.5 ± 2.1 |

Table 2. Comparison of average biomass expressed as g/m² ± standard error for perennial grasses in an ungrazed control pasture and a grazing release pasture sampled periodically throughout the growing season of 1973.

| Item | Harvest dates | | | | |
|---|---|---|---|---|---|
| | Mar. 19 | Apr. 9 | Apr. 30 | May 21 | June 11 |
| Ungrazed control pasture | | | | | |
| Live | | | | | |
| *Agropyron spicatum* | 7.1 ± 1.3 | 22.0 ± 3.0 | 35.0 ± 4.5 | 26.0 ± 5.0 | 40.0 ± 6.0 |
| *Poa cusickii* | 0.1 ± 0.1 | 1.0 ± 0.7 | 0.4 ± 0.4 | 2.0 ± 1.8 | 0.5 ± 0.3 |
| *Poa secunda* | 3.6 ± 0.3 | 4.0 ± 0.4 | 0.4 ± 0.1 | 0.2 ± 0.1 | 0.2 ± 0.1 |
| *Stipa thurberiana* | 0.1 ± 0.1 | 0.1 ± 0.1 | 0.3 ± 0.3 | 0.3 ± 0.3 | 0.5 ± 0.4 |
| Total | 11 | 27 | 36 | 28 | 41 |
| Standing dead | | | | | |
| *Agropyron spicatum* | 87.0 ± 17.0 | 74.0 ± 9.0 | 88.0 ± 17.0 | 65.0 ± 16.0 | 105.0 ± 17.0 |
| *Poa cusickii* | 0.1 ± 0.1 | 0.9 ± 0.6 | 0.3 ± 0.3 | 3.5 ± 3.3 | 2.6 ± 1.5 |
| *Poa secunda* | 6.0 ± 0.6 | 4.7 ± 0.7 | 7.4 ± 1.3 | 6.8 ± 0.9 | 4.4 ± 0.7 |
| *Stipa thurberiana* | 0.1 ± 0.1 | 0 | 0.4 ± 0.4 | 2.0 ± 2.0 | 1.7 ± 1.6 |
| Total | 93 | 79 | 96 | 77 | 113 |
| Grazing release pasture | | | | | |
| Live | | | | | |
| *Agropyron spicatum* | 4.7 ± 0.9 | 16.0 ± 4.3 | 34.0 ± 5.0 | 23.0 ± 4.3 | 23.0 ± 2.0 |
| *Poa cusickii* | 0.6 ± 0.3 | 1.1 ± 0.5 | 1.6 ± 0.8 | 1.1 ± 0.6 | 0.5 ± 0.2 |
| *Poa secunda* | 3.7 ± 0.5 | 4.1 ± 0.3 | 0.4 ± 0.1 | 0.4 ± 0.06 | 0.1 ± 0.1 |
| *Stipa thurberiana* | 0.2 ± 0.2 | 1.0 ± 0.6 | 0.1 ± 0.1 | 0.6 ± 0.5 | 0.7 ± 0.4 |
| Total | 9 | 22 | 36 | 25 | 24 |
| Standing dead | | | | | |
| *Agropyron spicatum* | 33.0 ± 9.0 | 37.0 ± 11.0 | 48.0 ± 8.0 | 28.0 ± 5.0 | 39.0 ± 4.0 |
| *Poa cusickii* | 0.4 ± 0.3 | 0.5 ± 0.5 | 0.4 ± 0.3 | 0.6 ± 0.4 | 1.0 ± 0.5 |
| *Poa secunda* | 3.4 ± 0.4 | 2.3 ± 0.4 | 4.7 ± 0.7 | 4.7 ± 0.3 | 3.7 ± 0.7 |
| *Stipa thurberiana* | 0.4 ± 0.3 | 1.0 ± 0.6 | 0 | 0.3 ± 0.2 | 1.0 ± 0.6 |
| Total | 37 | 41 | 53 | 34 | 45 |

wheatgrass were compared to the control and release pastures by harvest dates using *t*-tests (Snedecor and Cochran, 1967). The two-tailed probability values obtained from the *t*-tests were subjected to a combination of *t*-tests (Winer, 1962) to obtain a single statistic. The probability values were treated as a Chi-square distribution. Throughout the growing season, biomass on the control pasture was higher ($\alpha \leq 0.05$) than on the release pasture.

Leaf length measurements showed that bluebunch wheatgrass, Cusick's bluegrass, and Thurber's needlegrass produced shorter leaves and/or flowering culms on the release pasture (Table 3). Cusick's bluegrass showed the most pronounced response to grazing with an average reduction of 39% for leaf length and 20% for the length of flowering culms. Grazing stress reduced average leaf length 21% in Thurber's needlegrass, while the length of flowering culms decreased by 8%. Average leaf lengths of bluebunch wheatgrass were reduced 18% by past grazing stress, and the length of flowering culms reduced 15%. All differences were significant at the $\alpha$ = 0.01 level. Spike length of bluebunch wheatgrass and Thurber's needlegrass was not affected by past grazing stresses. Measurements were not made for Cusick's bluegrass.

Grazing reduced the number of flowering culms produced by individual clumps of Cusick's bluegrass dramatically, i.e., 23 flowering culms as compared to only three on the grazing-release pasture (Table 4). The number of flowering culms per clump on the grazing-release pasture would probably have been fewer if some clumps had not been provided a measure of protection from grazing by the stiff branches of sagebrush. Some clumps of Cusick's bluegrass in the ungrazed pasture did not produce flowering culms; nevertheless, the number of clumps that did not produce flowering culms was lower in the pasture with the grazing history ($\alpha$ = 0.01). The percentage of bluebunch wheatgrass and Thurber's needlegrass bearing flowering culms was about the same in control and grazing-release pastures. A reduction of flowering culms per clump occurred for these two species of plants but was less pronounced than with Cusick's bluegrass.

Among the three species of grasses, only bluebunch wheatgrass showed a significant impact due to grazing on basal area. A reduction of 26% in basal area occurred, with no significant decreases occurring for the other two species of plants (Table 3).

Chemical feed analyses showed that

Table 3. Average lengths ± standard error (cm) of leaves, flowering culms, spikes and basal area (cm²) of crowns of perennial grasses from control and grazing release pastures in 1973.

| Species | Average leaf length | Average culm length | Average spike length | Average basal area |
|---|---|---|---|---|
| *Agropyron spicatum* | | | | |
| Release | **24.8 ± 0.2 | **32.5 ± 0.5 | 6.6 ± 0.1 | *428 ± 55 |
| Control | 30.3 ± 0.3 | 38.2 ± 0.7 | 6.2 ± 0.1 | 582 ± 73 |
| *Poa cusickii* | | | | |
| Release | **13.6 ± 0.3 | **31.1 ± 1.1 | NM | 285 ± 21 |
| Control | 22.4 ± 0.3 | 39.0 ± 1.1 | NM | 295 ± 25 |
| *Stipa thurberiana* | | | | |
| Release | **22.6 ± 0.4 | **34.9 ± 0.5 | 13.8 ± 0.2 | 102 ± 11 |
| Control | 28.6 ± 0.4 | 38.1 ± 0.4 | 13.9 ± 0.1 | 103 ± 12 |

* Significantly different from control at $\alpha \leqslant 0.05$.
** Significantly different from control at $\alpha \leqslant 0.01$.
NM=No measurement made.

Table 4. Comparison of the number of grass clumps with at least one flowering culm on control and release from grazing pastures and the average number of flowering culms per clump.

| Species | Proportion (%) of clumps with flowering culms | | Number of flowering culms per clump | |
|---|---|---|---|---|
| | Number | Mean | Number | Mean ± SE[1] |
| *Agropyron spicatum* | | | | |
| Release | 85 | 73 | 62 | 18.6 ± 2.7 |
| Control | 76 | 72 | 55 | 24.8 ± 3.8 |
| *Poa cusickii* | | | | |
| Release | 48 | **23 | 11 | **3.3 ± 0.8 |
| Control | 48 | 85 | 41 | 22.9 ± 3.3 |
| *Stipa thurberiana* | | | | |
| Release | 48 | 90 | 43 | *13.9 ± 1.7 |
| Control | 48 | 96 | 46 | 19.4 ± 1.9 |

* Significantly different from control at $\alpha \leqslant 0.05$.
**Significantly different from control at $\alpha \leqslant 0.01$.
[1] Mean ± standard error of the mean.

Table 5. Feed analysis (%) of three perennial grasses on control and release from grazing pastures on the Arid Lands Ecology Reserve.

| Species | Protein | Fat | Fiber | NFE | TDN | Ash |
|---|---|---|---|---|---|---|
| Live tissues | | | | | | |
| *Agropyron spicatum* | | | | | | |
| Release | 6.7 | 3.2 | 34 | 53 | 49 | 9 |
| Control | 5.8 | 3.4 | 35 | 54 | 50 | 9 |
| *Poa cusickii* | | | | | | |
| Release | 10.6 | 5.7 | 30 | 51 | 50 | 13 |
| Control | 11.6 | 5.7 | 31 | 50 | 50 | 15 |
| *Stipa thurberiana* | | | | | | |
| Release | 6.8 | 3.0 | 38 | 51 | 49 | 10 |
| Control | 6.1 | 2.8 | 40 | 49 | 48 | 12 |
| Dead tissues | | | | | | |
| *Agropyron spicatum* | | | | | | |
| Release | 3.9 | 1.9 | 39 | 53 | 49 | 16 |
| Control | 3.9 | 1.7 | 40 | 53 | 49 | 14 |
| *Poa cusickii* | | | | | | |
| Release | 6.9 | 2.1 | 33 | 53 | 48 | 18 |
| Control | 7.5 | 1.7 | 33 | 55 | 49 | 23 |
| *Stipa thurberiana* | | | | | | |
| Release | 4.3 | 1.7 | 36 | 54 | 49 | 20 |
| Control | 4.3 | 1.6 | 39 | 51 | 48 | 21 |

live Cusick's bluegrass tissue had higher contents of protein and fat and a lower fiber content than did equivalent tissues of bluebunch wheatgrass and Thurber's needlegrass (Table 5). There were no measurable differences in terms of feed analyses between grazing-release and control areas. Contents of crude protein and fat were approximately 50% lower in dead tissues, while fiber, NFE, ash, and TDN remained approximately the same as in live tissues.

## Discussion

Cattle grazing is the most widespread biological stress imposed upon grassland ecosystems in western North America. As compared to grasslands east of the Rocky Mountains, the shrub-steppe regions of the Pacific Northwest have not had a long history of livestock grazing (Galbraith and Anderson, 1971). Some effects of long-term grazing by cattle upon plant communities in the steppe regions of southeastern Washington have been described by Daubenmire (1970), where invasion by cheatgrass (*Bromus tectorum*) results from over grazing. The study site described in this investigation is unusual in that it has not been grazed by livestock for 30 years and cheatgrass is sparsely represented. The grazing history prior to 1943 is not documented, but it is known that cattle and sheep were both grazing within the general area. The long distance from drinking water, 6 miles to the Yakima River, probably helped contribute to light grazing.

Simple measurements of leaf heights and counting the number of flowering culms are the most efficient ways to describe the effects of past grazing stress on forage grasses. Biomass measurements are time consuming to make but provide meaningful information on amount of forage produced per unit area over time. Unless large numbers of samples are taken, their utility is lessened by large variances associated with average harvest values even in small pastures with relatively homogeneous vegetation. Although a limited number of samples were analyzed for proximate feed analyses, these were not useful in indicating past grazing stress.

Studies of grazing effects on rangeland plants have been of two general kinds: (1) field observations recording changes in plant species composition and relative abundance by comparing pastures with known grazing histories with nearby or adjacent areas (exclosures) without grazing, and (2) inferences derived from hand-clipping of plants at various heights aboveground and at different times of the year. Hand-clipping simulates herbage removal by grazing animals and examples of these studies are by Stoddart (1946), Blaisdell and Pechanec (1949), Wilson et al. (1966), and Mueggler (1972). Dramatic responses to clipping have been reported. Wilson et al. (1966) reported a 70% decrease in herbage production of bluebunch wheatgrass following three consecutive years of ground-level clipping.

Clipping studies do not necessarily simulate the ways in which grazing animals treat the plants they eat, especially if the animals have a chance to select many species and plant parts over a large grazing area. Although conducted over a short period of time, the studies presented here represent stresses imposed by grazing cattle under realistic grazing conditions and moderate stocking rates. It also appears that many years of moderate grazing will be needed before pronounced shifts in species composition and abundance would be noticed.

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# Initial Response of Bitterbrush to Disturbance by Logging and Slash Disposal in a Lodgepole Pine Forest

PAUL J. EDGERTON, BURT R. McCONNELL, AND JUSTIN G. SMITH

**Highlight**: *The impact of logging and slash disposal on the bitterbrush understory in a lodgepole pine forest on easily disturbed pumice soils in central Oregon was evaluated. Soils were moderately to heavily disturbed on 75% of the area, and bitterbrush crown cover was reduced by 71%. Most of the damage resulted from slash disposal. Despite extensive damage, shrubs quickly responded to more favorable growing conditions in the postlogging environment. Current twig growth doubled, and large numbers of seedlings were established on disturbed soils.*

The lodgepole pine (*Pinus contorta*)[1] /bitterbrush (*Purshia tridentata*) communities on the pumice plateau of south-central Oregon are important summer range for mule deer (*Odocoileus hemionus hemionus*) and livestock. Increased harvests of lodgepole pine are planned, and managers are concerned about maintaining a bitterbrush understory sufficient for forage needs. Soil, site, and vegetation relationships have been described (e.g., Dyrness and Youngberg, 1966; Youngberg and Dahms, 1970; Franklin and Dyrness, 1973) but there is little information on the impact of logging on understory vegetation.

We studied bitterbrush reduction due to logging disturbance and the initial response of surviving shrubs to the postlogging environment. The results contributed to development of guidelines for coordinated management of timber and wildlife habitat.

The authors are wildlife biologist, plant ecologist, and former project leader (retired), respectively, U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, La Grande, Oregon.

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[1] Sources for scientific nomenclature are Little (1953), Hitchcock et al. (1955), and Ingles (1965).

## Study Area

The study area was located on the Pringle Falls Experimental Forest, 40 miles southwest of Bend, Ore. Elevation is 4,300 ft and annual precipitation averages 20 inches, mostly as winter snowfall. The growing season is short and frosts are common during the summer.

Soils and vegetation are characteristic of much of the level to gently rolling plateau. Soils are poorly developed and belong to the widely occurring Lapine series formed on pumice deposits. They are primarily composed of easily disturbed sand and pumice gravels, variable in depth and underlain by buried soil (Cochran et al., 1967). Lodgepole pine occurs in extensive, nearly pure stands on flats and in shallow depressions and is the climax species due to topographic conditions preventing establishment of ponderosa pine (*Pinus ponderosa*) (Berntsen, 1967). Several communities dominated by lodgepole pine have been identified (Youngberg and Dahms, 1970), with the lodgepole pine/bitterbrush the most widespread. Characteristic species in the sparse understory include western needlegrass (*Stipa occidentalis*), bottlebrush squirreltail (*Sitanion hystrix*), and Ross sedge (*Carex rossii*).

**Table 1. Percent of line intercept by ground disturbance classes.**

| Ground disturbance class | Definition | Percent of area in this condition |
|---|---|---|
| None | No disturbance | 8 |
| Light | Litter displacement only | 12 |
| Moderate | Soil disturbed <3 inches | 32 |
| Heavy | Soil disturbed >3 inches | 46 |
| Slash | Debris >3 inches diameter | 2 |
| All classes | | 100 |