Vegetation Change after 13 Years of Livestock Grazing Exclusion on Sagebrush Semidesert in West Central Utah

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Abstract

Range managers often assume that release of vegetation from livestock grazing pressure will automatically result in a trend toward the pristine condition. The pathways and time scales for recovery are also sometimes assumed to be the same as for retrogression. These assumptions were examined via monitoring of plant community composition and forage production in five large paddocks of sagebrush semi-desert vegetation in west central Utah over a 13-year interval. No significant increases in native perennial grasses were noted over this period despite a trend toward more favorable precipitation in recent years. Thus, the present brush-dominated plant community is probably successionally stable. A return to vegetation similar to the original sagebrush-native grass mixture is unlikely. The possibility of a successional deflection via fire is enhanced by the increase of annual grass. Improvement of forage production in this vegetation will not necessarily follow after livestock exclusion. Direction manipulations are mandatory if rapid returns to perennial grass dominants are desired in such environments.

By their actions, many range managers demonstrate assumptions of succession as a linear, deterministic process, and climax as a single stable point to which vegetation returns following disturbance. Some range managers also appear to believe that retrogression and progression should follow the same time scales as well as trajectories. Adoption of these assumptions simplifies planning but contradicts much recent theory (Sutherland 1974, van Hulst 1979, Miles 1979, Pickett 1980, Noble 1981) and empirical data for semiarid vegetation (Hanley 1979, Anderson and Holte 1981, Walker 1981).

If the manager's expectations of pathways and time scales for vegetation recovery following disturbance are unfounded, then much time and potential rangeland productivity could be lost waiting for changes that may never or very slowly materialize. One such example may be the assumption that elimination of livestock use will necessarily result in short-term improvement of the grass component of sagebrush semidesert vegetation.

The longevity and the population dynamics of sagebrush and associated grasses, as well as sagebrush/grass competition, has been much studied. The literature of these topics has been recently reviewed by Tisdale and Hironaka (1981), Blaisdell et al. (1982), and West (1983a and b). Sagebrush-grass associations can appear to be stable over a wide range of relative compositions of brush to grass. The introduction of cheatgrass (*Bromus tectorum* L.) has, however, led to instability because the chance of earlier fires is enhanced by the invasion of this winter annual grass.

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Study Area

This study was conducted at Tintic Valley, Juab County, west central Utah. A research area has been cooperatively maintained there by Utah State University and the Bureau of Land Management, U.S. Dep. of Interior, since 1949. Although the main thrust of past research has been to determine ways of establishing exotic wheatgrasses and managing animals grazing these plants, a parallel set of native pastures was also grazed by livestock to compare animal performance on improved versus native rangeland (Cook 1966).

The native rangeland at the study site is presently dominated by basin big sagebrush (*Artemisia tridentata* Nutt. ssp. *tridentata* Beetle). Small amounts of Sandberg's bluegrass (*Poa secunda* Vasey.), bottlebrush squirreltail *(Elymus (Sitanion) hystrix* (J.C. Smith) (Dewey), bluebunch wheatgrass *(Elytrigia (Agropyron) spicata* (Scribn & Smith) Dewey), and western wheatgrass *(Elytrigia (A.) smithii* (Rydb) Dewey) are the major perennial herbaceous species. Cheatgrass (*Bromus tectorum* L.) can be an abundant annual on disturbed microsites, especially in wetter than average years.

Livestock grazing on the native pastures was eliminated following the conclusion of Cook's experiments in 1968. In 1979 we initiated a study to determine if rest from livestock grazing had resulted in improvement of the herbaceous forage component. Because the presettlement vegetation had apparently much more perennial grass (Christensen and Johnson 1964) and because the climate and soils (loamy to loamy skeletal mixed, mesic families of Xeric Torrifluvents, Xerollic Calciorthids, Xerollic Durorthids, and Xerollic Durargids) are typically associated with good grass production, perennial grasses were expected to rapidly regain their dominance once livestock grazing was removed.

Methods

Changes in the herbaceous vegetation after livestock grazing ceased were assessed by comparing the standing crop measurements that were taken by Cook from 1956 to 1964 on the native grazed pastures with standing crops measured during the last 3 years of a period of no grazing during 1969-81. Cook's assessment of standing crops involved random placement of 20 to 29 0.9-m^2 hoops in each of 5 pastures varying from 90 to 172 ha in size. The residue and any subsequent regrowth on these plots was surveyed near the end of July each year. This followed grazing by sheep during May and June. The stocking rates varied from 11 to 26 sheep days per ha from 1960 to 1968 and an unrecorded number during earlier years. Estimates of utilization during 1960–64 ranged from 12 to 53%.

A double-sampling approach was used from 1956–1964 to estimate the standing crop of each palatable herbaceous species that weighed more than 1 g. Species considered nonpalatable were not inventoried. This procedure involved clipping and weighing plots prior to sampling, to gain confidence in the estimates, and thereaf-

Table 1. Average end-of-growing season standing crops of grasses and forbs for five sagebrush pastures over various time periods from 1956-1981, and crop-year[1] precipitation totals and indices for the study site near Tintic Junction, Utah.

	Grazed years[2]											Non-grazed years[3]			
	1956	1957	1958	1959	1960	1961	1962	1963	1964	Average[3] 1956-64	Average 1963-64	1979	1980	1981	Average 1980-81
Average standing crop (kg/ha)	234	368	209	220	223	273	240	130	132	226	131	37	163	80	122
95% confidence intervals (kg/ha)	90	88	81	59	76	53	61	74	65	18	37	56	118	26	56
Crop year precipitation (mm)[1]	264	212	264	209	272	199	375	257	368	280	313	346	406	288	347
Crop year precipitation index (%)[1]	84.8	100.2	84.8	74.2	96.6	70.7	133.3	91.2	130.8	99.5	111.1	122.8	144.2	102	123.3

[1]Crop-year (1 Sept.-30 June) precipitation totals and indices (percent of a long term median value) are unavailable for the study site prior to 1959 and from 1965 to 1978. Precipitation and indices for 1956-1958 are from Eureka, Utah which is less than 25 km from all pastures and has similar precipitation. The average crop precipitation for Eureka, Utah for 1965-1978 is 409 mm.
[2]Standing crop during years that patures were grazed represents residual crop after grazing during May and June.
[3]Average precipitation and precipitation indices for 1956-1964 includes only Tintic data from 1959-1964. Precipitation data from the pastures were unavailable for 1956-1958.

ter clipping and weighing occasionally to assure observers of the accuracy of their ocular estimates. We conducted similar sampling of all herbaceous species in 1979 (August 29-30), 1980 (July 27-28), and 1981 (July 28-29).

Precipitation, the major driving variable for plant productivity in such environments, was recorded monthly in storage gauges at the study site. Following the recommendations of Sneva and Britton (1983), we totaled precipitation from September 1 through June 30 (crop-year).

Results and Discussion

The total herbaceous standing crop did not increase following 13 years of rest from livestock grazing, as indicated by comparison of the average standing crop during 1963-64 with that of 1980-81 (Table 1), representative of grazed and ungrazed periods, respectively. The lack of change is even more dramatic because the data for 1956-64 represent residual herbage following grazing during May and June. The earlier sampling was also limited to palatable species and thus some minor forbs may have been overlooked. The low values for 1979 are at least partially a result of the sampling date, since less standing crop was likely present in August than July. Herbage standing crops measured in 1980 and 1981 were during a more comparable time and conditions to Cook's readings. The precipitation during 1980 was the highest of the entire sequence. Nevertheless, herbage was considerably less than the average (226 kg/ha) during the 1956-1964 grazing period.

The standing crop of many perennial grasses decreased over the 13 years of rest (Table 2). In contrast, cheatgrass apparently increased during the rest period. This may be partially influenced by consumption or breakage of cheatgrass during the earlier grazed period.

Unfortunately, estimates of sagebrush phytomass were not available from the earlier period. Observations of the brush stand from 1979-81 indicated that most sagebrush and juniper (*Juniperus osteosperma* [Torr.] Little) plants were young and vigorous. Where decadent overstories of sagebrush existed, the understory consisted mostly of vigorous young sagebrush plants. Thus, rather than the perennial grasses and forbs increasing as the older generation of sagebrush dies, new cohorts of sagebrush are establishing under the dead or dying shrubs.

There was no apparent trend in favorableness of precipitation to explain these vegetation changes (Table 1). The 1959-64 period was almost normal (average crop year index of 99.5). Weather records at nearby stations indicate that the intervening 1965-78 period was not characterized by pronounced drought except for the short below-normal period in the winter-spring of 1977. Near-normal precipitation returned in 1978 and the 1979-81 period was, if anything, wetter and more favorable for vegetation production than the preceding periods. Several possibilities emerge as to why the herbaceous species did not increase upon release from livestock grazing.

First, more time may be required for the perennial grasses to increase in density to the point that they may produce adequate seed. Anderson and Holte (1981) suggest a logarithmic model of increase with barely detectable changes during the first 10-12 years of recovery turning to significant increases later. Sneva et al. (1980) noted some increases in grass relative to sagebrush in exclosures

Table 2. Average ± 90% confidence intervals for understory standing crops during selected years during the grazed and non-grazed periods on five sagebrush semi-desert paddocks near Tintic Junction, Utah.

Growth form/species	Grazed[1] 1963-64	Nongrazed 1980-81
	——kg/ha——	
Grasses		
Elytrigia intermedia (Beauv.) Dewey	28 ± 8	13 ± 10
Elytrigia smithii (Rydb.) Dewey	44 ± 10	10 ± 8
Elytrigia spicata (Scribn. & Sm.) Dewey	4 ± 5	12 ± 11
Elymus hystrix (J.G. Sm.) Dewey	25 ± 4	11 ± 5
Oryzopsis hymenoides (R. & S.) Ricker	29 ± 11	7 ± 5
Stipa comata Trin. & Rupr.	1 ± 1	0 ± 0
Stipa lettermanii Vasey	1 ± 1	0 ± 0
Poa secunda Presl.	$<1 \pm <1$	1 ± 1
Bromus tectorum L.	17 ± 5	44 ± 18
Forbs		
Descurainia pinnata (Walt.) Britt.	3 ± 1	3 ± 0.2
Other forbs measured[2]	——	20 ± 8
Total	144 ± 19	122 ± 26

[1]The total of this time period does not agree with the total in Table 1 because the 1963 data on individual species for one of the pastures are missing.
[2]Forbs, other than *Descurainia pinnata*, were not included in the 1963-64 measurements.

over 30 years old. They were, however, studying plots in the sagebrush steppe, a significantly more mesic type (West 1983b).

Prevailing ideas about succession assume either that change is not a zero sum game (that "winners have to balance losers"), that grass can increase in the face of sagebrush competition, or that competition is not a major organizing feature of such communities. If competition is accepted as important, then the common assumption is that perennial grasses will replace shrubs as they grow older, lose vigor, and eventually die. Another possibility is that sagebrush is simply a better competitor.

An alternate explanation is that herbivory by hares (*Lepus californicus deserticola* Mearns) and rabbits [*Sylvilagus nuttallii grangeri* (Allen)] is keeping the grass populations in low abundance and vigor such that they rarely reproduce. Surveys of the study area by C.B. Smith and P.J. Urness (pers. comm.) during 1980 have indeed shown a high index of hare numbers compared to other studies. Currie and Goodwin (1966) showed that 7 hares are approximately equal to 1 sheep in herbage consumption on similar ranges. Thus, hares may be depressing the relatively small grass component of this community. Rabbit-proof exclosures were recently established to examine the validity of this hypothesis.

A third possibility is that grass is not an important component of stable vegetation in the study area. The original grassland with scattered sagebrush and juniper was likely maintained by periodic fire (Wright et al. 1979). In the terminology of Westman (1978) the original system could have had low inertia and resilience. Removal of fine fuels necessary for periodic fire by the heavy unrestricted livestock grazing between 1870 and 1935 may have set a successional trajectory toward greater stability. Hanley (1979) and Walker et al. (1981) have made a strong case for multiple stable points in rangeland succession. Without fire, or a substitute, sagebrush and juniper may out-compete perennial grasses through more efficient use of water, nutrients, and space. Also, allelochemics given off by living tissues and litter may help the woody plants to dominate. The much greater longevity of brush and tree individuals also gives them a demographic edge over grasses (West et al. 1979).

Regardless of the explanation, which can only be defined with further basic research, the practical importance of our findings is to dissuade the manager from the misconception that livestock exclusion will necessarily result in rapid improvement of the grass component of sites dominated by brush and trees. Hull (1976) indicated that the first significant loss of grass on these kinds of rangelands took only 10–12 years. We have shown that the change cannot be reversed on such a time scale. Rather than improving itself with 13 years of rest from livestock grazing, our vegetation has deteriorated toward more profound dominance by woody species. Only annual grasses have apparently increased during the 13 years. This increases the likelihood of firestorms that may destroy everything. We concur with Sneva et al. (1980), who studied these phenomena over a longer time span on more mesic sites, that direct manipulations are mandatory if rapid return to grass dominance is desired in such environments.

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