

CHAPTER 5: Monitoring for Success

By Steven H. Sharrow and Steven S. Seefeldt

Steven H. Sharrow is Professor of Rangeland Ecology in the Department of Rangeland Ecology and Management at Oregon State University, Corvallis, OR. *Steven S. Seefeldt* is Research Agronomist at the USDA-Agricultural Research Service Subarctic Agricultural Research Unit in Fairbanks, AK.

10 KEY POINTS

- Monitoring entails making observations – then gathering, organizing, and reporting information from those observations.
- An initial inventory provides an important benchmark for comparing progress.
- Management goals should be specific and stated in terms of things that can be measured.
- Who will monitor and what they'll monitor should be determined at the outset.
- The more precise the data, the more difficult and expensive they are to gather.
- When assessing grazing progress, consider outside influences like precipitation and wildlife impacts.
- Monitoring with photos is an easy and effective method for measuring long-term change.
- Consistent techniques, locations, and plot sizes make monitoring data more valid.
- Field notes and records should be logged systematically in a form that can be updated easily.
- Assessing vegetation change is essential to determine the economic viability of targeted grazing.



INTRODUCTION

To determine if a grazing prescription is altering vegetation, the vegetation must be measured and the data compared with subsequent measures. Likewise, to establish that livestock are effective vegetation management tools, data must be collected to show that they are achieving the contracted ecological benefits. Many grazing contracts require the service provider to log activities and record pertinent observations. These are the kinds of activities that fall under the scope of monitoring. Monitoring is the process of making observations and gathering, organizing, and reporting the information from those observations.

The first step in any vegetation management program is to inventory the current state of the target area. These initial data provide a benchmark against which subsequent conditions can be compared. Vegetation measurements should catalog what is present and its current condition relative to management objectives. This information is so fundamental to successful management that monitoring should be a part of decision-making rather than a separate and independent activity.

Monitoring assesses current conditions and compares those conditions to past measurements so that land managers and service providers can understand how the vegetation has changed and predict what might happen in the future. Management strategies must be changed if the current or predicted conditions are unsatisfactory or not trending in the desired direction. With this in mind, the objectives for monitoring are to: assist in making management decisions, detect changes in animal status or vegetation communities, and determine if contract requirements are being met.

Setting Management Goals and Monitoring

Monitoring protocols should be developed with management goals in mind. The best management goals are stated in such a way that progress toward meeting them can be easily understood and measured.

A vegetation management goal should:

- Clearly describe the desired end point of the management activity – what the land should look like when the work is completed.
- Be written in terms of conditions and activities that can be measured.
- List a timeframe for expected results.

Most importantly, effective management plans contain specifically stated goals. For example, a goal that says "reduce pasture weeds" is difficult to evaluate. It fails to address what is considered a weed, how many weeds there are now, how many fewer there would have to be for weeds to be meaningfully "reduced," and when results are expected. A goal that captures these questions might say: "The Lazy Bar X ranch will reduce the canopy cover of spotted knapweed plants by 80% over the next four years."

Start with reasonable expectations. When setting goals for targeted grazing projects, it is important to understand the capability of the land and to set achievable goals. The land manager will base expectations on

previous experience on that piece of land. Other sources of information about a site's potential are the county soil survey (<http://websoilsurvey.nrcs.usda.gov>), land capability class of farmland, site index for forest land, and ecological site descriptions for rangelands. The Ecological Site Information System (<http://esis.sc.egov.usda.gov>) can be accessed to determine expected production levels in favorable, normal, or unfavorable years for different sites. When a pasture or other land management unit contains more than one type of site, it is generally best to monitor each site separately.

Who Should Monitor

If the land manager or the grazing service provider wants to measure effectiveness of the targeted grazing practices, someone needs to measure and monitor land response. However, who should do the monitoring is less clear. All parties involved can benefit from monitoring. But a meaningful and effective monitoring program is often time-consuming and may require training and experience. The party responsible for monitoring and the expected monitoring activities should be clearly outlined in each contracted grazing endeavor. At a minimum, the land manager and service provider should regularly take photos and conduct joint site visits. Another alternative for monitoring is to hire a third-party consultant. People who are trained and hold credentials in natural resource management, such as a

Certified Range Management Consultant or a licensed consulting forester, can work with land managers and service providers to implement monitoring programs that assess progress toward project goals.

What to Measure

Gathering useful information requires asking the right questions. Monitoring data may be expressed as numbers or observations, such as photos. Numbers may be precise, as in 570 pounds per acre, or a range, such as between 500 and 1,000 pounds per acre. The more precise the data, the more difficult, expensive, and time consuming it will be to gather. So, how precise must data be? That depends on how the information will be used. A grazing contract may require specific target levels of animal impacts, so precise numbers may be required to evaluate contract compliance. Likewise, concern over legal liability may encourage managers to collect information more detailed than that required to make management decisions. The amount and refinement of information needed to support decisions is related to the fineness of the decision being made. *The best way to judge what information is required is to ask: "What would make me change my decision?"*

Measurements should be relevant to the goals of the project or enterprise. To place those measures into an interpretable context, general background information about the situation is needed. This may include wildlife use, insect activity on plants, growth stage of vegetation, or evidence of soil erosion, fires, or disturbance. Background information is simply a clear description of the current situation. Though much less detailed than the primary measurements, background information helps explain why changes are occurring. *Measurements only become information when their meaning is understood.*

Because vegetation responds strongly to moisture, *precipitation data are also important.* A warm, moist growing season can have a greater influence on plants and animals than all but the most drastic management actions. Precipitation data help distinguish between changes resulting from yearly or seasonal weather patterns and changes resulting from management actions. Inexpensive rain gauges are available in most hardware or garden stores. They should be read at least monthly. A few drops of oil added to the barrel will reduce evaporation between readings. Few rain gauges measure snow accurately, so areas with significant snow require larger-diameter gauges. The National Weather Service logs precipitation and temperature data accessible on the Internet at sites like the Regional Climate Center's

www.ncdc.noaa.gov/oa/climate/regionalclimatecenters.html.

The most commonly measured aspects of grazing are:

- Livestock performance or weight gain
- Consumption of vegetation
- Changes in vegetation structure.

Livestock performance can profoundly affect revenue stream and profitability. It should be monitored and accounted for in setting the price or value of targeted grazing projects. Changes in livestock condition over time can be documented by periodic weighing or by assessing and recording body condition score. In the long run, animal body condition and weight reflect the type and amount of vegetation present. However, condition and weight are poor reflections of current vegetation structure because they rarely decline until substantial changes in vegetation are well under way.

Consumption of vegetation by livestock or native herbivores like deer and elk may be measured with utilization or residue techniques. Utilization is the proportion of current year's plant growth that is consumed or destroyed by grazing animals. It is often used to describe the degree of grazing that has occurred. Utilization is most frequently measured by comparing plant weight, number, or size before and after grazing, or by comparing grazed areas to ungrazed reference areas, such as grazing exclosures. Residue is the amount of vegetation remaining at the end of a grazing period. Comparing the kind and amount of plants before grazing or in ungrazed areas with that remaining after grazing indicates which plants animals chose or avoided. Monitoring the herbage utilized or residue from plants targeted for removal is important to meet vegetation management goals. It is also important to track use of desirable plants to be maintained in the community. Vegetation-reduction goals are often stated as either utilization or residue values. For instance, a goal in a timber stand may be to reduce ground vegetation present by 50% or to 500 pounds per acre. This goal could be monitored by clipping or visually estimating the weight of understory vegetation before and after grazing. If there are 1,500 pounds per acre before grazing and 1,000 pounds after, then residue is 1,000 pounds per acre and utilization is 33% $[(1,500-1,000)/1,500 = 500/1,500 = 33\%]$. That means more grazing is needed.

Vegetation structure describes the type, size, and amount of plants present. It is used to describe the plant community and to determine whether the grazing has had a negative or positive impact on the vegetation. The most commonly measured characteristics for describing the impact of targeted grazing on vegetation are:

Using Biomass to Estimate Carrying Capacity

An Example

A flock of 250 ewes, each weighing 140 pounds, eats 3% of their body weight per day. This requires $250 \times 140 \times 0.03 = 1,050$ pounds of dry forage each day for the flock.

If a 20-acre pasture currently has 2,500 pounds per acre of forage and the goal is to have 1,000 pounds per acre of residue left, then the usable forage is 20 acres \times 1,500 pounds per acre = 30,000 pounds.

The pasture can be grazed for 28 days (30,000 pounds of forage supply @ 1,050 pounds of daily forage demand = 28 days).

For more information about setting stocking rates, see the National Range and Pasture Handbook www.glti.nrcs.usda.gov/technical/publications/nrph.html



Photo: Rodney Kott, Montana Sheep Institute

- Biomass
- Canopy cover or basal area
- Plant density

Biomass is the weight of vegetation. It may be measured by harvesting, drying, and weighing the vegetation within an area of known size, such as a small frame. This provides an estimate of the pounds per acre of material present. Most people can learn to estimate biomass from the general appearance of vegetation. Training involves estimating biomass and then clipping plots to check the accuracy of the estimates. A good estimator will consistently be within 10% of the actual clipped weight. Estimates are sensitive to season of year, climatic fluctuations, changes in soil fertility, changes in grazing patterns, or anything else that affects plant growth. Because so many things affect it, biomass is sometimes difficult to interpret, but it does respond rapidly to management changes. Biomass numbers can be used to estimate the number of animals or days of grazing necessary for specific vegetation management jobs (see example above).

Canopy cover is the proportion of land area covered by plants. It can be visualized as the percentage of area in shadow if the sun is directly overhead. Basal area is the area occupied by plant bases. Canopy cover and basal area are often estimated by the proportion of a plot of known size or the intercept along a 50- or 100-foot line (transect) that is covered by plants. Basal area is

less affected by seasonal growth patterns than is canopy cover, so time of year has less effect on measures. Canopy cover is especially useful for monitoring shrubs and clumped vegetation like bunchgrasses. For example, a goal in rehabilitating a bunchgrass stand may be to increase perennial grass basal area to 10% within five years. This can be assessed each year by randomly establishing a group of 10 to 20 line transects in the management unit. The length of line that crosses grass bases is recorded and the percentage basal area calculated by dividing this intercepted distance by the line length (Figure 1). If 20 inches of a 1,200-inch-long line cross over plant bases, basal area for that transect would be $20/1,200 = 2\%$.



Figure 1. For more information on the line intercept method, consult the Sampling Vegetation Attributes manual available at: <http://www.blm.gov/nstc/library/pdf/samplveg.pdf>.

Density, the number of plants per square foot or per acre, is a useful measure for examining changes in plant populations over a period of years. It can be estimated by counting all of the plants within a plot of known size. Density is less sensitive to season, and responds to management actions less quickly, than biomass and cover. Monitoring density is especially important for annual or biennial weeds that reestablish each year from seed. Reducing the number and size of flowering stems is often a prescription goal for these plants. For example, tansy ragwort is a biennial or short-lived perennial pasture and range weed. Sheep grazing that consumes the flowering stems will control the tansy by denying seed production. A prescription goal might be to consume over 95% of the flowering stems. Success could be gauged by randomly establishing plots immediately before and after grazing and counting the first-year rosettes along with the flowering and stripped stems of older plants in each plot. If a 25-foot-square plot had 21 stripped stems and two flowering stems, then $21/23 = 91\%$ of the stems were consumed, leaving $2/25 = 0.08$ plants per square foot (3,484 plants per acre) to set seed. A similar sampling to count new plants (rosettes) the year after grazing would provide a reference to determine if the number of tansy plants is declining. However, long-lived perennial plants maintain a stable population without frequent reproduction. So, absence of young perennial plants does not necessarily indicate a declining population for them.

Photo Monitoring

For many years, the Bureau of Land Management and Forest Service have used sequential photos to study vegetation changes over time. This technique is becoming more popular with livestock producers because it offers a relatively simple way to document land condition and the effects of management over years or decades. Areas where vegetation is being measured make excellent sites to photograph. Photos typically include a general view of the area and several detailed views of the sampling plots in each area. To ensure that photos are of exactly the same place and the same scale, a lens with the same focal length should be used each year. Plot photos should be taken pointing straight down. A marker of known size, such as a profile board, should be placed in the center of each photo to provide a reference for scale (Figure 2, see next page). The location, date, and compass bearing of each photo should be recorded along with a photo number and associated field information. The information can be written on a piece of paper and included in each photo. Taking past photos into the field and taking photos from the same spot (a steel fence post or wooden stake) and on the previously recorded compass bearing helps assure a consistent view over time. A short guide to using photo monitoring is available at www.anrcatalog.ucdavis.edu/pdf/8067.pdf. A more detailed guide can be found at the U.S. Forest Service website, www.fs.fed.us/pnw/pubs/gtr503/.

How to Measure

Size and Shape of Sampling Plots

Vegetation measurements are best made using plot frames. The same set of frames should be used throughout the monitoring program. Most sheet metal shops can make them by bending 1/4 inch round stock or rebar, or they can be made from small-gauge PVC pipe and elbows.

Frame shape depends on the type of measurement and the vegetation to be sampled. *Rectangular plots* work well for rangeland and pastures because they tend to include more variation of the vegetation community within each plot. Rectangular plots are more likely to cut across plants or clumps of plants rather than being completely occupied by a single plant or all bare ground. A common rectangular plot frame has a short side half the length of its long side. Typical frame sizes are 12 x 24 or 24 x 48 inches. Square and rectangular plots are especially useful when estimating cover because envisioning proportions in these plots is easier than in circular plots. When estimating density, it is also

Table 1: Commonly measured plant characteristics.

Plant Type	Characteristic to Measure
Grasses	Canopy cover, basal area, plant height, biomass, or utilization
Forbs	Canopy cover, density, or plant height
Shrubs	Canopy cover, density, or plant height
Canada thistle	Rosette or stem density
Knapweeds	Rosette or flower density
Leafy spurge	Stem density, canopy cover, or biomass
Downy brome	Plant density or biomass



Figure 2. A profile board or person in a photo can create a reference to assess the height and amount of vegetation.

Photo: Karen Launchbaugh, University of Idaho



Photo: Don C. Schuhart, USDA, NRCS

easier to count individual plants from one end to the other of a square or rectangular plot than to count plants in circular plots. Rectangular frames are commonly constructed with one side open for easier placement in dense vegetation. Circular frames are often used for estimating biomass in dense uniform vegetation because a circle has a lower perimeter for a given area than a square or rectangle. Circular plot placement is easier with fewer perimeter decisions about whether a plant is “in” or “out.”

Plot size depends on the variability of the plant community and the size and density of plants being measured. Any size plot should be able to accurately reflect vegetation. The issue is really efficiency – how much work is required to obtain the estimate. Here are a few guidelines for setting an appropriate plot size:

- Plots that are too small will be noticeably different from each other and will require a large number of such plots to be accurate. It is more efficient to sample fewer larger plots. Sampling plots that are too large will waste time examining more space than is really needed to represent that spot within the community.
- A plot should be larger than the average-size plant and larger than the average space between plants.
- If more than 5% of sampling units have values of 0 for the plants of interest, the plot size should be increased.

Once a plot size is selected, converting the density of plants per plot to plants per acre is relatively simple, as is converting grams of biomass per plot to pounds per acre. (Common conversion factors can be found in *Calculating Available Forage* www.extension.usu.edu/files/natrpubs/range3.pdf.)

Selecting sample locations randomly guards against inaccurate data caused by patterns in vegetation or observer bias. The location can be randomly selected by tossing the plot frame or some other object into the area to be measured. Long-term monitoring studies are more efficient if the same spots are marked and periodically re-measured. Markers for permanent plots, such as T-post, rebar, or PVC stakes, should be placed well away from the plots because curious animals often over-utilize the area around them. Inexpensive Global Position System (GPS) devices can be invaluable for relocating plots, particularly when continuity of personnel is not assured.

Number of Plots to Measure

Several observations should be made in each area to be measured. The vegetation will be denser in some parts of the area and less dense in others. Generally, the more diverse the vegetation, the more plots are needed. At least 10 to 12 plots is a good rule of thumb.

Where to Monitor

One of the most important decisions to make in establishing a monitoring system is *selecting the sites or plant species to be monitored*. Sites and species are generally selected because they meet one or more of these criteria:

- They represent a larger vegetation type or management unit.
- They are of special interest relative to management goals (i.e., contain exotic weeds).
- They are especially sensitive to change.

Key Areas

Monitoring sites should include several small key areas that represent a significant portion of the land, are major contributors to seasonal forage supplies, or are targets for vegetation management (i.e., contain weeds of interest). Key areas may also contain rare or endangered plant or animal species, be under public scrutiny, be included in contracts using livestock to provide ecological benefits, contain critical wildlife habitat, or have other special significance. Roadsides, fence lines, salting or bedding grounds, areas near corrals or water, and sites where livestock congregate or human activities are concentrated make poor monitoring sites because they do not represent the larger area surrounding them.

Land management units often vary in topography, plant communities, or other characteristics. Lumping together information from these distinctly different areas is a poor practice. Monitoring each separately is more likely to provide meaningful information. When uncertainty arises whether two areas are sufficiently

different to warrant separate monitoring, it's probably a good idea to monitor them separately.

Key Species

A few key species within the plant community should be selected for measuring. Key species include the plants targeted for management and a few desirable species that the targeted grazing is meant to enhance. Species may also be selected because they are the first to show signs of change.

Proper Controls

Because areas monitored over years will show changes from both weather patterns and management practices, proper controls are needed to detect and understand vegetation changes. Climate impacts can be separated from management impacts by including untreated reference areas. Such ungrazed "control" areas are routinely used in research projects to separate management impacts from outside forces like weather, wildfires, invasion by new plants, or natural cycles in plant and animal populations. Excluding livestock by fencing off small areas (exclosures) has proved to be one of the best tools for demonstrating the long-term ecological impacts of managed livestock grazing. To be a useful reference, an exclosure should be as similar as possible to the rest of the area and large enough for the plant community it represents to fully develop within it. Exclosures generally range from 10 × 10 feet for grasslands to 25 × 50 feet for shrublands, to over one-tenth of an acre for forests and woodlands.

When to Measure

Under grazing contracts, it is best to measure vegetation just before and just after grazing. For short-term monitoring within a single year (grazing period less than two weeks), it is important to attach to the observations a description of the growth stage of plants, when the site was last grazed, and the date data were collected. Monitoring conducted over several years requires that information be collected at similar times of year. This is best done by setting collection dates based on plant growth stage rather than the calendar. For example, a perennial pepperweed infestation may be examined each year when the pepperweed is in full bloom. Grass stands are often sampled each year at the soft dough stage, a time when plants are in seed and seed is still soft. The time of targeted grazing should also be based on plant growth stage, not the calendar.



Photo: ASI

Keeping Field Notes and Records

All data should be recorded and stored systematically in a field book or on a computer in a form that can be easily updated. Computer-stored data should be backed up on a CD or DVD. Notes should include dates and the names of who collected the data.

Observations should be factual, not judgmental. For example, knowing that the density of Scotch thistle plants in 1995 was 670 plants per acre is much more useful today than knowing that “there were a lot” or that “there were more than last year.” Accurate numerical measurements of vegetation are difficult to achieve, especially in wildland ecosystems. The natural variability in the landscape, the influence of climate, and the season of measurement can alter measurements considerably. Each plant being measured is growing or

dying and constantly changing. Insects, microbes, viruses, and large wildlife could be preying on these plants. A contract grazer’s vegetation measure one day may bear little resemblance to a second measure by someone else two weeks later. Vegetation may have increased because of timely rains or declined because of elk or deer grazing or browsing.

Still, it is important to measure and note success or failure each year in meeting grazing prescriptions, contracts, or goals as a means of evaluating current vegetation conditions relative to important management objectives. Collecting data carefully and making observations of what is happening are keys to understanding cause and effect. The better the information gathered, the more knowledge is available about vegetation response to targeted grazing techniques.

PARTING THOUGHTS

In every business, costs and profits must be calculated. If profits outweigh costs, the business will have a chance for success. Targeted grazing for vegetation management is the business of intentionally altering plant communities and landscapes. If the ecological benefits of grazing outweigh the cost of grazing, then targeted grazing will be a good business venture. Assessing vegetation change is an essential part of determining the viability of targeted grazing practices. Monitoring will help livestock and land managers impartially assess these costs and benefits, learn from mistakes, and replicate successes.

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