Guidelines and Terminology for Range Inventories and Monitoring

Report of the

Range Inventory Standardization Committee
Society for Range Management

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Contents

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Preface

Increased interest and activity in natural resource inventories and monitoring by federal and state agencies in the United States began in the 1970's. Much of this activity was precipitated by Congressional legislation and court decisions that required federal natural resource agencies to prepare environmental impact statements on resource management activities; to prepare, implement and periodically revise multi-resource management plans on public lands; and to assess and monitor the extent and status of natural resources on both public and private lands as a basis for natural resource policy decisions.

Although these inventory, planning and monitoring activities involved a wider spectrum of range resource values and uses than previous efforts, range managers continued to play a key role because, for many rangeland attributes, procedures by range managers were better than those developed by other disciplines. Moreover, they were the only resource managers with much prior inventory and monitoring data. However, these data were less useful than they might have been, because use of different approaches and procedures among agencies, or even within the same agency, made it difficult to integrate, aggregate and interpret data from different sources. Data collected for specific uses were not always helpful for multiple use planning. Confusion and conflict occurred because some terms and concepts used in range inventory and monitoring were not perceived the same way by all range managers, not to mention other resource managers.

In recognition of these problems, the Board of Directors of the Society for Range Management (SRM) resolved that SRM should take a position of leadership to promote a uniform methodology and terminology for rangeland inventories and assessments. In May, 1978, the Range Inventory Standardization Committee (RISC) was established as a sub-committee of the Research Affairs Committee for this purpose. Since February, 1981, RISC has functioned as an independent ad-hoc committee; its chairman is appointed by the President of SRM.

Membership on RISC consists of 9-10 SRM members selected to obtain representation from the U.S. agencies involved in range inventory and planning, and from the academic community. Agency heads have appointed the member representatives of: Soil Conservation Service, U.S. Forest Service (one each from National Forest Systems and Research), Bureau of Land Management, Bureau of Indian Affairs, Cooperative State Research Service, and Agricultural Research Service. In addition, there have been 2-3 representatives from universities. Alternates were named by some federal agencies to assure representation at all meetings. The composition of RISC was a deliberate strategy based on the notion that its work could only proceed effectively with continual input and feedback from the agencies involved in rangeland inventories. RISC is not an "interagency committee"; its members have not served to represent official agency positions nor have the agencies been obligated to accept RISC's viewpoints. All of the agencies and universities involved have supported RISC's activities by providing time and expenses for the participation of members in 10-12 days of meetings per year since its inception. In addition, the U.S. Forest Service, Bureau of Land Management, Soil Conservation Service and Bureau of Indian Affairs have provided additional funding to support RISC's activities.

The first action of RISC was to write a working paper to define the objectives of the Committee (see Appendix). The objectives were to develop and recommend adoption of: (1) standard terminology for inventory, classification and analysis of range ecosystems, (2) a uniform system for classification and mapping range ecosystems, (3) minimum standards and guidelines for data collection and (4) a common philosophical base for data interpretation. The committee was to address needs for local management, for regional and national assessments, and for research. The working paper was accepted by the SRM Board of Directors and published in *Rangelands*, August 1979.

RISC then considered the terminology used in range inventory and monitoring. A list of proposed standard definitions was published in the August 1980 issue of *Rangelands* with a request for comment. Based on comments received and those of selected reviewers, revisions were made. RISC then prepared written statements on information needs, rangeland classification, and collection and interpretation of data. These statements, along with the revised terminology, were submitted in April, 1982 to reviewers selected by RISC, the SRM Board of Directors, and all SRM Sections. Comments of the SRM membership also were solicited (announcement in *Rangelands*, May 1982). All comments were considered by RISC in preparing this report of the committee.

This report presents concepts and a framework within which compatible range inventories can be conducted. It is not a "cookbook" for range inventory techniques. *It is intended to serve as a conceptual basis and guideline within which specific inventories can be developed.* Basic information requirements and measurement procedures are presented which should be included in any inventory and around which the entire inventory may be developed.

The report is limited in scope to information requirements and terminology for rangelands in the United States. Inventory or monitoring requirements of all possible rangeland resource users or values (i.e. for wildlife, timber, recreation, soils, or other associated elements) were not considered in this report.

Some international comment was received and considered in preparing this document. However, much additional effort will be required to reach conformity with international usage in either terminology or procedures. RISC supports initiatives of the SRM to promote more uniform international terminology and procedures.

This report is a consensus viewpoint and represents compromise. It is the result of much debate among people dedicated to the concept of compatible range inventories, but with different experiences and perspectives. For some readers, some statements will seem radical and threatening to long-held basic tenets of range management. To others, the report may appear timid and conservative in relation to recent advances in ecological thought, remote sensing, computer technology, and multi-resource inventory and planning needs. RISC views the report as a significant, but incremental, step toward better communication among range managers and between range managers and other resource managers by providing more useful and interpretable range inventory data. If the report stimulates thought, research and discussion, and leads to further improvement of methods and concepts, we will have accomplished our purpose.

Introduction

Purpose of Inventory and Monitoring

Range management planning and decision-making require information about the kind, quality, production potential, location, and amount of soil, animal and vegetation resources. Selection of management alternatives requires the ability to predict changes that will result from different management practices. Information is needed for planning and management at several levels, including specific projects, ranches or other management units, and regional or national assessments.

Definition of Inventory and Monitoring

Range inventory and monitoring are processes for obtaining and analyzing information about physical and biological resources. Range inventory establishes the status of resources at a given time, either by complete measurement or statistical inference based on sampling. Monitoring measures change in the status of resources over time. Monitoring may involve complete reinventory, but more commonly involves repeated measurements on selected areas. Decision-making is not a part of inventory and monitoring per se; but it involves economic and social evaluations or value judgements based upon inventory and monitoring data.

Background Information

Broadly defined, range inventory and monitoring involve more than the actual field collection of data. Some information is obtained by observation, or from public and private records. A partial list includes:

- Legal description and ownership of land including surface rights, water rights, and boundaries of the management unit.
- Location and condition of cultural features - buildings, roads, fences, water developments, power lines, and others.
- Natural features important to management - natural waters, natural barriers to livestock, threatened and endangered species, and others.
- Weather records.
- Records of actual and historical use by livestock and wildlife, including kind, numbers, periods of use, and productivity.
- Existing resource information, such as maps of geology, vegetation, soils, range condition or utilization.
- Data from studies and research, such as soil-vegetation relationships or response to management practices, that will help define and characterize ecological sites and vegetation response characteristics.

Classification and Mapping of Land

Classification of the land into relatively homogeneous units provides a framework for collection, storage and interpretation of data on vegetation, soils, animals and other elements of the range ecosystem. Site identification provides the basis for predicting potential resource values under alternative management strategies. Mapping land units furnishes a relatively permanent base for display of data on soils, present vegetation, range conditions and trends, utilization and associated resources or values. Classification and characterization of land are generally based on studies and research and are usually refined over a long period of time. Classification provides a basis for mapping, but the two tasks may be carried out concurrently.

Characterization of Present Resource Values

Estimation of present resource outputs and prediction of response to management alternatives requires characterization of the present status of resources (mainly vegetation but including some attributes of animals and soils). Characterizing information on vegetation includes plant species present, their relative abundance, present resource values for particular uses, rates of production, current levels of utilization, and changes in these characteristics over time. Data also are needed on current degree of soil protection and perhaps on wildlife species and other resources.

When vegetation is classified by criteria related to resource values, the present value for a given use may be estimated by simply identifying the vegetative class (range condition class) on a given land unit. In this case, detailed information on species composition, vigor, stand structure, yield, utilization, and soil properties are needed only for selected monitoring locations.

Interpretation of Inventory and Monitoring Data

Available information, including field data, is interpreted in terms of ecological status, present or potential resource values, trends in these values, and probable causes of identified trends. Some of these computations or interpretations may be, and should be, made in the field when data are collected. However, the difference between data collection and data interpretation should be recognized. Data collection is objective. Interpretation depends on value judgements or state of knowledge and can vary over time and among different interests. For example, estimating utilization is a relatively straight-forward procedure, but stating that a given level of forage utilization is without harmful effects is a matter of professional interpretation.

Scope of Report

The following sections of this report outline an approach and the minimum needs for range classification, data collection, and data interpretation for general range management purposes. Land mapping procedures are available through the National Cooperative Soil Survey and thus, will not be discussed here. It is recognized that additional types of information or different intensities of sampling will be needed for specific cases.

Basis for Classifying Land and Defining Ecological Sites

RISC recommends the term *ecological site* for the basic unit of rangeland classification. An ecological site is a kind of land which differs from other kinds of land in its potential natural community and physical site characteristics, and thus also differs in its ability to produce vegetation and its response to management.

Relationships of Range Sites and Habitat Types to Ecological Sites

The concepts of range site and habitat type are similar, but not identical. According to each concept, land units are defined on the basis of their inherent productivity and their climax vegetation. Implicitly, both concepts also include the criterion of response to disturbance or management by predictable seral vegetation patterns. Although similar in concept, range sites and habitat types often do not correspond exactly in a given area. This lack of correspondence is due primarily to differences among attitudes of individuals or agencies responsible for land classification.

The relative emphasis placed on floristics, structure or productivity of vegetation and on edaphic, topographic and climatic features will produce somewhat different classification units, as will the allowable amount of variability within—or required differences among—classified units. Differences between range sites and habitat types are mainly due to differences in approach to or purpose of classification and not to any basic philosophical difference between the proponents of the two systems. However, since one term or the other has sometimes come to be identified with certain agencies, disciplines, land types or regions of the country, we have chosen to use the term *ecological site* rather than attempt to standardize either of the presently used terms.

Ecological Sites in Relation to Potential Natural Plant Communities

The potential natural plant community of an ecological site is the assumed end point of natural succession for that site in the absence of disturbances and physical site deterioration. It is the plant community that is best adapted to a unique combination of environmental factors and that is in dynamic equilibrium with the environment. Natural disturbances, such as drought, wild fires, grazing by native fauna, and insects are inherent in the development of any natural plant community. Plant communities protected from these natural influences for long periods do not typify the potential natural vegetation. The term *potential natural plant community* is used in lieu of the term *climax community* to reflect realistically the conditions existing today. Most present vegetation and its physical environment have been altered by past use, including intentional and unintentional species introductions, such that the potential natural community will differ from the original pristine "climax" plant community.

The potential natural community of an ecological site is not a precise assemblage of species for which the proportions are the same from place to place or even in the same place from year to year. Generally, one species or a group of species is most prominant on a site. Their prominance in the potential natural community does not vary from place to place, or from year to year and can be used to help classify and characterize sites. Associated species of the potential vegetation may fluctuate greatly from place to place according to local differences in microenvironment or weather conditions. Consequently, using associated species alone for site classification can be misleading. In all plant communities, variability is apparent in production and occurrence of individual species. Variability within reasonable limits is the rule rather than the exception. Boundaries of communities, however, can be recognized by characteristic patterns of species association and community structure.

Determining the Potential Natural Plant Community of an Ecological Site

The following methods are used in determining the potential natural plant community of an ecological site:

- Evaluation of relict vegetation and associated soils on areas that have been subjected to minimal disturbances. Both production and the species composition of the plant community should be evaluated.
- Interpolation and extrapolation of plant, soil, and climatic data from existing relict areas along a continuum to other points on that continuum for which no suitable relict is available.
- Evaluation and comparison of areas currently grazed, logged or otherwise disturbed in varying degrees and comparison of such areas with similar areas that are not disturbed.
- Evaluation and interpretation of research data dealing with the ecology, management, and soils of plant communities.
- Review of early historical accounts and botanical literature of the area.

Characteristics of a plant community obtained from a single location are not likely to be conclusive. Evaluation of plant communities must consider such factors as drought, unusually favorable moisture years, effects of recent fire, excessive rodent concentrations or insect damage, plant disease, or excessive soil removal or deposition by wind or water. Every effort should be made to examine plant communities throughout the area of occurrence of the ecological site and at different seasons and during different years. The initial description of a potential natural plant community should be considered as an approximation subject to modification as additional knowledge is gained.

Permanence of Ecological Sites

Ecological sites are subject to many influences that modify or even temporarily destroy vegetation but do not necessarily preclude recovery or reestablishment of a potential natural plant community. Examples of such influences are drought, timber harvest, grazing, fire, and even short periods of tillage. Unless these influences are particularly severe, the potential of the ecological site is not permanently affected and the site remains capable of supporting the potential natural community.

Deterioration of the plant community is often followed by loss of soil and fertility, loss of ability of the soil to absorb and retain water, increase of stones on the surface, and other forms of site deterioration. The cumulative effect of such detrimental influences reduces the opportunities for reestablishing the original cover and productive capacity of the ecological site. Severe site deterioration will significantly alter the potential of the site. A different site is then recognized and described on the basis of its altered potential.

Differentiations Among Ecological Sites

Differences in the kind, proportion, and production of plants are in large measure the result of differences in soil, topography, climate, and other environmental factors. Marked changes in soil texture, depth, and topographic position usually result in pronounced differences in plant communities. Environmental conditions associated with a specific ecological site can be used to identify the site in the absence of the potential natural vegetation.

Potential natural plant communities change along environmental gradients. Where changes in soils, topography, or moisture conditions are abrupt, plant community boundaries are usually distinct. Boundaries will be broader and less distinct where plant communities change along gradual environmental gradients. Even though plant community changes may be gradual, plant communities can be identified, classified and described. The occurrence of these communities is predictable and they are associated with concomitant changes in soil, topography, and climate that also can be identified, classified and described.

Distinguishing between ecological sites along gradual environmental gradients is difficult. Site differentiation may not be readily apparent until the cumulative environmental impact on vegetation is examined over a broad area. Ecological site differences may be reflected in production or in the kinds and proportion of the plant species making up the core of the plant community or both. Of necessity, boundaries between ecological sites along a gradient of closely related soils (i.e. catena) and a gradually changing climate may be somewhat arbitrary.

The criteria used to differentiate one ecological site from another are:

- Significant differences in the kind and proportion of species groups in the plant community.
- Significant differences in the production of the plant community because of differences in soil properties, climate and topographic position.
- Significant differences in soil properties, slope and topographic position reflecting different use potentials and hazards that are not reflected in the community.

Any differences in criteria, either singly or in combination, great enough to indicate a different use potential or to require different management, are bases for establishing an ecological site.

Environmental factors are largely interrelated and the effect of a change in any single environmental factor will vary, depending on the influence of other factors. For example, a deep soil is more significant on an ecological site that receives additional moisture from repeated overflow than on a sloping upland site that receives no overflow. An additional two inches of annual rainfall may be highly important in an arid climate but of minor significance in a humid climate. Similar variations in degree of significance apply to most factors of the environment. Consequently, in identifying an ecological site consideration must be given to its total environment as well as to the individual environmental components.

In evaluating the significance of kinds and proportion of species or species groups that are prominant in the potential natural plant community, the relative importance of a species may indicate whether one or more ecological sites are involved. On deer winter range, for example, the potential natural vegetation may consist of 30% bitterbrush in one area and less than 10% bitterbrush in another area with otherwise similar species composition and total annual production. If this truly indicates a different site potential, then it would be important to recognize the difference to insure proper management of the winter range.

Identifying Ecological Sites

Naming Ecological Sites

Ecological site names should be simple, based on readily recognizable features and descriptive of the site. Such names will help users and managers recognize and remember the significant inherent differences of the ecological sites in their locality.

Ecological sites are named using a two-part, abiotic and biotic name. The abiotic portion should be brief and should be based on such readily recognized permanent physical features as the kinds of soil, climate, topography, or a combination of three features. Some examples based on these criteria are Sandy Plains, Clay Upland, Saline Lowland, Gravelly Outwash Plains, Pumice Hills, Granitic Fluvial Lands, Basalt Plains, and Sandy Skeletal Moraine Lands.

The limited number of permanent physiographic features or other features make the repeated use of these terms inevitable. Deep sands, for example, occur in areas of widely divergent climate and support different natural plant communities. Where repetition occurs, applicable adjectives descriptive of precipitation zone, biotic name or other features must be used to differentiate ecological sites.

The biotic name should consist of two (sometimes three) common names of characteristic, diagnostic, or prominent species. Where one layer of vegetation exists, two names should be chosen, e.g. Western wheatgrass/Green needlegrass. Where more than one vegetation layer exists, names should come from both (or three) layers. For example, Big sagebrush/Idaho fescue or Ponderosa pine/Bitterbrush/Idaho fescue.

An example of a complete ecological site name might be a Ponderosa pine/Bitterbrush/Idaho fescue—Upland stoney loam ecological site or a Upland stony loam—Mountain big sagebrush/-Bitterbrush/Idaho fescue ecological site. The order of the biotic and abiotic portion of the name is unimportant. However, the same combination of biotic and abiotic names should not be used to identify different ecological sites, except as described below.

Ecological sites with similar soils and topography may exhibit significant differences in their potential natural plant communities because of climatic differences. Two or more ecological sites may be recognized and distinguished by the inclusion of the precipitation zone (PZ) as a manifestation of climate in the naming of sites when quantitative evaluation indicates that the amount of vegetation produced is significantly different, e.g., Mountain big sagebrush/Idaho fescue-Upland stony loam ecological site, 16-19 PZ and Mountain big sagebrush/Idaho fescue-Upland stony loam ecological site, 20-25 PZ. If the soils have been described adequately, it is likely that the soils would differentiate the sites in this case.

Correlating Ecological Sites

Ecological sites are correlated on the basis of species composition, production of the potential natural plant communities, and soils. Sometimes it is necessary to extrapolate composition and plant production data from one soil to describe the plant community on a similar soil for which no data are available. It must be noted that delineation of two distinct soil taxonomic units does not automatically require recognition of two ecological sites. Likewise, some soil taxonomic units occur over broad environmental gradients and thus may support more than one distinctive potential natural plant community because of changes in an environmental component such as average annual precipitation or temperature. Where this occurs the soil taxonomic unit should be phrased to reflect the different potential plant community.

Only one name should be given to a single ecological site that occurs in adjacent states. If this is not feasible, use the local name in the description of the ecological site and indicate the name used in the adjacent state.

A mechanism is needed to systematically correlate ecological sites within and among agencies and states to insure uniformity. Correlation could be accomplished by establishing an interagency committee of agency representatives to resolve differences.

Ecological Site Descriptions

A technical description should be prepared for each ecological site that is identified and named. Descriptions should be brief, but they should clearly present the features that characterize the site. They should not be oriented solely around single resource uses such a livestock grazing or timber harvest. Other resources of the site may be highly significant in planning, developing, managing, and monitoring resources. Descriptions should include the following, as appropriate, along with other pertinent information:

Full name. The full name of the site should be placed on each page of the description.

Physiographic features. Physiographic features should include:

1. Position of site in the landscape, e.g., ridgetops, swales, south-facing slopes.
2. Aspect, shape, length and steepness of slopes.
3. Range in elevation.

Special notation should be made concerning susceptibility to surface water flow, depth of water table, and similar characteristics.

Climatic Features. Pertinent climatic features include:

1. Extremes and seasonal distribution of annual precipitation and, where available, probability of receiving selected amounts of monthly precipitation.
2. Temperature characteristics, (average length, beginning and ending dates of growing season for major native forage species).
3. Other macroclimatic features such as storm intensity, wind velocity, and drought cycles.
4. Microclimatic features such as frost pockets and cold air drainage that typify site and relate to its potential.

Potential Natural Vegetation. Several kinds of information are needed to determine the potential natural vegetation for each ecological site; these include:

1. Structure and appearance of the community.
2. List of major plant species and relative proportion of each in the community. Criteria for identifying relative importance of plant species must be defined. These criteria may include frequency, cover, yield or other measures of relative dominance.
3. List of tree species, the approximate canopy cover of the overstory, and site index for forested sites.
4. Brief description of common patterns of succession and retrogression, including casual agents associated with each pattern and a list of plant species most likely to invade if cover deteriorates.

Total annual herbage and browse production. Show estimated total annual herbage and browse production as median air-dry production and the fluctuations to be expected during favorable and unfavorable years. In areas where examples of the potential natural plant community are not available, cite the production of the highest ecological condition class for which examples are available. Production of individual seral stages is desirable and should be incorporated as information becomes available.

Soils. The name of all soils associated with the site should be given. Because soil names are subject to change, list the soil taxonomic units associated with the site on a separate sheet that can be easily updated. Other information needed includes:

1. Key properties of soils associated with site, especially those that significantly affect plant-soil-water relations.

2. Amount of ground cover necessary to protect soil from accelerated erosion.

Site Interpretations. Site interpretations should explain the potential importance of the site for each of its major uses, including grazing, timber, habitat for wildlife, recreation, esthetics, and watershed quality. Interpretations should note:

1. Kinds and classes of livestock and seasons of grazing best suited to the site.

2. Wildlife species that inhabit the area, along with important food and habitat plants for each major wildlife species.

3. Relative stability of the site for watershed species.

4. Unique properties important to management of the ecological site.

5. Resource value ratings for expected uses for the known ecological stages as well as the potential natural community.

Other information. Other pertinent interpretative and descriptive information may be included.

Classification in Relation to Mapping

Development of an ecological site classification and the actual mapping of ecological sites are two distinct processes. Classification is the process of ordering and arrangement of land into groups—ecological sites—based on similarities and dissimilarities in data for the parameters measured. The classification and description of ecological sites does not involve mapping. However, inventory and mapping are often used to help refine classified sites. Mapping of ecological sites involves the systematic evaluation of the landscape to stratify it into ecological sites based on similarities to the ecological sites described in the classification.

Mapping of Ecological Site Complexes

Within a specific area of land, ecological sites can be delineated on maps as a single site, with inclusions of small areas of other sites, or as a complex of two or more sites that are so interspersed that separate delineation would not be practical or meaningful.

The names of ecological sites are generally shown on the map within each delineation, but if space is limited, the names can be represented by appropriate symbols explained in a legend. If a delineation represents a single site or a major site that has minor inclusions of other sites (making up as much as 15% of the delineation), the name of the major site is used. If a delineation represents more than one site (i.e. a complex) the name of each major site and the approximate proportion of each is indicated. For example, Bluebunch wheatgrass/Idaho fescue—Loamy upland, 65%; Bluebunch wheatgrass/Sandberg bluegrass—Shallow loam, 35%.

Establishment of a uniform minimum acreage for site delineations is usually not practical. Need for mapping detail varies in accordance with relative productivity of a site, size of management unit, map scale, intensity of use patterns and information requirements. Land that has relatively high productivity is usually mapped in greater detail than that of low productivity. Land that is suitable for many alternative uses also may be mapped in more detail.

Intensity and details in mapping ecological sites, therefore, are determined locally on the basis of the kinds of land and the needs for planning. Major consideration is given to management needs for various uses of the land, including but not limited to timber harvest, livestock grazing, habitat for wildlife, and watershed protection. To insure compatibility of mapping units, soil scientists and vegetation specialists should work closely together to define mapping units that insure that soils and vegetation information is coordinated.

Data Storage and Retrieval

Because of the extremely large volume of existing information and the additional data accumulated annually, some means of automated data storage and retrieval is necessary. This will require common definitions, common units of measure, and a minimum standard data set so that meaningful analysis, evaluations, and comparisons can be made. These needs are being addressed by other working groups. Compatibility of storage format and some degree of computer compatibility also are required.

There are a number of data systems in operation. The Soil Conservation Service has Range Data System (RDS), The Forest Service has Range Management Information System (FSRAMIS) and a number of regional systems, and a large number of universities have developed systems of their own. The system that currently has most universal application to a wide variety of ownerships and conditions appears to be the SCS-Range Data System. RISC does not have the expertise nor is it in their charge to evaluate data storage and retrieval systems, but we recognize that a system is needed. A single system would greatly aid the correlation process between states and agencies.

Collection and Interpretation of Data for Management Planning and Resource Assessment

Guiding Principles

Data Collection Compared to Data Interpretation

Measurement of range attributes and the interpretation of measurement data for management and planning purposes are two distinct processes. Selection of attributes for measurement is determined by characteristics of the resource, the interpretation to be made, and cost or time requirements. Once attributes are selected, their measurement should be as objective as possible. The attribute measured must be adequately defined and the accuracy and precision of measurement reasonably specified. Data collection should be objective and free of value judgements.

Measurements are of value to the manager only when they are interpreted in terms meaningful to goals and human values. Interpretation involves two basic processes: (1) translation of measurements into outputs or values, and (2) a comparison or prediction of outputs or values obtained by present management relative to those obtained under an alternative management strategy.

Kinds of Interpretations

Many kinds of interpretations may be needed for planning and decision-making, especially for multiple use management. We do not attempt to discuss them all. A few basic interpretations considered necessary in almost any range inventory or monitoring program will be defined, the types of data necessary will be specified, and the general approach to collecting the data outlined.

One kind of interpretation needed relates to range condition, the present status of the vegetation and soil resource. Another important interpretation is estimation or documentation of change (trend) in certain vegetation or soil characteristics and reasons for observed changes. Other interpretations necessary for economic or environmental evaluation of present or proposed grazing management include grazing capacity under alternative management systems, need for and location of range improvements, and competing or complementary relationships among different uses.

Detail Required

The need for detailed data collection will vary as the scale and purpose of inventory and monitoring changes. For broad assessments the number of sample locations or the accuracy and detail of mapping may have more effect on validity of the results than will precision of measurement at a given location. Even at the management level, e.g., ranch or allotment, simple ranking or assigning to classes may furnish data of sufficient accuracy for the decisions required. It is primarily for monitoring trends where quantitative data amenable to calculation of confidence intervals are needed.

Importance of Ecological Sites

All data collection and interpretation should be based on ecological sites. For broad scale assessments, data from different ecological sites can be grouped according to similarity in present or potential vegetation, soils, geology, present land use, land ownership, administrative policy or jurisdiction, or any other useful criteria. However, data collected without reference to ecological site, even within one mapping unit, cannot be interpreted in terms of site potential because there is no basis for disaggregating back to the site level.

Long-term vs. Short-term Objectives

Total inventory may be required for long-range management planning. Such inventories may be required only infrequently, 5 to 20 + year intervals. The long-term effects of implementing a management plan are ultimately expressed as changes in range condition and trend. Such changes may be documented only by monitoring over a long period of time. Documenting causes of such changes, including amount and distribution of utilization, weather records and actual use may provide useful information for short-term adjustments in management.

Range Condition

General Considerations

Range condition often has been called "the state of range health." There are two approaches to range condition assessment. They involve different concepts of range condition and hence require different evaluations: (1) an evaluation of whether the long-term productive potential of sites is being maintained, and (2) an evaluation of the present level of production relative to the potential production for a given objective or use of the site.

In the past, procedures developed for interpreting range condition have dealt with one or the other of these approaches, or have combined elements of both. Using one term—range condition—for both concepts has led to confusion. Since the term "range condition" is so much a part of the language and literature of range management, we recommended that it be used in the generic sense covering the broad concept of range condition and that two terms with specific meanings (ecological status and resource value rating) be used for the two separate concepts.

Ecological Status

Definition. Ecological status is use-independent and is defined as the present state of vegetation and soil protection of an ecological site in relation to the potential natural community (PNC) for the site. Ecological status is evaluated by two independent ratings, one for successional stage of vegetation and one for stability of the soil. The vegetation rating is an expression of the relative degree to which the kinds, proportions and amounts of plants in a community resemble that of the PNC. The soil rating is the relative amount of protective cover furnished by vegetation and litter compared to the level of protection provided by the PNC for the site. Both vegetation and soil are rated relative to site potential. This means that proper definition and identification of ecological sites is a prerequisite for interpreting ecological status.

The kinds, proportions and amounts of plants in the PNC for each ecological site are determined by sampling stands representing the PNC. Potential natural community (PNC) is defined as "the biotic community that would become established if all successional sequences were completed without interference by man under the present environmental conditions." We prefer the concept of PNC to that of climax (see definition, p. 10) because it recognizes *past* influences by man, including past use and introduced exotic species of animals or plants. Man's influence is excluded from the present onward to eliminate the complexities of management. The concepts of climax and PNC both refer to a relatively stable community resulting from secondary succession after disturbance. Although man may or may not have caused the disturbance, succession to climax or PNC occurs without further perceptible influence of man's activity. RISC prefers PNC because this term explicitly recognizes that naturalized exotic species may persist in the final stage of secondary succession and that succession after disturbance does not always reestablish the "original" vegetation.

Vegetation Rating. The vegetation rating should be based on kind, proportion and amount of plants in the present community relative to PNC. Specifying an amount implies that an absolute measure of plant species is required, rather than a species list or the composition alone. The present community can be compared with the PNC in absolute terms by several kinds of measurements, such as cover, density, weight or frequency. Use of cover or weight results in a few major species controlling the degree of similarity to PNC. The importance of common, but small, plants is emphasized to a greater degree when using density or frequency. Most agencies currently use weight by species as a basis to estimate vegetation condition, even though weight data are more time-consuming to obtain and more subject to error than some other attributes. Frequency requires less time to obtain objective and repeatable data. Some agency personnel and researchers are developing guides to use frequency for rating vegetation status in place of weight.

To compare present vegetation to PNC both communities must be described in terms of the same attributes. If the present community is described in terms of frequency, the PNC also must be expressed in terms of frequency. Although the degree of similarity of present vegetation to PNC will vary somewhat depending on the attribute chosen for characterization, in most cases the difference will not be significant enough to alter interpretation.

The degree of similarity between the present vegetation and PNC can be calculated by a coefficient of community similarity ($2w/a+b$) where a is the sum of species values for measured parameters of present vegetation, b is the sum of values in the PNC and w is the sum of the values common to both (Table 1). Although other measures are available, this index is widely accepted and used. Vegetation ratings may be expressed as a percentage. If vegetation rating classes are used, they should be four in number, corresponding to 0–25%, 26–50%, 51–75% and 76–100% of the PNC standard. The reasons for using four classes are: (1) use of more classes implies a precision of measurement that may not be achievable, (2) use of fewer classes would make the rating insensitive to change, and (3) use of different numbers or definition of classes among agencies makes comparisons difficult.

Table 1. Example of calculation of ecological status of vegetation using coefficient of community similarity on herbage production data.

	Herbage Production (lb/acre)		
Species	Present Vegetation	Potential Natural Community	Amount in Common
1	100	200	100
2	50	100	50
3	100	50	50
4	200	50	50
5	50	50	50
Total	a = 500	b = 450	w = 300

Condition Score (2w/a+b) = 600/950 = .63 = Late Seral

Vegetation rating classes should not be given names implying value judgements, such as good or poor. Ecological vegetation ratings do not have any reference to values produced or to management goals. Vegetation rating classes may be referred to as early seral, midseral, late seral and PNC or early-, mid-, late-succession and PNC. The use of "PNC" for the entire upper class (76–100%) seems justified. Experience of ecologists indicates that variability in plant composition within a "homogenous" community is sufficiently high that any similarity index in excess of 75–80% between two stands would indicate that the samples could have been drawn from the same population.

Soil Rating. Although the procedures described above for rating vegetation status are similar to approaches widely accepted and used in the past, no such generally accepted procedure exists for rating soil status. Thus, the suggestions for rating soil status should be taken more as a hypothesis than an accepted procedure.

Deterioration of site potential comes mainly from soil erosion. Some erosion is natural, and it is important to distinguish between natural and induced erosion. Even natural erosion can lead to site deteriortion, but as managers we are primarily concerned with accelerated rates of erosion induced by management. Since natural erosion rates vary from one ecological site to another, rates considered to represent accelerated erosion must be defined on a site by site basis.

Erosion rates are difficult to measure directly. On a given site, erosion hazard is related mainly to effective vegetation, litter and other soil surface cover. Minimum amounts of vegetation and litter cover should be determined for each ecological site by comparison with areas considered to represent natural erosion rates for the site. These comparisons or standards may have to be adjusted for slope. The soil rating can be expressed as the ratio of vegetation-litter cover on the test location to vegetation-litter cover on a reference area representing natural erosion for the site.

Resource Value Rating

RISC proposes a third type of interpretation or rating related to the general concept of range condition—Resource Value Ratings (RVR). RVR is the value of vegetation or other features of an ecological site for a particular use or benefit. RVR's may be established for each plant community capable of existing on an ecological site, including exotic or cultivated species.

On a given ecological site, each use (or potential use) has a separate RVR. This interpretation may be based on species, growth form, foliage type or other criteria. For example, an RVR for forage useful for a particular kind or class of animal and season of use could be based on proper use factors (PUF's). The RVR could be based on production, cover, density or frequency of plants with different forage values. RVR's should be derived for various kinds of animals. An RVR for nesting cover useful to a particular species of bird might be based on density or cover of plants of certain height or size class, perhaps without regard to plant species. An RVR related to scenic beauty might be based on abundance of flowering plants, species with fall color, evergreens, diversity of growth form, or other attributes.

The RVR is intended for rating of a specific location without regard to its relationship to other sites or vegetation types in the area. For instance, the RVR for summer cattle grazing is based only on the vegetation present at that specific location. If RVR is expressed in terms of forage acre factor or acres/AUM, these terms should not indicate carrying capacity, because such considerations as slope, distance from water, juxtaposition of other sites or vegetation types are not included. The RVR is a measure of suitability or usefulness of the vegetation of an ecological site for a specific use assuming full use is possible. Off-site considerations do not influence it.

The RVR may be used in an absolute sense, i.e., without reference to site potential. For instance, the forage acre factor is nothing more than a rating of the amount and usefulness of plants for grazing at the present time. It is usually desirable for planning purposes to know how the present RVR relates to the potential RVR for that use on the site. For this purpose the present RVR can be expressed as a percentage of the highest RVR actually measured on the ecological site. Or, in the absence of areas judged to represent site potential, the potential RVR could be estimated based on measurements of a similar ecological site. The potential RVR for a use is the management site potential for that use (see definition, p. 11).

In planning it is also necessary to calculate trade-offs among uses or potential uses, that is, to estimate RVR's for a number of uses in response to a management alternative. For example, for each ecological site, an array of possible vegetation types, including seeded stands, obtained by various management alternatives, could be described and their associated RVR's approximated.

Data Collection for General Assessment

Classification of present vegetation provides a basis for estimating successional status of the vegetation and resource value ratings *when* considered in the context of the ecological site on which it occurs. Classification of present vegetation should be based on criteria related to seral stage and major resource values, such as forage for cattle, fuelwood production, or sagegrouse nesting cover. In some cases a classification based on dominant species in each layer may be adequate. In other cases, additional classes based on density or cover of some species or life forms may be necessary.

The attributes chosen to classify present vegetation depend on management needs and uses considered. Attributes may include cover, relative standing crop, density or height depending on the character of the vegetation and the resource values considered. Visual classification of vegetation types and or condition classes, usually with preliminary mapping on aerial photos, has formed the basis for most range inventories in the past 50 years. For general assessment purposes, attributes identified through remote sensing with minimal ground checking are preferred for economic reasons.

Soil status may be estimated in cover classes directly or by use of a score sheet similar to those used by several agencies for many years. If certain vegetation types on a given ecological site consistently provide adequate soil protection while others do not, then classification of present vegetation alone may provide adequate data on soil status for general assessment.

Data Collection for Detailed Analysis

More precise quantitative information on ecological status, resource value ratings, or soil status generally requires sampling attributes such as cover, standing crop, density or frequency using point samples, lines, plots or other measurement techniques. Selection of an appropriate attribute and technique for measurement depends on the nature of the vegetation and purpose of the inventory.

Quantitative data are not always more accurate or less subjective than the ranking or general estimation procedures described above. Accuracy of quantitative data can be improved by reducing bias in sample selection and by other means. The high degree of variability in range vegetation and soils results in low precision except on intensively sampled monitoring locations.

Measuring and Interpreting Trend

General Considerations

Trend is the directional change in kind, proportion and/or amount of plant species, or soil characteristics. Trend may be interpreted in both an ecological context and in terms of resource value. The principal criteria to interpret trend in ecological status should be the vigor and reproductive success of plant species that are indicative of later seral stages as compared to those of an earlier seral stage for the site. The potential natural community is used as the reference plant community and trend is described as toward or away from the potential natural community, or not apparent. Trend of soil surface conditions is interpreted from evidence of accelerated soil erosion.

Trend in RVR, when compared to management ojective(s), refers to the change in utility of vegetation at a particular location for a specific use. The trend of a particular resource value may be up, for another use the trend may be down, and not apparent for still another. The direction of trend is based on whether the changes in vegetation and soil conditions are desirable or undesirable for specific management objectives.

Because of the dual interpretation of trend, the type of trend must be specified, either ecological status or resource value for a specific use or both.

Trend can be interpreted at various levels depending on the amount of detail needed or available. At the macroscale, changes in lifeform of dominant species, gross changes in cover and density of shrubs and trees and marked changes in ground cover can be monitored by use of remote imagery and aerial photography. In such situations, documentation of trend in vegetation and soil surface conditions can be achieved without detailed measurements of kind, proportion and amount of major species. Often these changes occur over a period of years or decades, unless catastrophic alterations due to fire or other severe disturbances occur. Less obvious changes in trend are difficult to detect and document unless critical on-site measurements of vegetation and soils are made.

Apparent vs. Measured Trend

Apparent trend is the interpretation of direction of change based on the evidence that is obtained at a single observation. It should only be done by an experienced observer and should always be clearly identified as *apparent* trend.

Measured trend is a quantitative assessment of change based on repeated measurements over time, of the kind, proportion and/or amount of plant species and soil surface properties. It provides quantitative data for interpreting the direction of change, often before it is detectable by repeated ocular examination or repeated photographs over time. Measured trend provides early feedback to indicate if management objectives are being reached. If progress is unsatisfactory, modification in management practices is needed.

Measuring Trend

Early detection of trend involves some risks because vegetational properties naturally fluctuate widely within and among years because of climatic variability and other influences. These normal fluctuations must be considered when determining trend. Sampling error further confounds the problem of early detection of trend.

Many techniques are available to monitor trend and each has pros and cons. A review of these techniques leads to the conclusion that plant yield, cover and density are not reliable measures of trend, particularly for herbaceous species.

Because of the complete renewal of above-ground growth annually, the varied growth forms, and phenologic differences of individual species, no single measure of herbaceous plants is best for determining trend. Each method has a deficiency. Plant production and foliage cover data are highly variable, both seasonally and annually. Basal cover is more stable, but difficult to measure for many species. Plant density is a difficult parameter to sample adequately because of varied growth forms and at times the difficulty in identifying what constitutes an individual plant.

Because of stand variability, obtaining an adequate sample of yield, cover or density with sufficient statistical reliability to detect trend is extremely difficult. For example, the number of samples necessary to obtain precision of ± 10% at a probability of 95% is frequently unreasonable for most land managers (Table 2).

Table 2. Number of sample units required to estimate vegetation parameters with sampling precision ± 10% at probability of 95%.

Parameter Measured	Type of Sampling Unit	Number Required	Source
Cover	100 sq. ft. plots	46–200	Costello and Klipple, 1939
Cover	100 ft. line intercept transects	44	Hyder and Sneva, 1960
Cover	Points	2400–3600	Clark, et al., 1942
Density	96 sq. ft. or 9.6 sq. ft. plots	38 and 174, respectively	Laycock, 1965
Yield	1.917 sq. ft. plots	28–193	Scoop and McIlvain, 1963

Frequency of occurrence is a measure of the spatial distribution of a species, i.e., its distribution in the community. This sampling technique has many advantages for the determination of trend. Frequency data are simple to obtain, objective, statistically reliable, and relatively inexpensive to collect. As with density and basal area, frequency is rather insensitive to seasonal and yearly variation, a desirable attribute when monitoring long-term vegetational trend. Statistically reliable frequency data are less expensive to obtain then density or basal area.

For trend interpretation frequency data generally are interpreted by analyzing differences in frequency of individual species over time on a specific ecological site. Key species may be selected for dominance, desirability for certain uses or indicator value in the community. Although rooted frequency is not consistently related to density, basal cover, or distribution pattern, positive statements about trend can be made if change in frequency occurs between two sampling periods. An increase in frequency indicates that new individuals have become established. This change in a preferred species can be interpreted as being desirable or showing an upward trend, and a similar change in undesirable species would indicate a down trend. If individual species of interest are recorded by categories, e.g., newly established (exclude current seedlings), mature, and senescent, the change in frequency can be interpreted as to how the age classes within species are undergoing change.

Frequency is dependent upon plot size, plot shape and distribution pattern of the individual species. Thus, change in frequency is difficult to interpret unless the same size and shape of quadrat are used in each sample period compared. To detect statistically significant change, the frequency value should fall in a range of 20 to 90% for sampling sensitivity.

Frequency data, like all other quantitative measures, cannot be used to evaluate ecological status or resource values rating before standards are established through prior study. Once standards have been established frequency data can be used for a rapid, objective and consistent method of trend analysis. Frequency can be used to indicate a real change in vegetation but it cannot be interpreted to indicate a specific amount nor the specific property of a species unless additional information is available. In spite of its limitations, frequency is the easiest, least costly and most reliable kind of quantitative data to collect to detect change in the role of a species in a community.

Frequency cannot be efficiently or meaningfully used in all vegetation types. It is more meaningful in perennial grasslands, and for interpreting change in the herbaceous and small shrub component in shrub-grass vegetation. RISC recommends the use of frequency for monitoring trend for these vegetation components. For large woody plants, canopy cover and density should be the basic measurements to monitor trend.

Soil surface condition can easily be obtained along with frequency by fixing points on the sample frame to record hits on bare ground, litter, gravel, total basal cover of vegetation and other characteristics of the soil surface. However, this method will not usually adequately sample basal cover of individual species because of insufficient number of observations.

Accuracy, Precision and Probability Statements

Regardless of the type of data collected to evaluate vegetation change, interpretation should be supported with reliable statistical analysis. Vegetation parameters are estimated by measurement from sampling. Accuracy concerns the nearness of the estimated value to that of the actual value. Precision refers to repeatability of the sample estimate. High precision suggests a high degree of accuracy, but this is not necessarily the case when dealing with vegetation.

Precision and probability statements are functions of sampling intensity and population variability. High precision in vegetation sampling is generally very costly to obtain because of the large number of samples required. For trend analysis a compromise between sampling cost and the risk of an incorrect interpretation of data suggests that a precision of ± 20% of the mean at a probability of 80% should be the minimum acceptable level. Increasing the probability to 90% would require an increase in sampling effort of about 50%. However, specification of an adequate level of statistical reliability of data will greatly enhance acceptance of related decisions.

Interpreting Trend Data

Measured or observed changes in kind, porportion and/or amount of plant species on a site, in soil characteristics, or in animal populations, are interpreted as trend in ecological status or resource value ratings. Trends in ecological status or RVR's should establish whether present management is resulting in changes toward or away from management objectives. In order to decide if a change in management is needed to reverse undesirable trends or to accelerate desirable ones, it is important to try to establish causes for trends. Several guidelines for collection and interpretation of trend data follow.

Interpreting Trend at One Location. Differences in measurements obtained at different dates on the same location because of sampling error, personal bias or lack of adequate training should be minimized. The location and size of the sample area must be adequately specified. The sample area should not involve more than one ecological site and sampling design should account for heterogeneity in plant pattern, topography, and microclimate. Sampling method should be amenable to statistical analysis and establishment of confidence intervals. Attributes measured must be defined in objective terms such that observer bias is minimized.

Interpreting Trend in a Management Unit. It is rarely feasible, nor is it necessary, to obtain a statistically valid sample of an entire management unit (pasture, allotment) for trend monitoring purposes. Rather, each monitoring location should be carefully selected with specified objectives developed for each location. Data from different sample locations should not be combined until after interpretation of each location is made and then only if it is certain no information will be lost. The overall trend on a management unit cannot be determined by averaging trend data from various locations except perhaps under cases of extremely good or poor management.

Collateral Data. Collection of collateral data to aid interpretation of soil or vegetation change is essential. Weather data collected on or near each monitoring location are highly desirable. Storage gages read monthly or seasonally can be used for precipitation. Max-min thermometers at selected locations may help explain extreme events. Actual use records of livestock and of wildlife should be maintained. Utilization should be measured on each monitoring location whenever trend data are collected and at other times when appropriate and feasible. Utilization data should be collected to represent the same location as other vegetation data. A method should be used which provides quantitative estimates of either percentage utilization or residue remaining. Examples are the grazed-class, stubble height, percentage plants or twigs grazed methods, or any number of other techniques suitable in different situations. Caged plots may be used to ensure that some ungrazed plants are present for making comparative kinds of measures, but generally the number of cages necessary to obtain precise estimates make their use impractical for direct determination of utilization by harvesting. Observations on populations or occurrence of rabbits, rodents, insects, fire or other disturbances also should be made.

Frequency for Collection of Trend Data. In order to establish the reality of trends and the causes for them, it is highly desirable to measure trend frequently. This is particularly important where management problems exist, but causes are debatable. Annual trend measurement is ideal. There is often value in measuring utilization more than once a year. However, budgets and manpower often dictate that trend monitoring can be done only at intervals of two, three, five or more years. In this case a monitoring strategy designed to aid in accurate identification of trends and their causes is especially important. Two ways are suggested to overcome the problem of infrequent measurement.

One strategy is to select a few locations for frequent, preferably annual, measurement. The location chosen should be where collateral information relative to management objectives can be obtained. Establishment of a continuous trend in soil/vegetation characteristics in relation to weather, utilization, actual use and other variables will support a more accurate interpretation of data gathered on an infrequent basis elsewhere.

Another strategy is to pay special attention to designed comparisons among trend locations. For instance, if vegetation cover is declining on numerous trend locations irrespective of the management system, it may be assumed that weather or factors other than management are responsible. However, if cover of forage species declines on an ecological site in one management unit but increases or is static on the same ecological site in an adjacent unit, a change in management is indicated.

Management Planning

General Considerations

A major use of inventory and monitoring data is in development, evaluation and revision of management plans. Inventory and monitoring data furnish only part of the information needed for planning purposes. The rest must come from economic analyses, public input, and legal or policy constraints concerning priority of uses, consideration of threatened and endangered species, or other value judgments. Planning may be directed at the individual range (grazing allotment) or broader regional/national assessments.

Management planning requires a knowledge of the present status of the resource in terms of resource outputs and the trade-offs among values produced by alternative management strategies. It also requires estimation of different resource values produced by management prescriptions designed to alter the present situation and of costs of achieving or maintaining such conditions. Research, studies and experience furnish the basis for making analyses and predictions.

Identification of ecological sites and their associated RVR's form the basis for development of alternative management strategies. Inventories of ecological sites and present plant community types are necessary for each planning unit. Such inventories generally involve maps, i.e., complete inventory, especially at the ranch/allotment or project level. For generalized resource assessments sampling data are most generally used. It is possible that classification and/or mapping may be replaced or complemented in the future by gradient modelling or direct remote sensing procedures. Such methods are not generally well-developed for rangeland uses at this time.

Grazing Management

Estimation of present or potential grazing capacity is an important interpretation. Grazing capacity is not a site characteristic as are RVR's but, rather, is a characteristic of the management unit (pasture, allotment or ranch) as a whole, including the pattern of ecological sites with their respective present or potential RVR's as well as the level of investment of time, money and energy economically feasible or compatible with management objectives.

Utilization surveys can identify key areas, problem areas and/or opportunities to improve livestock distribution. Utilization measurements on properly selected key areas can be used to estimate proper stocking levels under current management, when actual use and climatic data are available. These procedures are recommended for estimating needed increases or decreases of livestock when no trend data are available and the need for adjustment is fairly obvious. Utilization data also may be used to furnish quantitative estimates of required increases or decreases in stocking rate when trend data indicate need for adjustments, or to furnish estimates of additional grazing capacity obtainable by alternative grazing systems or range improvements.

For management planning or for monitoring of adherence to grazing management systems, highly quantitative methods of estimating utilization are not necessary nor feasible. Estimation of utilization on major forage species in 3 to 5 classes usually provides a reliable measure of the pattern of use in a management unit. This is usually sufficient to identify problem areas or opportunities to improve distribution.

There is no feasible way to precisely estimate either present or potential grazing capacity based on a one-time inventory alone. The most satisfactory, and ultimately, the only way to establish proper stocking rates is to monitor trends in ecological status and RVR's under a given stocking level. If measured trends indicate progress toward management goals, stocking levels under present management can be maintained or increased. Trends contrary to management goals indicate that present management is unsatisfactory. If the intensity, frequency, distribution or duration of livestock grazing can be established as the cause for undesirable trends, than a change in one or more of these is indicated. Changes resulting from other causes, such as wildlife influences, fire or absence of it, weather, plant succession, etc. will require changes in management designed to correct such trends or to accommodate the undesirable trends.

Forage inventories can provide baseline data for management planning especially when an area is presently ungrazed, if grazing history is available, or if alternative management is proposed. Estimates of potential grazing capacity based on forage inventories can be used for economic evaluation of range improvements or vegetation manipulation, design of grazing systems, accommodating needs of other consumptive users, and for other planning purposes.

Forage inventories can be based on maps, samples of present vegetation types, on resource value ratings known to be associated with these types, or established by production studies designed for this purpose. Projection of future forage production from present or alternative management practices must be based on ecological sites. For each site the change in plant community and the RVR associated with the new community must be predicted as a basis for estimating future forage production. Forage production estimates from inventories of present vegetation or projection of future production must be adjusted for present or projected distribution patterns of livestock, class or kind of livestock, season of use, and needs of other forage users.

Forage inventories are time consuming and subject to error because of variability in herbage production in time and space. Inventory of forage production can be justified only where local experience and knowledge is lacking or for relatively small, uniform and very intensively managed areas such as irrigated pasture. Utilization studies and the monitoring of trend should be used to arrive at proper numbers of livestock rather than forage inventories.

Other Management Considerations

The preceding discussion of management planning has focused on planning of livestock grazing. However, data collected and interpretations made will serve for planning other types of range use as well. In fact, these principles and approaches should serve equally well for any use dependent on the soil-vegetation resource provided the information needs of these uses are built upon the classification of ecological sites and present vegetation, selection of inventory and monitoring techniques, and sampling design concepts previously discussed.

Site classification and vegetation measurements are intended to be as use-independent as possible, with use-oriented features restricted to interpretation. As knowledge and technology change, and as the number of outputs or resource values increase, classification of sites and vegetation as well as data collection procedures may need to be refined and modified.

Proposed Standard Terminology for Inventory, Classification and Analysis of Range Ecosystems

Allowable Use—the degree of utilization considered desirable and attainable on various parts of a ranch or allotment considering the present nature and condition of the resource, management objectives, and level of management.

Apparent Trend—an interpretation of trend based on a single observation. Apparent trend is described in the same terms as measured trend except that when no trend is apparent it shall be described as *none.*

Available Forage—that portion of the forage production that is accessible for use by a specified kind or class of grazing animal.

Bare Ground—all land surface not covered by vegetation, rock or litter. (c.f. *ground cover)*

Basal Area—the cross sectional area of the stem or stems of a plant or of all plants in a stand. Herbaceous and small woody plants are measured at or near the ground level; larger woody plants are measured at breast or other designated height. (Syn. *basal cover*).

Bedrock—in-place, solid rock exposed at the surface of the earth or overlain by unconsolidated material.

Biomass—the total amount of living plants and animals above and below ground in an area at a given time.

Browse—(n) the part of shrubs, woody vines and trees available for animal consumption. (v) to search for or consume browse.

Canopy Cover—the percentage of ground covered by a vertical projection of the outermost perimeter of the natural spread of foliage of plants. Small openings within the canopy are included. It may exceed 100%. (Syn. *crown cover*).

Capability Area—Synonymous with ecological response unit.

Carrying Capacity—the maximum stocking rate possible without inducing damage to vegetation or related resources. It may vary from year to year on the same area because of fluctuating forage production. (Syn. *grazing capacity*).

Classification—the assignment of items or concepts into classes based on similarity of selected attributes.

Climax—the final or stable biotic community in a successional series; it is self-perpetuating and in equilibrium with the physical habitat (Odum, 1971); the assumed end point in secondary succession.

Community—an assemblage of populations of plants and/or animals in a common spatial arrangement.

Comparison Area—an area with a documented history and/or condition that is used as a standard for comparison.

Critical Area—an area which must be treated with special consideration because of inherent site factors, size, location, condition, values, or significant potential conflicts among uses.

Cryptogam—a plant in any of the groups Thallophytes, Bryophytes, and Pteridophytes—mosses, lichens and ferns.

Density—numbers of individuals or stems per unit area (Density does not equate to any kind of cover measurement).

Ecological Response Unit—synonymous to ecological site.

Ecological Site—a kind of land with a specific potential natural community and specific physical site characteristics, differing from other kinds of land in its ability to produce vegetation and to respond to management.

Ecological Status—the present state of vegetation and soil protection of an ecological site in relation to the potential natural community for the site. Vegetation status is the expression of the relative degree to which the kinds, proportions and amounts of plants in a community resemble that of the potential natural community. If classes are used, they should be described in ecological rather than ultilitarian terms. Soil status is a measure of present vegetation and litter cover relative to the amount of cover needed on the site to prevent accelerated erosion.

Ecosystem—a complete interacting system of organisms (i.e. community) considered together with its environment.

Foliar Cover—the percentage of ground covered by the vertical projection of the aerial portion of plants. Small openings in the canopy and intraspecific overlap are excluded. Foliar cover is always less than canopy cover; either may exceed 100%.

Forage—(n) browse and herbage which is available and may provide food for grazing animals or be harvested for feeding. (v) to search for or consume forage.

Forestland (Forest)—land on which the vegetation is dominated by trees. Lands shall be classified forestland if the trees now present will provide 25% or greater canopy cover at maturity. Lands not presently forestland that were originally or could become forested through natural succession may be classified as potential natural forestland. (Schwartz, Thor and Elsner. 1976.) c.f. *tree, potential natural community).*

Grassland—lands on which the vegetation is dominated by grasses, grasslike plants, and/or forbs (c.f. *dominant).* Non-forest land shall be classified as grassland if herbaceous vegetation provides at least 80% of the canopy cover excluding trees. Lands not presently grassland that were originally or could become grassland through natural succession may be classified as potential natural grassland.

Gravel, Cobble, Stones—as defined in Soil Taxonomy (Soil Conservation Service 1975): gravel (2 mm-3 inches), cobble (3-10 inches), stones (over 10 inches). (Note: For standard range inventory procedures it is recommended that gravel smaller than 5 mm in diameter be classed as bare ground in cover determinations.)

Grazing Management—the manipulation of grazing and browsing animals to accomplish a desired result.

Ground Cover—the percentage of material, other than bare ground, covering the land surface. It may include live and standing dead vegetation, litter, cobble, gravel, stones and bedrock. Ground cover plus bare ground would total 100 percent.

Habitat Type—the collective area which one plant association occupies or will come to occupy as succession advances. The habitat type is defined and described on the basis of the vegetation and its associated environment.

Herbage—the above-ground material of any herbaceous plant.

Key Area—a relatively small portion of a range selected because of its location, use or grazing value as a monitoring point for grazing use. It is assumed that key areas, if properly selected, will reflect the overall acceptability of current grazing management over the range.

Key Species—(1) forage species whose use serves as an indicator to the degree of use of associated species. (2) those species which must because of their importance, be considered in the management program.

Leaf Area Index—sum of total leaf area expressed as a percentage of ground surface. Leaf area index may exceed 100%.

Litter—the uppermost layer of organic debris on the soil surface; essentially the freshly fallen or slightly decomposed vegetal material.

Management Site Potential—the kinds or levels of productivity or values of a range site that can be achieved under various management prescriptions.

Pastureland—grazing lands, planted primarily to introduced or domesticated native forage species, that receive periodic renovation and/or cultural treatments such as tillage, fertilization, mowing, weed control, and irrigation. Not in rotation with crops.

Phytomass—total amount of plants (including dead attached parts) above and below ground in an area at a given time. (c.f. *biomass*).

Plant Association—a kind of climax plant community consisting of stands with essentially the same dominant species in corresponding layers.

Potential Natural Community—the biotic community that would become established if all successional sequences were completed without interferences by man under the present environmental conditions.

Productivity—the rate of production per unit area, usually expressed in terms of weight or energy.

Proper Use—a degree of utilization of current year's growth which, if continued, will achieve management objectives and maintain or improve the long-term productivity of the site. Proper use varies with time and systems of grazing. (Syn. *proper utilization*).

Range Condition—a generic term relating to present status of a unit of range in terms of specific values or potentials. Specific values or potentials must be stated. (See *ecological status* and *resource value rating*.)

Range Inventory—(v) the systematic acquisition and analysis of resource information needed for planning and for management of rangeland. (n) the information acquired through range inventory.

Range Site—synonymous with ecological site when applied to rangeland.

Range Type— refers to, and only to, the 18 standard range vegetation types recognized by the 1937 Task Force (Interagency Range Survey Committee, 1937).

Rangeland (Range)—land which supports vegetation useful for grazing on which routine management of that vegetation is through manipulation of grazing rather than cultural practices.

Resource Value Rating (RVR)—the value of vegetation present on an ecological site for a particular use or benefit. RVR's may be established for each plant community capable of being produced on an ecological site, including exotic or cultivated species.

Riparian Zone—the banks and adjacent areas of water bodies, water courses, seeps and springs whose waters provide soil moisture sufficiently in excess of that otherwise available locally so as to provide a more moist habitat than that of contiguous food plains and uplands. (Adapted from Warner, 1979).

Savanna—a grassland with scattered trees, whether as individuals or clumps, often a transitional type between true grassland and forest.

Seral Community—a successional community.

Shrub—a plant that has persistent, woody stems and relatively low growth habit, and that generally produces several basal shoots instead of a single bole. It differs from a tree by its low stature—less than 5 meters (16 feet) and nonarborescent form. (c.f. *tree*).

Shrubland—lands on which the vegetation is dominated by shrubs. Nonforested land shall be classified as shrubland if shrubs provide more than 20% of the canopy cover excluding trees. Lands no presently shrubland that were originally or could become shrubland through natural succession may be classified as potential natural shrubland.

Standing Crop—the total amount or number of living things or of one kind of living thing in an area at a given time.

Stocking Rate—the number of specified kinds and classes of animals grazing (or utilizing) a unit of land for a specific period of time. May be expressed as animals per acre, hectare, or section, or the reciprocal (area of land/animal). When dual use is practiced (e.g. cattle and sheep), stocking rate is often expressed as animal units/unit of land or the reciprocal.

Tree—a woody perennial, usually single-stemmed plant that has a definite crown shape and characteristically reaches a mature height of at least 5 meters (16 feet). Some plants, such as oaks (*Quercus* spp.) may grow as either trees or shrubs. (c.f. *shrub*).

Trend—the direction of change in ecological status or resource value rating observed over time. Trend in ecological status should be described as *toward*, or *away from* the potential natural community, or as *not apparent*. Trend in a resource value rating for a specific use should be described as *up, down* or *not apparent*. Trends in RVR's for several uses on the same site at a given time may be in different directions, and there is no necessary correlation between trends in RVR's and trend in ecological status.

Unsuitable Range—range which has no potential value for, or which should not be used for, a specific use because of permanent physical or biological restrictions. When unsuitable range is identified, the identification must specify what use or uses are unsuitable (e.g., "unsuitable cattle range").

Usable Forage—that portion of the forage that can be grazed without damage to the basic resources; may vary with season of use, species, and associated species.

Vegetation Type—a kind of existing plant community with distinguishable characteristics described in terms of the present vegetation that dominates the aspect or physiognomy of the area.

Vigor—relates to the relative robustness of a plant in comparison to other individuals of the same species. It is reflected primarily by the size of a plant and its parts in relation to its age and the environment in which it is growing.

Yield—(1) the quantity of a product in a given space and/or time (syn. *production*). (2) the harvested portion of a product.

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Appendix

Working Paper for the Range Inventory Standardization Committee Convened by the Research Affairs Committee, Society for Range Management

Background

On July 22, 1977, the Board of Directors, Society for Range Management, acting on a recommendation from the Advisory Council, resolved that SRM "take a position of leadership to draw agencies, universities and land management organizations together to promote uniform methodology and terminology for rangeland inventories and assessments." The Board went further in February 1978 with a resolution endorsing efforts to coordinate and improve range inventory systems in the U.S., supporting national research and development programs on identification, classification and inventory of natural ecosystems through coordinated efforts of applicable agencies and institutions, with the recommendation that emphasis of such efforts be addressed to local management needs.

Considerable information has been collected by a variety of inventory procedures, management studies, experience, and research, but application of that information to the solution of management problems has been hampered by:

(1) poor accessibility of information
(2) incomplete information
(3) lack of uniform terminology and classification systems, and compatible inventory procedures.

Acting on the July 22, 1977, resolution of the SRM Board of Directors, then-President Thad Box invited appropriate organizations to send representatives to an exploratory meeting and assigned SRM responsibility to the Research Affairs Committee. This meeting was held in Denver, Colorado, on May 31, 1978, and the Range Inventory Standardization Committee (RISC) was established.

This paper has been developed for guidance of the Committee, and to inform the SRM Board of Directors, SRM membership and others of the purpose of the Committee.

Purpose of the Committee

The purpose is to develop and recommend adoption of:

(1) standard terminology for inventory, classification;
(2) a uniform system for classification and mapping of range ecosystems;
(3) minimum standards and guidelines for data collections; and

(4) a common philosophical base for data interpretations. Accomplishment of the above will facilitate communications among range users and managers. It will also facilitate the collection and availability of valid and useful data (a) for local management needs (b) for regional and national assessments and programs and (3) for research.

Issues to be Addressed

Terminology

Standard definitions of words and phrases are basic for mutual understanding and communication. Problems with current terminology include (1) use of the same term to describe dissimilar items or concepts and (2) use of different terms to describe the same item or concept. RISC proposes to establish a common core of terms and definitions relating to inventory and classification, and to encourage its usage.

Inventory

The range resource inventory should be conducted to collect data necessary for local management purposes as well as for regional and national assessments and program planning. The inventory should include certain information on basic resources (e.g. soil, vegetation, animals, water) collected by all who conduct range inventories, and such additional information as needed.

Classification

A uniform ecologically-based classification system is needed. Such a system would provide a common base upon which to collect range inventory information, to accumulate and extrapolate management experience and research results, and for the assessment of the status and needs of ranges. Such a system would facilitate storage and retrieval of data and have a hierarchical capability for aggregation and disaggregation of all types of information about range ecosystems.

Mapping

The basic resource map should be based on integrated ecological units as defined by the classification system. Criteria for mapping at various scales and mapping intensities should be standardized. Uniform standards should be developed for map display of certain kinds of resource data and interpretations.

Data Collection

Data should be collected by compatible procedures in readily convertible units and in such a manner as to allow reproducibility in the characterization of the resource, within identified limits of error, and facilitate reproducible interpretations of range ecosystems.

Data Interpretation

Interpretation of basic data will be made for each ecological unit to determine (a) its potential, (b) its present condition, and (c) the current trend in the condition. Other interpretations can be made as necessary. These interpretations should be made with a common conceptual framework.

Data Management

Basic inventory data and interpretations of potential, condition, and trend of ecological units should be expressed in terms that are standard and uniform. This is desirable to permit consistent accumulation, storage and retrieval of data for local management needs and is imperative for aggregation of information on ecological units for use in resource planning and assessment at the regional and national levels. In planning for the use of computers to do the job of data management for range inventories, it is important that final interpretations of data be reviewed and approved by qualified and locally knowledgeable professional people.