Range Condition Classification Based on Regressions of Herbage Yields on Summer Stocking Rates¹

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Highlight

Vegetation on a clay upland range site in the Kansas 20- to 24-inch precipitation zone was differentially stocked at three rates with yearling cattle for 20 summer grazing seasons. Applications of the currently accepted range condition classification system on yield data for the last 10 grazing seasons indicated need for improvements in classifying range condition for this site. With existing range condition classification concepts, it appeared impossible either to reduce vegetation to poor condition or to maintain excellent range condition under summer grazing. Much of the difficulty was caused by herbaceous species not responding to grazing (decrease, increase, or invade) as classified in the condition guide. A modified range condition classification system incorporating re-evaluated responses of species to grazing was developed from yield regressions and compared with the existing system. The proposed method gave somewhat more consistent condition evaluations and better separation of test pastures into condition classes than the method currrently used.

A major U.S. system of range condition classification was introduced by Dyksterhuis (1949). Initial stages of development and ecological principles involved were further reviewed by Dyksterhuis (1952, 1958). The system is widely used in central U.S. to categorize ranges into excellent, good, fair, and poor condition, to recognize their productive capacity in relation to the potential for the site, and to help with management decisions for range improvement or to make full use of the highest condition class. The relative proportion of herbaceous dominants in the highest and presumably most productive condition-climax; the responses of individual species to grazing; i.e., decreasers, increasers, and invaders; departures in herbage composition from the highest condition; and the assumption that condition will improve through plant succession, constitute the basis for the range condition classification concept.

Although in its conception the system recognized a direct relationship between range condition and herbage production, the relation was considered to be only general. The need was expressed, however, for quantitative data to show specific yieldcondition relationships for each site under different kinds and seasons of livestock use. Current technical range site descriptions give average herbage yields for range sites in excellent condition (U.S. Dept. Agr.-SCS, 1967a). The range condition guides recognize not only a forage production differential associated with condition class, but also a need to stock lighter to bring about range improvement, by recommending lowest stocking rates for ranges in poor condition and highest stocking rates for ranges in excellent condition, (U.S. Dept. Agr.-SCS, 1967).

A recently published study on a clay upland range site in the Kansas 20- to 24-inch precipitation zone reported effects of long-term summer stocking at rates of 2.0, 3.5, and 5.0 acres/yearling steer on floristic cover and herbage yields (Launchbaugh, 1967). Major species in native stands in-

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cluded buffalograss, Buchloe dactyloides (Nutt.) Engelm.; blue grama, Bouteloua gracilis (H.B.K.) Lag. ex Steud.; western wheatgrass, Agropyron smithii Rydb.; Japanese brome, Bromus japonicus Thunb.; downy brome, B. tectorum L.; little barley, Hordeum pusillum Nutt.; upright prairieconeflower, Ratibida columnifera (Nutt.) Woot. & Standl.; and western ragweed, Ambrosia psilostachya DC. The study also contained yearly range condition evaluations of the test pastures for the last 10 years of grazing, using the latest Kansas range condition guide for the site (U.S. Dept. Agr.-SCS, 1962). Although test pastures were differentiated into condition classes most years, inconsistencies in the condition evaluations were significant.

This paper further evaluates species performances on clay upland range under the grazing treatments cited above, and synthesizes a modified system of range condition classification based on yield responses of major herbage species to different intensities of summer grazing.

Resume of Grazing Study

Basal cover changes were recorded over 20 years for major grass species associated with three summer stocking rates (Launchbaugh, 1967). Important basal cover and botanical composition shifts in response to intensity of use occurred during the first 10 years. Cover characteristics then became identifiable with the degree of summer use. Changes within treatment the next 10 years appeared to be caused more by weather variations than by grazing intensity. In terms of basal cover, western wheatgrass was inversely related to grazing pressure, buffalograss directly related, and blue grama was affected only slightly by grazing intensity.

Herbage yields of the various vegetation components were measured on caged plots the last 10 years of grazing. Since major cover changes already had taken place, production data characterized vegetation in different conditions rather than following annual step-by-step departures from one condition class to another.

Western wheatgrass and blue grama yielded the most herbage under light grazing, blue grama and buffalograss the most under moderate grazing, and buffalograss dominated under heavy grazing. Annual grasses were most productive under light grazing, intermediate under moderate grazing, and least productive under heavy grazing. Downy and Japanese bromes were the important annuals in the moderately and lightly grazed pastures, while little barley was the most frequent annual grass on heavily grazed range.

Weeds were present in significant quantities when spring rainfall amounts were high and produced higher yields on moderately and lightly

Table 1. Annual and mean range condition classification of experimental pastures according to U. S. Dept. Agr.-SCS RANGE CONDITION GUIDE for Kansas Areas V and VII in the 20- to 24-inch precipitation zone.¹

	Acres per steer, 5 months							
	2.0 Heavily grazed		3.5 Moderately grazed		5.0 Lightly grazed			
Year	%2	Condition class ³	% 2	Condition class ³	% 2	Condition class ³		
1956	41	F	67	G	65	G		
1957	31	F	58	G	73	G		
1958	38	F	56	G	78	E		
1959	38	F	63	G	58	G		
1960	40	F	63	G	53	G		
1961	40	F	62	G	73	G		
1962	43	F	58	G	48	F		
1963	39	F	67	G	70	G		
1964	49	F	73	G	91	Е		
1965	44	F	87	Е	95	E		
Mean	41	F	67	Ĝ	73	G		

¹ A summary of Table 7 from Launchbaugh, 1967, with revisions in percentages allowable in climax according to 1967 Range Condition Guide (U.S. Dept. Agr.-SCS, 1967).

² Percent of climax vegetation.

³ Condition Class: P = Poor (0-24); F = Fair (25-49); G = Good (50-74); E = Excellent (75-100).

grazed ranges than on heavily grazed. Western ragweed was the major weed species associated with light and moderate grazing, and upright prairieconeflower was the most abundant weed under heavy grazing. All weeds were scarce during years of low spring rainfall.

Table 1 recapitulates the range condition classification of the test pastures according to the existing system. Grazing treatments ranked in logical order in terms of condition class, but under light grazing condition varied greatly from year to year and ranged from fair to excellent. It seems unlikely that an excellent condition class would ever be maintained under light usage, because of weather controlled variability in western ragweed and western wheatgrass abundance. It also appears impossible to reduce vegetation on this site to the poor condition class, because the so-called increasers, which make up a large part of the vegetation on both the highest and lowest condition ranges are so abundant. The composition would need to degenerate to almost pure buffalograss and annual invaders to qualify as poor condition. That prospect appears unlikely without feeding a supplemental roughage to cause both severe trampling and destructive grazing.

Reactions of Species to Grazing.-Response of individual species to grazing pressure constitutes the fundamental basis for the range condition classification concept. Under the current system it is assumed western wheatgrass is a decreaser; buffalo-



FIG. 1. Regressions of total herbage and individual species yields on summer stocking rate (10-year average). Significance of regression coefficients by the t-test: Total yield, $t = 3.83^{**}$; Buffalograss, $t = 3.93^{**}$; Blue grama, $t = 5.57^{**}$; Western wheatgrass, $t = 4.69^{**}$; Upright prairieconeflower, $t = 3.08^{**}$; Little barley, $t = 2.69^{*}$; Western ragweed, $t = 3.67^{**}$ and Annual bromes, $t = 4.43^{**}$.

grass, blue grama, western ragweed, and upright prairieconeflower, increasers; and all annual grasses, invaders on the clay upland range site (U.S. Dept. Agr.-SCS, 1967). Fig. 1 shows regressions of total herbage production and important species on summer stocking rate. In each case tested there was a significant linear regression of herbage production on stocking rate. Thus, over a wide range of stocking rates major species on this site may be characterized as decreasers, increasers, and invaders according to their responses to grazing intensity. Accordingly, blue grama, western wheatgrass, western ragweed, and the annual brome grasses responded as decreasers; buffalograss was the only significant increaser, followed by upright prairieconeflower. Little barley, although relatively unimportant under any grazing intensity, might be considered an invader as only minute quantities of it would appear in the highest condition range. Several inconsistencies exist between these findings and prevailing assumptions-responses of blue grama, western ragweed, and annual brome grasses.



FIG. 2. Percentage yield of buffalograss relative to the combined percentages of blue grama and western wheatgrass calculated from yield regressions on stocking rate.

Development of a Revised System

The above findings indicate that the condition classification system should be revised to be consistent with species responses to grazing on this range site. Yield composition data suggest a classification system based on assumptions that: (1) yield regressions indicated species reaction to summer grazing intensity; (2) the most reliable index to condition was relative yields of the three major perennial grasses, because their relationship appeared to be influenced more by grazing intensity than by weather differences; and (3) yields of other species, though associated with summer grazing intensity, depended highly on weather conditions.

The yield percentage of buffalograss relative to the combined percentages of blue grama and western wheatgrass were plotted against stocking rate using yields calculated from regression (Fig. 2). Assuming linearity beyond data used in regressions, buffalograss would be replaced by blue grama and western wheatgrass at a light stocking rate of 0.25 animal unit month/acre. At the other extreme a heavy rate of 1.85 AUM/acre would result in 100% buffalograss.

Extrapolations far beyond observed points on regression are not valid. Also, it is doubtful that such extremes occur extensively under grazing. Protected vegetation in livestock exclosures on the clay upland range site had small percentages of buffalograss in the perennial grass matrix. On the other hand, clipping treatments more frequent and intensive than possible with grazing for seven years did not produce a pure stand of buffalograss on this site (Albertson et al., 1953). Western wheatgrass was absent, but blue grama persisted and made up approximately 5% of the perennial grass growth. It was assumed therefore that had a wider



FIG. 3. Percentage yield ratio of buffalograss to blue grama plus western wheatgrass in range condition classes, assuming highest condition range would contain at least 5% buffalograss, and lowest condition, not over 95% buffalograss.

range of stocking rates been tested, the relationship between percentage buffalograss and stocking rate would not be linear at very high or very low stocking rates. Thus the lightest stocking rates would leave some buffalograss, which would increase but not take over completely under heavier stocking rates. Limits were arbitrarily set at 5 and 95%, respectively, and the familiar condition classes, excellent, good, fair, and poor were established by equal four-part division of the horizontal axis between these percentages of buffalograss (Fig. 3). The different condition ranges on this site would have yield ratios shown in Table 2. Figure 4 was prepared from this table and total herbage yield regression on stocking rate. It incorporates the relationships of percentage yield ratio, range condition, average herbage yield, relative yield, and summer stocking rate.

Application of System.—The system requires relative yields of buffalograss to total buffalograss, blue grama, and western wheatgrass. If, for example, buffalograss composes 40% of the total perennial grass growth, the condition class would be judged good, predicted average herbage yield would be approximately 3,600 lb/acre (approximately

Table 2. Yield ratio percentages of buffalograss to blue grama plus western wheatgrass for each condition class.

Range	Yield p	Yield percentage				
condition class	Buffalograss to	Blue grama plus western wheatgrass				
Excellent	5–22	78–95				
Good	22-44	56-78				
Fair	44-71	29-56				
Poor	71–95	5-29				



FIG. 4. Relationship of buffalograss yield ratio to range condition class, average total herbage yield, relative total herbage production, and summer stocking rate. Broken-line arrows indicate relationship assuming buffalograss is 40% of the perennial grass production on a clay upland range site in the Kansas 20- to 24-inch precipitation zone.

73% of the potential production), and summer stocking rate to achieve and to maintain the condition would be 1.0 AUM/acre.

Applying the system to individual year data of the previous study (Table 3), showed consistent condition class ratings, particularly for lightly grazed range. Divergence was greater in condition class ratings between lightly and heavily grazed ranges than with the existing system (Table 1), and a poor condition class became a reality for the site. Condition classes deviated from the mean for the heavily and moderately grazed pastures twice each;

Table 3. Annual and mean range condition classificationof experimental pastures according to modified rangecondition classification system shown in Fig. 4.

Year		Acres per steer, 5 months							
	2.0 Heavily grazed		3.5 Moderately grazed		5.0 Lightly grazed				
	%1	Condition class ²	%1	Condition class ²	%1	Condition class ²			
1956	69	F	24	G	17	E			
1957	87	Р	57	F	7	E			
1958	80	Р	53	F	9	E			
1959	78	Р	38	G	10	E			
1960	77	Р	33	G	6	Ε			
1961	73	Р	36	G	12	E			
1962	73	Р	40	G	18	E			
1963	77	Р	36	G	11	Ε			
1964	68	F	37	G	8	Ε			
1965	73	Р	27	G	13	Ε			
Mean	$\overline{76}$	P	$\overline{40}$	Ē	11	Ē			

 $^{\rm 1}$ Yield ratio of buffalograss to blue grama and western wheat-grass.

² Condition Class: P = Poor (71-95); F = Fair (44-71); G = Good (22-44); E = Excellent (5-22).

however, no variations were greater than one condition class. Most of the deviation in condition class within treatment appeared to result from cover change interactions associated with drought and subsequent recovery. Drought may cause differential cover reductions of buffalograss and blue grama and disproportionate recovery rates following drought (Albertson, 1937; Albertson et al., 1953).

Discussion

Confirmed accuracy of this approach to range condition evaluation will require further testing, particularly on data not included in the regression analyses, from both previously sampled and similar sites. Several points need further consideration. Stocking rates lighter and heavier than those used in calculating regressions need to be tested to arrive at actual improvement and deterioration limits under grazing. The extreme range of stocking rateyield regression linearity is needed to verify or reject assumptions made on the limited projections beyond regressions. Also, if such a system has advantages over present ones, the expense of longterm grazing research to obtain information even for major range sites must be reconciled.

Although the most widely accepted range condition classification method has proved satisfactory in many situations, apparent failure to evaluate clay upland range vegetation may be attributed largely to the grazing reactions of blue grama and buffalograss. Blue grama decreased rather than increased with grazing. The major increaser, buffalograss, did not respond to grazing in the classical sense (increase, then decrease under heavy grazing); but, behaved like an invader under heavy grazing. A similar situation has been reported for Canadian Mixed Prairie where increasers are the main species in both climax and depleted ranges (Coupland et al., 1960).

When severely deteriorated vegetation is composed primarily of increasers with relatively few invaders; or if major decreasers persist in significant quantities under heavy grazing, the Dyksterhuis system gives a very narrow spread between highest and lowest condition ratings. Treating certain increasers as invaders does not solve the problem, because their normal occurrence in high condition range minimizes the probability of having an excellent condition class made up of 75 to 100% decreasers and allowable increasers. In addition, certain decreasers are more persistent than others under grazing. Blue grama did not disappear along with western wheatgrass at a heavy stocking rate. If blue grama were treated as a decreaser in the present system, difficulties still arise in getting divergence in condition class ratings between lightly and heavily grazed ranges.

Yield proportion of major herbaceous dominants relative to grazing intensity appears to be the most reliable index to range condition evaluation where increasers and certain decreasers persist under heavy grazing, and true invaders play only minor roles. Yield ratios should include only species influenced most by grazing treatment and least by yearly weather differences.

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