# Vegetation Response on Allotments Grazed under Rest-Rotation Management

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## Abstract

**The effects of grazing management systems on plant communities in the Great Basin are largely unknown. This study is a quantitative description of the response of vegetation from 1973 to 1983 on the Goldbanks and Pueblo Mountain cattle allotments in northern Nevada managed under a 3-pasture rest-rotation grazing system. Shrub canopy cover, basal-area cover of herbaceous species, and frequency of occurrence of all species were used to estimate change in vegetation characteristics on macroplots representing 9 community types. Forage use was heavy in all years and averaged 65% in June, 75% in July and August, and 80% in October. Sandberg bluegrass [*Poa sandbergii* Vasey] and sagebrush [*Artemisia* spp. L.] were the most responsive species. Long-term increases or decreases in frequency and cover of desirable grasses were found on very few sites. Perennial forbs increased on a number of sites. Short-term changes in frequency and cover of Sandberg bluegrass and in frequency of sagebrush seedlings and young plants were attributed to a sequence of dry and wet years and to level of competition from herbaceous species. Frequency data indicated more significant changes in species composition than did cover data. The management system, forage utilization levels imposed, and climatic conditions present maintained prestudy range condition throughout the study on most sites at Pueblo Mountain. An increase in frequency and cover of Wyoming big sagebrush [*A. tridentata wyomingensis* Beetle] and a decrease in the cover of desirable grasses at Goldbanks suggest a downward trend in range condition on some sites where either Thurber needlegrass [*Stipa thurberiana* Piper] or bluebunch wheatgrass [*Agropyron spicatum* (Pursh) Scribn. & Smith] is the potential dominant grass.**


Many hectares of western rangeland presently are managed under intensive grazing systems. By 1978 for example, allotment management plans had been implemented on about 11 million ha managed by the Bureau of Land Management (BLM) (USDI 1978). About 2 million ha were under intensive management in Nevada. In addition, the "Proposed Action" in many current Environmental Impact Statements and Resource Management Plans indicates that grazing systems will be the primary means of range improvement in the future. In many cases, intensive management has come to mean deferred or rest-rotation grazing systems.

Hickey (1967) and Herbel (1971) described many kinds of grazing systems and results obtained. Hormay (1956, 1970), Hormay and Evanko (1958), and Hormay and Talbot (1961) discussed the reasons for range deterioration and developed a 5-pasture rest-rotation grazing system for improving bunchgrass range in northeastern California. Hughes (1979, 1980) reported the effects of rest-rotation management on the Arizona Strip of southern Utah and northern Arizona. Laycock and Conrad (1981) evaluated the response of vegetation and cattle to several grazing systems on mountain rangelands of eastern Utah. Johnson (1965) and Gibbens and Fisser (1975) compared different grazing systems in Wyoming. Only Hyder and Sawyer (1951) studied grazing systems in an environment and vegetation typical of the Great Basin. These authors compared rotation-deferred and season-long grazing.

This study is a quantitative description of changes in species composition on representative plant communities in different seral stages. The study was conducted on 2 allotments in northern Nevada grazed by cattle in a 3-pasture rest-rotation management system. The study was not designed to compare rest-rotation management to any other grazing system or to compare rest-rotation grazing under management conditions different from those described.

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## Experimental Areas

### Goldbanks Allotment

This 7771-ha allotment is located about 48 km south of Winnemucca, Nevada and is administered by the Winnemucca District, BLM. Topography consists of broad alluvial fans, hills, several drainages, and a very steep escarpment on 1 boundary. Elevation ranges from 1,500 to 2,700 m. Annual precipitation, mostly snow, averaged 26 cm for the period 1974–1983 and ranged from a low of 15 cm in 1980–81 to a high of 37 cm in 1977–78. Ecological range condition on study areas varies from early- to mid-seral. Wyoming big sagebrush [*Artemisia tridentata wyomingensis* Beetle] is present on all study sites. Decreaser grasses are Thurber needlegrass [*Stipa thurberiana* Piper], bluebunch wheatgrass [*Agropyron spicatum* (Pursh) Scribn. & Smith], and Idaho fescue [*Festuca idahoensis* Elmer]. Big sagebrush, green rabbitbrush [*Chrysothamnus viscidiflorus* (Hook.) Nutt.], bottlebrush squirreltail [*Sitanion hystrix* (Nutt.) J.G. Sm.], and Sandberg bluegrass [*Poa sandbergii* Vasey] are the principal increaser species. Common forbs are desert phlox [*Phlox austromontana* Cov.], milkvetch [*Astragalus* spp. L.], tapertip hawksbeard [*Crepis acuminata* Nutt.], tailcup lupine [*Lupinus caudatus* Kell.], and Stansbury phlox [*Phlox stansburyi* Hel.].

A 3-pasture rest-rotation management system for grazing from May through October was established in 1973. Actual use in grazed pastures has varied between 152 and 1,193 AUM's (Animal Unit Months) of cow-calf use. Average use in grazed pastures has been 633 AUM's. The grazing sequence for 1 pasture over a 3-year period is:

A. First year-graze (graze from May 1 to Oct. 31)
B. Second year-seedripe (graze from July 15, seedripe, to Oct. 31)
C. Third year-rest (rest year-long)

### Pueblo Mountain Allotment

This 4,007-ha allotment is located about 160 km north, northwest of Winnemucca, Nevada and also is administered by the Winnemuca District, BLM. Topography consists of mountain slopes, small alluvial fans, and several drainages with rimrock and steep mountains forming 2 boundaries. Elevation ranges from 1,524 to 1,981 m. Annual precipitation averaged 36 cm for the period 1974–1983 and ranged from a low of 25 cm in 1976–77 to a high of 40 cm in 1981–82. Ecological range condition on study areas varies from early- to late-seral. Basin big sagebrush [*Artemisia tridentata tridentata* Nutt.] and mountain big sagebrush [*A. tridentata vaseyana* (Rybd.) Beetle] are the dominant subspecies of big sagebrush on fans and mountain slopes. Low sagebrush [*A. arbuscula* Nutt.] occurs on the steeper slopes on soils with a strong argillic B horizon. Antelope bitterbrush [*Purshia tridentata* (Pursh.) DC.] is a common decreaser shrub. Principal decreaser grasses are bluebunch wheatgrass and Idaho fescue. Increaser species include big and low sagebrush, green rabbitbrush, squirreltail, thickspike wheatgrass [*Agropyron dasystachyum* (Hook.) Scribn.], Thurber needlegrass, and Sandberg bluegrass. Forbs are more prevalent than on the Goldbanks Allotment. Important species are: low pussytoes [*Antennaria dimorpha* (Nutt.) T. & G.], agoseris [*Agoseris* spp. Raf.], fleabane [*Erigeron* spp. L.], crag aster [*Aster scopulorum* Gray], tailcup lupine, tapertip hawksbeard, Stansbury phlox, and milkvetch.

A 3-pasture rest-rotation management system for grazing from June through October was established in 1972. Actual use in grazed pastures has varied between 330 and 636 AUM's of cow-calf use. Average use in grazed pastures has been 491 AUM's. The grazing sequence for 1 pasture over a 3-year period is:

A. First year-graze (graze from June 1 to July 31)
B. Second year-seedripe (graze from Aug. 1, seedripe, to Oct. 31)
C. Third year-rest (rest year-long)

The grazing systems on both allotments were quite similar in spite of different periods of time indicated for cattle use in the graze pasture. At Pueblo Mountain, normal drift of cattle was followed by riding to move all animals from the graze to the seedripe pasture soon after July 31. At Goldbanks, all movement of cattle was accomplished by drift and most animals were in the seedripe pasture soon after July 15. Some animals, however, remained in the graze pasture until Oct. 31. Remaining cattle grazed the more favored areas, such as riparian sites, not the upland sites where study sites were located. Because of this, grazing impacts on the 2 allotments were similar. Management at Goldbanks has now been modified to specify removal of all cattle from the grazed pasture by riding soon after July 15.

Low stocking rates at both allotments occurred in years of below average precipitation. Fewer head were grazed in these years or animals were grazed for a shorter time. High stocking rates occurred early in the study when additional cattle numbers were authorized above the active preference (temporary non-renewable use) through 1976 at Goldbanks and through 1978 at Pueblo Mountain. This additional use was given as an incentive for ranchers to participate in the allotment management plan. The adjustment of stocking rates among favorable and unfavorable years resulted in rather uniform utilization of forage as will be discussed later.

## Methods

Study sites were subjectively located in homogeneous stands of vegetation that appeared to represent ecological units of different potential. Since a synecological study of each allotment was not conducted, the ecological sites (range sites or phases of habitat types) present could not be determined absolutely. However, soil, remnant vegetation, and Ecological Site Descriptions for the Malhauer High Plateau (USDA 1965) and for the Humboldt Area (USDA 1982) were used to make inferences between present vegetation on a study site, termed community type (CT), and potential vegetation. We feel that the community types studied represent the important potential natural communities on these allotments.

On the Goldbanks Allotment, 7 study areas represented the Wyoming big sagebrush-Thurber needlegrass CT, 3 represented the Wyoming big sagebrush-bluebunch wheatgrass CT, 3 represented the Wyoming big sagebrush-Idaho fescue CT, and 1 represented the Wyoming big sagebrush-Great basin wildrye CT. On the Pueblo Mountain Allotment, 5 study areas represented the basin big sagebrush-bluebunch wheatgrass CT, 5 represented the mountain big sagebrush-bluebunch wheatgrass CT, 5 represented the mountain big sagebrush-Idaho fescue CT, 1 represented the low sagebrush-bluebunch wheatgrass CT, and 2 represented the low sagebrush-Idaho fescue CT.

Vegetation response was based on changes in species composition on a 30 × 60-m macroplot at each study site (Fig. 1). Changes were evaluated by estimates of basal-area cover of herbaceous species, canopy cover of shrubs, and frequency of occurrence of all species from 1973 to 1983. All data were collected by the same individual throughout the study. Five permanent 0.9-$m^2$ quadrats were selected along a transect through the center of the macroplot by restricted randomization so that at least 2 quadrats were located in the 0 to 15-m or in the 16 to 30-m segment of each macroplot. Basal area of bunchgrasses and caespitose forbs, ground area covered by mat-forming forbs, and canopy cover of shrubs rooted

**Table 1. Number of macroplots on 4 community types at the Goldbanks Allotment on which shrub, grass, or forb species increased (+) or decreases (-) significantly or showed no significant change (0) in percent frequency or percent cover (canopy or basal by chart quadrat and canopy by line intercept) during the study period.[1,2] Quadrat cover is shown in parentheses. Intercept cover is shown on the second data line for each shrub species. A dash indicates that a species did not occur in the frequency or cover sample.**

| | Community Types | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Wyoming big sagebrush/Thurber needlegrass (7)[3] and Wyoming big sagebrush/Great Basin wildrye (1) | | | Wyoming big sagebrush/bluebunch wheatgrass (3) | | | Wyoming big sagebrush/Idaho fescue (3) | | |
| Shrub | + | – | 0 | + | – | 0 | + | – | 0 |
| Wyoming big sagebrush | 4(2) | 0(0) | 4(4) | 0(1) | 0(0) | 3(2) | 1(0) | 1(0) | 1(3) |
| | 4 | 2 | 2 | 2 | 0 | 1 | 1 | 1 | 1 |
| Green rabbitbrush | — | — | — | 0(0) | 0(0) | 0(2) | 0(0) | 0(0) | 2(2) |
| | | | | 0 | 0 | 2 | 0 | 0 | 2 |
| Grass | | | | | | | | | |
| Sandberg bluegrass | 2(0) | 0(2) | 5(4) | 3(1) | 0(0) | 0(2) | 3(1) | 0(0) | 0(2) |
| Bottlebrush squirreltail | 0(0) | 2(1) | 5(5) | 0(0) | 0(0) | 3(3) | 1(0) | 0(0) | 2(3) |
| Thurber needlegrass | 0(0) | 0(1) | 1(2) | 1(0) | 0(0) | 2(3) | 0(0) | 0(0) | 1(2) |
| Bluebunch wheatgrass | — | — | — | 0(0) | 0(1) | 3(2) | — | — | — |
| Idaho fescue | — | — | — | — | 0(0) | 0(1) | 0(1) | 0(0) | 3(2) |
| Great Basin wildrye | 0(0) | 0(0) | 4(2) | — | — | — | 0(0) | 0(0) | 2(1) |
| Forb | | | | | | | | | |
| Milkvetch | 2(0) | 0(0) | 1(0) | 1(0) | 0(0) | 0(1) | 0(0) | 1(0) | 1(1) |
| Tapertip hawksbeard | — | — | — | 1(0) | 0(0) | 1(1) | 2(0) | 0(0) | 0(0) |
| Tailcup lupine | — | — | — | 1(0) | 0(0) | 0(1) | 2(0) | 0(0) | 0(0) |
| Desert phlox | 3(0) | 0(2) | 2(3) | 0(0) | 1(0) | 1(2) | 0(0) | 0(0) | 2(2) |
| Stansbury phlox | 1(1) | 1(0) | 1(0) | — | — | — | 1(0) | 0(0) | 2(1) |

[1]Frequency data are compared between 1974 and 1981 or 1982. Chart-quadrat cover is compared between 1974 and 1980, 1981, or 1982. Intercept cover is compared between 1973 and 1980.
[2]Significant differences between beginning and ending frequency or cover values were determined by Duncan's multiple range test ($P \leq 0.05$).
[3]Number of sites representing the community type.

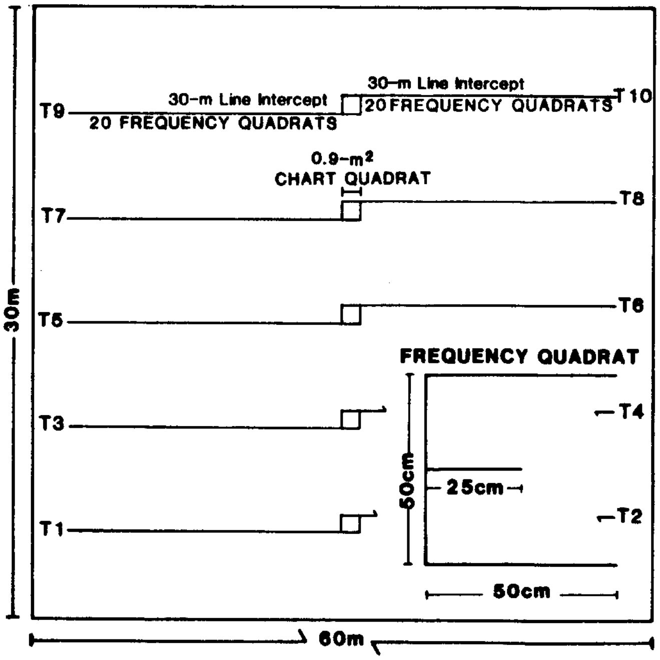


**Fig. 1.** *Illustration of plots and transects used to sample vegetation within a macroplot.*

in or overhanging the quadrat were charted. The quadrat was subdivided into 7.5-cm² units to facilitate charting individual plants. A dot grid was used to calculate total area of each species charted. Cover data were obtained every 3 years on the same quadrats in an ungrazed pasture. Shrub canopy cover over the entire macroplot was estimated by the line-intercept method (Canfield 1941). Measurements were made in 1973 and in 1980 on 10, 30-m lines originating from 2 opposite corners of each of the 5 randomly located chart-quadrat plots.

Frequency of occurrence (Hyder et al. 1963) was selected as the most objective and sensitive method to detect vegetation change. In addition, frequency is rather insensitive to weather fluctuations (Range Inventory Standardization Committee 1983). Rooted frequency of all species was estimated on 20 quadrats on each of 10 transects. Frequency transects originated from the same random points as did the line-intercept transects. Quadrats were divided into sub-units so that frequency of important species was between 30 and 70%. A 25-cm² quadrat was the sample size for Sandberg bluegrass at Pueblo Mountain and for Sandberg bluegrass, desert phlox, and Stansbury phlox at Goldbanks. A 50-cm² quadrat was used to sample all other species on both allotments. Frequency was estimated on the same transect lines in consecutive years from 1974 to 1979 in seedripe and rested pastures. Since 1980, these data were collected every 3 years in a rested pasture.

Forage utilization was estimated on the 5 chart-quadrat plots on each macroplot by the Key Forage Plant Methods (USDI nd). From 1974 to 1976 utilization was estimated at the end of the grazing season. From 1977 to 1983 utilization estimates were made at least once during the growing season as well as at the end of the grazing season.

Individual chart quadrats, intercept lines, and frequency transects were at least 4 m apart in the macroplot. Therefore, we assumed that these samples were independent and that sample size was the number of independent plots and transects in each macro-

**Table 2. Number of macroplots on 5 community types at the Pueblo Mountain Allotment on which shrub, grass, or forb species increased (+) or decreased significantly or showed no significant change (0) in present frequency or percent cover (canopy or basal by chart quadrat and canopy by line intecept) during the period.[1,2] Quadrat cover is shown in parentheses. Intercept cover is shown in the second data line for each shrub species. A dash indicates that a species did not occur in the frequency or cover sample.**

| | Community Types | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Basin (5)[3] and mountain (5) big sagebrush/bluebunch wheatgrass | | | Mountain big sagebrush/Idaho fescue (5) | | | Low sagebrush/bluebunch wheatgrass (1) and low sagebrush/Idaho fescue (2) | | |
| | + | – | 0 | + | – | 0 | + | – | 0 |
| Shrub | | | | | | | | | |
| Basin big sagebrush | 2(0) | 0(0) | 3(5) | — | — | — | — | — | — |
| | 0 | 0 | 5 | | | | | | |
| Mountain big sagebrush | 2(1) | 0(0) | 3(4) | 3(0) | 0(0) | 2(5) | — | — | — |
| | 0 | 1 | 4 | 0 | 1 | 4 | | | |
| Low sagebrush | — | — | — | — | — | — | 3(2) | 0(0) | 0(1) |
| | | | | | | | 1 | 0 | 2 |
| Bitterbrush | 0(0) | 0(0) | 2(3) | 0(0) | 0(0) | 1(1) | — | — | — |
| | 0 | 1 | 3 | 0 | 0 | 3 | | | |
| Green rabbitbrush | 1(0) | 0(0) | 2(4) | 2(0) | 0(0) | 1(5) | 0(0) | 0(0) | 2(1) |
| | 0 | 0 | 5 | 0 | 0 | 4 | 0 | 0 | 2 |
| Grass | | | | | | | | | |
| Sandberg bluegrass | 3(2) | 0(2) | 7(6) | 4(0) | 0(0) | 1(5) | 3(3) | 0(0) | 0(0) |
| Bottlebrush squirreltail | 0(0) | 2(0) | 6(6) | 0(0) | 0(0) | 3(3) | 1(0) | 0(0) | 2(3) |
| Thurber needlegrass | 1(1) | 0(1) | 9(6) | 1(0) | 0(0) | 4(5) | 0(0) | 0(1) | 1(0) |
| Bluebunch wheatgrass | 2(1) | 0(0) | 5(8) | 0(1) | 0(0) | 5(4) | 0(0) | 0(0) | 3(3) |
| Thickspike wheatgrass | 1(0) | 0(0) | 4(4) | 1(0) | 0(0) | 0(0) | — | — | — |
| Idaho fescue | 0(0) | 0(0) | 1(1) | 1(0) | 0(0) | 4(5) | 0(0) | 0(0) | 2(2) |
| Great Basin wildrye | 0(0) | 0(0) | 3(0) | 0(0) | 0(0) | 1(1) | — | — | — |
| Forb | | | | | | | | | |
| Milkvetch | 1(0) | 0(0) | 1(3) | 0(0) | 0(0) | 4(3) | 3(1) | 0(0) | 0(2) |
| Tapertip hawksbeard | 2(0) | 0(0) | 1(0) | 0(0) | 0(0) | 2(1) | 0(0) | 0(0) | 3(0) |
| Tailcup lupine | 6(2) | 0(0) | 2(6) | 4(1) | 0(0) | 0(4) | 2(1) | 0(0) | 1(0) |
| Desert phlox | — | — | — | — | — | — | 1(0) | 0(0) | 0(1) |
| Stansbury phlox | 1(1) | 0(0) | 6(7) | 0(1) | 0(0) | 2(1) | 1(1) | 0(0) | 2(1) |

[1]Frequency data are compared between 1974 and 1981, 1982, or 1983. Chart-quadrat cover is compared between 1974 and 1980 or 1983; between 1975 and 1981; and between 1976 and 1979 or 1982. Intercept cover is compared between 1973 and 1980.
[2]Significant differences between beginning and ending frequency or cover values were determined by Duncan's multiple range test ($P \leq 0.05$).
[3]Number of macroplots representing the community type.

plot. This assumption is subject to further research to test the relation between the independence of data from adjacent plots and the distance between those plots. The sample size for quadrat cover was 1 observation for each species on each of the 5 chart-quadrat plots. The sample size for line-intercept cover and frequency was 1 observation, composed of the transect mean for each species estimate, for each of the 10 transects.

A repeated-measures analysis (Winer 1971) was used in this study because data were collected periodically from the same plots or transects. A Hartley F-max test performed on percent frequency data showed that a transformation was needed. The variance was stabilized by the arcsin squareroot technique. A 1-way analysis of variance with repeated measures was conducted on transformed data. If a significant ($P\leq0.05$) F value was obtained, a Duncan's multiple range test was used to determine significant means for frequency or cover measured at the start and end of the study, or at any point during a management cycle. Although analyses were performed on transformed data, untransformed means and standard errors are presented in this paper.

## Results

Macroplot data are presented for 2 time intervals: long term, based on frequency and cover data collected at the start of the study, and again at, or near, the end of the study; and short term, based on frequency and cover data collected every 1 to 3 years during the study. The number of macroplots with a significant increase or decrease or no significant change in percent frequency or cover is given for the Goldbanks Allotment (Table 1) and for the Pueblo Mountain Allotment (Table 2). Examples of changes in percent frequency and cover, with standard errors, on 4 macroplots are shown in Tables 3–6 (frequency and cover data for all 32 macroplots are available from the authors). Frequency and cover data presented in the text are average values based on the number of sites with a significant change.

**Table 3. Frequency (%), basal cover of herbaceous species (% by chart quadrat), and canopy cover of shrubs (% by line intercept and chart quadrat) with standard errors on a macroplot representing a Wyoming big sagebrush-Thurber needlegrass community type in the Panther Canyon Pasture of the Goldbanks Allotment. The 2 entries in the frequency change column are the values at the beginning (1974) and at the end (1982) of data collection. The 2 quadrat-cover entries in the cover-change column are the values at the beginning (1974) and at the end (1980) of data collection. The 2 intercept-cover entries are data collected in 1973 and 1980.**

| | Frequency | | Cover[1] | |
|---|---|---|---|---|
| Species | Change | Standard error | Change | Standard error |
| Shrub | | | | |
| Wyoming big sagebrush | 37–60*[2] | 3.8 | 15.8–23.3* | 1.8 |
| | | | 0.7–1.5* | 0.3 |
| Grass | | | | |
| Sandberg bluegrass | 60–73 | 4.9 | 2.6–1.2 | 0.4 |
| Bottlebrush squirreltail | 42–29* | 3.2 | 0.3–0.04 | 0.1 |
| Thurber needlegrass | 0[3] | | 0.1–0.2 | 0.04 |
| Great Basin wildrye | 8–11 | 0.3 | 0 | |
| Forb | | | | |
| Milkvetch | 0 | | 0 | |
| Tapertip hawksbeard | 0 | | 0 | |
| Tailcup lupine | 0 | | 0 | |
| Desert phlox | 32–48 | 5.8 | 0.4–0.2 | 0.1 |
| Stansbury phlox | 0 | | 0 | |

[1]For shrubs, intercept cover is listed first, followed by quadrat cover.
[2]Significant differences between beginning and ending frequency and cover values are indicated by an asterisk and were determined by Duncan's multiple range test at $P\leq0.05$.
[3]Species did not occur in the frequency or cover sample.

### Utilization

Forage use was heavy in each year on macroplots in all grazed pastures of both allotments with no significant differences among years for each grazing period. Utilization during the grazing season averaged 65% in June, 75% in July and August, and 80% in October. Utilization after seedripe averaged 80% in October. Heavy use throughout the grazing season is probably related to the stocking rate established when the management plan was initiated. In each case, allowable cattle numbers for the allotment as a whole were not reduced, but in some cases were temporarily increased. Under a 3-pasture rest-rotation system, therefore, two-thirds of each allotment had to support the same number of cattle, or more, each year that previously had grazed over the entire allotment prior to implementation of the management system.

### Long-Term Changes

*Intercept-Shrub Cover*

Changes in the canopy cover of sagebrush varied with community type, species of sagebrush, and subspecies of big sagebrush (Tables 1–6). On the Goldbanks Allotment in the Wyoming big sagebrush-Thurber needlegrass CT, big sagebrush cover increased on 4 of 7 sites from a mean of 15.4% in 1973 to 30.8% in 1980. In the same CT, sagebrush cover decreased from 9.8 to 4.4% on 1 site, and remained unchanged on 2 sites. Cover of sagebrush in the Wyoming big sagebrush-bluebunch wheatgrass CT increased on 2 of 3 sites from a mean of 12.3% in 1973 to 23.4% in 1980 and remained unchanged on 1 site. Cover of sagebrush in the Wyoming big sagebrush-Idaho fescue CT decreased on 1 of 3 sites, from 7.7 to 2.2% and remained unchanged on 2 sites. On 1 Wyoming big sagebrush-Great Basin wildrye CT, sagebrush cover decreased from 24.7% to 9.8%. Rabbitbrush cover was unchanged on the 4 sites where it occurred.

On the Pueblo Mountain Allotment, big sagebrush cover did not increase on any site in any community type. Cover was unchanged on all 5 sites in the basin big sagebrush-bluebunch wheatgrass CT. In the mountain big sagebrush-bluebunch wheatgrass CT, big sagebrush cover decreased on 1 of 5 sites from 53.5% in 1973 to 34.7% in 1980 and was unchanged on 4 sites. In the mountain big sagebrush-Idaho fescue CT, big sagebrush cover decreased on 1 of 5 sites from 29.3% in 1973 to 19.1% in 1980 and was unchanged on 4 sites. Cover of low sagebrush increased from 26.2 to 29.4% on 1 of 2 sites in the low sagebrush-Idaho fescue CT. Cover of bitterbrush decreased from 23.3 to 12.6% on 1 of 4 sites in the mountain big sagebrush-bluebunch wheatgrass CT. Rabbitbrush cover was unchanged on all 11 sites where it occurred.

### Frequency and Quadrat Cover

On macroplots at Goldbanks, the increaser species Wyoming big sagebrush and Sandberg bluegrass, and perennial forbs were the most responsive (Table 1). An example of the direction and magnitude of significant and nonsignificant changes for 1 study site in the Wyoming big sagebrush-Thurber needlegrass CT is shown in Table 3. On sites with Thurber needlegrass the potential dominant grass, frequency of big sagebrush increased on 4 of 7 sites from 29 to 47% and quadrat cover increased on 2 of 7 sites from 2.4 to 4.0%. Frequency of sagebrush decreased from 12 to 4% on only 1 site, that in the community type with Idaho fescue the potential dominant grass. An increase in the frequency (57 to 79%) and cover (2.5 to 5.8%) of bluegrass and in the frequency of milkvetch (11 to 26%), of hawksbeard (10 to 41%), and of lupine (10 to 21%) occurred on macroplots in the more moist community types and those in mid-seral range condition. These community types have bluebunch wheatgrass or Idaho fescue as the potential dominant grass. Decreases in frequency (46 to 30%) and cover (0.5 to 0.02%) of squirreltail and cover (4.2 to 12.%) of bluegrass occurred on sites with Thurber needlegrass the potential dominant grass. Also, on the same sites, an increase in frequency (28 to 48%) of desert phlox accompanied by a decrease in cover (4.4 to 1.0%) suggest that the large plants of this species with a mat-like growth form are breaking into many, small plants.

At Goldbanks the frequency and cover of most decreaser grasses on most sites did not change during the study (Table 1). Cover of Thurber needlegrass decreased (1.9 to 0.5%) on 1 of 3 sites where this species was present in the sample and where it is the potential dominant grass. In this case, needlegrass responded as a decreaser species. Frequency of needlegrass increased (10 to 30%) on 1 of 3 sites where bluebunch wheatgrass is the potential dominant grass. In this instance, needlegrass responded as an increaser species. In the Wyoming big sagebrush-bluebunch wheatgrass CT, basal area of bluebunch wheatgrass decreased on 1 of 3 study sites from 8.1% in 1974 to 0.4% in 1982. The concurrent decrease in frequency (39 to 30%) was not significant. Cover of Idaho fescue increased (1.4 to 2.8%) on 1 of 3 sites where this species is the potential dominant grass.

The trend in species frequency and cover on macroplots at Pueblo Mountain was similar to that at Goldbanks (Table 2). The major difference was that decreaser grasses and perennial forbs had significant increases in frequency and cover on a few more sites. This difference would be expected because of greater precipitation, more productive soils, and generally higher ecological range condition at Pueblo Mountain than at Goldbanks. Examples of the direction and magnitude of significant and non-significant changes for the mountain big sagebrush-bluebunch wheatgrass CT, the mountain big sagebrush-Idaho fescue CT, and the low sagebrush-Idaho fescue CT are shown in Tables 4, 5, and 6, respectively.

Basin and mountain big sagebrush and low sagebrush were the most responsive shrubs at Pueblo Mountain (Table 2). The mean increase in frequency of basin big sagebrush was from 10 to 28% on 2 of 5 sites, for mountain big sagebrush from 10 to 37% on 5 of 10 sites, and for low sagebrush from 59 to 82% on all sites where this species was the dominant shrub. No species or subspecies of sagebrush decreased in frequency or cover. Quadrat cover of basin big sagebrush did not increase on any of the 5 sites where it is the dominant shrub. Cover of mountain big sagebrush increased on only 1 of 10 sites where it is the dominant shrub. Quadrat cover of low sagebrush increased from 11.3 to 15.6% on both sites with Idaho fescue the potential dominant grass.

**Table 4. Frequency (%), basal cover of herbaceous species (% by chart quadrat), and canopy cover of shrubs (% by line intercept and chart quadrat) with standard errors on a macroplot representing a mountain big sagebrush-bluebunch wheatgrass community type in the Albertson Basin Pasture of the Pueblo Mountain Allotment. The 2 entries in the frequency-change column are the values at the beginning (1974) and at the end (1982) of data collection. The 2 quadrat-cover entries in the cover-change column are the values at the beginning (1976) and at the end (1982) of data collection. The 2 intercept-cover entries are data collected in 1973 and 1980.**

| Species | Frequency | | Cover[1] | |
|---|---|---|---|---|
| | Change | Standard error | Change | Standard error |
| Shrub | | | | |
| Mountain big sagebrush | 14–28*[2] | 2.9 | 15.9–19.2 | 2.9 |
| | | | 5.0–11.3* | 2.7 |
| Bitterbrush | 0[3] | | —[4] | |
| | | | 0.0–1.8 | 1.0 |
| Grass | | | | |
| Sandberg bluegrass | 14–17 | 2.5 | 0.3–0.1 | 0.08 |
| Bottlebrush squirreltail | 0 | | 0 | |
| Thurber needlegrass | 40–45 | 3.0 | 1.0–0.5 | 0.2 |
| Bluebunch wheatgrass | 52–60 | 3.9 | 7.6–10.1* | 1.1 |
| Forb | | | | |
| Milkvetch | 0 | | 0 | |
| Tapertip harksbeard | 1–4* | 0.9 | 0 | |
| Tailcup lupine | 21–30* | 2.7 | 0.00–0.04 | 0.07 |
| Desert phlox | 0 | | 0 | |
| Stansbury phlox | 0 | | 0 | |

[1]For shrubs, intercept cover is listed first, followed by quadrat cover.
[2]Significant differences between beginning and ending frequency and cover values are indicated by an asterisk and were determined by Duncan's multiple range test at $P \leq 0.05$.
[3]Species did not occur in the frequency or cover sample.
[4]Cover to sparse to calculate a valid mean and standard error.

**Table 5. Frequency (%), basal cover of herbaceous species (% by chart quadrat), and canopy cover of shrubs (% by line intercept and chart quadrat) with standard errors on a macroplot representing a mountain big sagebrush-Idaho fescue community type in the Denio Basin Pasture of the Pueblo Mountain Allotment. The 2 entries in the frequency-change column are the values at the beginning (1974) and at the end (1981) of data collection. The 2 quadrat-cover entries in the cover-change column are the values at the beginning (1975) and at the end (1981) of data collection. The 2 intercept-cover entries and data collected in 1973 and 1980.**

| Species | Frequency | | Cover[1] | |
|---|---|---|---|---|
| | Change | Standard error | Change | Standard error |
| Shrub | | | | |
| Mountain big sagebrush | 20–30*[2] | 3.2 | 16.4–11.2 | 2.3 |
| | | | 2.7–7.6 | 2.0 |
| Green rabbitbrush | 14–25* | 2.6 | 4.0–6.7 | 1.5 |
| | | | 0.3–3.1 | 1.7 |
| Bitterbrush | 6–12 | 2.3 | 8.2–7.0 | 3.4 |
| | | | 0 | |
| Grass | | | | |
| Sandberg bluegrass | 23–38* | 3.5 | 0.6–0.7 | 0.1 |
| Bottlebrush squirreltail | 10–8 | 1.8 | 0.1–0.2 | 3.2 |
| Thurber needlegrass | 9–10 | 2.2 | 0.3–0.4 | 0.05 |
| Idaho fescue | 59–72* | 3.4 | 1.6–2.7 | 0.4 |
| Bluebunch wheatgrass | 24–31 | 3.6 | 0.1–0.4 | 0.2 |
| Forb | | | | |
| Milkvetch | 7–10 | 1.8 | 0.02–0.1 | 0.08 |
| Tapertip hawksbeard | 14–24 | 2.9 | 0 | |
| Tailcup lupine | 51–70* | 3.2 | 2.8–2.2 | 0.6 |
| Desert phlox | 0[3] | | 0 | |
| Stansbury phlox | 0 | | 0 | |

[1]For shrubs, intercept cover is listed first, followed by quadrat cover.
[2]Significant differences between beginning and ending frequency and cover values are indicated by an asterisk and were determined by Duncan's multiple range test at $P \leq 0.05$.
[3]Species did not occur in the frequency or cover sample.

Sandberg bluegrass was the most responsive grass. Frequency increased from 20 to 34% on 4 of 5 sites in the mountain big sagebrush-Idaho fescue CT and from 32 to 70% on all sites with low sagebrush the dominant shrub. Cover of bluegrass increased on only 2 of 15 sites where either basin or mountain big sagebrush was the dominant shrub and bluebunch wheatgrass the potential dominant grass. Bluegrass cover increased (1.0 to 3.0%) on all sites with low sagebrush the dominant shrub. An increase in frequency (21 to 40%) and cover (1.8 to 4.5%) of Thurber needlegrass and in frequency (16 to 24%) of thickspike wheatgrass occurred on sites where either bluebunch wheatgrass or Idaho fescue is the potential dominant grass. In these instances needlegrass and thickspike wheatgrass appeared to respond as increaser species.

Frequency (6 to 15%) and cover (7.6 to 10.1%) of bluebunch wheatgrass increased on 2 sites and frequency (59 to 72%) of Idaho fescue increased on 1 site where these species are the potential dominant grass. On these same sites frequency and cover of the more desirable forbs, milkvetch and hawksbeard, and of the less desirable forb, tailcup lupine, also increased.

Most grasses and perennial forbs with a significant long-term change in frequency or quadrat cover showed a trend either to consistently increase or to consistently decrease in that attribute throughout the study. For example, of 219 frequency comparisons on both allotments, only 14 showed a significant increase during the course of the study followed by a significant decrease in that attribute by the end of the study. Similarly, of 215 cover comparisons only 6 showed a significant increase followed by a significant decrease in that attribute. Neither frequency or cover decreased significantly then increased significantly during the study.

**Total Quadrat Cover**

Total canopy cover of shrubs and total basal cover of herbaceous species at the start and end of data collection were calculated from estimated cover of individual species on chart quadrats on each macroplot. Total shrub cover did not decrease significantly on any study sites at either allotment. At Goldbanks, mean total shrub cover increased on 4 of 12 sites from 1.8 to 3.7%. Only Wyoming big sagebrush accounted for the increase in total shrub cover in community types with either Thurber needlegrass or bluebunch wheatgrass the potential dominant grass. Both Wyoming big sagebrush and green rabbitbrush accounted for the increase in total shrub cover in the community type with Idaho fescue the potential dominant grass. Total cover of herbaceous species increased from 6.7 to 9.1% on 1 site in the Wyoming big sagebrush-Idaho fescue community type due mainly to an increase in the cover of Sandberg bluegrass. Total herbaceous cover decreased from 11.6 to 6.5% due to a decrease in basal cover of bluebunch wheatgrass and Thurber needlegrass on 1 site in the Wyoming big sagebrush-bluebunch wheatgrass CT in mid-seral range condition. The decrease in total basal cover would have been greater had the basal area of bluegrass not increased from 2.3 to 5.6%. Total herbaceous cover also decreased from 9.6 to 5.2% due to a decrease in basal cover of Sandberg bluegrass, Thurber needlegrass, squirreltail, and desert phlox on 2 sites in the Wyoming big sagebrush-Thurber needlegrass CT in early-seral range condition. Total herbaceous cover did not change significantly on 10 of 14 study sites.

**Table 6. Frequency (%), basal cover of herbaceous species (% by chart quadrat), and canopy cover of shrubs (% by line intercept and chart quadrat) with standard errors on a macroplot representing a low sagebrush-Idaho fescue community type in the Pueblo Pasture of the Pueblo Mountain Allotment. The 2 entries in the frequency-change column are the values at the beginning (1974) and at the end (1982) of data collection. The 2 quadrat-cover entries in the cover-change column are the values at the beginning (1974) and at the end (1980) of data collection. The 2 intercept-cover entries are data collected in 1973 and 1980.**

| | Frequency | | Cover[1] | |
|---|---|---|---|---|
| Species | Change | Standard error | Change | Standard error |
| Shrub | | | | |
| Low sagebrush | 50–88*[2] | 3.3 | 26.2–29.4* | 3.0 |
| | | | 11.3–15.6* | 0.9 |
| Green rabbitbrush | 4–8 | 2.4 | —[4] | |
| | | | 0.4–0.4 | 0.01 |
| Grass | | | | |
| Sandberg bluegrass | 42–86* | 3.1 | 1.0–3.8* | 0.2 |
| Bottlebrush squirreltail | 18–22 | 2.4 | 0.04–0.2 | 0.05 |
| Thurber needlegrass | 0[3] | | 0 | |
| Idaho fescue | 52–58 | 3.6 | 1.3–1.2 | 0.2 |
| Bluebunch wheatgrass | 8–6 | 1.3 | 0.1–0.04 | 0.03 |
| Forb | | | | |
| Milkvetch | 40–64* | 4.3 | 0.3–1.1* | 0.3 |
| Tapertip hawksbeard | 2–2 | 1.0 | 0 | |
| Tailcup lupine | 1–2 | 1.0 | 0 | |
| Desert phlox | 0 | | 0 | |
| Stansbury phlox | 6–12 | 2.7 | 0.0–0.8* | 0.01 |

[1]For shrubs, intercept cover is listed first, followed by quadrat cover.
[2]Significant differences between beginning and ending frequency and cover values are indicated by an asterisk and were determined by Duncan's multiple range test at $P \leq 0.05$.
[3]Species did not occur in the frequency or cover sample.
[4]Cover too sparse to calculate a valid mean and standard error.

At Pueblo Mountain, total shrub cover increased on 4 of 15 sites in community types with basin (1 site) or mountain (3 sites) big sagebrush the dominant shrub and either bluebunch wheatgrass (2 sites) or Idaho fescue (2 sites) the potential dominant grass. The average increase was from 5.0 to 10.5% with both big sagebrush and green rabbitbrush contributing to the change in total shrub cover. Total shrub cover, mostly low sagebrush, increased (7.9% to 11.0%) in the low sagebrush-Idaho fescue CT. Total herbaceous cover increased (6.2% to 12.6%) on 4 of 15 sites in community types with either basin or mountain big sagebrush the dominant shrub and either bluebunch wheatgrass (1 site) or Idaho fescue (3 sites) the potential dominant grass. Total herbaceous cover increased (5.4 to 11.1%) on 1 of 2 sites in the low sagebrush-Idaho fescue CT. Species contributing to the increase in total herbaceous cover in these community types were Sandberg bluegrass, Thurber needlegrass, bluebunch wheatgrass, Idaho fescue, lupine, Stansbury phlox, low pussytoes, and crag aster. Total herbaceous cover did not decrease significantly on any study site in this allotment.

**Short-Term Changes**

Data in Tables 1 through 6 represent changes in frequency and cover of individual species on macroplots over a 7- to 10-year period. However, the direction, magnitude, and perhaps the permanence of these long-term changes can be influenced by species response during the intervening years. We used species frequency to quantify these changes because frequency data were collected more often than were cover data. Changes in cover, however, support the conclusions reached from frequency data.

Subspecies of big sagebrush, low sagebrush, and Sandberg bluegrass were also the most responsive species over the short term. The general trend on macroplots at both allotments was an increase in the frequency and cover of bluegrass from 1974 to 1977 with little change in frequency of sagebrush. Drought conditions in 1976–77, 18 and 25 cm precipitation at Goldbanks and Pueblo Mountain, respectively, resulted in a significant decrease in frequency and cover of bluegrass. Frequency and cover of desirable grasses or perennial forbs did not decrease on any site on either allotment during this dry year. This very dry year was followed by a very wet year in 1977–78, 37 cm at Goldbanks and 39 cm at Pueblo Mountain. In the 2 years following this sequence of low and high precipitation, frequency of sagebrush seedlings increased significantly on all 14 study sites at Goldbanks and on 9 of 18 sites at Pueblo Mountain. A reduction in bluegrass competition followed by a year of high precipitation probably account for good seed germination and seedling emergence of sagebrush. Most of the decreases in bluegrass frequency and increases in sagebrush frequency were on study sites in the Wyoming big sagebrush-Thurber needlegrass CT at Goldbanks and in the basin big sagebrush-bluebunch wheatgrass, mountain big sagebrush-bluebunch wheatgrass, and low sagebrush-Idaho fescue CT's at Pueblo Mountain.

After 1978, the frequency of bluegrass continued to increase at Goldbanks and by the early 1980's was higher than predrought levels on 7 of 14 sites by an average of 21%. Six of these sites were in the more moist community types with either bluebunch wheatgrass or Idaho fescue the potential dominant grass. After 1978, bluegrass frequency increased on 4 of 18 sites at Pueblo Mountain by an average of 30%. By the early 1980's bluegrass frequency was equal to pre-drought levels on all 5 sites in the basin big sagebrush-bluebunch wheatgrass CT and on both sites in the low sagebrush-Idaho fescue CT, was greater by 19% on the 1 site in the low sagebrush-bluebunch wheatgrass CT, was less on 2 of 5 sites in the mountain big sagebrush-bluebunch wheatgrass CT by an average of 22%, and was less on 3 of 5 sites in the mountain big sagebrush-Idaho fesuce CT by an average of 21%.

After 1978, the frequency of big and low sagebrush decreased to pre-increase levels on many sites on both allotments. In the early 1980's, however, 3 sites at Goldbanks, 2 of which were the Wyoming big sagebrush-Thurber needlegrass CT, had frequencies of Wyoming big sagebrush that were higher than pre-increase levels by an average of 14%. At Pueblo Mountain, frequency of sagebrush on 3 sites was higher than pre-increase level: by 15% on 2 of 5 sites in the basin big sagebrush-bluebunch wheatgrass CT, by 10% on 2 of 5 sites in the mountain big sagebrush-bluebunch wheatgrass CT, and by 12% on both sites in the low sagebrush-Idaho fescue CT.

## Discussion

Significant reductions in intercept cover and frequency of big sagebrush occurred on only a few sites and probably were due to local disturbances rather than to the grazing system. For example, reductions in cover of Wyoming big sagebrush in 3 community types at Goldbanks were attributed to damage by the sagebrush moth [*Aroga websteri* Clark]. Reductions in the cover of mountain big sagebrush on 2 sites and of bitterbrush on 1 site at Pueblo Mountain may have been caused by insect or rodent damage, by waterlogged soils following a very wet winter, or by winter-induced physiological drought during a very dry winter as described by Hanson et al. (1982). All of these perturbations occurred in northern Nevada during certain years of the study.

Significant increases in the cover and frequency of Wyoming big sagebrush at Goldbanks occurred on sites in early-seral range condition and on sites with a reduction in the basal area of decreaser grasses. The negative response of decreaser grasses may have been due to heavy utilization during the study. In both cases little competitive understory vegetation was present to restrict growth and reproduction of sagebrush. Significant increases in the frequency of basin and mountain big sagebrush and low sagebrush at Pueblo Mountain occurred on those sites where shrub reproduction has survived for several years in existing stands of vegetation under conditions of reduced bluegrass competition and favorable precipitation. Heavy grazing also may have reduced the competitive level of decreaser grasses enough to permit survival of these sagebrush seedlings. If these plants establish and grow, secondary succession may be slowed or prevented by additional brush competition. The localized nature of the factors responsible for increases or decreases in shrub cover and frequency may explain some of the variability in these parameters encountered among macroplots during the study.

Significant decreases in the cover of Thurber needlegrass and bluebunch wheatgrass on 2 sites at Goldbanks suggest at least a beginning of a downward trend in range condition on community types where these 2 species are the potential dominant grass. An increase in cover of Idaho fescue on 1 site was the only example of a favorable response of a decreaser grass to the management system, utilization level, and climate at Goldbanks during the study. At Pueblo Mountain, increased cover and frequency of bluebunch wheatgrass and frequency of Idaho fescue on a few sites where these species are the potential dominant grass suggest at least a beginning of an upward trend in range condition. An accompanying increase in the frequency of desirable forbs on the same sites supports this contention.

Variability in the response of herbaceous species among macroplots within a community type can be attributed to several factors. (1) The study period may have been too short to show a positive or negative response to grazing management on a majority of sites. The results obtained may just be starting to show a change in vegetation composition. (2) Variation in sagebrush cover described previously can produce different levels of competition that may be responsible for the varied response of understory species. For example, sagebrush canopy cover on 14 macroplots on Goldbanks ranged from 4.3 to 29.8% in 1980. On 18 macroplots at Pueblo Mountain sagebrush canopy cover ranged from 8.4 to 34.7%. Although considerable variation in sagebrush cover occurred among macroplots within a community type, the small number of significant changes in the cover and frequency of decreaser species in response to this variation resulted in a sample too small to test for a relation between brush cover and species response. (3) Differences in species abundance on macroplots within a community type create variability in the competitive status of the community and, therefore, in the seed production potential and in the space available for growth of existing plants and for establishment of new plants from seed. Our ability to obtain an adequate estimate of species frequency or cover by the sampling techniques used also is dependent on the abundance of that species. Therefore, data from a macroplot with sparse cover and frequency of a decreaser grass may indicate no significant change in that species, where change actually occurred, because of an inadequate sample. In comparison, data from a macroplot with more of a decreaser grass may correctly indicate a significant change in composition because our sample was adequate. (4) Different kinds of soils, as identified at the Family level of soil taxonomy (USDA 1975), are associated with macroplots representing each community type. At Goldbanks, 6 different soils were associated with the 7 macroplots representing the Wyoming big sagebrush-Thurber needlegrass CT, 2 soils were associated with the 3 macroplots representing the Wyoming big sagebrush-bluebunch wheatgrass CT, and 3 soils were associated with the 3 macroplots representing the Wyoming big sagebrush-Idaho fescue CT. At Pueblo Mountain, 4 soils were associated with each of the 5 macroplots representing either the basin big sagebrush-bluebunch wheatgrass, mountain big sagebrush-bluebunch wheatgrass, or mountain big sagebrush-Idaho fescue CT's. The effects of individual and integrated soil profile features on species response to grazing management were not determined. Therefore, we are unable to discuss the cause and effect for differential species responses due to specific soil differences. These effects should be the subject of future research. Research should also identify those soil profile features, not now considered in soil classification, that may affect plant response to various perturbations.

The *variability* in species response among macroplots within a community type indicates the difficulty of obtaining an estimate of change in species composition on a key management area based on data from 1 or a small number of macroplots. If an estimate of change is based on data from only 1 macroplot, that estimate will not likely be accepted as representative of the "true change" on the management area! If an estimate of change is based on data from several macroplots with different responses, which composite statistic will be selected to represent the "true change" on the management area?

Based on the information obtained in this study, several suggestions can be made to decrease this variability and to increase the value of interpretations made from the data obtained. (1) Consult with a statistician who is familiar with finite sampling theory and field sampling techniques. (2) Stratify vegetation into units of similar potential and select, in cooperation with all interested parties, at least 1 area and 1 species in each stratum to be the "key area" and "key species" on which management decisions will be made. (3) Sample the key area or areas by locating several macroplots according to accepted field-sampling procedures. Macroplots should be located on the same or very similar soil, elevation, slope, and exposure and should have enough of the key species to ensure that the sampling techniques used will give an adequate estimate of the character of that species. (4) Plan on a long-term sampling program to allow time for all possible changes to occur.

## Interpretation and Management Implications

Statistical inference is restricted to results obtained from individual macroplots representing certain community types. We believe, however, that trends based on macroplot data allow us to make subjective statements about vegetation response on unsampled but similar community types managed under similar grazing systems and utilization intensity and with similar climatic conditions. The authors are responsible for these interpretations.

Many claims have been made for the efficacy of a grazing system to improve vegetation. In this study, frequency and cover of decreaser grasses were unchanged on a majority of sites after 7 to 10 years of rest-rotation grazing management under the climatic conditions present and the utilization levels imposed. We attributed this lack of response to 3 factors: (1) Heavy utilization that maintained low plant vigor and restricted basal-area growth and seed production; (2) sagebrush competition that reduced the environmental potential for plant growth, seed production, and seedling establishment; (3) ecological range condition when management was initiated that determined the potential for "openings" in the stand and the availability of seed of desirable species.

Grasses and desirable forbs in pastures grazed during the growing season or after seedripe were heavily utilized. Damage done by heavy grazing, particularly during the growing season, may exceed the benefits gained from subsequent, supposedly better, management (Robertson et al. 1970), Heady 1975, Mueggler 1975). Heavy use is sometimes recommended as a means of reducing competition between palatable and unpalatable species. Heady (1975) stated that most evidence, however, favors the view that heavy defoliation reduces the vigor of desirable species more than it helps them by lessening competition from undesirable species. Hickey (1967) and Hyder and Bement (1977) concluded that no management system is entirely satisfactory if that system requires overgrazing during the growing season in order to obtain rest or deferment from grazing at other times during the grazing season.

Logic suggests that rest-rotation management should have a better chance of success on grasslands, where all species are fairly palatable, than on ranges where unpalatable species, such as sagebrush, are important components in stands of palatable species (Mueggler 1972). In this case, brush can respond to reduced competition due to defoliation of herbaceous species and become more competitive with desirable species. Bullock (1975) theorized that in 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. In mixed stands of forage plants and brush, anything approaching full forage use inevitably leads to an increase in brush (Day 1979). Brush competition also reduces the establishment of seedlings of desirable herbaceous species. Many authors have shown the futility of seeding semiarid rangelands without adequate weed control, even when species with excellent seedling vigor are used. In grazing management, the problem of seedling establishment is compounded because seed is not properly planted, most native herbaceous species have low seedling vigor, and resident brush is very competitive with seedlings for soil water and nutrients.

We speculate that an upward trend in ecological range condition, as indicated by an increase in the composition of desirable species and a decrease in the composition of undesirable species, is strongly influenced by ecological range condition at the time management is initiated. This concept is in agreement with observations made on a BLM allotment in Idaho after about 10 years of rest-rotation management (Blaisdell et al. 1982). An upward trend on rangelands in early-seral condition will be extremely slow, or will not occur at all, because grazing pressure continues on the few remaining desirable plants, little or no seed is produced by these species, and competition from sagebrush prevents establishment of seedlings of desirable species. On sites in late-seral condition, upward trend also will be slow because competition within the community prevents recruitment of new individuals of desirable species except on rare occasions. The best opportunity to obtain an upward trend may be on sites in mid-seral condition. Under proper management, vigor, growth, and seed production of desirable species is enhanced. Then as the less desirable, short-lived herbaceous perennials become senescent and die, the major seed source is that of desirable species. At this time the chance for recruitment of new individuals of desirable species is enhanced provided conditions for seed production and seedling establishment are favorable over a sequence of years. A downward trend can be measured at all levels of range condition by a decrease in the composition of desirable species and an increase in the composition of undesirable species. If this speculation is correct, land management agencies should select trend plot locations on key management areas with vegetation in mid-seral condition. In this way, both upward and downward trend can be measured on the same site.

Results of the study showed that both frequency and quadrat cover data detected change in understory vegetation. For the more responsive species, frequency and cover data tended to support the same conclusions, although frequency data indicated significant changes on more sites than did cover data. At Goldbanks, frequency data indicated 35 significant differences, cover data 14. At Pueblo Mountain, frequency data indicated 54 significant differences compared to 23 for cover data. Others (Hyder et al. 1963, Tueller et al. 1972, and Range Inventory Standardization Committee 1983) have stated that frequency data are easy to obtain, objective, statistically reliable, and cost efficient. In this study, for example, the time required per macroplot to obtain an estimate of frequency of occurrence was 1 man-day compared with 5 to 10 man-days for estimating cover on 5 chart quadrats. An adequate sample of shrub crown cover by this technique would be too expensive for large-scale monitoring purposes. We suggest that the line-intercept method be used to estimate growth of desirable and undesirable shrubs and to aid in interpretation of changes in understory vegetation.

If rest-rotation grazing will maintain vegetation in late-seral condition and improve vegetation in mid-seral condition, it is a valuable management tool. If rest-rotation grazing can only maintain early-seral vegetation in an unimproved condition, then these areas are candidates for range improvement practices.

This research should continue through additional grazing cycles to further evaluate vegetation response. Based on results to date, however, land managers perhaps can consider modifications of the grazing plans on these 2 allotments that may retard increases in the composition of undesirable species and stimulate increases in the composition of desirable species.

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