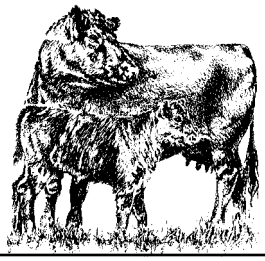

Western Beef Resource Committee *Fourth Edition*

Cattle Producer's Handbook

Range and Pasture Section 518

Monitoring Grazing Lands

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An important step in developing a ranch or allotment management plan for grazing lands is establishing a rangeland monitoring program to evaluate progress toward achieving management objectives (Bedell 1998). A monitoring program can:

- Help determine the benefits gained from changes in grazing management or investments in range improvements;
- Facilitate a better understanding of rangeland plants and how they interact with each other, the environment, and grazing animals;
- Build confidence in the management strategy;
- Detect negative trends early to prevent more extensive problems with weed infestations, loss of productivity, and vegetation composition shifts toward less desirable forage species; and
- Provide lessons of success and failure (as the case may be) that can be shared with others as learning opportunities. Perhaps most importantly, monitoring allows managers to practice adaptive management, which is the process of adjusting management plans in response to monitoring results.

A monitoring program is a multi-step process that includes more than just the collection of data and information on grazing lands. It also involves analysis and interpretation of monitoring results in relation to management objectives and adjustments to support short-term and long-term management decision-making. Analysis and interpretation of monitoring information are difficult and less meaningful without clearly defined management objectives by which progress can be measured. Management objectives can take many forms but should describe the desired conditions of one's resources including vegetation, soil, and water on grazing lands. If current conditions characterize what is wanted or needed, then management objectives should focus on maintaining those conditions.

Two approaches to monitoring grazing lands are needed to evaluate the effectiveness of a management strategy.

1. One needs to be able to compare resource conditions to those identified in the management objectives over time to determine if the management strategy is making progress toward achieving desired conditions on the grazing land. This type of monitoring is typically repeated every 5 to 10 years (after establishing baseline conditions over 2 or 3 years) and is often referred to as long-term or trend monitoring. In more fragile environments, trend data may be collected on a more frequent basis (i.e., every 3 to 5 years) (Bedell 1998).
2. There is a need to categorize yearly or short term the effects of inputs such as forage utilization that can influence long-term trend. Inputs can be viewed as factors that affect grazing land resources over time. For example, if one is maintaining an irrigated perennial grass pasture, management inputs may include the amount, timing, and frequency of irrigation or fertilizer applications.

The pasture will respond to adjustments in fertilizer and irrigation inputs with varying forage production levels. The magnitude and direction of change in forage production can be explained by considering adjustments in those management inputs along with factors external to management (e.g., weather inputs) that also affect a pasture's growing conditions. Because inputs on grazing lands frequently change from one year to the next, they must be monitored annually and are often referred to as short-term monitoring information. Considered together, short-term and long-term monitoring information offer the best opportunity for grazing land managers to evaluate one's progress toward meeting management objectives.

Rangeland monitoring is generally associated with public land grazing allotments but is just as important

on private rangeland. The fundamental goal of both public and private land managers is to promote the sustained yield of rangeland resources such as forage, wildlife and wildlife habitat, recreational opportunities, and clean water. A monitoring program is as integral to a ranch/allotment plan as defining the grazing system or stocking rate because effective management decisions cannot be made without knowledge of effects of past management actions.

Establishing a Monitoring Program

One of the first steps that should be taken when establishing a monitoring program is to identify who should be involved in the process. Stakeholders in the monitoring program can vary widely depending on the nature of the operation. At a minimum, monitoring of public grazing lands should be a cooperative effort between the permittee(s) and the agency resource specialist(s) responsible for managing the land. Depending on management objectives and the resource value(s) associated with public lands, there may be other individuals or groups interested in the monitoring program, and it may be appropriate to encourage participation from those additional stakeholders. Conversely, on deeded property, the landowners and family members may be the only ones involved in the program.

Inventory

Developing a useful management objective first requires a good understanding of the present situation. Therefore, a logical starting point is to inventory the grazing land and define current resource conditions and production levels (Fig. 1). Historical records, maps, field notes, experience and ecological site data can be valuable for defining the current situation and for estimating grazing land potential. An ecological site is a distinctive kind of land with specific characteristics that differs from other kinds of land in its ability to produce a distinctive kind and amount of vegetation (Bedell 1998). Information that may be important includes:

- Previous/existing management plans for your ranch/allotment.
- Existing monitoring data/historical photos.
- Records of stocking rates and seasons.
- Kinds and classes of livestock.
- Past grazing systems (i.e., timing, frequency, and intensity of livestock grazing).
- Problems encountered on the rangeland (e.g., trespass livestock, recreational use, poisonous plants, invasive plants or weeds, and unreliable livestock water).
- Range improvements (types and locations) and resources responses.
- Wildlife and feral animal numbers/use.
- Historical climate data.
- Soil surveys (http://websoilsurvey.nrcs.usda.gov/app/) and ecological site descriptions (http://esis.sc.egov.usda.gov/).

Management Objectives

Using information gathered during the inventory, the next step is to identify areas needing improvement and areas where current conditions should be maintained. Cattle producers should set realistic management objectives that take into account the potential of the grazing land and compatibility with the long-term goals of the ranching operation. Management objectives should describe the desired conditions of the grazing land and are typically tied to the primary natural resources of vegetation, soil, or water. They should define reasonable and achievable expectations.

Generally, a well-written management objective will answer the following: **Who**, **What** (and how much), **When**, **Where**, and **Why**? For example, the manager of a ranch may wish to increase the cover of desirable perennial bunchgrasses by 10 percent in the North Pasture over the next 10 years to reduce the risk of accelerated erosion, increase forage quantity and quality for livestock, and decrease the risk of weed invasion. This example clearly identifies **who** is responsible for ensuring the objective is achieved (i.e., the ranch manager), **what** needs to change and by how much (i.e., cover of desirable perennial bunchgrasses will be increased by 10%), **when** the desired change is to occur (i.e., over the next 10 years), **where** the desired change needs to occur (i.e., in the North Pasture), and **why** the change is desired (i.e., to reduce risk of accelerated erosion, increase forage quantity and quality for livestock, and decrease the risk of weed invasion).

The development of objectives generally occurs through consideration of long-term goals for the land unit and/or the ranching operation. On private land, this again may only involve the landowner but can be supported by requested assistance from natural resource specialists with the Cooperative Extension Service, Natural Resources Conservation Service, and/or private range consulting services. On public grazing lands, management objectives will be influenced by public needs, ranch operational needs, and resource needs identified by multiple use planning efforts of the involved agencies.

Selecting the Resource Attribute(s), Location, and Timetable for Long-Term Monitoring

Once the management objectives have been clearly defined, the next step in the process is to identify (1) what needs to be monitored; (2) when the information should be collected; and (3) where monitoring efforts should be focused. All of these decisions are largely determined by a well-written management objective.

If the management objective is to increase perennial bunchgrass cover by 10 percent over the next 10 years

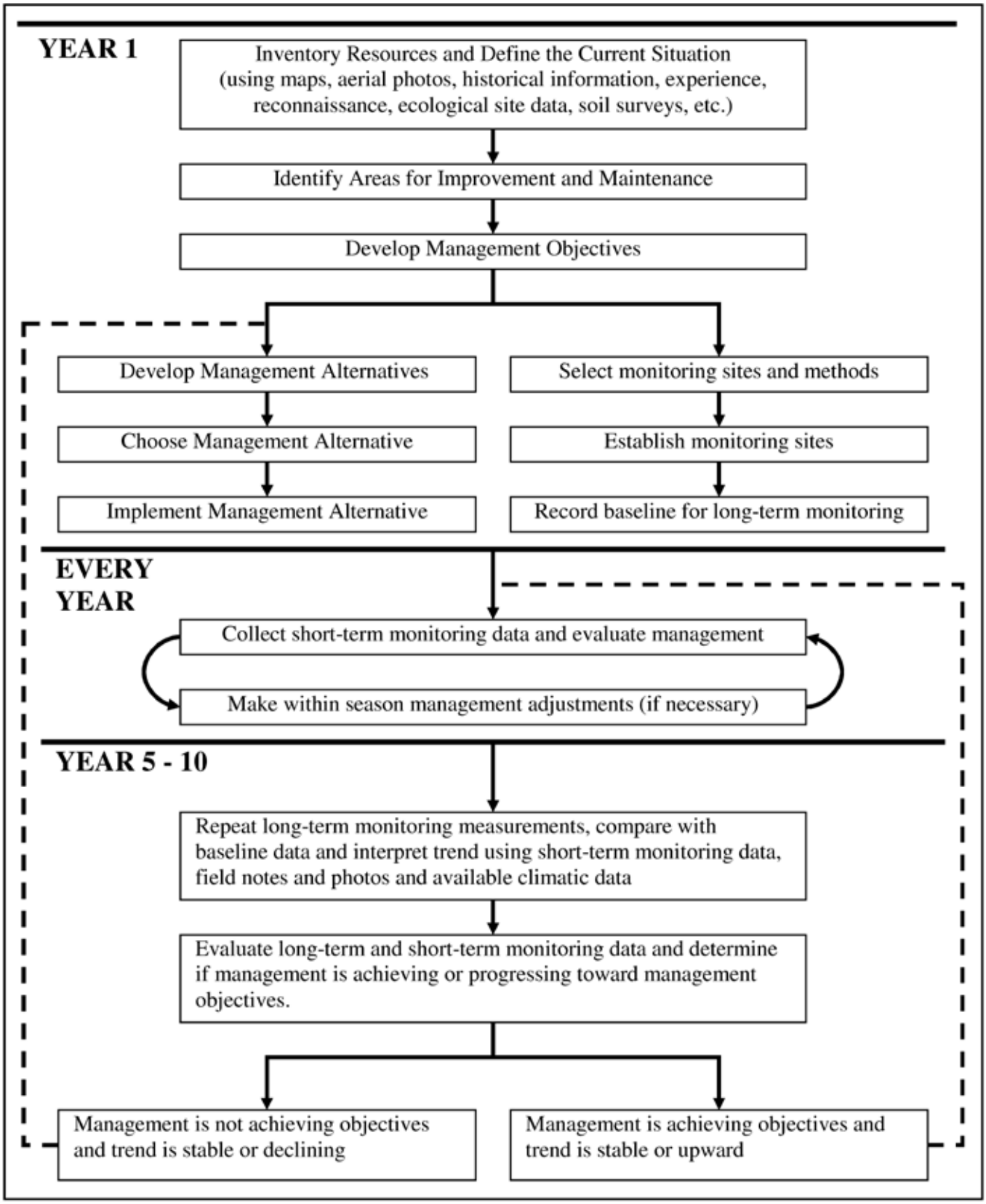

Fig. 1. Management and monitoring program design, implementation, and integration (Adapted from Herrick et al. 2005).

in the North Pasture, the monitoring program must then include periodic measurement of perennial bunchgrass cover (i.e., the resource attribute) in the North Pasture over the next 10 years. Although the exact location of the monitoring area is not explicitly defined in the provided management objective, the approach for selecting the monitoring area is.

Making reference to the North Pasture as a whole suggests the objective applies to the entire management unit and, therefore, the manager would likely attempt to select a monitoring location that would reflect what is occurring in the whole pasture. These locations are referred to as key areas, and the approach involves selecting locations that are representative of the management unit, meaningful to management decisions, and broadly applicable to management's influence on the larger area. Procedures for selecting key areas are discussed in BLM (1999a).

A different approach identifies critical areas, which generally receive special focus because of inherent site factors, size, location, conditions, values, or significant potential conflicts among uses (Bedell 1998). Critical areas represent smaller parts of a management unit that receive particular attention, such as important wildlife habitat, areas having threatened or endangered species, highly erodible areas, or riparian areas.

If management objectives are specific to maintaining and improving a small piece of land such as a riparian area, then it may be appropriate to select a critical area as a monitoring location. Once a monitoring site is selected, it should be permanently marked with t-posts or re-bar and documented on aerial photos or maps. The location's coordinates should also be collected by a Global Positioning System (GPS) to help relocate the site.

Short-term and Long-term Monitoring Information

Monitoring provides information to support both short-term and long-term management decisions; therefore, monitoring programs should include both short-term and long-term methods. Long-term monitoring focuses on documenting the direction of change (i.e., trend) in the resource or attribute that one wants to maintain, increase, or decrease. Trend is the direction of change in the resource and is usually described in terms of being upward (i.e., toward management objectives), downward (i.e., away from management objectives), or stable. Trend can be thought of as the overall response of the grazing land to management and the environment.

Interpretation of trend is one of the most important elements of a monitoring program. It is the point where a decision is made about the direction of change in grazing land resources. Once the direction of trend is identified, the challenge is determining whether the changes were due to management, factors external to management (e.g., the weather), or due to combinations of management and external factors.

Grazing lands are dynamic systems that constantly change in response to fire, animals, climate, insect infestations, weed invasions, and natural vegetation succession; not just to livestock grazing. Short-term monitoring focuses on identifying management inputs and external factors that affect the responses of grazing land resources over time. These are the factors that influence the change documented with long-term monitoring and may include growing conditions for plants (e.g., precipitation, temperature trends, drought, etc.), livestock and wildlife numbers, utilization patterns of livestock and wildlife, insect and rodent infestations, recreational use, trespass livestock, and timing, duration, and frequency of livestock grazing. Together, short-term and long-term monitoring information are the best tools for detecting change in grazing lands (trend), its potential cause(s), and the effectiveness of management decisions.

Long-term Monitoring Information

A well-defined management objective will largely determine the resource attribute(s) that are included in a monitoring plan. Because long-term monitoring is intended to detect change, it should be repeated consistently through time at permanently marked locations, regardless of the resource attribute or monitoring method that is selected.

Vegetation is commonly the focus of long-term monitoring programs because it: (1) readily responds to changes in management inputs and (2) is an excellent indicator of the overall condition of the grazing land. Ground cover is also frequently collected at the same time vegetation is measured. Techniques for documenting or measuring trend in vegetation attributes include repeat photo monitoring (see 520, Photo Monitoring Your Range) and a wide array of quantitative methods described in BLM (1999a). The following is a brief description of the most common quantitative measurements used for trend monitoring:

Frequency—Frequency is a number describing how often one encounters a plant in an area. It is defined as the percentage of occurrence of a plant in a series of plots of uniform size. To make frequency comparable, the plot must be the same size and shape for every time period. Frequency measurements often indicate changes in species composition density or dispersion.

Frequency can be used to assess trend in long-term monitoring but can change radically for some plants from year to year. A change in frequency may trigger the need to collect more detailed data regarding species density, cover, or composition by weight. Methods for measuring frequency are discussed in BLM (1999a).

Plant Density—Plant density is the number of plants in a unit of area. It has been used to assess when it would be economical to treat specific areas for forage

production. For rhizomatous and other species for which the delineation of separate, individual plants is difficult, density can also mean the number of stems, seed heads, or other plant parts per unit area. Density is sensitive to changes in the adult plant population caused by long-term climatic conditions or resource uses.

Density provides useful information on seedling emergence, survival, and mortality. Plant communities on the same ecological sites can be compared using density estimates on specific species, life forms, or functional groups. A functional group is defined as two or more plant species that share attributes allowing them to perform similar ecological functions and roles and may be able to replace each other to some extent (Bedell 1999). Density can be useful in estimating plant responses to management actions. Methods for measuring density are discussed in BLM (1999a).

Above Ground Production (standing crop)—Above ground production is the weight of the current year's above ground plant growth. There are several different methods for measuring production, including clip and weigh, volumetric, comparative yield, dry weight rank, and estimation techniques (BLM 1999a). Specific changes in production by species (species composition) may indicate the direction of trend but can be sensitive to annual precipitation amounts and patterns. Production has been used to describe ecological sites and is used to describe and assess management objectives for plant communities.

Ground Cover—Ground cover describes the percent of an area that is covered by vegetation, gravel, rocks, bare ground, and litter. Vegetation can be grouped by species into life form or functional groups depending on the information desired. Measures of basal cover are more representative of trend than foliar cover, because foliar cover is more affected by year-to-year changes in growing conditions.

Note: Basal cover is the area of ground surface covered by the stem or stems of a plant, usually measured one inch above the soil surface, in contrast to the full spread of the foliage. Foliar cover is the percentage of ground covered by the vertical projection of the aerial portion of plants.

Ground cover is often measured using line intercept or Daubenmire frames (BLM 1999a). Measuring ground cover over time will indicate if the amount of bare ground is stable, increasing, or decreasing. Increases in bare ground usually indicate a higher risk of runoff, erosion, and weed invasion.

Species Composition—Species composition refers to the percentages (proportions) of various plant species in relation to the total on a given area. It may be expressed in terms of cover, density, weight, etc. Measuring plant species composition over time gives an indication of whether desirable plants are being maintained on the rangeland or being replaced by undesirable vegetation such as weeds. It is one of the most common methods used to measure long-term changes in a plant community. Composition is a calculated attribute rather than one that is directly collected in the field. These calculations are described in BLM (1999a).

Greenline Stability—In riparian areas, where the number of species is often greater than on uplands and many plant species are rhizomatous, plant communities can be used as the response unit. In areas where communities are not well classified or understood by the observers, vegetation can also be observed and recorded by noting the most prominent species in plots or in patches of similar vegetation.

Note: Rhizomatous is a group of plants that spread by rhizomes or underground stems. These plants are often referred to as "mat forming" species. Plant communities are a group of species that characteristically occur together and become recognizable as a known entity.

Greenline monitoring involves documenting plant communities or dominance types along the streamside (Winward 2000). The greenline is the first line of perennial vegetation on or near the low water line. Most often it occurs at or slightly below the bankfull stage, which is the water level, or stage, at which a stream, river, or lake is at the top of its banks and any further rise would result in water moving into the flood plain. For more details about these methods see Winward (2000) or Cowley and Burton (2005).

Short-term Monitoring Information

Short-term monitoring may include keeping records of observations and gathering data on actual use, utilization patterns, and streambank alteration (Cowley and Burton 2005). Documentation of growing conditions, insect infestations, fire events, other disturbances, and adequacy of range improvements is also important. Techniques used for short-term monitoring may include notes recorded in a pocket calendar or herd book and other livestock management records, precipitation and temperature measurements, utilization mapping, residual vegetation sampling, and photography.

Actual Use Records— Range managers should maintain accurate actual grazing use by livestock, wild horses and burros, and wildlife by management unit or pasture. Grazing use records contain dates and numbers of livestock gathered and moved, as well as death losses, grazing problems involving water or livestock distribution, salting and mineral supplementation records, forage conditions, and any other important matters. These data provide information on the season and duration of use and the number, kind, and class of grazing animals that are using and have used pastures.

Climate (Weather) Data—Weather is commonly the most important single factor influencing variation in grazing land production. When properly recorded,

weather data are an essential part of both short-term and long-term monitoring interpretation. General observations on growing conditions and any applicable measured weather data should be considered when making changes in grazing use. Monitoring plans should include collection of information on weather (temperature and precipitation).

Ranch weather stations can be extremely useful. Other sources of long-term climate data are the Natural Resources Conservation Service (NRCS), the United States Forest Service (USFS), the Bureau of Land Management (BLM), Agricultural Experiment Stations, State Departments of Transportation, National Oceanic and Atmospheric Administration, State Climate Services, any neighboring or nearby ranches that maintain records, and the Western Regional Climate Center (WRCC). The WRCC provides weather data for 2,608 locations throughout the western United States (http://www.wrcc.dri.edu/).

Insects, Disease, and Rodents—All rangeland vegetation is subject to disease, insect, and rodent infestations. Monitoring records should include field notes on the location of significant occurrences and impacts. It can also be informative to read existing long-term studies after an insect or disease episode to document the effects and rates and patterns of recovery.

Utilization—Utilization is the measure of the proportion of standing crop consumed or affected by grazing animals. Utilization may be measured on a single plant species, a group of species, or the plant community as a whole. Seasonal use is estimated during the growing season. End-of-season utilization is estimated at the end of the grazing and growing season. Most studies on forage utilization are based on end-of-season utilization levels.

Utilization data are important in evaluating the effects of grazing on rangeland. In the short-term, utilization data are considered with actual use and climate data to determine resource use levels and to identify needed adjustments in grazing management. Approaches to estimating utilization are discussed in BLM (1999b).

Utilization Mapping—Utilization mapping involves periodic range inspection tours of an allotment or pasture to map the distribution of grazing use (utilization) near the end of the grazing season. Utilization mapping helps to establish key areas, identify distribution problems and solutions, develop management objectives, and make adjustments in management plans.

The utilization map for an allotment or pasture can help managers determine whether grazing management is functioning as designed. These maps can identify and indicate the relative extent of areas underused, overused, and properly used. Problem areas can be identified for closer study to determine causes and potential solutions. Photographs at use areas may be taken to display utilization levels at certain locations. These locations may be mapped using a Global Positioning System (GPS). An approach to utilization mapping is discussed in BLM (1999b).

Residual Vegetation or Stubble Height—Stubble height is often used as an indicator of the effectiveness of riparian grazing management. Because intensity of use during the growing season is important to plant physiology and regrowth, seasonal use (measured within the growing season) is often used as a trigger for livestock movement. Residual vegetation, stubble height, or utilization at the end of the growing season indicates the overall effect of grazing. It can be measured in key areas, critical areas, or designated monitoring areas and estimated and mapped throughout riparian areas.

A specific stubble height is not a long-term resource objective but a tool to ensure the desired level of utilization is accomplished. For guidance on measuring residual vegetation or stubble height, see BLM (1999b). The use of stubble height is further discussed in Clary and Leininger (2000), University of Idaho Stubble Height Review Team (2004), Hall and Bryant (1995), and Cowley and Burton (2005).

Adaptive Management

Adaptive management is the process of adjusting management based on monitoring results to meet long-term management objectives. Short-term monitoring information is important for interpreting trend and is also critical for making short-term (i.e., within a year) management adjustments to ensure progress is made toward long-term management objectives (Fig. 1). For example, making and regularly updating utilization maps is an important tool for adaptive management. These periodic range inspections help identify if adjustments are needed in grazing management to meet long-term management objectives.

Adjustments might be in the form of new or relocated water developments, fences, or salt grounds, or changing the grazing strategy by modifying livestock numbers, the duration, or season of use. If analysis and interpretation of long-term monitoring information indicates management objectives have been achieved, these data will provide rationale for continuing current management practices.

The following two conditions may warrant an adjustment to the management strategy if livestock grazing is determined to be a contributing factor to the observed trend: (1) the current management strategy is not achieving management objectives and trend is stable or not apparent, or (2) trend is downward. If there has been no change, the decision must be made whether that is acceptable or not.

Perhaps management objectives were unrealistic and not obtainable. If it is not acceptable, then a minor adjustment in management may be all that is necessary.

In the case of the second conclusion, if it is determined that livestock grazing is contributing to the observed downward trend, a change in grazing management is probably warranted. All aspects of grazing management should be considered for adjustment including the timing, frequency, intensity, and distribution of grazing; not just the stocking rate.

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