RANGELAND MONITORING AND EVALUATION

INTRODUCTION

Rangeland monitoring and evaluation are essential to good rangeland management. Monitoring and evaluation can be described as the gathering of sufficient information so the manager knows what is happening to the rangeland resources and why it is happening. Goals and objectives in the Forest Plan and allotment management plan (AMP) portray a vision of desired condition of allotment resources. The intent of monitoring and evaluation is to test the success of the prescribed management strategy in accomplishing these goals and objectives.

To facilitate coordination with adjacent landowners and other agencies, the Pacific Southwest Region has adopted the procedures described in the Interagency Technical Reference Utilization Studies and Residual Measurements BLM/RS/ST-96/004+1730. This interagency guide was developed to provide a basis for consistent, uniform vegetation sampling that is economical, repeatable, statistically reliable, and technically adequate. The interagency technical team that developed the guide included representatives from the Forest Service, Bureau of Land Management, Natural Resource Conservation Service, and Cooperative Extension Service.

Rangeland monitoring attempts to analyze effects of management on the entire ecosystem involved. Ecosystem management dictates that monitoring methods be diverse. These methods are not necessarily all-inclusive. In many situations, range personnel will need assistance from additional resource specialists to suggest and implement monitoring methods not described in this guide.

Adequate monitoring programs have value to the Forest Service, to permittees, and to various individuals or groups interested in rangeland resources. Proper monitoring will accomplish the following:

- Determine permittee compliance with annual operating instructions.
- Verify results against prescribed management objectives. If progress towards objectives is not occurring, the manager can use the monitoring information to adjust the management strategy, or to determine if objectives are unrealistic.
- Firm up grazing capacity estimates.

- Provide necessary information to develop annual operating instructions.
- Identify the need to revise allotment management actions, such as grazing strategy and improvement needs.
- Provide estimates of trend with respect to desired condition or desired plant community.
- Determine impacts from livestock and other uses on rangeland resources.
- Provide a data base of information for reporting.

The intensity of monitoring and evaluation varies between allotments based upon rangeland conditions, management complexity, conflicting interests, and controversy. Periodic ocular estimates of rangeland conditions may suffice on some allotments, while numerous resource studies involving a variety of methodologies may be needed on other allotments. Tailoring monitoring efforts to each individual allotment is an important component of allotment management planning. In general, monitoring efforts will be greatest during the years immediately following implementation of a new allotment management plan. Usually this extends through the first full cycle of the management system, at which time the system should be operating smoothly and opportunities for improvement found and applied.

TYPES OF MONITORING

Monitoring is classified into three types: implementation, effectiveness, and validation.

IMPLEMENTATION MONITORING

Implementation monitoring determines whether standards and management practices are implemented as detailed in the AMP and Forest Plan. The question asked with this type of monitoring is: "Did we do what we said we were going to do?" Implementation monitoring includes allotment inspections and utilization estimates. Implementation monitoring is short-term monitoring.[1]

EFFECTIVENESS MONITORING

Effectiveness monitoring determines whether management practices are effective in moving the allotment towards desired condition as described in the Forest Plan and AMP objectives. The question asked is: "Did the management practices do what we wanted them to do; did they meet the objectives?" An example of effectiveness monitoring is trend studies that determine whether vegetation is moving towards the desired plant community. Effectiveness monitoring is long-term monitoring.[2]

[1] FSH 1909.12.6.11.

[2] FSH 1909.12.6.12.

VALIDATION MONITORING

Validation monitoring determines whether the information upon which standards, guidelines, and objectives are based is valid and correct. The question asked is "Is there a better way to meet Forest Plan and AMP goals and objectives?" An example of validation monitoring is the continual assessment of proper use guidelines to insure they reasonably describe the level of grazing use that encourages progress towards allotment objectives.[3]

THE ALLOTMENT MANAGEMENT PLAN

Monitoring and evaluation, like all aspects of allotment management, should be carefully analyzed and planned. All allotment management plans will have a monitoring section that describes the specific monitoring methods to be conducted on the allotment (See Planning Chapter). Monitoring allows the manager to determine if the AMP goals and objectives are being met. Following are general guidelines to consider in developing the monitoring and evaluation section of the AMP.

MONITORING GUIDELINES

1. Compliance inspections to determine accomplishment of the terms and conditions of grazing permits, AMPs, and annual operating instructions is a critical monitoring effort. Before rangeland management personnel can make any judgment on the cause of resource impacts or the trend in resource condition, there has to be the assurance that plans were followed as specified.

   Although the Forest Service has the responsibility for compliance monitoring, permittees need to take a primary role. Effective implementation of rangeland management programs demands that permittees take full responsibility for compliance with grazing permits and relevant management plans. Non-compliance with the terms and conditions of a grazing permit cannot be tolerated nor allowed to continue, and should be followed by permit action. Involvement by the permittee in compliance monitoring enables Forest Service rangeland managers to spend more of their limited time on planning and implementation of management strategies for allotments not meeting the Desired Condition established in Forest Plans.

2. Monitoring techniques that collect measurable resource attributes are more accurate and defensible. Subjective monitoring techniques should be kept to a minimum.

3. The monitoring and evaluation effort should be commensurate with the level of grazing use and the complexity of the overall allotment situation. Resource constraints, such as personnel and funding availability, should be factored into keeping monitoring simple and realistic.

4. Develop the monitoring plan as a schedule, with specific assignments, techniques to be utilized, precision and confidence limits, and time frames.

[3] FSH 1909.12.6.13.

5. **DOCUMENT! DOCUMENT! DOCUMENT!** Each monitoring section should identify how and where the monitoring information will be recorded and filed.

6. The monitoring section will be developed jointly with permittees and other interested persons or groups. Some monitoring efforts can, and should, be assigned to the permittee, or others. The Forest Service is responsible for ensuring that monitoring by others meets specified standards and is documented appropriately. Monitoring techniques that determine range readiness and utilization levels are easily learned and quickly accomplished through a partnership approach with permittees or others.

KEY AREAS AND KEY PLANT SPECIES

The use of key areas allows for sampling of relatively small areas of the allotment and extrapolation of the results to much larger areas. The key area concept is based on the premise that evaluations of correctly identified small areas are reliable indicators of grazing impacts on a larger portion of the unit or allotment. Depending on management objectives, key areas may be representative samples of a large stratum such as a pasture or allotment, or they may be representative of a much smaller area with important value such as a riparian zone, critical nesting habitat for grouse, or a special plant community.

Key areas are selected because they provide valuable resource information. Range personnel should be aware of disturbances or changes in livestock use patterns that may cause the areas to no longer be representative. Key areas may need to be changed or new ones selected when the pattern of use is significantly modified because of differences in season of use, kinds and classes of livestock, pasture size, and water supplies. Keep information from abandoned key areas to provide a historical background for future analysis.

In many cases the key areas identified for resource inventory can also be used for monitoring. Delineate key areas accurately on aerial photos and the allotment map. The existing vegetation of key areas should be described using the Series or Association descriptions included in the California Native Plant Society's (CNPS) publication, *A Manual of California Vegetation* (1995). The potential natural community (PNC) will be determined for those key areas located in areas that have a completed formal ecological type classification.

In association with selecting key areas, key plant species should be identified within the key area.

Key species are generally an important component of a plant community. Key species serve as indicators of change and may or may not be forage plants.

KEY AREAS

Key areas are:

> "...a portion of the range, which, because of its location, grazing or browsing value, and/or use, serves as an indicative sample of range conditions, trend, or degree of use seasonally. A key area guides the general management of the entire area of which it is part." (SRM 1974).

Key areas are located in suitable range and are permanently marked. Measurements and observations will be made on these areas to direct management and guide the manager in determining if standards and guides are being met and/or desired contions. They must be representative of the primary range and sensitive to changes in livestock management. As a minimum, there should be one per grazing unit.

Key areas are usually five acres or more. They are sites where use must be closely monitored because of management plan requirements, such as riparian areas or areas where threatened, endangered, or sensitive species may occur. These locations will vary by grazing strategy. There will be at least one, but probably several key areas per allotment. ***Locations of key areas should be identified and delineated on the allotment map.***

Key areas can be reference points that are sensitive to management changes. These are the small areas where *long-term* trend studies are installed and maintained so that the manager can assess the resource impacts from management.

Selection of key areas for long-term trend studies is an important task, and should be carefully evaluated. Key areas should be selected by experienced personnel familiar with the allotment, including permittees, other interested agencies and individuals. Interdisciplinary team personnel should also be involved with selection of key areas, and the types of studies to be conducted in their related field of expertise. Key areas should be representative of the area in which they are located. They should be located away from fence lines, roads, salt grounds, water developments, recreation facilities, and other features that may concentrate use or otherwise cause disturbance.

The ecological characteristics of the key area site should be well understood, including existing vegetation, ecological type, and wildlife species using the area. Evaluation and adjustments in the management system should only be made by persons with a working knowledge of the entire ecosystem.

KEY PLANT SPECIES

Selection of key plant species should be tied directly to management objectives in land use, coordinated resource management and activity plans. An ID Team should be used in selecting key species to ensure that data needs of the various resources are met. For further discussion on selecting

key plant species, see page 4, Interagency technical reference, *Utilization Studies and Residual Measurements, 1996.*

STATISTICAL CONSIDERATIONS FOR MONITORING

Rangeland management is both an art and a science. In other words, good management can only occur through professional judgment based upon accurate data. Information based upon judgment should not be confused with information collected through scientific study. It should also be clear that good decisions are based upon a combination of both judgment and science, never one exclusive of the other. Managers must make every effort possible to insure *all* information used to make decisions is correct.

Many monitoring methods (specifically rangeland use and trend determinations) are for plot level sampling of vegetative characteristics. The rangeland manager and decision-maker must be reasonably sure that the data collected through sampling accurately represents the overall population.[4]

SHORT-TERM MONITORING

Short-term (implementation) monitoring methods described in this guide include: range readiness, allotment inspections, forage production, vegetative residue methods, utilization methods & streambank alteration.

RANGE READINESS

Early spring use by livestock on most National Forest range allotments with traditional, continuous, deferred, or rest rotation grazing systems can be detrimental to vegetation reproduction and establishment of new plants. Indicators used to determine range readiness are soil and vegetation conditions. Rangeland is generally ready for grazing when soil has become firm after winter and early spring precipitation, and when plants have reached the defined stage of growth at which grazing may begin under a specific management plan without long-lasting damage.

The concept of range readiness has changed somewhat in current years. Riparian management techniques, and livestock grazing to improve forage quality for wintering wildlife has demonstrated that livestock use prior to traditional range readiness can actually benefit rangeland conditions. The key to the success of these new management systems is the ability to graze the important forage species early and then allow sufficient regrowth before further use. Range readiness dates will vary between allotments with differing resource attributes and management systems. Before establishing turn-on dates that are earlier than traditional range readiness, the rangeland manager must be reasonably certain that the proposed management strategy will work. Early turn-on dates must be based upon documented successes in other areas with similar vegetation types and similar objectives.

Establishment of a range readiness should be developed during the allotment management planning process. Select representative areas of the primary range for range readiness observation. Properly selected, a location may furnish data for several allotments that are uniform in elevation,

[4] Appendix C contains information managers can use to support decisions with statistical analysis.

exposure, soil, vegetation, climate, and prescribed management system. Successive annual observations will indicate validity of opening dates. Record range readiness observations in field inspection notes. See References section for more details on range readiness.

ALLOTMENT INSPECTIONS

Allotment inspection is an on-the-ground visit of the grazing allotment. A number of items will be monitored during each allotment inspection; however, compliance with the terms and conditions of the grazing permit(s) is the primary objective. Allotment inspections must be documented in writing. Allotment Inspection Forms of local design should be used for recording pertinent information collected during the inspection. Annual allotment inspections, including suggestions, should be consolidated and submitted to the permittee for review at the end of the season. Use of photographs or video recordings can be used to greatly enhance the documentation.

Observations over time are critical to writing satisfactory allotment management plans, taking permit action, evaluating our progress toward desired conditions and myriad of other allotment tasks. The secret to good documentation is to have the training to understand what you observe and to record those observations immediately. Using the right equipment is essential and greatly improves efficiency. Consider using a small microcassette recorder such as a Sony M-527V, costs about $40, fits easily in a shirt pocket, and works great. Observations can be recorded as they are made. A small pocket 35 mm camera is indispensible as well. The Olympus Stylus or Kodak Advantix cost about $150 dollars and weigh only a few ounces. The notes and photos must both be tied to points on a topographic map or ortho photo. In using this system, it is not uncommon to have four or five pages of notes that are supported with photos. A Lanier VoiceWriter 205 is a combination dictate/transcribe unit that makes transferring the notes from the microcassette a snap. We are not far away from being able to cheaply transfer the recording directly to computer text files. The notes, map, and photos become the documentation for your range inspection.

The objectives or items that you want to monitor should be decided prior to visiting the allotment. There are many items to consider during an inspection.

LIVESTOCK MANAGEMENT

- Determine livestock ownership through brands and eartags.
- Conduct livestock counts, to insure stocking does not exceed permitted numbers or is not less then 90 percent of permitted numbers.
- Validate management system compliance, including if livestock are in the correct pastures for the correct season.

- Verify that maintenance of range improvements is satisfactory; also note need for reconstruction of improvements and ideas for potential improvements such as water sources and fences.
- Inspect salting locations; identify recommended salting areas that will encourage better livestock distribution.
- Determine if sheep bedgrounds are properly located and used.
- Determine livestock distribution by describing locations and general use levels.
- Evaluate herder or rider performance.
- Document contacts with the permittee(s).

RANGE VEGETATION

- Estimate forage utilization and/or forage residue. Sketchings on a map of use intensity or forage residue levels are generally preferable to notes for recording this information.
- Estimate vigor of individual plant species. Seed production, seedling establishment, dead plant centers, and other general vegetation health characteristics are important items to observe when estimating vigor.
- Note phenology of important forage species such as specific flowering and seed maturity dates.
- Record noxious weed, rodent, insect, and poisonous plant infestations and delineate their locations on a map for future planning and control efforts.

OTHER RESOURCE CONSIDERATIONS

- Observe wildlife numbers and use patterns. Special attention should be placed on identifying threatened, endangered, or sensitive species that may exist in the area.
- Note soil conditions by assessing relative amount of displacement, compaction, rilling, gullying, surface soil losses and deposits, accumulation of litter, and other indicators.
- Inspect special concern areas to ensure that livestock are not in closed areas, such as campgrounds or Research Natural Areas.
- Note impacts to rangeland resources from other users, such as recreationists or off-road vehicles.
- Document riparian values and water quality including bank stability, apparent stream siltation, kinds and vigor of shrubs, and livestock/wildlife use patterns in riparian areas.

This list is not all-inclusive since there are numerous things encountered during an allotment inspection. An allotment inspection may be the only time a Forest Service employee visits the area during the year, so it is important to observe and document all activities and occurrences on the allotment.

The examiner should be familiar with the grazing permit, the AMP, and the annual operating instructions prior to making the examination. Knowledge of travel management regulations, wildlife management objectives, and recreation values is also desirable when performing an inspection. Take a map along to record locations of observations. Concise documentation is best, portraying facts, figures, measurements, people, and dates. Include as many specifics as possible and avoid generalities. Proper documentation is necessary to evaluate the effectiveness of the AMP, and may even be used in a court of law.

Include the permittees in allotment inspections when possible. Apart from insuring you are both looking at the same thing(s), these are good opportunities to exchange viewpoints, share information, and get to know each other. Open and honest communication during an allotment inspection can go a long way towards solving problems and designing management strategies that will help to move the range resource towards its desired condition.

FORAGE PRODUCTION

Forage production is the current growth of browse and herbaceous plants that is both palatable and available to grazing animals. Forage may vary with season of use and kind of livestock. Forage production estimates are primarily an inventory procedure (see page 3-23). Forage production measurements can also be an important part of monitoring if the observer considers the limitations of this approach.

Forage production fluctuates greatly with changes in climatic conditions. Reliable information can only be obtained from many years of production monitoring spanning climatic cycles. Estimating forage production alone is a poor method of determining stocking rates on allotments with a history of livestock use. On existing allotments, stocking rates should be determined by a combination of forage production, livestock use patterns, and trend determinations.

There is value, however, in using forage production estimates as a factor in establishing initial grazing capacity on areas without a history of grazing use. As we continue to analyze rangelands from an ecosystem (landscape scale) perspective, vegetative production will also be useful in defining resource value ratings (production potentials) for the various plant communities that may occur within an ecological type.

Production should be measured according to the procedures outlined in the Inventory Chapter (see page 3-23 and techniques described in the Interagency technical reference, *Sampling Vegetation Attributes, 1996.*

RANGELAND USE

Determining the use of forage by all herbivores is an important aspect of rangeland management. Managers must know when use occurs, to what extent, and by which animals. Use data helps the manager assess the desirable level of livestock use that moves resource conditions toward the objectives described in the allotment management plan. Level of use, timing of use, and grazing system in place determines how individual plant species are affected by livestock grazing. Livestock use is one factor influencing trend that can be readily adjusted. Use is also one of many considerations when determining grazing capacity. Rangeland use data is intended to provide information that can be used to: determine timing of pasture moves, identify distribution problems, and develop future management actions such as grazing strategies and potential improvements.

Rangeland use can be measured and expressed in two ways: the amount of forage left after grazing (residue), or the amount of forage removed by grazing (utilization). In the past, the Forest Service has primarily used utilization methods in determining rangeland use. Residue methods, by contrast, are relatively new procedures for many National Forest System lands. Residue methods and utilization methods of monitoring are discussed in the Introduction of the Interagency technical reference, *Utilization Studies and Residual Measurements, 1996.*

VEGETATIVE RESIDUE

There is increasing interest from the livestock industry and various resource specialists for describing proper use in terms of residue, that is, the amount of forage left after grazing.

Rangeland resource values vary considerably between geographic locations. Allotment objectives are developed to enhance and protect different resource values on each allotment. Because of specific resource values, rangeland use might be more appropriately expressed by the amount of "standing crop" left after grazing, instead of the percentage of forage removed by grazing. For example, the amount of vegetation left ungrazed is the critical factor in successful bird nesting or wildlife winter range for some rangelands. Another example occurs where a certain amount of herbage must be left to protect fragile soil from excessive erosion.

Residue guidelines should, at minimum, protect the basic health and productivity of range and watershed resources. Increased residue may also address the needs of wildlife, fisheries, and aesthetics. While traditional utilization measurements are aimed entirely at key species, residue methods may measure key species or the total standing crop, regardless of species.

Residue methods are simple, quick, and accurate. These methods can be used to monitor large areas in less time than with traditional utilization methods. Statistical reliability improves because numerous measurements can be taken in a relatively short time. Limitations of these methods may stem from infrequent application in a variety of rangeland ecosystems. While residue methods have been very successful on the Great Plains, and California annual grassland range types, there needs to be more research

on the use of residue methods in other plant communities and ecosystems in the National Forest System.

Testing these methods is strongly encouraged due to the potential advantages. These methods are easily learned and can be applied by permittees and other interested groups and individuals. See pages 51-69 and pages 119-125 of the Interagency technical reference, *Utilization Studies and Residual Measurements, 1996.*

But you need to be cautious in setting a specific residue as a standard. The standard must meet the physiological needs of your key plants and almost all of the research that addresses grazing and plant physiology is based upon utilization by weight. You need to set a maximum utilization level first and then transform that to a residue or stubble height. If the purpose of the standard is for other reasons such as wildlife cover or sediment retention, you will retain, as a minimum, the amount that meets the needs of the plants.

VEGETATIVE UTILIZATION

Utilization is expressed as a percentage of available forage weight[5] that has been consumed or trampled. Utilization estimates are in terms of the current year's biomass removed. Utilization measurements should be confined to forage species, not total herbaceous vegetation. Generally, only plants of selected key species are monitored. This does not preclude sampling other species if additional data is needed.

Utilization studies are conducted as often as necessary to satisfy data requirements for the allotment. Conduct utilization monitoring at various intervals throughout the grazing season as needed to adjust pasture rotations. Utilization is monitored annually until AMP objectives are achieved. Utilization monitoring requirements are unique to each allotment and should be focused on accomplishing allotment objectives.

Measure utilization soon after livestock are removed from the allotment or unit (not more than a week) to eliminate bias due to regrowth. This is especially important on bluegrass bottoms, riparian areas, and mountain meadows where regrowth occurs fairly rapidly. If utilization is used as a guide for moving livestock from one unit to another, utilization estimates should be made far enough in advance to insure movement at or prior to the desired use level. Timing of measurements is critical in furnishing the data needed to adjust permitted use or to obtain improved distribution of livestock within the current season.

It is essential that when establishing Desired Utilization Guidelines for key species and key areas, that time of use be considered. 50% of use of the forage available in sedge meadow during the early part of a growing season would result in a relative use level considerably less than 50% of

[5] Weight is not evenly distributed in most plant species. A higher percentage of the weight is in the basal portion of the plant where growth is thicker and more dense. A lower percentage of the weight is in the upper portion of the plant where growth is tapered and less dense. Weight distribution in relation to height is reasonably constant among plants of the same species.

the annual peak production when regrowth is considered. Likewise, the timing of use needs to consider plant phenology, as 30% use on a species such as bluebunch wheatgrass during the critical spring growing season may have more of an impact on future production than 50-70% use at the end of the growing season.

Plant regrowth occurs following an interruption of growth by grazing, fire, or other disturbance. Regrowth also occurs in response to favorable weather events following the normal growing season. When animals use the same area more than once a year and plant regrowth occurs, utilization is still based on the amount of available growth at the time the data are collected. Percent utilization after each use represents only the *amount of available growth* utilized up to the time the studies are conducted. Utilization percentages or stubble heights for various use periods during the grazing season cannot be summed to get total utilization for the year. For example, 30 percent utilization of 6 inches of plant growth available in the spring and 30 percent utilization of 12 inches of plant growth in the fall, do not add to 60 percent utilization for the year.

Monitoring browse utilization is an important aspect of rangeland management. It is important to know how much use occurs and which animals are using the browse.

UTILIZATION MONITORING METHODS

Utilization monitoring methods approved for use in the Pacific Southwest Region are included in the Interagency Technical Reference BLM/RS/ST-96/004+1730, *Utilization Studies and Residual Measurements, 1996.* In addition, the Visual Determination of residual dry matter (RDM) as described in the University of California Cooperative Extension leaflet 21327, is approved for monitoring use on annual grassland vegetation types. No single method is preferable in all situations. Each has advantages and disadvantages that must be considered with respect to the area and purpose for which the study will be conducted.

LONG-TERM TREND MONITORING

Probably the most important role of monitoring is to determine whether management is successful in achieving, or moving rangeland resources towards, the allotment objectives (effectiveness monitoring). Determining trend toward or away from allotment objectives allows rangeland managers to accurately determine the relative success of the management system and to adjust management to speed the accomplishment of objectives. Trend for a variety of rangeland resource parameters may need to be monitored.

This guide describes accepted methods used to determine trend in vegetative and soil characteristics. Vegetative trend is based on such characteristics as species composition, density, cover, vigor, production, and frequency. Soil condition trend considers ground cover and erosion status. Trend data is considered along with actual use, authorized use, utilization,

climatic cycles, and other resource activities and impacts, in designing and adjusting the management strategy. Permittees and other interested parties should be encouraged to become active partners in monitoring trend.

Early detection of trend involves some risks because vegetative characteristics naturally fluctuate widely within and between years due to climatic variability and other influences. These normal fluctuations must be considered when determining trend.

Apparent Versus Measured Trend

Apparent trend is the interpretation of direction of change based on professional judgment during a single observation. Apparent trend results are highly subjective and depend to a great extent on observer experience. Apparent trend is useful in early detection of problems, and is a precursor to measured trend studies.

Measured trend is a quantitative assessment of change based on repeated measurements over time of the characteristics and amount of plant species, and soil surface properties. It provides quantitative data for interpreting change direction, often before it is detectable by repeated ocular examinations or repeated photos over time. Measured trend provides feedback to indicate whether management objectives are being attained. If progress is unsatisfactory, modification in management practices is required, if the objectives are determined to be realistic.

Frequency of Studies

Trend studies are conducted as frequently as necessary to satisfy data requirements for the allotment or designated management area. They are generally conducted at intervals, in sequence with grazing treatments. For example, trend studies could be conducted once every three years on a three-pasture grazing system and once every five years on a five-pasture rotation system. Where studies are conducted only once during the grazing cycle, they should be conducted at the same relative point in each cycle so the data is comparable. Because limited resources often dictate trend monitoring be done infrequently, a monitoring strategy designed to aid in accurate identification of trends and their causes is important. Means to overcome infrequent measurement are described below.

1. Select a few sites for frequent measurement. Sites should be where collateral information relative to management objectives can be obtained. Continuous trend of soil and vegetation characteristics with respect to weather, utilization, actual use, and other variables on a few sites will support a more accurate interpretation of data gathered elsewhere on an infrequent basis.
2. If vegetation cover is declining at numerous sites, regardless of the management system, it may be presumed that weather or factors other than management are responsible. However, if cover of forage species declines on an ecological type in one management unit, but increases or is static on the same ecological type in an adjacent unit, a management change is warranted.

TIMING OF STUDIES

Trend studies should be started before initiating management under a new or revised allotment management plan to ensure the resource situation is documented prior to management changes. Trend data is normally collected after the growing season, when the majority of plants have reached their maximum growth. However, certain plant communities and environmental influences may require that photos be taken and measurements recorded at different times during the growing season. In order to obtain the best data, trend studies should be conducted on ungrazed pastures. It is important that once the time for trend studies is established, follow-up studies in succeeding years must be conducted at the same time (phenologically) during the growing season.

INTERPRETING TREND DATA

Changes in soil cover characteristics or in kind, proportion, or amount of plant species on a site are interpreted as trend in status (see page 3-12). To determine if a management change is needed to reverse undesirable, or to accelerate desirable trends, the causes of trends need to be established. Annual precipitation and growing conditions should be compared to the averages for the area. The following are guidelines for collection and interpretation of trend data.

INTERPRETING TREND AT ONE LOCATION

Differences in measurements obtained 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 determined and specified. The sample area should not involve more than one ecological type and sampling design should account for heterogeneity in plant pattern, topography, and micro climate.

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 for trend monitoring purposes. Each monitoring location should be carefully selected with specified objectives developed. 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. Overall trend on a management unit cannot be determined by averaging trend data from various locations except perhaps where the various locations are ecologically similar.

COLLATERAL DATA

Collection of collateral data to aid interpretation of soil or vegetation change is essential.

- Weather data should be collected on or near each monitoring location. National Weather Service or Forest Service storage gauges read monthly or seasonally can be used for precipitation.

Max-min thermometers at selected locations may help explain extreme events. The years that trend measurements are made should be compared with averages for the area.

- Records of actual livestock and wildlife use should be maintained.
- Utilization should be measured on each monitoring location whenever and wherever trend data is collected and at other times when appropriate and feasible. Any residue or utilization method described in the Interagency technical reference, *Utilization Studies and Residual Measurements, 1996* can be used.
- Document observations on populations or occurrence of rabbits, rodents, insects, fire, or other disturbances.

TREND STUDY REQUIREMENTS

A trend study must be properly planned, implemented, analyzed, and documented. Components of a trend study are described below.

PROPER PLANNING

The allotment management plan should have a monitoring section describing how allotment objectives will be monitored. The monitoring section will describe which trend method is most appropriate for the particular allotment, who will perform the trend monitoring, and when monitoring will be accomplished.

PROPERLY COLLECTED FIELD DATA

Field data should be collected utilizing accepted methods. Instructions should be taken to the field to insure consistency with regional standards and between different observers. Key areas should be established and identified on aerial photos and allotment maps. All data forms should be completed and summarized in the field. Photos should be taken and labeled for easy reference. Plants should be collected, identified, and mounted for future reference.

PLANT COLLECTION

Collect voucher speciments of plants found within the trend study.

PROPER DOCUMENTATION

Trend monitoring is not complete until the data is properly analyzed and conclusions made. Perhaps the most important aspect of trend monitoring is to summarize the data in a clear and useful package so that resource managers can make reasonable management decisions based upon the information. All trend data, summary sheets, pinpricked aerial photos, descriptions of study areas, mounted photographs, and narrative informa-

tion should be compiled, summarized, and placed in the files. The folder should be marked "Permanent Record, Do Not Destroy." Two complete sets of the study should be made: one set for the District files, and the second set for the Supervisor's Office.

SELECTING A METHOD

No single method of vegetation sampling for trend determination is suitable for all vegetative types and management situations. Selecting a sound sampling method and location is critical to the success of a study. Trend methods must be sensitive to changes in the plant community, and should be unbiased, efficient, and cost-effective. Carefully consider the advantages and limitations of each method with respect to the type of vegetation on which the studies are to be conducted, and the type of study needed to determine whether objectives are being met. Measurement of more than one vegetation or soil characteristic will provide a more complete picture of trend. A combination of methods should be used to yield more informative and reliable data when appropriate.

PERMANENT VERSUS TEMPORARY SAMPLES

One of the most important decisions regarding trend studies is the permanence of the sample. Permanent samples should be located on key areas representing the entire site. Temporary samples should be installed within well-defined key areas shown on the allotment map. Following are guidelines to consider when locating trend transects.

- A mix of both permanent and temporary samples is recommended for allotments where trend information is needed. Long-term trend studies using permanent transects provide the most reliable data.
- Temporary samples are quickly installed and read. They are a good tool for determining apparent trend. Several temporary samples can often be measured in the same amount of time required to locate and read one permanent transect. Temporary samples are located randomly within a key area and should be established using the same methodology as permanent samples, except that no stakes or permanent markers are used. Temporary samples are not paced transects, since a tape is *always* used and data is read along the tape. Using the tape greatly eliminates bias inherent with paced transects.
- Permanent samples should be established with permanently marked beginning and ending points. The samples should be marked so they are easily relocated. Inventory crews should use Global Positioning System (GPS) technology to locate and relocate permanent samples. Rangeland managers must make every effort to get training and use GPS technology where possible. Photos attached to the permanent samples should clearly indicate significant changes in vegetation.

TREND DETERMINATION METHODS

There are several methods for determining trend of vegetative and soil characteristics. Approved methods include: cover-frequency, transect, line intercept, shrub density, and rooted nested frequency.