Growth and Reproduction of Grasses Heavily Grazed under Rest-Rotation Management

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Abstract

This study evaluated the effects of heavy forage use in a rest-rotation grazing system on the basal-area growth and frequency of occurrence of native bunchgrasses from 1975 to 1984. None of these grasses increased in basal-area cover with brush competition or in basal-area cover or frequency without brush competition when subjected to periodic heavy grazing (65% utilization in June and 75% in July) during the growing season. When plants were protected from grazing, average basal-area cover increased for Idaho fescue [*Festuca idahoensis* Elmer] and squirreltail [*Sitanion hystrix* (Nutt.) J.G. Sm.] in a Wyoming big sagebrush [*Artemisia tridentata wyomingensis* Beetle]-Idaho fescue community type and for Thurber needlegrass [*Stipa thurberiana* Piper] in a Wyoming big sagebrush-bluebunch wheatgrass [*Agropyron spicatum* (Pursh) Scribn. & Smith] community type. Average basal-area cover was unchanged for protected Thurber needlegrass plants in a Wyoming big sagebrush-Thurber needlegrass community type. Average basal-area cover of Thurber needlegrass plants in the same community type decreased when heavily grazed during the growing season in 1 year during the first 3 years of the study and with no grazing during the growing season in the last 4 years of the study. Bluebunch wheatgrass showed no differential response to grazing or protection. Results of this study strongly implicate periodic heavy grazing during the growing season as a primary cause of restricted basal-area growth and lack of reproduction. These results support the contention that such grazing pressure can prevent range improvement in an otherwise appropriate rotation grazing system.

Key Words: basal area, frequency, bluebunch wheatgrass, Idaho fescue, Thurber needlegrass, exclosures, sagebrush competition

Uneven livestock distribution under season-long grazing each year can cause excessive forage utilization on key sites and species during the growing season and result in deterioration of the vegetation resource. This problem can be reduced by rotation grazing plans that include periodic deferment from grazing during the growing season so plants can regain vigor and productivity (Hormay and Talbot 1961, Hyder and Bement 1977). Hyder and Bement (1977) stated, however, that the need for moderate utilization during the growing season often is neglected in the design of rotation management plans. Hormay and Talbot (1961), for example, advocated fairly heavy forage use (66%) in the pasture grazed during the growing season in a 5-pasture, rest-rotation system. This heavy utilization level was justified on the basis that grazing is limited to a comparatively short time and is always followed by a rest period long enough to overcome the adverse effects of heavy use.

Based on this philosophy, 3-pasture rest-rotation grazing systems that included periodic heavy use during the growing season were initiated on some Bureau of Land Management allotments in the early 1970's. Heavy use was the result of no reduction in stocking rate when the system was initiated and a concentration of cattle in 1 pasture of the allotment during the growing season in order to obtain rest or deferment from grazing in other pastures of the allotment. Eckert and Spencer (1986) evaluated 2 such grazing systems in the sagebrush-grass type of northern Nevada and reported that frequency and cover of decreaser grasses essentially were unchanged on a majority of sites after 7 to 10 years of rest-rotation management. They attributed this lack of response of desirable species partially to heavy utilization that maintained low plant vigor, restricted basal-area growth, and reduced seed production. Others (Robertson et al. 1970, Heady 1975, Mueggler 1975) also have suggested that heavy grazing during the growing season may exceed the benefits gained from subsequent rest or deferment. Bullock (1975) theorized that in many areas of low growing-season precipitation, even moderate use of perennial grasses places them at a severe competitive disadvantage with nonpalatable and well-adapted shrubs. Blaisdell et al. (1982) believe that vegetation improvement on sites in early-seral range condition will be extremely slow or will not occur at all because of continued heavy use on the few remaining desirable plants and because of competition by sagebrush. Hickey (1967) and Hyder and Bement (1977) concluded that no management system appears to be satisfactory if that system results in overgrazing during the growing season in order to defer or rest vegetation in other grazing periods.

The objective of this study was to determine the effects of heavy forage use with and without sagebrush competition in a rest-rotation grazing system on basal-area growth and frequency of occurrence of native grasses. Exclosure and sagebrush control studies were conducted to meet this objective.

Description of Study Areas

Studies were conducted in the Panther Canyon and China Mountain Pastures of the Goldbanks Allotment. This allotment is about 48 km south of Winnemucca, Nev., and is administered by the Winnemucca District, BLM. Elevation of study sites varies from 1,615 to 1,768 m. Annual precipitation, mostly snow, averaged 275 mm for the period 1975 to 1984 and varied from lows of 142 mm in 1980–81 and 175 mm in 1976–77 to highs of 356 mm in 1977–78 and 411 mm in 1982–83 (Table 1). The most widespread community types on the allotment are Wyoming big sagebrush [*Artemisia tridentata wyomingensis* Beetle]-Thurber needlegrass [*Stipa thurberiana* Piper), Wyoming big sagebrush-bluebunch wheatgrass [*Agropyon spicatum* (Pursh) Scribn. & Smith], and Wyoming big sagebrush-Idaho fescue *Festuca idahoensis* Elmer.

A 3-pasture rest-rotation management plan for grazing from

Table 1. Precipitation and grazing treatments during the study period.

	Precipitation[1]		Pasture and grazing treatment	
Year	mm	% of 10-year-mean	China Mountain	Panther Canyon
1975	297	111	Rest	Seedripe
1976	183	66	Graze	Rest
1977	175	64	Seedripe	Graze
1978	356	129	Rest	Seedripe
1979	254	92	Graze	Rest
1980	272	99	Seedripe	Graze
1981	142	52	Rest	Seedripe
1982	330	120	Seedripe	Rest
1983	411	149	Rest	Graze
1984	333	121	Rest	Seedripe

[1]Oct. to 30 Sept.

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May through October was initiated in 1973. Actual use in grazed pastures during years of the study varied between 525 and 742 cow-calf AUM's. The grazing sequence over a 3-year period was: (1) graze from 1 May to 31 Oct.; (2) graze from 15 July (seedripe) to 31 Oct.; and (3) rest year-long. The sequence of grazing treatments from 1975 to 1984 in both pastures is given in Table 1. Utilization on study areas in each pasture each year since 1974 was heavy and averaged 65% in June, 75% in July, and 80% in October on pastures grazed during the growing season and 80% in October on pastures grazed after seedripe (Eckert and Spencer 1986).

An exclosure study was established in all 3 community types in the China Mountain Pasture. Soil associated with the big sagebrush-Thurber needlegrass site is a fine, montmorillonitic, mesic Xerollic Natrargid. Canopy cover of sagebrush was 21% in 1973 and 26% in 1980. Soil associated with the big sagebrush-bluebunch wheatgrass site is a fine, montmorillonitic, mesic Durixerollic Natrargid. Canopy cover of sagebrush was 17% in 1973 and 30% in 1980. Soil associated with the big sagebrush-Idaho fescue site is a fine, montmorillonitic, mesic Haploxerollic Nadurargid. Canopy cover of sagebrush was 21% in 1973 and 23% in 1980. Vegetation on all study areas was in mid-seral range condition when the study began with a mixture of the decreaser grasses potential for the site and increaser grasses such as Sandberg bluegrass [*Poa sandbergii* Vasey] and squirreltail [*Sitanion hystrix* (Nutt.) J.G. Sm.].

A brush control study was established on a big sagebrush-Thurber needlegrass community type in the Panther Canyon Pasture. Soil is a fine-loamy, mesic Haploxerollic Nadurargid. Sagebrush cover was 21% when the study was initiated and vegetation was in mid-seral range condition with a mixture of decreaser and increaser grasses.

Methods

Exclosure Study

This study evaluated the growth response of bunchgrasses to heavy grazing and to protection from grazing under a similar level of sagebrush competition. Nine 4.8 × 4.8 m exclosures were built in spring 1977. Individual plants of decreaser and increaser bunchgrasses were selected at random inside and outside each exclosure and permanently marked for repeated measurement. Three exclosures were on a big sagebrush/Thurber needlegrass site. At each site, 14 Thurber needlegrass and 10 squirreltail plants were sampled: a total of 42 needlegrass plants and 30 squirreltail plants both inside and outside the 3 exclosures. Three exclosures were on a big sagebrush-bluebunch wheatgrass site. At each site from 6 to 11 bluebunch wheatgrass plants and from 4 to 10 Thurber needlegrass plants were sampled: a total of 24 wheatgrass plants and 18 needlegrass plants both inside and outside the 3 exclosures. Three exclosures were on a big sagebrush-Idaho fescue site. At each site from 3 to 14 Idaho fescue plants and 10 squirreltail plants were sampled: a total of 24 fescue plants and 30 squirreltail plants both inside and outside the 3 exclosures.

The same individual measured total and dead basal diameter of each bunchgrass in late summer of 1977, 1978, 1981, and 1983. These were the years when plants outside the exclosures were not grazed during the growing season. The ellipse formula ($A = \pi ab$), where a and b are the major and minor radii of each plant, was used to calculate total and dead basal area. Live basal area was the difference between total and dead basal areas. The study was a completely randomized design with 3 replications (exclosures and adjacent grazed area). Plants outside the exclosures were grazed in a normal 3-pasture sequence from 1977 to 1981 but the grazing sequence was not followed in 1982 and 1983 (Table 1). A wildfire in 1 pasture of the allotment not used in this study required rescheduling of the grazing use in the China Mountain Pasture during a 2-year post-fire rest period. Plants outside exclosures were grazed after seedripe in 1982 and were not grazed in 1983.

Sagebrush Control Study

This study evaluated the growth and reproduction of bunchgrasses and sagebrush with little brush competition for a portion of the study period. Individual sagebrush plants on 3, 12 × 12 m plots were sprayed with a tank mix of 4 l of water and 200 ml of 2,4-D [(2,4-dichlorophenoxy) acetic acid] in spring 1975. The line intercept method (Canfield 1941) was used to estimate canopy cover of shrubs in 1975, and again in 1976, the year after treatment. Response of sagebrush after brush control was determined by change in canopy cover and frequency while response of increaser and decreaser grasses was determined by change in basal-area cover and frequency. One permanent 0.9-m^2 quadrat was randomly located in each plot. Basal area of bunchgrasses and canopy cover of shrubs rooted in or overhanging the quadrat were charted in the late summer of 1976, 1981, and 1984. The quadrat was subdivided into 7.5-cm^2 units to facilitate charting. A dot grid was used to calculate the total area of each species charted and this area was expressed as percent cover. Frequency was sampled by 4 transects each with 20 quadrats in 1975, 1976, 1978, 1981, 1982, and 1984. Quadrat size was 10 × 10 cm for Sandberg bluegrass and 20 × 20 cm for all other species. Vegetation data were collected in either the seedripe or rest treatment by the same individual. The study was a completely randomized design with 3 replications (sprayed blocks). A normal 3-pasture rest-rotation grazing sequence was followed from 1975 to 1984 with heavy grazing during the growing season in 3 of 10 years (Table 1). Soil-moisture blocks were placed at depths of 15, 30, and 45 cm in each plot and were read periodically from May through September each year.

A repeated measures analysis of variance (Winer 1971) was used in both studies because data were collected periodically from the same plots or transects. Percent cover and frequency data from the sagebrush control study were transformed by the arcsin squareroot procedure before analysis. Significantly different cover and frequency means in both studies were determined by Duncan's multiple range test at the 0.05 probability level.

Results and Discussion

Exclosure Study

Average size (live basal area) of individual grazed and protected plants of a species within each community type did not vary significantly at the start of the study in 1977 (seedripe year) (Table 2). When these plants were remeasured in 1978 (rest year), again no size difference was detected. Average size of grazed bluebunch wheatgrass, Idaho fescue, and squirreltail plants did not change significantly from 1977 to 1983; however, size of grazed Thurber needlegrass plants decreased significantly (Table 2). Average size of protected bluebunch wheatgrass and squirreltail plants on the big sagebrush-bluebunch wheatgrass site also did not change significantly and both protected and grazed plants were similar in size in 1983. Conversely, protected Thurber needlegrass, Idaho fescue, and squirreltail plants were significantly larger than grazed plants

Table 2. Mean live basal area (cm^2) in 1977 and 1983 of individual native bunchgrasses on 3 community types in the China Mountain Pasture. Plants were protected from grazing throughout the study or were grazed in a 3-pasture system that included grazing during the growing season in 1979; grazing after seedripe in 1977, 1980, and 1982; and no grazing in 1978, 1981, and 1983.

	1977		1983	
	Protected	Grazed	Protected	Grazed
	Wyoming big sagebrush-Thurber needlegrass			
Thurber needlegrass	71 a[1]	53 a	62 a	30 b
Squirreltail	25 a	26 a	33 a	23 a
	Wyoming big sagebrush-Bluebunch wheatgrass			
Bluebunch wheatgrass	142 a	121 a	171 a	173 a
Thurber needlegrass	44 b	31 b	62 a	41 b
Squirreltail	25 a	22 a	30 a	25 a
	Wyoming big sagebrush-Idaho fescue			
Idaho fescue	66 b	52 b	100 a	72 b
Squirreltail	21 b	24 b	40 a	27 b

[1]Species means in each row followed by the same letter are not significantly different ($P<0.05$).

on certain sites in 1983 (Table 2). On the Wyoming big sagebrush-Thurber needlegrass site, protected needlegrass plants did not change in size from 1977 to 1983. However, since grazed needlegrass plants declined significantly in size from 1977 to 1981 and remained the same size between 1981 and 1983, they were significantly smaller than protected plants in 1983. Heavy use of these plants during the growing season occurred only in 1979. Protected Thurber needlegrass plants on the big sagebrush-bluebunch wheatgrass site and protected Idaho fescue and squirreltail plants on the big sagebrush-Idaho fescue site increased significantly in size from 1977 to 1981, remained the same size through 1983, and thus were larger than grazed plants in 1983. The increases and decreases in plant size from 1977 to 1981 occurred over a period of 1 above- and 2 near-normal precipitation years, 2 very dry years, 1 year of heavy grazing during the growing season, 2 years of heavy grazing after seedripe, and 2 years of rest. The above-average precipitation in 1982 and 1983 did not affect a growth response of any species on any site.

Other research has shown that vigor and growth of Idaho fescue and bluebunch wheatgrass were affected adversely for many years by a single heavy or extreme defoliation when plants were subjected to full competition from associated species (Mueggler 1975). In the present study, grazed Thurber needlegrass, Idaho fescue, and squirreltail plants were affected adversely, compared to ungrazed plants, by a combination of heavy defoliation during the growing season in only 1 of 7 years and sagebrush competition every year. Hormay and Talbot (1961) also have shown that herbage removal when grasses are dry and apparently dormant, as in a seedripe grazing sequence, can also reduce basal area. In the present study, plants were grazed heavily after seedripe in 3 of 7 years. The differential growth response of heavily grazed and protected plants under the same level of sagebrush competition implicates heavy use as a factor restricting basal-area growth. Basal area of bluebunch wheatgrass did not vary significantly on grazed or protected areas from 1977 to 1983, although the trend was for larger plants in 1983 on both treatments. The growth form of this species and the method of measurement used may account for our inability to determine plant size accurately. Because of its very open bunchgrass form, the amount of dead basal area could not always be distinguished from the rather large natural openings between tillers in a bunch. Also, an increase in sagebrush competition due to the large increase in canopy cover from 17% in 1973 to 30% in 1980 may have prevented a differential growth response by either protected or grazed bluebunch wheatgrass plants.

Sagebrush Control Study

Canopy cover of big sagebrush was 1% the year after treatment. Very low precipitation in 1976–77 (Table 1) resulted in a significant reduction in the frequency (from 68 to 58%), and presumably in the basal cover, of Sandberg bluegrass in 1978. Following this decrease in bluegrass competition and the high precipitation in 1977–78, frequency of sagebrush increased significantly from 2% in 1976 to 77% in 1978. These new plants were seedlings located in the interspace between dead shrubs. The canopy cover of these new sagebrush plants was not measured between 1978 and 1980 but probably was quite small due to the size of 2- and 3-year-old shrubs. The canopy cover of these new sagebrush plants was 6.6% in 1981 with a frequency of 53%. Frequency of bluegrass did not recover to a pre-drought level until 1981. Therefore, the amount of sagebrush and bluegrass competing with Thurber needlegrass and squirreltail was reduced from 1976 to 1981. Canopy cover of sagebrush continued to increase after 1981 to 27% in 1984 with a frequency of 72%.

The reduction in sagebrush and bluegrass competition from 1976 to 1981, as indexed by frequency, canopy cover, and basal cover, resulted in different trends in available (<–1.5 MPa) soil water. In years of below-normal precipitation, soil water was available only early in the growing season. After the dry winter of 1980–81 for example, mean soil matric potential in May was less than –0.04 MPa at both 15 and 30 cm and was –0.32 MPa at 45 cm. However, no available soil water was present from June through September. In years of above-average precipitation, soil water was available throughout the growing season. After the wet winter of 1977–78, for example, mean matric potentials at depths of 15, 30, and 45 cm were less than –0.02 MPa in both April and May. By June, mean matric potentials were –0.60, –0.15, and –0.05 MPa, respectively, at 15, 30, and 45 cm. In July, mean matric potentials were greater than –1.50 MPa at 15 cm and were –0.67 and –0.60 MPa, respectively, at 30 and at 45 cm. Similar matric potentials in June and July were not evident in wet years after 1981, probably because of the increased sagebrush cover and competitive use of soil water.

In spite of reduced bluegrass and sagebrush competition from 1976 to 1981, normal or above-normal precipitation in 1978, 1979, and 1980, and readily available soil water during the growing season in these years, frequency of cover of Thurber needlegrass and squirreltail did not increase significantly. The frequency and cover of these species also did not change significantly after 1981 when sagebrush again dominated the site. Mean frequency of Thurber needlegrass was 19, 24, and 23%, respectively, in 1976, 1981, and 1984; and frequency of squirreltail was 39, 42, and 41% respectively, in the same years. Mean basal cover of Thurber needlegrass was 1.1, 0.8, and 0.7%, respectively, in 1976, 1981, and 1984; and basal area of squirreltail was 0.4, 0.2, and 0.2%, respectively, in the same years.

A positive response of understory grasses was expected after sagebrush control. Past research has shown a substantial increase in grass production due to a reduction in sagebrush competition in vegetation types similar to that in the present study (Hyder and Sneva 1956, Hedrick et al. 1966, Miller et al. 1980). These authors attributed part of the increased grass production to new plants on treated areas, to an increase in basal cover of existing bunchgrass plants, and to more vigorous growth of existing plants. Production was not measured in the present study, but frequency and basal area were determined and no significant change in these attributes occurred. The lack of vegetation response in this study, in spite of reduction competition, implicates heavy grazing during the growing season in 3 of 9 years as a primary factor restricting the growth and reproduction of understory grasses. Heavy use also occurred after seedripe in 3 of 9 years.

Summary and Management Implications

Utilization estimates indicated that stocking levels were too high on the Goldbanks Allotment from 1975 to 1984. This was due to concentration of cattle on certain pastures in order to obtain deferment or rest from grazing on other pastures.

Basal-area cover of bluebunch wheatgrass, Idaho fescue, and squireltail did not increase when plants were growing in competition with big sagebrush and when grazed heavily during the growing season in 1 year within the first 3 years of the study and with no grazing during the growing season in the last 4 years of the study. Basal area of Thurber needlegrass in the big sagebrush-Thurber needlegrass community type decreased under these conditions. Ungrazed plants of Idaho fescue, squirreltail, and Thurber needlegrass did increase in size on some community types, but bluebunch wheatgrass did not respond to protection. Size and frequency of squirreltail and Thurber needlegrass plants also did not increase when sagebrush competition was reduced but plants were heavily grazed during the growing season in 3 of 9 years.

Results from the exclosure study with similar sagebrush competition between grazing treatments implicate periodic heavy grazing during the growing season as contributing to restricted basal-area growth. The sagebrush control study with little or no competition for 6 years strongly implicates periodic heavy grazing during the growing season as a primary cause of restricted basal-area growth and lack of reproduction. Also, the amount of deferment and rest provided by the 3-pasture rest-rotation management system evidently was not sufficient to mitigate the effects of periodic overuse.

These results support the contention that periodic overstocking and heavy forage use during the growing season can prevent range improvement in an otherwise appropriate rotational grazing system as demonstrated on this allotment by Eckert and Spencer (1986).

Current allotment management plans no longer authorize high stocking rates and heavy forage use. Rather, stocking rate is adjusted to forage production in order to obtain proper utilization levels, at least in years of average growing conditions. Management plans implemented without consideration of proper use should be examined and stocking rates adjusted, if necessary, to obtain utilization levels that allow plants of desirable species to respond to proper management.

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