Condition and Management of Range Land Based on Quantitative Ecology

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TODAY there are many different bases for range condition classifications. Stockmen commonly associate the term "range condition" with favorableness of the season. In this sense, good range condition may mean simply that an area recently received good rains. However, professional range conservationists have long associated good range condition with something less fleeting than good seasonal growth.

In the glossary of technical terms published by the Society of American Foresters (*11*), range condition is defined as "The state of health or productivity of both soil and forage of a given range, in terms of what it could or should be under normal climate and best practicable management". This article describes a system for determining range condition which considers climate, soil, and vegetation both present and potential. It includes a review of researches that provide a scientific foundation for the system, and shows how earlier qualitative applications have been replaced by quantitative ones. An actual example is used to demonstrate practical application of the system to range management.

Review of Literature

Most of the literature on range condition classes was published within the past decade. In 1936 Talbot and Crafts (*29*) called attention to the need for simple, usable measures of range condition. Since then, Farmers' Bulletins of the U. S. Department of Agriculture (*13, 22*), and livestock journals as well as numerous mimeographed and processed publications have popularized the idea of range condition classes. They have resulted in a new and better understanding of range condition by many ranchers and professional conservationists. However, popularized descriptions must eschew elaboration of underlying principles and technical procedures. The descriptions themselves testify that many different bases for classification were used. Since the descriptions usually show a different floristic, or species, composition for each condition class and also associate range improvement with secondary plant succession, it is concluded that the concept of range condition classes dates back to research by Sampson (*23, 24*).

Sampson's research published in 1919 after about 13 years of study in western United States, contains the conclusion that "The most rational and reliable way to detect overgrazing is to recognize the replacement of one type of plant cover by another." Equally important was his conclusion, "The grazing value of the vegetative covers is essentially determined by the stage of succession. Locally, and indeed generally, the carrying capacity and forage value are the highest where the cover represents a stage in close proximity to the herbaceous climax and lowest in the type most remote from the climax." This was application of the Clementsian concept of plant succession and climax to practical range problems. Later researches (*5, 6, 14, 20, 21*) covering both plant production and succession showed differences in methods, as well as in locale, but served to confirm Sampson's (*24*) conclusions. While research was in progress, the idea of an ecologic classification of range conditions was generally accepted and put to extensive use (*27*). The "stage" concept of range degeneration of Sampson (*24*) meanwhile had been transformed into range condition classes. Humphrey (*19*) traced early development of the use of range condition classes in forage surveys. He also presented one method of determining range condition. There are now many ways of determining, as well as applying, range condition classes. Some no longer have the original ecologic basis. This is true of classifications that do not depend upon position of the vegetation in the scale of secondary succession. For example, one viewpoint is that range condition may be measured directly in terms of forage production. However, ecologic research shows that forage production is generally only a reflection of range condition. Also, that "Range recovery is accomplished through secondary succession" (*12*).

Attempts to apply the information on range condition classes reported in research and popular literature showed: 1) That different classes in the series for a site were either described qualitatively, or only selected examples were described quantitatively; 2) That quantitative data on classes were inadequate to cover variations in the vegetation encountered on a site, and; 3) That one description for each class of a series for a site was inadequate because a site with one kind of vegetation when in climax condition often had many kinds of vegetation when in poor condition. A quantitative system for determining range condition with respect to a climax evidently has not been published. However, some features of a quantitative system were presented at a joint session of the American Society of Range Management and the American Society of Agronomy (*16*). The system has been in daily use since 1945 in field operations of the Soil Conservation Service throughout Oklahoma and Texas.

Ecologic Principles in a Quantitative System

Range condition might be defined at this point as "The percentage of the present vegetation which is original vegetation for the site." However, the definition could have little meaning without a background of principles applied and alternatives discarded in practical field tests.

In the first attempts to develop a quantitative system, factors relating to trend were considered in defining range condition classes. For example, relatively good plant growth or vigor was considered important in determining range condition. But this variable could not be expressed quantitatively. As Fosberg, (*17*) aptly said, "The problem of detecting, classifying and evaluating all the factors which affect plant growth in an environment has so far defied the ingenuity of even the best plant ecologists and physiologists. It is so complex that even the complexity is hard to grasp." Furthermore, when depleted range has widely spaced perennials of the climax growing among invading annuals these perennials may exhibit more vigor after a short deferment than do the same species in the climax. For these reasons plant vigor was discarded as a measure of range condition. However, it may be an indictor of trend in range condition. Despite the importance of being able to recognize upward and downward trends, these trends must still be from a certain point which is here regarded as range condition. Until all factors relating to trend were sharply distinguished from those relating to present condition, our maps had little value because trends changed within periods of less than a year. On the other hand, maps of range conditions based on position in the subsere, or "stage" in secondary succession, provided useful inventory data.

Many problems were encountered in developing a uniform conception of areas that should be differentiated on maps. In any climate there are many soils and vegetation types, both climax and developmental. The combination of climatic and soil conditions of an area may be referred to as site (*8*). Many kinds of vegetation may occur on the same site; depending upon the history of use of the vegetation. Range condition ratings were first applied to current forage types, even though these sometimes crossed important site or soil differences. Such differences became apparent when the range reached a higher condition. Since range condition expresses departure from potential for a site, it followed that delineation of sites had to precede delineation of range condition classes. It has been stated (*18*) that sites should be classified on the basis of potential forage production. This would be the case if range condition classes were simply production classes. Attempts to base a quantitative system of range condition classification on potential production showed: 1) That there was often as much difference in forage production on one site from year to year as there was difference between sites in the same year; 2) That relative coverage (species composition) fluctuated less from year to year than forage production; 3) That climaxes which are different floristically may produce essentially the same amount of forage per unit of surface area; and 4) That in field operations, men could not classify a range with respect to potential production except as judged from relative coverage. Though there is a direct relation between range condition and production, the relation is general. Quantitative data are needed to show the specific relation for each site under different kinds and seasons of grazing. Accordingly, sites are now delineated on the basis of differences in relative coverage in the climax. In rare instances sites have been sub-divided because of differences in production within a map unit of climax vegetation. In those rare cases where two or more sites have about the same species composition in the climax but differ in productivity (*14*), composition must still be considered to determine departures from potential. Differences in productivity are recognized by recommending different stocking rates. Differences in range condition are recognized by comparing present vegetation with climax vegetation.

There was a problem of obtaining a common basis for recognizing climax vegetation and necessary subdivisions. Climax may be defined as the highest point, or culmination, of plant succession. The dependent relation between plant succession and soil development, to climax for both, are shown in their mutual dependence on climate in a simple yet ever so comprehensive diagram by Tansley (*30*). Enlarged copies were used with groups of field men to clarify relations of these pertinent variables. The monoclimax and polyclimax concepts were distinguished. Field men readily agree that range condition cannot well be based on the monoclimax theory. This is true because where range occurs on greatly deteriorated or immature soils the slow process of soil genesis might require that the range be classed as in poor, fair, or good, rather than in excellent condition for more than the lifetime of a range operator; even if he practiced perfect management. We, therefore, accept products of man-caused erosion along with intrazonal and azonal soils as potentially stable soils or sites, and consider the relatively stable plant community in equilibrium with such soils as climax. Summarily, the term climax as used here refers to climatic, edaphic, or physiographic climaxes and is usually synomyous with original vegetation. In early 1945 our guides to range condition divided sites of each climatic belt between preclimax, climax, and postclimax sites, according to the climatic climax theory of Clements (*10*). Our site classifications may still be grouped under these headings but the terms do not appear on the guides. For any area a site separation is considered justified if: 1) There is a measurable difference in species composition of the climax or; 2) There is sufficient difference in productivity to justify recommending a different rate of stocking. Differences considered measurable are indicated by field data in a later section. The climax vegetation of a region, as verified by scattered relicts on comparable sites, shows far less variation than present range vegetation (*15*). The former is a product of soil and climate. The latter is a product of soil and climate plus the particular kind and amount of grazing disturbance it has received. As would be expected, the site classification based on climax units has resulted in mapping fewer sites than range condition classes.

It will be appreciated that if the climax for a certain site is forest, secondary succession would finally result in loss of grazing values. Accordingly, the concept being presented is limited to soils and climates where the climax vegetation is suitable for grazing; for example, grasslands or savannahs. Perhaps the term "range land" should also be limited to such sites. Natural pastures in poorly developed forest are commonly called forest range. If a classification of native pasture conditions is made in poorly developed forest, it would seem appropriate to determine whether secondary succession would lead to savannah or to forest. Areas where the climax is savannah may show a great increase in woody plants after decades of overgrazing and may appear like poor forest. Range degeneration and condition classes under such circumstances have been described for the Western Cross Timbers of Texas (*15*).

There are annual-plant ranges such as those of the granite basin of Texas, and the California foothills (*4*), where range management may logically be aimed at efficient use of annual-plant forage in its most productive condition. The best annual-plant range in these areas is evidently far from the climax. Accordingly, it would not be classified as range in excellent condition under this system of classification though it might be excellent annual-plant range. Our goal in range management is not invariably excellent range condition. Our goal may be a lower range condition, but it is understood that the concept of excellent range condition remains unchanged.

Pioneering efforts to describe local range condition classes assumed that degeneration of original vegetation under grazing resulted in a single series of lower and poorer types of vegetation. When we attempted to describe a floristic composition for each condition class in the series for a site, we ignored the different kinds of degeneration. One pasture may have deteriorated under grazing by sheep, another under year-round grazing by cattle, and another under seasonal grazing by cattle. We also ignored the important ecologic principle of convergence. Clements (*10*) pointed out that all seres converge to the final community. One description is adequate for the top condition, but it would usually take many descriptions for the kinds of poor condition which will return to a single excellent condition. Range improvement on the poor pastures mentioned could be visualized as movement upward from the ends of the spokes of the lower portion of a wheel, toward the hub, or climax. Consequently, the present system describes only the climax or 100 per cent level of development of vegetation for a site. The 100 per cent level may not be reached under practical rates of stocking with domestic animals. Range condition is measured by percentages of departure in any downward direction from the 100 per cent level.

New Grouping of Range Plants

A discussion of the ecologic basis for range condition classes in 1944 (*3*) presented a diagram showing range deterioration as a curve downward from climax vegetation, to bare soil. This showed a departure from the stage, or stair-step, idea of range improvement. It was felt that segments of the curve from top to bottom should represent range condition classes. The counterparts of the stages of primary succession had not been readily discernible in secondary succession on range lands (*14*). All of the range conditions that could be found on a site at one time could seldom be related to a series of stages or steps because the more orderly processes of priseres are variously modified by grazing in range subseres. There remained a need for some means of quantitatively measuring position of a range on this curve rather than finding a series of stages or steps. This led to a new grouping of range plants. Among range men, the time-honored groups of plants were "Weeds," "Grasses and Grass-like Plants," and "Shrubs." In 1940, Smith (*26*) reported a classification of prairie species on the basis of behavior under range deterioration from climax. He listed species that had decreased in abundance, species that had increased, invading species, and species more or less unaffected. In 1941, Weaver and Hansen (*31*) reported a classification of plants based upon their response to grazing. They provided data on distribution and relative importance of six kinds of plants, namely, prairie grasses and prairie forbs that decrease under grazing, prairie grasses and prairie forbs that increase under grazing, and grasses and weedy forbs that invade pastures. Many ecologists previously had observed that certain climax species might increase in abundance for a time under grazing.

These ecological classifications of species, based upon response to grazing were grouped and incorporated in a quantitative system of range classification by applying percentages of coverage to them and terming them "Decreasers," "Increasers," and "Invaders" (*15*). The "Decreasers" and "Increasers" being species of undisturbed and relatively stable or climax plant communities, whereas the the "Invaders" are not. Though many invaders were present in the original vegetation, they occupied disturbed areas such as mounds of burrowing animals. Overstocking with domestic livestock has since permitted them to occupy entire landscapes, where they are now often associated with species not native to North America. The usefulness of the concept that all range plants belong to one of these groups is apparent.

A quantitative study of the regeneration of native ranges reported in 1946 (*14*) resolved field data into graphs indicating trends in the importance of the principal grass species under progressively less disturbance by grazing. The graphs clearly revealed the counterparts of decreasers, increasers, and invaders. It was concluded that "The species of the disclimax may be grouped in three categories, depending upon behavior in the subsere. These are: species that simply increase in relative coverage, species that decrease some in relative coverage after a period of increase, and species that are ultimately eliminated." These and other data (*12*) showed that upward and downward movements along the curve of range improvement and deterioration were continuous series of changes in the relative proportions of decreasers, increasers, and invaders. Range condition classes may then be shown diagrammatically, as indicated in Figure 1.

In Figure 1, the course of degeneration is arbitrarily, but objectively, divided into four parts called excellent, good, fair, and poor, range condition. Since each is actually a class of conditions, the term range condition class is appropriate. The adjective ratings and segments of curves intercepted may be varied without changing the basis for the concept. As shown in Figure 1 the total of decreasers, increasers and invaders is always 100 per cent. The horizontal scale shows percentage of decreasers plus the percentage of increasers prior to increase. It has been found practical to use relative coverage of decreasers, increasers, and invaders when estimated to the nearest five per cent (*1*). This relative coverage is based on the total of all foliage produced

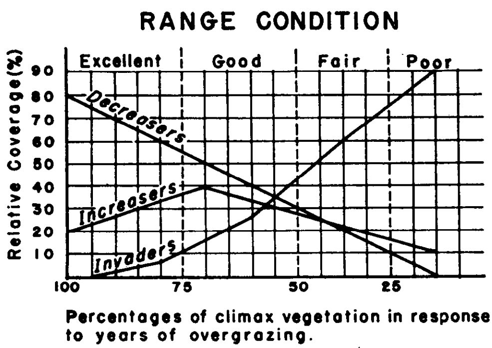

FIG. 1. DIAGRAM ILLUSTRATING A QUANTITATIVE BASIS FOR DETERMINING RANGE CONDITION

in average years. Relative foliage production in pounds of air-dry weight might prove to be more satisfactory. These are but two of five distinctly different concepts in quantitative relations of vegetation (*2*). It should be emphasized that annuals, as well as tree canopies beyond the reach of livestock, must be included in estimates of relative amounts of decreasers, increasers, and invaders. There are good theoretical grounds for including all of the vegetation on a site rather than only perennials or forage within reach of livestock. Increase or invasion by annuals and woody plants are among the most common results of range depletion. The range concept of density is not used as a criterion of range condition in this system (*1*). Where range condition is based upon position in the subsere relative amount of various species is always more certain evidence of condition than density of total vegetation. Instances have been reviewed where a decrease in absolute density was associated with range improvement and vice versa (*28*). Furthermore, estimates of absolute coverage or total density and forage density have been found unreliable (*25*).

LOCAL GUIDES FOR TECHNICIANS

The foregoing review of research, ecological principles, and trial and error field experience could be greatly extended. It should provide necessary background for application and improvement of a quantitative system that applies ecology to range classification and management. A similar review is given technicians before they undertake development of local guides. Their guides assemble all pertinent local data on one page that they carry in the field. The present type of guide was first used near Dublin, Texas, in 1945. Such guides, with modifications, are in daily use by range technicians in Soil Conservation Districts from claypan soils under 42 inches of average annual precipitation in northeastern Oklahoma, to desert soils under 10 inches of average annual precipitation near El Paso, Texas. The technicians' guide used here as representative, was prepared for the general vicinity of San Angelo, Texas. Mr. Ben O. Osborn, Work Unit Conservationist, Soil Conservation Service, San Angelo, Texas, provided most of the percentage values and described the sites. These were corroborated by examination of relicts. The portion of the guide used to determine site and range condition class is given in Table 1.

The data and the use of Table 1 may be best explained by applying it to a typical problem. Assume that you have examined a native range, and on an aerial photo you have delineated the boundary of perhaps 100 acres of very shallow upland, or Site 1. Your estimate of relative coverage is indicated in the first column of figures in Table 2.

Reference to Table 1 shows sideoats grama to be a decreaser in this climate and on these soils. Therefore, any amount remaining represents a part of the original vegetation and counts toward the possible 100 per cent coverage by climax vegetation. The 10 per cent, therefore, is tallied in the second column of figures of Table 2. Perennial three-awn is an increaser. In fact, the estimate of 10 per cent shows an increase of five per cent over the maximum of five per cent found in the original vegetation of such sites. Therefore, only five per cent is tallied. Texas grama, though ordinarily an increaser, shows no increase under the

TABLE 1

Part I of "Technicians' guide to condition and management of ranges in District Group 39, Soil Conservation Service, San Angelo, Texas, September 1947."

(Key species, are grouped according to response to overstocking. Increasers in this climate are shown with their percentages of coverage in climax vegetation of various sites)

DECREASERS (ALL SITES)	INCREASERS (MAX. IN CLIMAX)	RANGE SITES*					INVADERS (ALL SITES)
		1	2	3	4	5	
		(%)	(%)	(%)	(%)	(%)	
Indiangrass	Texas wintergrass	†d	d	d	10	15	All annuals
Big bluestem	Perennial threeawns	5	5	0	0	0	Red grama
Little bluestem	Fall witchgrass	5	5	5	0	0	Hairy triodia
Pinhole bluestem	Silver bluestem	d	5	5	5	10	Tumblegrass
Sideoats grama	Tobosa	0	0	10	20	5	Windmillgrass
Neally grama	Sand dropseed	d	5	5	5	5	Ear muhly
Green sprangletop	Texas grama	5	5	5	5	0	Nightshade
Vine-mesquite	‡Buffalo grass and						Coneflower
Wildryes	curlymesquite	d	20	30	40	10	Broom snakeweed
Tall dropseed	Hairy grama	d	d	10	5	0	Mealycup sage
White triodia	Forb increasers	10	5	5	5	5	Western ragweed
Texas cupgrass	Wood increasers	5	30	10	0	20	Woody invaders

* Site 1 = *Very shallow upland* (Soil group 24v); Site 2 = *Scrub-oak upland* (Soils on which shin oaks are part of climax); Site 3 = *Ordinary upland* (Soil groups 24d, 17); Site 4 = *Deep upland* (Soil groups 1 and 2; heavy clays); Site 5 = *Draws and bottomlands* (Soil group 4; overflow land).

† "d" indicates that on this site the species is a decreaser rather than an increaser.

‡ Consider the two species together in estimating coverage. For sites 3, 4, and 5 near 19-inch isohyet use 35, 50, and 15%, respectively, and near 29-inch isohyet use 25, 30, and 5% respectively.

circumstances surrounding deterioration of this pasture. The five per cent is not abnormal for the site and is tallied. Certain of the less palatable forbs associated with the original vegetation ordinarily increase for a time under deterioration. Such species now compose only five per cent of the total vegetation. However, they may have increased beyond 10 per cent of the total at some point in the course of range deterioration. Since the remaining five per cent represents five per cent of the climax vegetation it is tallied. Certain woody species were always present on this generally shallow site, though they were rooted in the relatively deep soils formed in joints of horizontal limestones. Under grazing, woody plants increased to 20 per cent of the total coverage. Originally, they composed not over five per cent and that amount is tallied. Hairy triodia and annuals were not found in recognizable amounts on areas of relict vegetation of this site. They are, therefore, classed as invaders. Any percentage of invaders represents an equal percentage departure from climax vegetation. Hence, they are not tallied in the second column of figures. The total of this column is 30 per cent. Reference to Figure 1 would place this range in the fair condition class.

TABLE 2

Example of calculation of range condition from coverage data

SPECIES OR GROUP	RELATIVE COVERAGE	CLIMAX PORTION
	%	%
Sideoats grama	10	10
Perennial threeawns	10	5
Texas grama	5	5
Forb increasers	5	5
Woody increasers	20	5
Hairy triodia	15	—
Annuals	35	—
Total	100	30

In field practice, technicians, though following a guide such as this, mentally calculate departures from climax or add what remains of the climax, whichever is the smaller number. These calculations are made with sufficient accuracy to name the correct condition class almost instantaneously. Moreover, in describing higher and lower range conditions to the rancher it can be stated in terms of kinds and amounts of key plants which may be pointed out. Table 1 shows that on site 3 as much as 10 per cent of the vegetation may be tobosa when a range reaches top condition, even though some other species might be preferred by the rancher in what is agreed upon as the top condition. Likewise, the herbaceous species listed in Table 1 as invaders will be virtually eliminated from the plant cover as a range improves even though the rancher is "sold" on certain annuals. This makes it necessary to explain how management of native ranges differs from management of tame pastures. On range, plants come in certain combinations indicated in Table 1. Figure 1 illustrates the principle. The guide utilizes indicator plants in the concept of Clements (*9*) who stated, "There can be no doubt that the community is a more reliable indicator than any single species of it. . . . The significant species are the dominants and subdominants which give character to definite communities." In Table 1, the term "key species" is used with this connotation. We endeavor to select the 30 to 40 key species, or groups of species, in each area. Any one rancher may have five to fifteen key species. We believe he should be able to identify them readily at all times of year and should understand the manner in which each responds to heavy and light stocking rates and to deferments from grazing in different seasons. Thus applied ecology becomes a simple medium for classifying ranges and for interpreting common range phenomena.

The technicians' guide, from which Table 1 was taken, shows recommended stocking rates for each site and condition on the lower half of the same page. This portion of the San Angelo, Texas, guide is here presented as Table 3.

Table 3 indicates grazing capacity for the top condition only. All other values are simply guides to appropriate stocking rates for rapid and obvious improvement in range condition. A presentation of the complete basis for the stocking rates is outside the scope of this article. Briefly, the recommended rates were based on stocking experience locally and at experiment stations, supplemented where necessary with determination of differences in plant production associated with sites and condition classes within a belt of similar average annual rainfall. It will be understood that great droughts, abnormally short or winter seasons of use, and other factors result in different recommended rates. The only purpose of presenting Table 3 is to show how data on range condition are applied in making recommendations on stocking rates.

TABLE 3

Part II of technicians' guide

For sites 2 and 3, consider values in the line corresponding with rainfall of the area. For site 1, consider those for a lesser rainfall belt and for sites 4 and 5, those for a greater rainfall belt

AVERAGE ANNUAL PRECIPITATION	RANGE CONDITION PERCENTAGE			
	100	75	50	25
inches	*animal-unit mos. per ac.*			
14–18	.6	.45	.3	.15
19–24	.8	.6	.4	.2
25–29	1.0	.75	.5	.25
30–34	1.2	.9	.6	.3

Assume that you were asked to recommend a rate of stocking for the 100 acres of very shallow upland which was found to be in fair (30 per cent) condition. Assume further that the range was in the vicinity of the 22-inch isohyet. The 22 inches of precipitation could not be as effective on very shallow upland (preclimax site) as on ordinary upland (site upon which the climatic climax would return). In fact, such a site might have much in common with an ordinary upland site in an area of 14–18 inches of rainfall. This being true, the recommendations for the 14–18 inch precipitation belt would be used. The recommendation for this belt when in fair condition is between .15 and .3 animal unit months of grazing per acre. The technician is intentionally permitted this leeway because, though the range condition is between 25 and 50 per cent, in this case 30 per cent, the site may be better or worse than the average of very shallow uplands. Other considerations may also influence the decision. Assume .2 is selected. If the 100 acres are each to provide .2 of an animal unit month of grazing the total is 20 animal unit months. Assume that other delineations within the same pasture brought the total animal unit months to 1000. If the pasture was going to be stocked for 10 months of the year, 100 mature cattle would be recommended, or for five months, 200 cattle. It is also possible that the operator would have a certain sized herd which he wished to run on this range. Assume this was 150 cattle. The 1000 animal unit months would then be divided by 150 indicating the length of the season should be about six and one-half months. These calculations are made in the field when the technician is on the ranch with the operator.

Finally, as part of the quantitative system, and particularly for checks on effectiveness of the recommended management, line interception transects, as described by Canfield (7), have been used. One or more lines are used in a key area of a pasture. Their locations are described and the ends of the line are permanently marked with iron stakes. A string or wire may then be tied to the same stakes in later years. These permanent transects are commonly reread at intervals of two years. The first of such lines was established in 1943. Since then, hundreds have been established in Texas and Oklahoma. It will be understood that these lines do not provide an adequate sample of the vegetation in the pasture. Rather, when reread they provide quantitative data on range improvement and range deterioration between these two stakes. The transects are a rich source of basic ecological information. Their establishment and rereading has been one of our best devices for giving new personnel an intimate knowledge of the vegetation of their area.

Summary

The development and use of systems for classifying range conditions was traced back to the researches of Sampson reported in 1919. "Common denominators" of current systems appeared to be; a) recognition of secondary succession toward a climax type, and b) the use of floristic composition to indicate condition or position of a range in this succession. A review of basic research showed a direct though general relation between forage production and secondary succession.

The evolution of a quantitative system of range condition classification was reviewed, particularly the practical problems encountered by field technicians and how these were resolved under widespread field trials. Such problems included; 1) distinction between factors relating to trend in condition and factors determining condition at any one time; 2) development of a site classification not dependent on current vegetation so that both current and potential range conditions under the climax theory could be recognized; 3) distinguishing between forage production as a purpose and forage production as a basis, for range condition classification; 4) recognizing that different principles apply when determining condition of range land and lands with forest climax; 5) recognizing that economic considerations may not justify restoration of excellent range condition in certain cases but not permitting this to influence the concept of excellent range condition; 6) making proper distinction between stages in plant succession and range condition classes; 7) replacing an empirical grouping of range plants with an ecologic classification namely, *decreasers*, *increasers*, and *invaders*, based on response to grazing; 8) quantitatively determining range conditions rather than quantitatively describing selected conditions, and 9) displacing the widely used concept of "forage density" with an expression of the quantitative relations of vegetation based on total annual foliage production.

After five years of field testing and development, the system includes: 1) delineation of sites based on differences in floristic composition or foliage production of the climax; 2) delineation of range conditions classes based on percentages of decreasers, increasers, and invaders, as measured from relative amounts in the climax for the site; 3) a recommended stocking rate based on stocking experience locally and at experiment stations, supplemented where necessary with determination of differences in plant production associated with sites and condition classes within a belt of similar average rainfall; and 4) permanent line-interception transects in key areas to provide quantitative checks on effectiveness of management.

Quantitaitve guides are prepared by field technicians for their local areas. The technicians are applying our accumulated knowledge of ecology and the guides are easily revised to incorporate new findings by research in vegetation science at experiments stations, colleges, and universities. One such guide, in use by range technicians in West Central Texas, is presented, and its application is demonstrated by an example.

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