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Range sites and soils in the United States

THOMAS N. SHIFLET

Chief Range Conservationist, Soil Conservation Service, United States Department of Agriculture, Washington, D.C.

Introduction

The concept of "site" as an ecological or management entity based on climax plant communities was transposed from forestlands to rangelands during the 1930's and 1940's. An early publication on forest sites by Korstian (1919) is thought by many to have provided the basic concept and thinking for range sites especially as they were developed by the Soil Conservation Service (SCS) of the U. S. Department of Agriculture. Korstian defined a site as "an area considered as to its physical factors with reference to forest producing power, or the combined effect of the climatic and edaphic conditions of the forest habitat.." Definitions of forest site embodying this basic concept appeared in ecological and forestry glossaries at later dates. Korstian made a strong plea for considering the climax plant community in the development of forest sites, pointing out that "when the reactions between the silvicultural characteristics and the physical factors which affect the growth and the correlation of increment with the associated shrubby and herbaceous species are better understood, the different sites may be regarded as integral biological units." He further stated that the natural classifications of forest stands should be based on the potentiality of the site rather than on one criterion such as average tree height, pointing out that in virgin (climax) forests, differences in physical environment result in differences in the total composition of the forest as well as in differences in the growth.

The transposition of this concept from forestlands to rangelands was logical, and is easily understood when it is realized that the American pioneers in range research and management were educated primarily in forestry schools and departments in the western United States.

Range site was first used in the literature without specific definition. Renner and Johnson (1942) implied that different kinds of rangeland existed without defining those differences. Later, Renner (1949) referred to sites as kinds of rangelands with inherently different soil and vegetation characteristics that result in differing potential capacity. About the same time, Humphrey (1947) described a range site as a part of an ecological type that has a different potential productivity. He further noted that each site must be separately mapped and described. However, in a later publication no mention was made of sites (Humphrey, 1949).

A more definitive description presented by Dyksterhuis (1949) characterized range sites as types of rangeland differing from each other in their ability to produce a significantly different kind or amount of climax or original vegetation. A similar concept was presented later in which sites were described as different kinds of rangeland resulting from complexes of soil and climate whose functional differences are based on measurable differences in kind or amount of climax vegetation (Dyksterhuis, 1958).

Range management textbooks of this general period referred to range sites but failed to define them. Sampson (1952) noted that all range areas do not have identical productivity and that those differing significantly should be separately mapped and described. Stoddart and Smith (1955) described 18 grazing types for the western United States but discussed only briefly the fact that different sites occurred within these types. During this general period, in-Service documents of some U. S. Agencies began to include definitions of range sites, essentially embodying the characteristics described by Dyksterhuis (1949) and Renner (1949) cited above.

A detailed definition of range site was presented by Renner and Allred (1962), who pointed out that, simply defined, a range site is a distinctive kind of rangeland that has certain potential for producing range plants. They further indicated that a site is the product of all environmental factors and has a distinctive plant community. Sites were said to differ from one another by the kinds or proportion of plants present and by differences in total production. The Society for Range Management presented a lengthy definition of range site as "an area of land having a combination of edaphic, climatic, topographic, and natural biotic factors that is significantly different from adjacent areas. These environmental areas are considered as units for purposes of discussion, investigation, and management. Changes from one site to another represent significant differences in potential forage production and/or differences in management required for proper land use" (Huss, 1964). The latter two definitions essentially represent the concept of range sites that are adhered to in this paper.

Current definitions of range site and the use of the concept vary among the several federal agencies concerned with use and management of rangelands. The Soil Conservation Service (SCS) of the U. S. Department of Agriculture (USDA), which assists owners and operators of privately-owned rangelands, defines a range site as "a distinctive kind of rangeland which differs from other kinds of rangeland in its ability to produce a characteristic natural plant community" (Soil Conservation Service, 1975. Range sites are differentiated on the basis of significant differences in kinds or proportions of plants making up the climax community or significant differences in productivity, or both. Significant differences are defined as those requiring different management such as stocking rates or key management species.

The Bureau of Land Management (BLM) of the Department of the Interior (USDI) administers the public domain lands in the United States including 65 million hectares (160 million acres) of grazing lands. According to BLM's current policy (Bureau of Land Management, 1960) "range site" as defined above is not used. Instead, range inventories are made using 18 standard vegetative types. The vegetative type is first delineated and then subdivided into range types based on species composition, abundance of vegetation, slope, exposure, kind of soil, and erosion (Bureau of Land Management, 1963). This in effect separates the vegetative type into sites. An exception to this policy is found in the Missouri River Basin Studies in the states of Montana and Wyoming. In this area the "ecological site" method is used for inventorying rangelands. Sites are referred to as unique climax plant communities resulting from local environment, in a manner that conforms closely to the concepts of Dyksterhuis (1949, 1958), Renner and Allred (1962) and others presented earlier.

The Forest Service of USDA administers National Forests and National Grasslands. Their present procedures call fo using "standard vegetation types" in range allotment analysis rather than "range site" (Rummel, 1964; Forest Service, 1964). However, Smith (1973) pointed out that changes are being made in range analysis activities to place greater emphasis on the ecosystem and the many relationships that exist among its components. Whether range sites as defined earlier will be used in ecosystem analysis was not indicated. However, the Forest Service does use range site in its research activities. A major portion of a symposium relating to range research methods was devoted to "Range Site Measurement and Evaluation" (Forest Service, 1963). One author indicated that the term "site" was approximately synonymous with "ecosystem." Another paper pointed out the need for measuring both productivity and floristic composition in determining and evaluating range sites.

The Bureau of Indian Affairs (BIA) of USDI provides technical assistance in range management on more than 16 million hectares of Indian Reservation lands throughout the United States. Their current procedures include range sites for inventory purposes in a manner almost identical to that of SCS (Bureau of Indian Affairs, 1958).

No discussion of the American concept of range sites would be complete without an accompanying discourse on range condition.

The concept of range condition as the ecological or successional status of the range when compared to its potential or climax plant community evolved during the 1930's and 1940's. However, its origin can perhaps be traced back to the work of many range management pioneers in the early part of this century. Sampson (1919) recognized four broad stages of plant succession in the wheatgrass (*Agropyron* spp.)[1] communities of Utah that generally correspond to the condition classes being used by some today. The first published reference to range condition *per se* was by Spence (1938). He credits the late Dr. L. A. Stoddart as having initiated the use of range condition classification in range survey work with the SCS in the Pacific Northwest in 1935. Spence referred to five classes of vegetation on a forage type, based on their relation to the climax plant community of the type. Three years later, Humphrey and Lister (1941) described six condition classes used by the SCS in the Pacific Northwest and credited Stoddart with having devised them. These classes were labeled A through F and represented excellent, good, fair, poor, very poor, and depleted, respectively, and were all based on degrees of retrogression from the climax plant community.

Later Renner and Johnson (1942) presented four range condition classes—excellent, good, fair, and poor—and described the conditions that prevailed with each class. Humphrey (1947) defined condition as being based on the present state of the vegetation in relation to the potential or climax for the site. He suggested five condition classes—excellent, good, fair, poor, and very poor. Later Humphrey (1949) indicated that four condition classes were adequate for range inventory purposes. Renner (1948) discussed range condition as an ecological classification of rangeland and qualified the four condition classes presented as follows:

Excellent—More than 75% of the original vegetation
Good—51-75% of the original vegetation
Fair—26-50% of the original vegetation
Poor—less than 26% of the original vegetation

He also presented the concept of classifying plants as to their response to overgrazing as decreaser, increaser, and invader species, although this concept was not original with him. Decreaser plants were those that decrease immediately under abusive grazing. Species that increase with overuse, filling the void left by the decline of the decreaser plants, were termed increasers. Plants alien to the site that establish on a site when it is abused were referred to as invaders.

A similar concept of range condition was presented by Dyksterhuis (1949) and Renner and Allred (1962), both employing the four conditon classes cited above.

A somewhat different concept of range condition was presented by Parker (1954). Criteria in addition to species composition were thought to be needed in order to properly classify range condition. These included density of vegetation, vigor of desirable species, and condition of the soil.

The definition of range condition presented by the Society for Range Management (Huss, 1964) is "the state and health of the range based on what that range is naturally capable of producing."

Currently, range condition is used by SCS in all range inventory activities and is defined as "the present state of vegetation of a range site in relation to the climax plant community for that site." It is an expression of how nearly the present plant community of a site resembles that of the climax community for that site. Four range condition classes as described earlier by Renner (1948) are employed in field activities (Soil Conservation Service, 1975).

The BLM employs range condition and trend studies to establish the relative position of range types in relation to their full production potential (Bureau of Land Management, 1960). These studies are not used to replace range surveys in obtaining a rating of forage production but are used as implements to refine management over time. Five range condition classes—excellent, good, fair, poor, and bad—are arrived at numerically by examining and scoring both vegetation and soil on a range type. In the Missouri Basin Studies referred to earlier, range condition is used in a manner similar to that described for SCS.

Range conditon, as currently used by the Forest Service, is quite similar to that used by BLM. Condition is defined as "the general health of the range in relation to what it should be" (Rummell, 1964). In their allotment analyses, condition and trend is determined for each vegetation type. Factors considered in arriving at condition and trend include plant cover, plant composition, vigor, soil stability, and related items (Rummell, 1964; Forest Service, 1964). These factors are scored and compared to a standard in order to arrive at condition and trend. Five condition classes are used.

The BIA use of range condition embodies the same concept and is very similar to that employed by the SCS.

Identification of Range Sites

Basically a range site is the product of all the environmental factors responsible for its development. The major environmental factors that interact to produce a distinctive climax plant community are climate, soils, and topography.

In a logical geographic area sites are identified by evaluating and describing the distinctive climax plant communities that occur. Distinctive differences between sites are generally thought of as differences in species composition or productivity, or both, large enough to require different management.

Data for this purpose is derived from many sources including:

1) Evaluation of relict (climax) stands and associated soils on areas subjected to minimal abnormal disturbance.
2) Comparison of areas receiving varying degrees of use with similar areas receiving no use.
3) Evaluation and interpretation of research dealing with natural plant communities and soils.
4) Review of early historical and botanical literature.
5) Interpolation and extrapolation of existing vegetation information to areas of similar soils, climate, and microenvironment or along environmental gradients.

Research sites have provided some of the highest quality information for this purpose. However, these data are from

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[1] All common and scientific names used are listed in Appendix 1.

limited geographical areas and therefore limited in application. It is very valuable in the geographical area where collected and quite useful when combined with other data, for interpolation and extrapolation to other areas.

The primary source of plant community information in the SCS is from productivity and composition data collected over many years in the normal course of field activities and from special studies. One such special study was initiated in 1957 to document vegetation, soils, and climatic data on climax stands in the Great Basin region. Procedures for the selection of study areas and the collection of the information were outlined by Passey and Hugie (1962). In all, 84 locations in Idaho, Utah, Nevada, Colorado, and Wyoming were selected. The study was designed to establish plant-soil relationships and determine climax communities for the purpose of interpreting soils and physiographic features into range sites (Williams and Hugie, 1966). Later the SCS initiated an automated system for the orderly collection, storage, and retrieval of productivity and composition data for which this author was assigned primary responsibility for development. The system is now partially operational. A stated objective of this system was to provide quality plant community data for the characterization of range sites and the refinement and improvement of site criteria being currently used in field operations (Shiflet, 1970a, 1970b). A detailed analysis of the system indicated that prescribed procedures and techniques are adequate to provide information of sufficient quality to accomplish the objectives envisioned (Shiflet, 1972). Collection of all plant community data in the SCS is stratified on the basis of soil series and phase.

The following information illustrates how plant community data might be used to arrive at range site groupings. Plant community information from one soil in northern Utah is summarized in Table 1. This information was collected over a five-year period from excellent condition stands thought to closely approximate the climax plant community. Average productivity and gross structure of the plant community are shown. Data such as these are compared with similar data from other soils. Those found to be similar in productivity and composition are grouped into the same range site. Table 2 shows a comparison of the vegetation on the Middle soil (Table 1) with that from two other soils in the same county in Utah. It is obvious that all three are supporting essentially the same plant community in terms of species composition. All are dominated by bluebunch wheatgrass (*Agropyron spicatum*) with only minor differences in the other components. However, there was a statistically significant difference in total production between the Manila and the Broad soils, with the Manila being approximately 17% more productive than the Broad. It must then be decided if such a difference is of practical importance. For example, if a 15% difference is selected as being large enough to affect management, then the Manila and Broad plant communities would be placed in separate sites and the Middle grouped with the one it most closely resembled since it was not significantly different from either of the other two. If a 20% differential is used for separation (which is probably more practical), all three would be grouped into a single range site.

The comparison of three stands studied for 10 years in the project described by Williams and Hugie (1966) is displayed in Table 3. The only major environmental difference in the three study locations was the soil. Production from the Hoelzle and Bancroft soils did not differ significantly. However, their plant communities averaged approximately 35% more productive than those of the Goodington soil. This difference was statistically significant and obviously large enough to require different management. The Goodington plant community would therefore be separated from the other two due to lower productivity if for no other reason. The other two stands did not differ in production but did differ in species composition. Idaho fescue (*Festuca idahoensis*) was a significantly higher producer in the Hoelzle community than in that of the Bancroft. However, in both it was the most important herbaceous species. The major difference in the two plant communities was within the shrub component. Big sagebrush (*Artemisia tridentata*), though relatively minor, was the major shrub in the Hoelzle community but did not occur at all on the Bancroft. On the other hand, threetip sagebrush (*Artemisia tripartita*) accounted for only 2% of the production of the Hoelzle vegetation but was the most important shrub on the Bancroft, contributing 17% of the total production. Differences among the minor vegetation components were also apparent. On the basis of lower productivity in the Goodington community and differences in species composi-

Table 1. Average production, composition, and frequency, of vegetation produced on Middle cobbly silt loam-Box Elder County, Utah.[1]

Major Species	Production kg/ha	Comp %	Freq %
Bluebunch wheatgrass	1650 (±83)[2]	85	100
Sandberg bluegrass	32 (± 6)	2	87
Balsamroot	50 (±12)	3	28
Cheatgrass	9 (± 5)	T	24
Big sagebrush	29 (±11)	1	7
Bitterbush	44 (±16)	2	6
Yellowbrush	32 (± 5)	2	39
Other species	92 –	5	–
Total	1938 (±79)	100	–

[1] Based on 30 observations of 10 subplots each.
[2] Parenthetical values refer to standard errors.

Adapted from Shiflet, 1972

Table 2. Average production, composition, and frequency of vegetation produced on three soils in Box Elder County, Utah.[1]

Major Species	Soil Taxonomic Units					
	Middle		Broad		Manila	
	Prod kg/ha	Comp %	Prod kg/ha	Comp %	Prod kg/ha	Comp %
Bluebunch wheatgrass	1650b[2]	85	1462a	82	1833b	88
Sandberg bluegrass	32	2	58	3	24	1
Balsamroot	50	3	34	2	7	T
Cheatgrass	9	T	7	T	1	T
Yellowbrush	32	2	64	4	36	2
Big sagebrush	29	1	32	2	30	1
Bitterbrush	44	2	–	–	1	T
Other species	92	5	116	7	140	8
Totals	1938ab	100	1773a	100	2072b	100

[1] Based on 30 observations of 10 subplots each.
[2] Production values in the same horizontal line followed by the same letter were not significantly different at the 5% probability level.
T = Trace percentage (less than 0.5%)
– = Did not occur or does not apply.

Adapted from Shiflet, 1972

Table 3. Average production, composition, and frequency of vegetation produced on three soils in Blaine County, Idaho.[1]

Major Species	Goodington		Hoelzle		Bancroft	
	Soil Taxonomic Units					
	Prod kg/ha	Comp %	Prod kg/ha	Comp %	Prod kg/ha	Comp %
Idaho fescue	187	24	430	39	257	24
Bluebunch wheatgrass	62	8	121	11	159	15
Sandberg bluegrass	144	18	149	13	91	9
Squirreltail	94	12	41	4	–	–
Prairie junegrass	13	2	6	1	84	8
Narrowleaf pusseytoes	43	5	–	–	–	–
Longleaf phlox	31	4	19	2	26	3
Hawksbeard	–	–	9	1	47	4
Balsamroot	–	–	8	1	–	–
Other annuals	55	7	38	3	11	1
Big sagebrush	25	3	67	6	–	–
Threetip sagebrush	11	1	21	2	175	17
Desert rabbitbrush	14	2	17	2	27	3
Other species	114	14	177	15	166	16
Totals	793a	100	1103b	100	1043b	100

[1] Based on 10 annual observations of 20 subplots each.
T = Trace percentage (less than 0.5%).
– = Did not occur or does not apply

Adapted from Shiflet, 1972

tion and proportion of species between the Hoelzle and Bancroft communities, it was concluded that all three were unique and represented three distinct range sites.

These examples illustrate one technique used for identification of range sites within a logical geographic or climatic area.

The influence of soils on natural plant communities cannot be minimized. Since climax stands of vegetation no longer exist for all sites and situations it is necessary to reconstruct these stands by interpolation and extrapolation of the plant community data that is available. Soils information plays the major role in extending existing data to similar environmental situations and to points along environmental gradients where usable data are not available. Anderson (1968) has pointed out that soil is the major physical component of the ecosystem. He further notes that soil is relatively permanent and that its characteristies are not altered by past treatment as is vegetation. The most meaningful correlation of soils and vegetation is found at the series and phase level according to Heerwagen and Aandahl (1961), a point also emphasized by Anderson (1968). For this reason all productivity and composition data collected by SCS is stratified on the basis of soil series and phase(s) as stated above.

The literature on soil-plant relationship studies spans the gamut from no meaningful correlations such as reported by Daubenmire (1970) in the steppe vegetation of western Washington to a very close relationship between soils and vegetation in Nevada reported by Summerfield (1969). The latter found that contiguous stands of big sagebrush and low sagebrush (*Artemisia arbuscula*) could only be explained at the soil series level. The literature and experience have proven that the delineation of soil series and phase does not automatically delimit a unique climax plant community. Anderson and Fly (1955), in a study in the Flint Hills of Kansas, identitied 15 distinct soils. Similarity of the plant communities on many of the soils resulted in the recognition of five range sites based on their climax vegetation. Similarly, the standard soil survey of Cherry County, Nebraska, identified 39 distinct soils but only 10 range sites (Eikleberry, 1956).

A survey of the literature and study of a wide range of plant community data by this author (Shiflet, 1972) indicated that distinct plant communities will occur on similar soils within areas of uniform environment. Seldom, will distinctively different communities be found on the same phase of a soil series under the present system of soil classification. However, they may occur on different phases of a single series.

The use of range sites to map rangelands does not eliminate the need for soil surveys on these lands. If soils and vegetation are properly correlated within a soil survey area, range site delineations can be taken directly from the soils map. In addition, the soil survey can be used for making other interpretations that are not possible from a range site inventory alone.

Climate, like soil, has a significant effect on plant communities. Such factors as precipitation, temperature, and elevation (as it affects climatic influences) are particularly important. Within relatively small geographical areas climate may be uniform and apply to all range sites. When sites are developed over broad areas it must be recognized that the nature of the plant community changes along environmental gradients. When such gradients occur over broad areas of uniform slope and topography the change from one range site to another is gradual and the point where one site is separated from another may, by necessity, be somewhat arbitrary.

Topography too plays an important role in determining the climax plant community. Features such as slope, exposure, and landscape position affect runoff and runon of water, evaporation, temperature, and other factors that influence what and how much grows there. Often soils quite similar in many respects support different vegetation due to the influence of topography. Table 4 illustrates the effect of exposure

Table 4. Average production, composition, and frequency of vegetation produced on two exposures of Trevino extremely stony silt loam in Power County, Idaho.[1]

Major Species	South Exposure			North Exposure		
	Prod kg/ha	Comp %	Freq %	Prod kg/ha	Comp %	Freq %
Bluebunch wheatgrass	165a[2]	27	84	172a	24	100
Sandberg bluegrass	99a	17	100	119a	17	100
Thurber needlegrass	77a	12	100	62a	9	100
Balsamroot	43a	7	12	78a	11	29
Hawksbeard	39a	6	38	53a	7	51
Longleaf phlox	20	3	83	26	4	88
MacDougal lomatium	17	3	62	1	T	1
Nineleaf lomatium	1	T	1	8	1	32
Cheatgrass	19	3	64	3	T	23
Other annuals	1	T	1	2	T	2
Big sagebrush	95a	15	28	124a	17	36
Bitterbrush	1	T	1	6	1	20
Desert rabbitbrush	–	–	–	4	1	5
Other species	41	7		63	8	
Totals	618a	100		721b	100	

[1] Based on an average of 10 annual observations of 20 subplots each.
[2] Values in the same horizontal line followed by the same letter were not significantly different at the 5% probability level.
T = Trace percentage (less than 0.5%).
– = Did not occur.

Adapted from Shiflet, 1972

on two study areas located on opposite sides of a hill in southern Idaho. Soils differed somewhat but were similar enough to be placed in the same series and phase. Only minor differences occurred in the structure of the two plant communities. None of the major components analyzed differed significantly. However, there was a significant difference in total production with the north exposure area producing an average of 103 kg/ha more than that on the south facing slope. It is doubtful that this 17% differential is great enough to warrant separation into two range sites but does serve to illustrate the influence of exposure when other environmental factors do not vary to any appreciable extent.

In the identification of range sites, soils, climate, and topography must be considered in order to properly interpolate and extrapolate existing plant community data to areas where no usable information is available. Sites are often described from limited information. For this reason, all site descriptions should be considered approximations, subject to change when more and better data become available.

Use of Range Sites

Range sites are used as basic ecological units, in which the rangeland landscape is divided for study, evaluation, and management. The range site expresses capability or potential while its condition indicates the status of the present plant community in relation to that potential. The literature is replete with references to use of range sites for the purposes cited above. McCorkle and Heerwagen (1951) assessed the effect of site and condition on livestock production in the plains area of New Mexico and Colorado. They found on the predominant site (upland plains) that good, fair, and poor condition ranges averaged 16.0, 12.5, and 10.0 kg/ha of beef, respectively. Three range sites were used by Pieper (1968) to compare the response of 12 years of non-use with continuous grazing in New Mexico. The response to protection from grazing varied by site. In Kansas, three range sites were used to study the effect of various burning treatments on Flint Hills rangeland (Anderson *et al.*, 1970). Goetz (1969) in North Dakota and Luebs *et al.*, (1971) in California employed range sites as landscape entities for the purpose of determining and comparing the effects of various fertilizer applications. Both studies found different effects between sites and concluded that sites should be considered when using this practice. Hulett and Tomanek (1969) selected one site in western Kansas to study the predictive value of various increments of precipitation on total production and on the production of various components of herbage. Numerous studies have been reported, comparing the production and vegetation between sites and between different condition classes within a single site.

The major use of range site and condition is to provide an inventory for range management purposes. Figure 1 illustrates how a range site and condition inventory might be recorded on a map of a ranch and used as the basis for developing and applying a management program. This simple example shows two sites to occur which are separated by solid lines. Range condition within sites is delineated with dotted lines.

Such an inventory, whether it is a privately-owned ranch, grazing allotment, or other logical management unit becomes the basis for decisions regarding management. Such decisions—whether to maintain, improve, or, in rare cases, to degrade the present range condition—can be based on overall objectives. Areas to reseed and species to use might well be based on this inventory. Key grazing areas within each grazing unit and key species on which to base utilization could also be decided. Stocking rates, season of use, and kind and class of grazı animals required to achieve objectives would be based on t site and condition inventory. The need for fencing, wa developments, and other enabling practices would likewise noted and planned.

Trend in range condition is normally determined, eith formally or otherwise, at the time range sites are mapped a condition is determined. This information provides a basis t adjustment in present management if trend is not in t desired direction. Subsequent evaluations of trend are used measure the effectiveness of applied management. Wh improvement in condition is accomplished, maps are chang to reflect the current status and management adjusted desired.

A paper by Dillon (1958) illustrates how site and conditi inventories are used in rangeland planning. A survey of 340-hectare ranch in Washington showed that five range sit occurred, most of which were in fair condition (26-50% climax). A complete management plan was developed usi the inventory to note needs and arrive at manageme objectives and decisions. The ranch was resurveyed seven ye later to evaluate the effectiveness of the management plan. was found that much of the rangeland had improved from f to good condition but the degree of response varied by site.

Range site and condition are used for broader manageme purposes. Cox and Cole (1960) used site as the basis f specifying species and seeding rates for range seeding activit in South Dakota. In Idaho, Rumsey (1971) drew manageme conclusions from a study of the production of three range si in eastern Idaho in near climax condition, with seed introduced wheatgrasses on the same sites. Seeded stands we more productive than the natural communities. It was co cluded that in some instances it might be desirable to se these sites to introduced species especially if in low ran condition.

Management oriented research by Sims *et al.* (1971) w based on two sandhill range sites in eastern Colorado. San plains and deep-sand sites were compared as to seaso herbage and nutrient production. They concluded that t sandy plains site was more suitable for late summer-fall-win

Table 5. Average production, composition, and frequency of vegetati produced on Middle cobbly silt loam in two range condition clas in Box Elder County, Utah.

Major Species	Excellent Condition[1]			Good Condition[2]		
	Prod kg/ha	Comp %	Freq %	Prod kg/ha	Comp %	Fr %
Bluebunch wheatgrass	1630a[3]	85	100	701b	45	[illegible]
Sandberg bluegrass	32	2	88	137	9	[illegible]
Balsamroot	50	3	28	18	1	
Cheatgrass	9a	T	24	136b	8	
Yellowbrush	32	2	39	6	T	
Big sagebrush	29a	1	7	262b	17	
Bitterbrush	44a	2	6	208b	14	
Snakeweed	6	T	5	34	2	[illegible]
Other species	86	5		58	4	
Totals	1938a	100		1560b	100	

[1] Based on an average of 30 observations of 10 subplots ea
[2] Based on an average of 12 observations of 10 subplots ea
[3] Production values in the same horizontal line followed by t same letter were not significantly different at the 5% probabil level.
T = Trace percentage (less than 0.5%).

Adapted from Shiflet, 1972

use than the deep-sand site because of the higher retention of herbage and nutritive quality during this period.

Broad scale inventories of range condition have been made by agencies administering public land on which to project long-range plans and goals. The BLM compiled range condition and trend figures in the early 1960's on 65 million hectares of public grazing land. These studies showed percentage values of 1, 15, 53, 26, and 5 for excellent, good, fair, poor, and bad range condition, respectively. Trend determinations showed 15% to be improving, 71% static or indefinite, and 14% to be declining in condition (Wilkes, 1973). Similar types of surveys have been reported by the Forest Service for the 44 million hectares of National Forest and National Grassland grazing lands, which it administers.

Throughout this discussion it has been pointed out numerous times that range site is based on the climax plant community. It should be emphasized in conclusion that this does not mean that climax or excellent range condition is always the management goal. Often a condition below the potential provides benefits more useful to management objectives and still provides adequate resource conservation. This point is illustrated in Table 5. Excellent and good condition

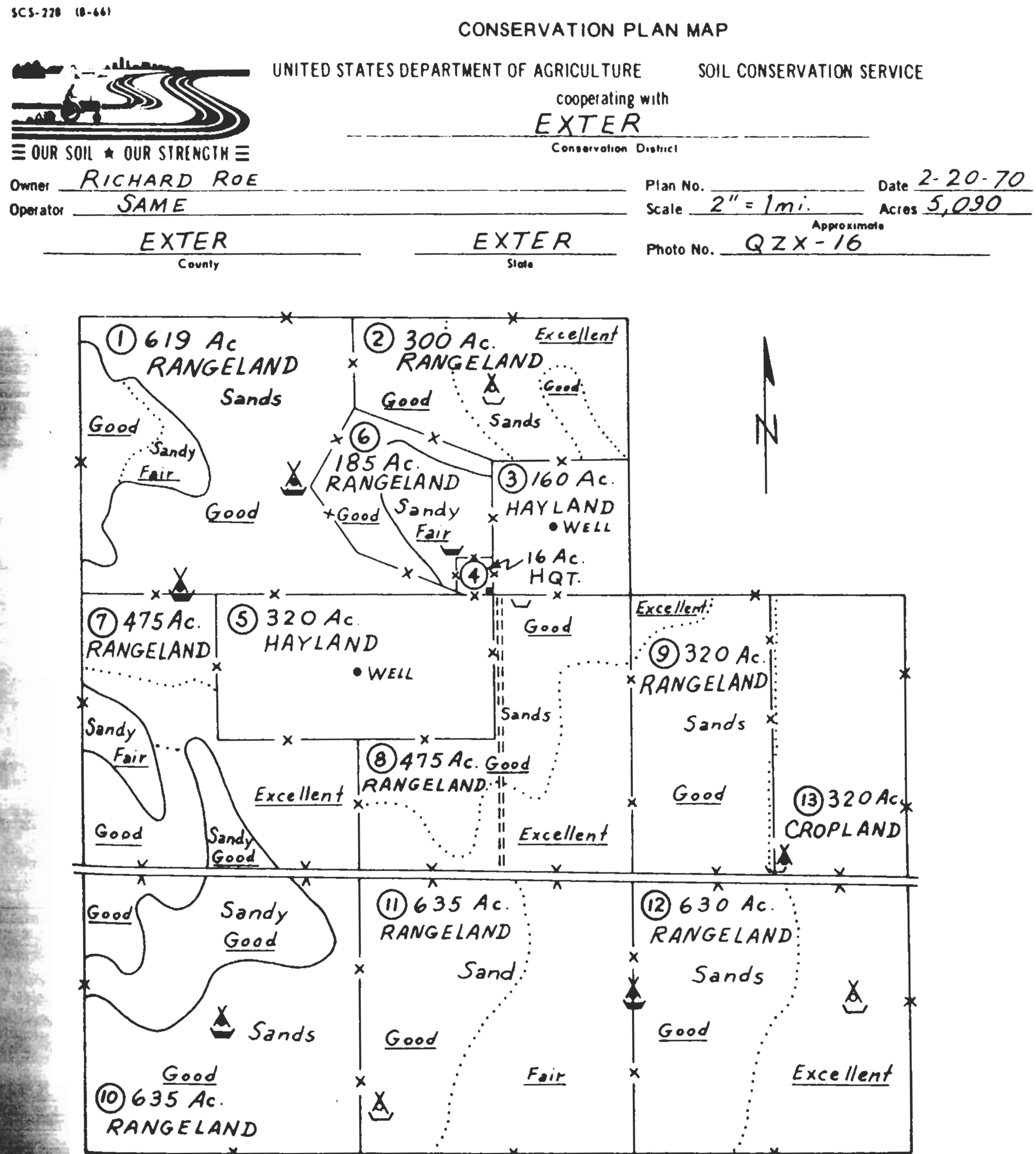

Fig. 1. *Range site and condition used to inventory rangeland for management purposes (after Soil Conservation Service, 1970).*

are compared. Even though the total production of the excellent condition is significantly higher than on the good condition, other benefits from the good-condition community are apparent. The large difference in big sagebrush and bitterbrush (*Purshia tridentata*) makes the good-condition range much better for big game species and for sheep (especially for winter use) than the excellent condition. The good-condition plant community corresponds very closely to that described by Julander (1962) as very good mule deer habitat in northern Utah.

Although, generally thought of as providing the basis for planning, applying, and evaluating the management of rangeland for domestic livestock, range site and condition interpretations are by no means limited to this use. They are also useful for making interpretation for wildlife, watershed, esthetic, and other beneficial uses of rangelands.

Summary

The concept of range site as a distinctive climax plant community evolved in the United States in the 1940's but finds its root in the concept of forest sites, which developed earlier. Most agencies working with private and public rangelands now use the concept, at least to some degree, as the basis for inventorying the potential of the rangeland with which they work.

Range condition as the ecological or successional status of the vegetation on a range site or type evolved during the same general period. It is now used by all agencies for rangeland inventory and studies. However the definition, techniques for determination, and factors considered in its computation will vary by agency.

Range sites are identified by evaluating and describing the distinctive climax plant communities within the particular area of interest. All available plant community data are used to establish sites. Available data are extended to areas where insufficient information exists by interpolation and extrapolation considering such environmental factors as soils, climate, and topography.

Range site expresses the rangeland capability in terms of its climax vegetation while condition indicates the present status of the vegetation in relation to that climax.

Range site and condition are used to dissect the rangeland landscape for purposes of investigation, evaluation, and management.

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Appendix 1. List of Common and Scientific Plant Names

Common Name	Scientific Name
Balsamroot	*Balsamorhiza sagittata*
Big sagebrush	*Artemisia tridentata*
Bitterbrush	*Purshia tridentata*
Bluebunch wheatgrass	*Agropyron spicatum*
Cheatgrass	*Bromus tectorum*
Desert rabbitbrush	*Chrysothamnus viscidiflorus*
Hawksbeard	*Crepis acuminata*
Idaho fescue	*Festuca idahoensis*
Longleaf phlox	*Phlox longifolia*
Low sagebrush	*Artemisia arbuscula*
MacDougal lomatium	*Lomatium macdougali*
Narrowleaf pussytoes	*Antennaria stenophylla*
Nineleaf lomatium	*Lomatium triternatum*
Prairie junegrass	*Koeleria cristata*
Sandberg bluegrass	*Poa secunda*
Snakeweed	*Gutierrezia sarothrae*
Squirreltail	*Sitanion hystrix*
Threetip sagebrush	*Artemisia tripartita*
Thurber needlegrass	*Stipa thurberiana*
Wheatgrass	*Agropyron* spp.
Yellowbrush	*Chrysothamnus viscidiflorus lanceolatus*

Biological characteristics of Australian *Acacia* and Chenopodiaceous shrublands relevant to their pastoral use

R. D. GRAETZ

Division of Land Resources Management, Commonwealth Scientific and Industrial Research Organization, Deniliquin, N.S.W. 2710, Australia

Introduction

Recently several Australian publications have provided an overview of the arid plant communities used by the pastoral industry (Slatyer and Perry, 1969; Moore, 1970; Leigh and Noble, 1972; Stobbs, 1973). These publications considered both the area and content of the communities as well as their importance to sheep and cattle production (see also the papers by Moore and Williams in these proceedings).

The present paper deals with research literature relating to the morphology, phenology, acceptability to livestock and nutritive value of some of the species comprising the *Acacia* and chenopodiaceous shrublands; the eucalypt shrubland has been omitted because of its small extent and low carrying capacity. A botanical description of this third type is available (Leigh and Noble, 1969; Moore, 1970).

The *Acacia* Shrublands

The *Acacia* shrublands occupy 30% of arid Australia, and include many different types of community structure; these structures range from semiarid shrub woodland where annual rainfall is up to 400 mm, to sparse *Acacia* shrubland where the annual rainfall is down to 100 mm (Moore and Perry, 1970). Snow does not fall in any of these shrublands.

Acacia shrublands are characterized by a layer of tall shrubs (or low trees), commonly monospecific and normally 2-8 m high. The density of the tall shrub layer varies from only one individual per ha to over 8000 per ha. Along the southern boundary of the arid zone *Acacia* shrublands give way fairly sharply to semiarid woodlands but in the east they grade imperceptibly into them.

Mulga (*Acacia aneura*) is the most widespread species and occupies the largest area (Moore, present proceedings). It can