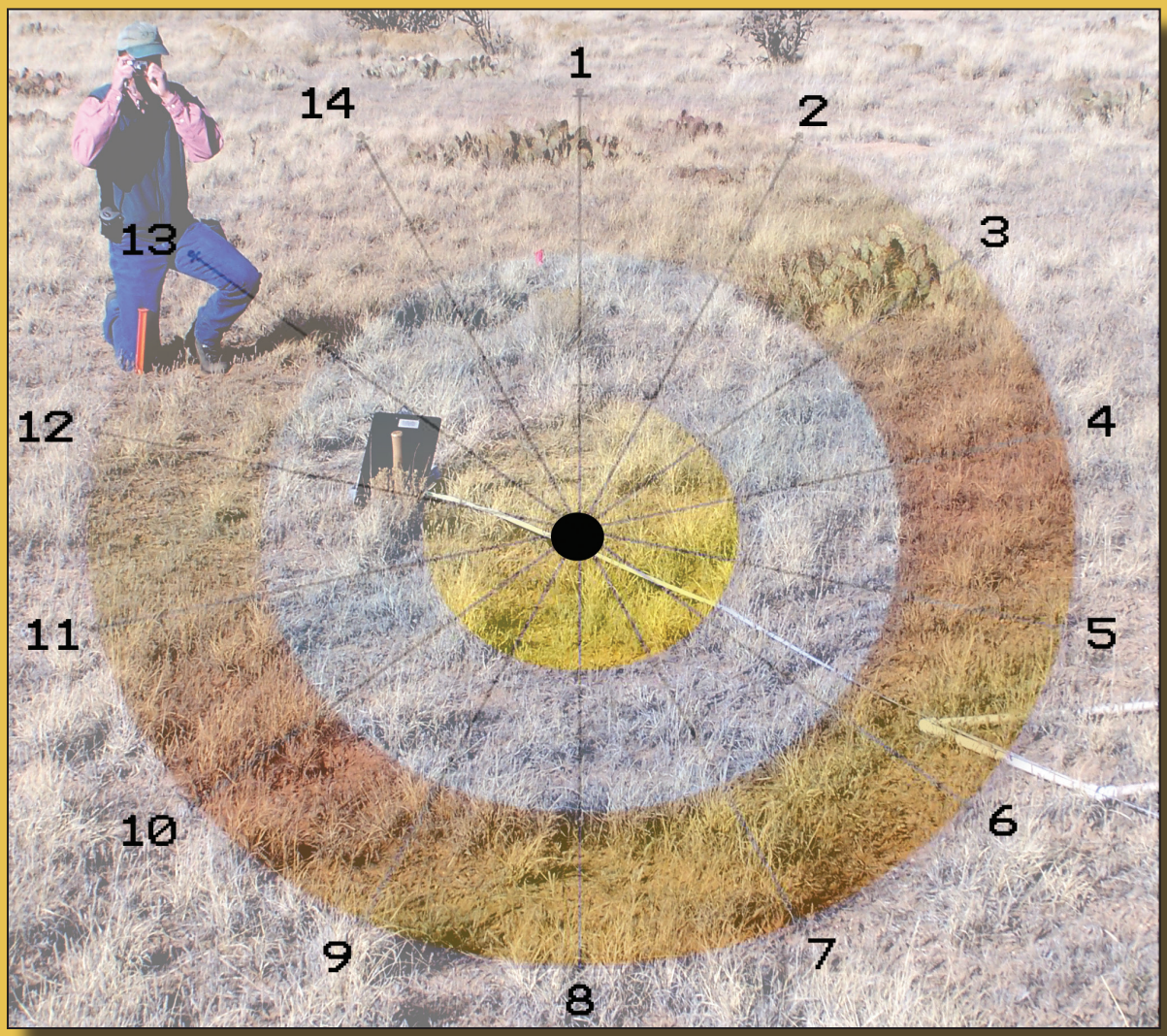
Bullseye!

Targeting Your Rangeland Health Objectives



Kirk Gadzia, Resource Management Services, LLC
& Todd Graham, Ranch Advisory Partners, LLC

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Authors' Comments:

We produced ***Bullseye! Targeting Your Rangeland Health Objectives*** to fill the gap between the needs of land managers and the confusing array of monitoring methods available. Often, monitoring results are exhibited as tables of numbers and confusing charts with interpretation difficult for hands-on application. In addition, the choice of which type of monitoring methodology best fits the situation of the potential user is commonly unclear. We hope this manual will be of use in your efforts to improve rangeland health. Further, we hope users will modify and improve the techniques and pass these on to help others.

It is important to note that the Natural Resource Conservation Service (NRCS) and nearly all the federal land management agencies have adopted ***Interpreting Indicators of Rangeland Health*** for measuring qualitative attributes of rangeland health (Appendix A). The three main differences between the ***Interpreting Indicators*** book and those presented in this publication are:

1. the graphic target representation of the information collected,
2. the use of a predetermined goal to help interpret the information collected, and
3. the use of the information to help you determine management changes that will move you closer toward your goal for the land.

The methodologies presented in this manual have been field tested in a number of different locations and rangeland health conditions. In addition, people performing the field tests had highly varied backgrounds and experiences in managing rangelands. This experience level ranged from cowboys and wildlife management technicians to professional public and private land managers. Their feedback has been incorporated into this manual. We look forward to an even wider range of potential users and their comments and suggestions.

For rangeland health everywhere.....

Kirk Gadzia and Todd Graham

Grateful acknowledgement is given to the Sand County Foundation~Bradley Fund for the Environment and the Quivira Coalition for their help in funding this project. We would also like to acknowledge the work of the Rangeland Health Committee for its critical role in changing the direction of rangeland health monitoring. Allan Savory, founder of Holistic Management International, is credited for his original thinking on the ecosystem process function descriptions and remarkable contributions to rangeland management worldwide. We are also thankful for the tireless work of so many researchers within the public and private land management agencies , and extension personnel who have brought their ideas on rangeland health and monitoring to the forefront. In particular, we want to recognize the work of Milo Deming, a Bureau of Land Management scientist who in the late 1950's created many of the rangeland health attributes used here.

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Blue grama

Introduction

What does this manual do? The manual aids users in establishing their own monitoring program in grasslands, shrublands, and grass/shrub mixes. It is not designed for use in measuring riparian or woodland areas. However, users will be able to perform a variety of monitoring functions with the methods outlined in this manual:

❒ Perform a rapid visual (qualitative) assessment of rangeland health. Such activities can be performed after clearing cattle from a pasture, while checking pasture, when considering buying a new property, and even when evaluating a landscape.

❒ Establish a long-term monitoring program for changes in an area with field data gathering (quantitative) methodology.

❒ Combine quantitative monitoring with the qualitative assessment for a complete picture of rangeland health that provides both a means of tracking changes on the land through time and helps guide management action. Users should have a better idea of how best to apply the various management tools available to them to achieve their land management objectives after completing the monitoring protocol.

Who should use this manual? This manual is intended for anyone interested in the management of rangelands. However, it is written for rangeland managers who want to improve their management techniques and conduct reasonable and meaningful amounts of monitoring. The techniques in this manual fill the gap between doing no monitoring and some of the very detailed and technical monitoring techniques in use today. The goal is to provide a hands-on tool for those who are working directly with the land.

An effort has been made to keep the explanations as simple and non-technical as possible, with links to more detailed information when necessary. Those requiring quick feedback on management decisions will find that the manual provides rapid assessment techniques. These will be ideal for evaluating a pasture between grazings, or other treatments. For those needing to design a long-term monitoring program, this manual will provide streamlined data-collection techniques meant for use on private and public lands.

Why Monitor? A rancher in western Wyoming said it best: "My great grandfather had to brand his cattle in order to survive. He did that so that people didn't steal them. My father had to vaccinate his cattle in order to survive. He did that so they didn't catch a disease. I have to check the health of my rangelands in order to survive. I do that because I'm the best person to understand and to speak for them."

He's right. Controversy over rangeland health has grown in recent years with many folks representing different groups arguing over how best to manage the land. Unfortunately, too few have the skills to actually listen to signals the land is sending.

Photo 1: A Montana ranch crew performs a quick assessment of a pasture.

The root of the word "monitor" means to warn. Those who practice monitoring are seeking early warning signals that they are moving away from their desired goals. In a practical sense, monitoring simply means paying attention to signals that the land is sending. We must focus on specific warning indicators that suggest we are not working toward our goal. Fortunately, these signals will also suggest ways of adjusting our management actions in relation to goals.

Why initiate a monitoring program? There are many reasons why people begin a monitoring program, but most want to know if the land is healthy or not. Use the information you collect to help work toward your pre-determined goals and objectives for land health. This manual will assist you in gathering data based upon your own objectives for your land and will help you make better management decisions in working toward those objectives. It will also help you create a record of land health and enable you to document both positive and negative changes over time. Once you have catalogued and stored your information for future reference, you and others will be able to check your progress.

Are you prepared to change management based on your findings? Unless your monitoring indicates your land health is right on track, these procedures will ask you to change your management actions one way or another in relation to your objectives. Expect a change in management if you want improved results in the future. Given your objectives, these techniques will help you interpret signs the land is sending into management actions. The speed with which you work toward your objectives in response to your monitoring findings is up to you.

Photo 2: Students practice line-point monitoring techniques during a rangeland health and monitoring workshop on the U-Bar Ranch near Silver City, NM.


Black grama

Chapter 1: Rangeland Health: Monitoring for Your Goals and Objectives

Rangeland Health

In its 1994 report Rangeland Health, the National Research Council defined rangeland health as the degree to which the integrity of the soil and the ecological processes of rangeland ecosystems are sustained. Rangeland in good health produces more forage and better wildlife habitat, while watershed condition is improved; resulting in more stable stream flows and higher water quality (3). Healthy rangeland generally supports more plant and animal diversity and provides greater ecological stability in terms of productivity and population flux.

The process of identifying goals, monitoring towards those goals and using early warning indicators to modify or change management is the foundation of the Holistic Management® decision making process (1).

The monitoring methods outlined in this manual are aligned with the findings of the Rangeland Health publication which recommended using easily understandable indicators of rangeland health.

Sample Future Landscape Description

Future Landscape of our Land:
(Details to be mapped and reviewed frequently.)

- ❒ Open rangeland with areas of heavy brush and brushy grassland. The natural community will be diverse enough to include many species and not be dominated by any one species where soil and other factors permit.
- ❒ Irrigated lands will maintain good soil cover and have "living" soils.
- ❒ In general on all lands, we must produce healthy permeable soils, covered with plants and litter. High diversity of plant and animal communities and species.
- ❒ Effective water and nutrient cycles, minimal runoff and clean water.
- ❒ High energy flow towards production of livestock, wildlife, crops and other enterprises.
- ❒ We want to produce healthy products and quality services. Our customers will increasingly be aware of our production process and seek out our products.

❒ *Measuring Against Your Objectives*

The procedures outlined in this manual are goal dependent, meaning that the site you are monitoring must have a desired future landscape description for you to measure against. When you are in the field collecting data, you will be evaluating a series of indicators against your pre-determined objectives. You must have a goal in order for the protocol to function properly.

Many monitoring procedures measure against "potential" or "climax," which is the level of performance (plant production and species present) you can expect on your study site. "Potential" for a site is determined by your area's ecological site descriptions / rangeland site guides (see note on page 6), or the local soil survey, both of which you should obtain from your local Natural Resources Conservation Service (NRCS) office as reference materials.

Methods outlined here use "potential" only as a comparison for understanding what level of plant production might be expected on your study site and what proportion of different plant species should be expected there. However, this potential is only a relative point; it may not reflect your particular goals. These procedures measure the resource condition against your specific objectives for the area, providing information for understanding which combination of tools will lead you toward that goal. It recognizes that your specific study site may have unique features toward which you are managing.

For example, the rangeland site guides used to determine "potential" were originally designed for maximized livestock production. Thus, if your goal matches the conditions described in the rangeland site guides, then you may want to manage for what is described as "excellent" rangeland condition. However, wildlife groups have recognized that maximum wildlife habitat for many species often occurs at a lower level of succession, perhaps in a "high fair" or a "low good" rangeland condition. If your goal includes providing both wildlife habitat as well as forage for livestock to harvest, then you may wish not to manage for the optimum condition described in the guides. We recommend making your site goal as specific as you need it to be. See the Sample Future Landscape Description on page 5.

Photo 3: A ranch crew in western Montana evaluates land health.

**NOTE: The NRCS is currently re-evaluating their rangeland site guides and has changed the name to ecological site descriptions (ESD's) to reflect wildlife and other values in the overall area of rangeland health. The goal is to have these ESD's available for all areas on the world wide web. [Check www.NRCS.gov for ESD information for your area of interest.]

Although this landscape goal on page 5 is not complex or detailed, is does provide enough information about the desired future condition of the land for the protocol to work. As you progress, a more detailed desired landscape description can be mapped with various zones and overlays or Geographic Information Systems (GIS) layers to provide additional clarification and direction. You might have rangeland improvements such as water sources on one layer and potential vegetative communities on another layer.

In any case, make a goal for the areas you will study. It's not hard and does not take long. Remember that when you formulate a goal, that you should focus on the things you want to create, not how you will create them. This vital step will help you assess tools you will apply once you have completed your data collection. Once you have this goal and have collected data, monitoring will challenge you to consider tools that will alter your landscape towards the chosen goals.

Rangeland Monitoring

❒ *Quantitative or Qualitative?*

In rangeland management and monitoring, a distinction is usually made between collecting quantitative data versus qualitative information. Quantitative data tends to contain hard numbers obtained by actual field measurements, such as percent shrub canopy cover and percent bare soil. Qualitative monitoring depends more on focused observations of rangeland health attributes such as how well litter is distributed over the soil, or how well the water cycle is functioning based on observations of erosion and other indicators.

Whether you choose to collect quantitative data or qualitative information depends upon your objectives. The monitoring matrix on page 8 of this manual will help you make this determination. However, in most situations you will want a combination of quantitative and qualitative information to help you make informed choices. Making qualitative observations will help you gain rapid feedback of ecosystem function, whereas quantitative data collection will help determine trend

and larger changes in the landscape through time. Thus, implementing both quantitative and qualitative methods will generally be more beneficial than either method alone.

❒ ***Coordination with Agencies***

If you are monitoring rangelands on public lands, you must build a working relationship with your federal and/or state land management agency representative. This manual's techniques provide means for improving land health through better decision-making based on sound information. It should not be viewed as ammunition for fighting a federal or state agency over stocking rates. It is imperative that you work with the agencies when designing your monitoring program before you begin work in the field.

It is important to recognize that one of the biggest problems facing agencies today is lack of funding and personnel to implement or continue required monitoring programs. Your efforts to assist in this process can be very valuable and lead to increased collaboration and results on the land. Furthermore, the agencies can provide you with a great deal of information for decision making in the field, including soil type, desired plant species, desired level of production, and others. In addition, the agency may have monitoring sites on your allotment that have been studied recently. Rather than wasting your time establishing another transect nearby, work with the agencies and learn where their study sites are, so that you can provide unique decision-making information that can add to the collective knowledge of the area.

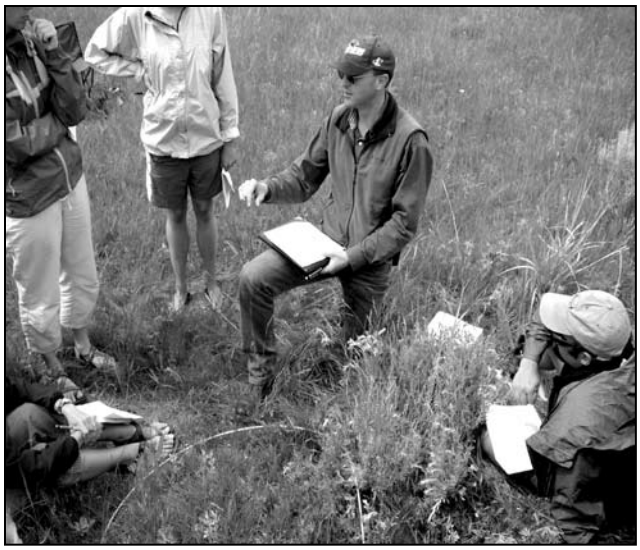


Photo 4: Performing a pasture assessment in southwest Montana.

When establishing your monitoring program, we recommend that you work with the agency to pick the actual spot on the ground you will study. Go to that spot on the land and talk about your desired landscape description for the area. You will need to have information on soils, desired and undesired plant species, wildlife, production, and a goal statement for guiding decision making. If you are on Bureau of Land Management (BLM) lands, have a copy of the Standards and Guidelines for your state handy as a specific reference for your landscape goal.

With your agency representative, re-visit your goal and ensure that you both share the same land health objectives. Make a list of those desired and undesired plant species that you will score against when assessing the land. Talk about your livestock management objectives. Share your concerns about rangeland health or abuse. Communication with the agencies is essential in this phase of the program.

Choosing the Right Monitoring Program for You.

❒ *Monitoring Methodologies Matrix (MMM)*

A confusing array of monitoring methods exists to gauge the health of rangelands. Often, monitoring results are exhibited as tables of numbers and confusing charts with interpretation difficult for the layperson. In addition, the choice of which type of monitoring methodology best fits the situation of the potential user is often very unclear. This in turn can result in inefficient use of monetary resources and valuable time, or a complete abandonment of the monitoring effort.

As previously stated, this manual was written for a primary audience of ranchers and other non-technical resource managers. It is not the

Monitoring Methodologies Matrix (MMM) - Choosing What's Best For You

Put a check in each box to mark the answer that best applies to your situation.

How Much Time and/or Money Can You Budget To Do The Monitoring?	Why Do You Want To Monitor?	What Do You Want Information About?	How Much Detail and/or Statistical Reliability Do You Require?	What Type of Reporting Do You Need?	How Often Do You need To Repeat The Monitoring?	Total Points Across Row
1-2 Days $100 - $200 1	I just want to know how the land is doing. 1	General Rangeland Health & Trend. 1	No data needed, photos helpful. 1	Fixed point photos only 1	Yearly 4	
3-4 Days $3,000-$4000 2	I need better information to manage toward my goals. 2	Detail on specific or general rangeland health. 2	Generalized information on rangeland health. 2	Simple graphic representation with narrative and photos. 2	One to three years. 3	
5-10 Days $5,000-10,000 3	Supporting documentation required by Federal Agency. 3	Specific area (treatments, etc.) health & trend. 3	Details and data on species composition, cover, density, frequency, etc. 3	Data Tables with photos, summary, and narrative. 3	Three to five years. 2	
> 10 Days > $10,000 4	Legal documentation of stewardship efforts. 4	Riparian, wildlife, cropland or woodland monitoring. 4	All the above plus production estimates and double sampling. 4	Full report with data tables, statistical analysis, photos, narrative, & recommendations. 4	Five to ten years. 1	
Total Points - This Total Helps Guide You to The Monitoring Procedure(s) That Best Fit Your Needs						

purpose of this monitoring manual to suggest any one method or combination of monitoring methods. This choice depends on many factors, and it is beyond the scope of this work to list all the potential methodologies available for monitoring rangeland attributes that might be of interest to the reader.

However, the Monitoring Methodologies Matrix (MMM) may serve as a beginning point in helping you choose the right combination of qualitative and quantitative methods that are right for you. Just as mentioned in the previous section, the choice of methods will be based on the goals and final purposes of the information by the user. Similarly, the MMM is not designed to guide you in the monitoring of riparian or woodland areas. However, some resources for doing so are provided in Appendix A.

The MMM first asks you to answer a number of questions about the purpose, constraints, and format of the monitoring needs. The choices under these headings help guide the user toward the categories of monitoring that may best serve their purposes. In addition, a list of monitoring resources is included in Appendix A where users may go for more information on rangeland monitoring techniques and choices.

To use the MMM, simply check the appropriate box for each column that best matches your answer to the column heading question. When you have finished, total the checked boxes across the rows and then total the last column to get a total point score. The Scoring Guide at the bottom of the page will help you decide if the procedures outlined in this manual are enough or if you need additional resources to complete your monitoring task.

The assessment methodologies outlined in this manual may be all you need, but as you can see from the list of resources, there are many options to choose from. Based on long experience, some important things to remember in making your choices are:

- Most quantitative monitoring methods are very time consuming and require many sample points to be statistically "valid."
- Because of the above constraint and the busy life most people lead, the time you allot to monitoring is probably your single biggest consideration. If, for example, you realistically can devote 3 days per year, this is the most important factor in using the rest of the matrix to help you select the right methodologies.
- Many people initially get very enthusiastic about monitoring and set out more work for themselves than can be realistically repeated.
- You may need to reevaluate your monitoring program in the future, but if you do not keep the same methodologies, that data may no longer be relevant.

Monitoring Methodologies Matrix Scoring Guide

■ A total score of 6 to 12 points means qualitative methodologies such as those outlined in this document, or in the qualitative section of Appendix A, will probably meet your monitoring needs.

■ A total score of 13-18 points means you will probably need to add quantitative methodologies to your monitoring protocol. Again, check the resources in this manual and the much longer list in Appendix A for specific procedures for gathering the data you need. Keep in mind that agencies may prefer or require a specific monitoring methodology for their needs.

■ A total score of 18-24 points means you need very detailed monitoring and professional experience in interpreting results. You may want to consider hiring qualified rangeland management professionals to conduct the monitoring and provide you with a report.

Indian ricegrass

Chapter 2: Assessing Rangelands

This section of the manual covers the use of rangeland assessment forms. These forms represent the qualitative information gathering portion of this manual. Rangeland assessment is meant to be a rapid, information gathering event where the user examines a series of indicators relating to rangeland health. Users will not normally collect quantitative data when using these techniques.

Potential uses of the rangeland assessment forms include the following:

1) Evaluating a pasture between grazings.
2) Evaluating the effectiveness of a vegetative treatment.
3) Examining soil stability and the effectiveness of the water cycle.
4) Examining the speed of the mineral cycle
5) Evaluating a site's ability to absorb solar energy.
6) Considering possible changes in plant species composition.
7) Contemplating future landscape-based objectives.
8) Helping a ranch crew better understand rangeland health and make better decisions for moving livestock across the landscape;.
9) Making changes to a grazing plan.
10) Determining whether or not to purchase a new piece of property.
11) Rapid evaluation of a landscape.
12) Teaching students the principles of range land health.
13) Increasing the level of collaboration between various rangeland users or interested public, by utilizing rangeland health as a common reference point.

The applications described above are intended for a wide audience. Procedures used are meant to have utility for a high school science class and college courses, as well as for the trained rangeland management professional of-

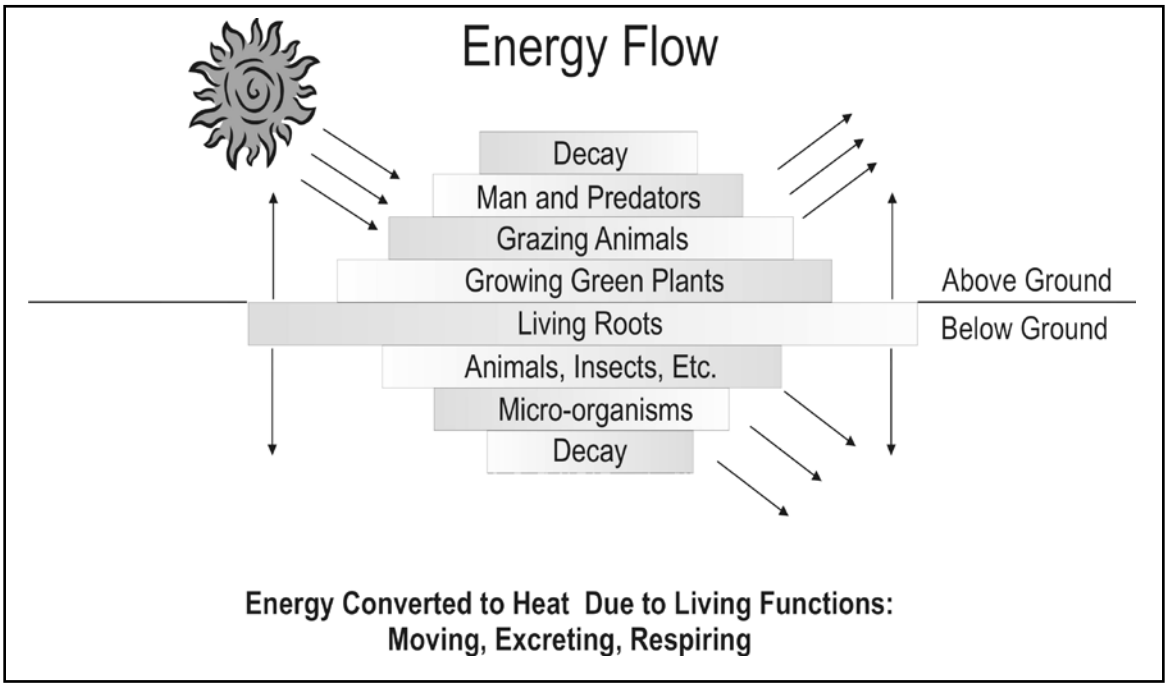


Figure 1.

fering recommendations to a rancher. The level of depth required for the use of these qualitative techniques can be set by those using them. If you are not trained in rangeland science, these techniques have been designed to help you learn the "language of land," and for better decision making. Conversely, if you have advanced learning in the world of rangeland science, these techniques were designed to help you have a written format for expressing your observations as you walk the landscape. Recorded observations can be shared with others, re-examined through time, and used to help others learn.

The rangeland assessment techniques ask the user to examine a series of rangeland health indicators. When considered collectively, the indicators portray the function of four fundamental ecosystem processes.

Fundamental Ecosystem Processes

Nature is best contemplated by appreciating its wholeness and interconnectedness, rather than breaking it down into pieces. However, when trying to broaden our minds to understand the complexity of a particular piece of country, we may quickly get confused. The four ecosystem processes identified here were originally linked together in this particular way by Allan Savory and described as fundamental to managing our ecosystems (1). The Rangeland Classification Committee recommended dividing nature into three fundamental ecosystem processes: mineral cycling and energy flow, water cycling, and recovery mechanisms (3). The indicators described here fall within one or more of these four ecosystem processes. They are briefly reviewed as follows:

❒ *ENERGY FLOW*

Almost all life requires energy that flows daily from the sun. The basic conversion of this solar energy to a usable form takes place through plant material on land and in water. [Energy passes from plants to whatever eats them, and in turn whatever eats the consumers of the plants.] Thus, energy doesn't cycle, but flows through the ecosystem as it is converted to another form of energy

Figure 2.

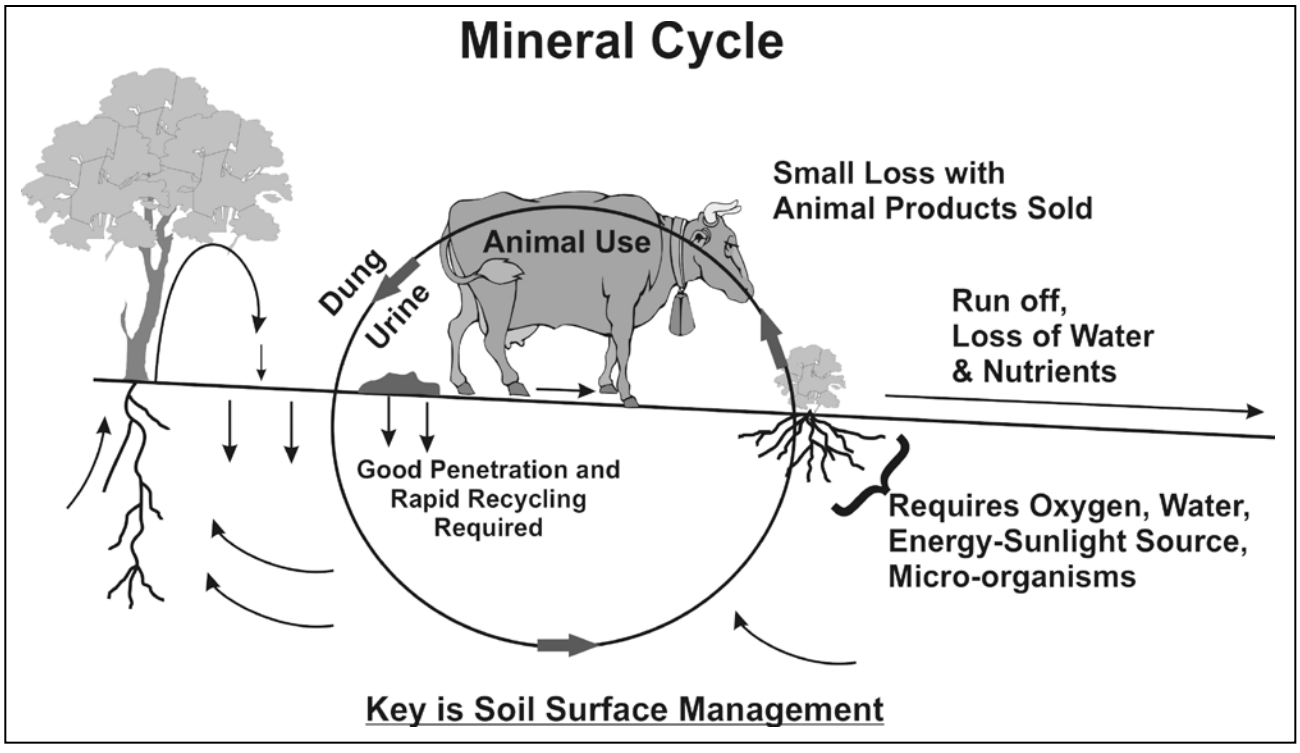
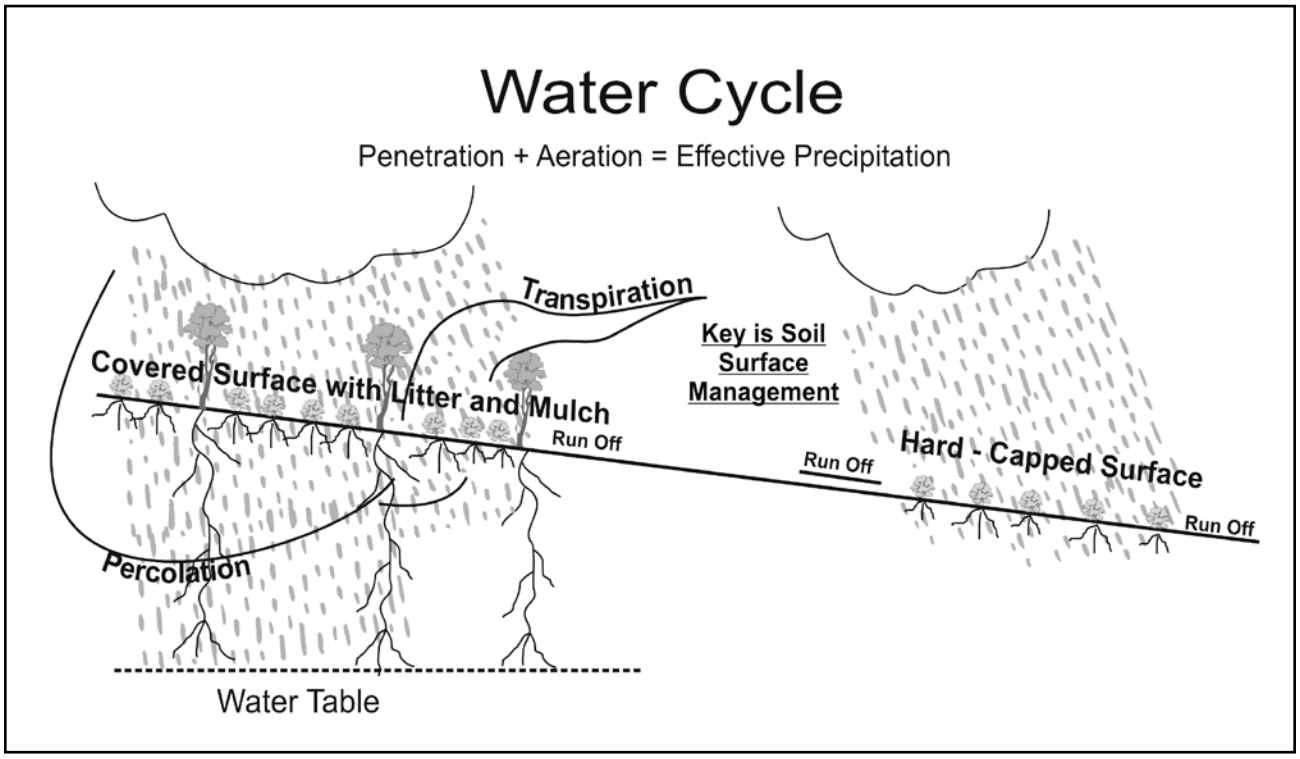


Figure 3.



(1). Also important to note is Savory's point that the energy flow "pyramid" takes place in a mirror image underground with roots, root consumers, predators, decay, etc. all playing their various trophic roles. He also notes that the actual pyramid is three dimensional, with axes of time, volume and area.

❒ *MINERAL CYCLE*

An effective mineral cycle requires covered soil and high biodiversity. When effective, many nutrients cycle between living plants and living soil continually. When soil is exposed and biodiversity is low, nutrients become trapped at various points in the cycle, or are lost to wind and water erosion (1).

❒ *WATER CYCLE*

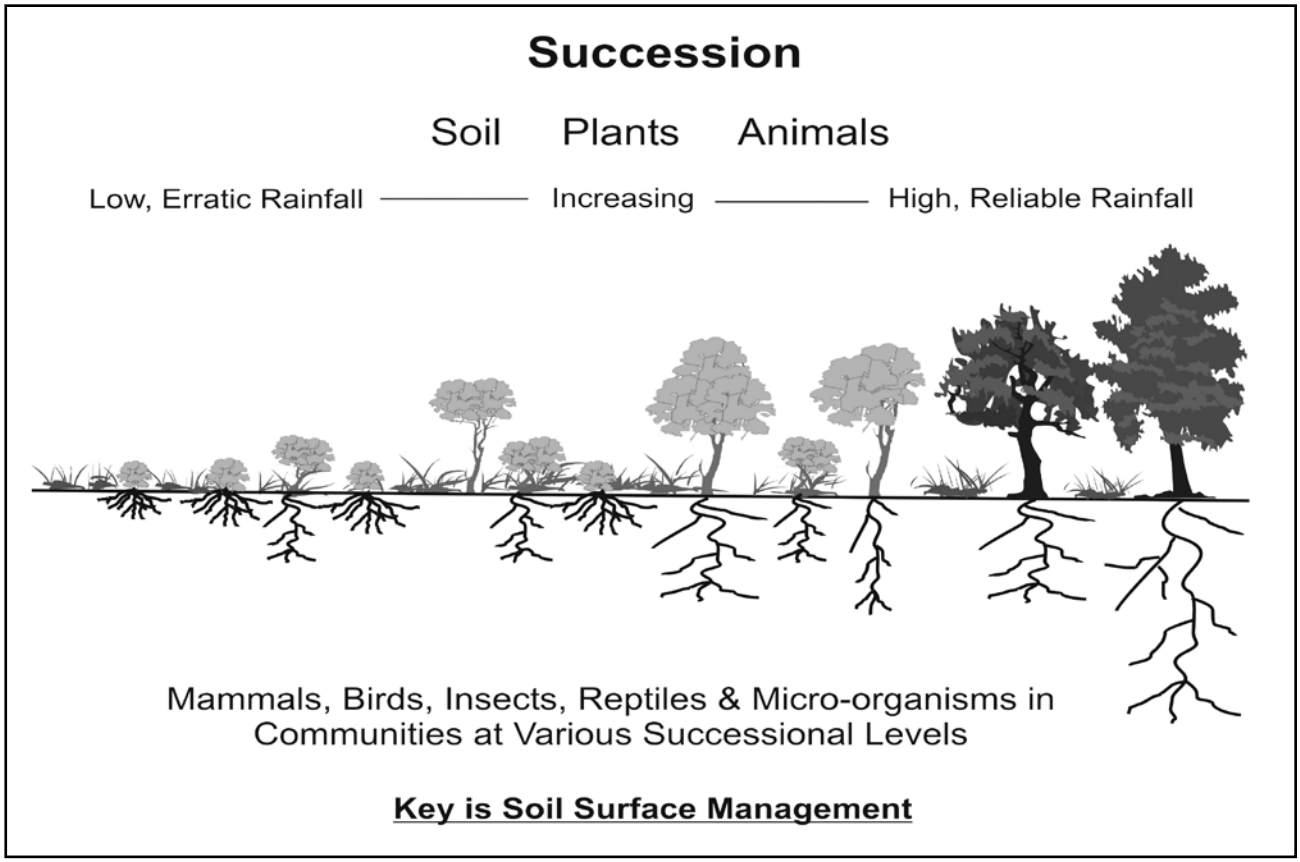
Like mineral cycling, an effective water cycle also requires covered soil and high biodiversity. When effective, most water soaks in quickly where it falls. Later it's released slowly through plants that transpire it, or through rivers, springs, and aquifers that collect through seepage what the plants don't take. When biodiversity is reduced and soil exposed, most water runs off as floods. What little soaks in is released rapidly through evaporation, which draws moisture back up through the soil surface (1).

❒ *COMMUNITY DYNAMICS - Succession*

With few exceptions, communities strive to develop toward ever-greater complexity, and thus stability. From unstable bare ground, where biodiversity is low, stable complex rangeland or forest communities, high in biodiversity, develop over time (1). This process is known as succession or more completely as community dynamics, since it is the whole community of plants, animals, insects and soils that change together over time.

These ecosystem processes may first appear to be quite intuitive. However, like most things in nature, one can explore their function to a great depth as has been done within ecology and rangeland science communities.

Figure 4.



Philosophy of the Rangeland Health Assessment

The basic philosophy of rangeland assessment is simple and straightforward. When assessing an area of rangeland using this manual, users will be asked to first consider their landscape objectives. Then, they will evaluate the function of the four ecosystem processes to compare the current situation with the stated objectives. The gap that forms between current land health and the stated objectives, forms the impetus for management action. Management will then be asked to consider those actions that will take the landscape toward the stated objectives.

The question is sometimes asked, "How do I know what the potential of my land is? If I have landscape objectives that are unattainable, I will be setting myself up for failure." This is a valid question, but the potential of the land can generally be determined within reasonable limits by looking at areas of the land which have been managed well or looking at the corresponding ESD's for your area.

Most of us have heard tales of "grasses that used to grow stirrup high" in the area. It may be true, and we may be able to expect significant improvement in production and potential as ecosystem process is improved. For example, if half the rainfall you now receive runs off, and you are successful in getting most of that in the ground, it would be like doubling the rainfall you receive! In most instances that would make a substantial difference to rangeland health indicators.

Little bluestem

Chapter 3: Using Range Assessment Forms to Evaluate Rangeland Health

Getting Started

You will need the following materials to perform this assessment and copies of the forms can be found in Appendix B:

- ☑ **Targeting Rangeland Health form.**
- ☑ **Targeting Rangeland Health Scoring Guide.**
- ☑ **A clipboard and some rubber bands to hold papers to the clipboard.**
- ☑ **A pencil with an eraser.**

We also highly recommend contacting the NRCS office in your area and obtaining soils and ecological site information. To best help you, the NRCS will need to know where you are planning to do your assessment. Having a map of the area you will visit, or at least a legal description, will benefit them greatly. The NRCS also has a great deal of information on area soils. They can be a great resource for making your assessment efforts easier.

Photo 5: Examining soil cover on Colorado's Bitterbrush Ranch.

To perform the assessments outlined in this manual, ask NRCS for ecological site descriptions from the area you wish to assess. These descriptions will contain abundant information on average rainfall, anticipated plant production, plant species composition, soils information, and many other factors. The newest tool to help you is the web soil survey at: www.websoilsurvey.com.

An ecological site is defined by the NRCS as a "distinctive kind of land with specific physical characteristics that differs from other kinds of land in its ability to produce a distinctive kind and amount of vegetation." The BLM and U.S. Forest Service use slightly different terms for the ecological site, but the meanings are essentially the same. The ecological site concept is helpful in that it helps us consider expectations for our particular study site. If the ecological site descriptions are lacking, ask NRCS for a copy of the local soil survey. The soil survey will also contain useful information, but in much less detail. Lastly, we recommend taking along any plant identification books you may need.

Choosing an Assessment Site

Choosing a location to perform the assessment is important. If you are in a pasture, for example, you want to assess an area that is important both from the standpoint of your objectives and also from the ability to make decisions from the information you gained. Thus, if one of your goals is improving land health, you should pick a spot in the pasture that provides meaningful information for your use in making management decisions.

With this form of qualitative methodology, no effort is typically made to permanently mark an assessment site. The intent is to have the work done rapidly, without the need to have a permanently marked location. Permanently marked

sites will be discussed in the quantitative portion of this manual on page 35. If you wish to revisit an assessed area in the future, use a Global Positioning System (GPS) unit to record the site's coordinates. Plenty of room exists on the rangeland assessment form for recording the units. Further, you may choose to take a photograph of the area for reference.

We offer the following tips for picking an assessment area:

Look for areas of interest . . .

1) Will the area change?

If you have recently changed your management in an area, perform an assessment where the greatest change will be noticeable. Remember the root of the word "monitoring": to warn. If your management actions are not moving land health toward your goal, you will want to know why. Conversely, if you believe an area is improving, you must consider what is enabling such change.

Examine your potential assessment site and focus on what aspects of the land will change. Will the amount of bare ground change here? Will more wildlife find a home here with increased land health? Can litter incorporation improve? Will plant production improve? Will more desirable plant species move into (out of) the community? Will less desired species move out of (into) the community?

2) Is the area representative of a significant amount of acreage?

Go onto a hillside that overlooks the area you will assess. Extend your arm in front of you and raise a thumb as if hitchhiking. Your thumb should block your view of a small piece of rangeland in the distance. Realize that this small piece of acreage is representative of what you will study when you perform an assessment. Your assessment will cover only a fraction of the landscape whose health you are responsible for monitoring.

Will the study speak for many acres? Will the information you gather with a study be applicable for the surrounding country, and will this land respond similarly to changes in management? Only you can answer these questions. In general, we recommend that you locate assessments in spots where the soils, vegetation, and topography are similar so that one assessment can speak for significant acreage. The monitoring term used for this is called picking a "representative" site.

If you have several pastures in a homogenous landscape, we recommend performing several assessments in each of these pastures. However, we recognize that time constraints for such an ambitious program can be prohibitive. Just remember that monitoring rangeland health is like any other type of sampling: the more samples you have, the more reliable your information will be. Your job is to try and strike a balance between the time and money you have to monitor and the need for accurate and reliable information.

3) Is the area important in terms of wildlife habitat?

Work with your local wildlife interests and learn if critical wildlife habitat is present in your area (fawning areas, duck nesting, roosting sites, sage grouse leks, etc). Depending on your goal, you may wish to study such an area and learn how you can improve this habitat.

4) Are the soils or vegetation deteriorating on the site?

Can you see soil actively moving on the site? Are plant roots exposed due to erosion? Are some plant species dying? The answers to these questions may suggest a need for a monitoring site, unless this area is atypical and the noticeable deterioration is caused by a known factor.

5) Will treatments be conducted in the area (burning, brush beating, chemicals, etc)?

If you are planning a vegetative treatment in the area, you may wish to track the success of your treatment through time by assessing the area be-

fore the treatment. Re-read the study through time and follow your progress while noting management tools that have been applied before and after the treatment.

6) Will grazing management be altered in the area?

If management of livestock is altered significantly in an area, vegetative and soil conditions will change as well. Assess an area that will track any response toward your goal.

7) Are noxious weeds abundant in the area?

If you have many undesirable plants in an area and you change your management, you may wish to track changes in the plant community toward or away from your goal. If desirable plants increase and the undesirable plants decrease, this is important to document. It should serve as positive reinforcement for a job well done. If the converse is true, you will need to implement other strategies for achieving your goals.

Using the Rangeland Assessment Form

Examples of rangeland assessment forms are included in Appendix B. It may be helpful to remove one for reading the following material.

Attach the rangeland assessment form to the clipboard. If the wind is blowing, wrap a rubber band around the forms and clipboard to prevent damaging the forms. Then complete the basic background information on the form:

Ranch Name, Site Name, Observers, and the Date.

Fill in the name of the ranch or the property you are assessing in the "**Ranch**" blank. When choosing a site name for the "**Site**" blank, choose something meaningful that represents the area. This may be the pasture name, ecological site, or it may reference a particular area landmark. The key is to choose something that will have meaning to you in the future. In the "**Observers**" blank, record who was present during the assessment. Finally, record the "**Date**" of the assessment.

Ranch:
Site:
Observers:
Date:

The next area is labeled "What do we want to see here?" Consider the site and how you would like it to appear. What is the ideal situation for this site, given your landscape description objectives? Note that if you are on public land, the land management agencies will already have this largely defined. For example, on BLM land, their Standards and Guidelines descriptions will examine a desired state of rangeland health. These vary by state. They should be used when evaluating your site.

On private land, the same considerations are in order. Consider your ideal landscape objectives for the site and how you would like the land to appear. Regardless of whether you are on private or public land, NRCS's ecological site descriptions will likely prove useful.

Desired plants:
Desired production:
Desired wildlife:
Other special objectives:

What do we want to see here?

Under "**Desired plants,**" list those species you prefer to find in the area. If you can, list particular grass, forb, shrub, and/or tree species. Within the blank "**Desired production**," list that level of production in pounds per acre desired for the site. If you are unsure about this production you can leave it blank. With both of these objectives, the ecological site descriptions from NRCS are a great resource. Next, consider those wildlife species desired for the area. They may be big game, birds, predators, rodents, insects, and/or amphibians. Finally, consider "**Other special objectives**" for the area. Examples of these may be preventing

the spread of noxious weeds, improving habitat for a particular wildlife species, promoting growth of a particular plant, and/or improving rangeland production.

With this exercise, the key is to consider the ideal desired landscape for the site. What do you want to see in this area? This will be the goal by which you examine management action and determine the success of your actions (see the Sample Future Landscape Description on page 5).

A sample is provided below.

What do we want to see here?

Desired plants: Green Needlegrass, King-Spike Fescue, Timber Oatgrass, Prairie Clover, Balsamroot, Lupine, Big Sagebrush, Species desired by wildlife...
Desired production: Around 1,200 Lbs/Acre
Desired wildlife: Elk, Mule Deer, Various songbirds, Raptors, Sage Grouse, Earthworms and Insects
Other special objectives: • Minimize spread of noxious weeds • Minimize bare ground

The above sample contains plant and wildlife species and production information from the NRCS ecological site descriptions for a particular site. Desired wildlife and plants are those preferred to be seen in the area by the land owner or manager because they help meet their ecological and production goals. The two items in "**Other special objectives**" reflect concerns and a goal of this particular landowner.

Next, examine how the land looks today.

What do we see now?

Look around the site and record the most prominent plant species in the "current abundant plants" box. When considering the most abundant plants, record those that seem to be the most prominent in the community. Which do you see the most? Don't worry about recording all species seen in the area, but get those that seem to be the most abundant and dominate the production. Record observations in the "What do we see now?" box.

OPTIONAL In the "current production" box, record the current year's plant growth in lbs/acre.

Current abundant plants:
Current production:
Current wildlife:
Current concerns:

This can be tricky, for you must estimate how much plant growth you see in pounds per acre. If you cannot estimate production, think about what level of production you see in relation to what is possible for the site from the ecological site description. Is production below this figure? Above it? About the same? Even if you can't answer these questions, think about the level of production required to meet your objectives. Is that level of production adequate?

Next, record current observations of wildlife. You may not see different wildlife species in the area at the time, but you may see signs of them, or have noted their presence in previous visits. Look for their dung on the ground, feathers caught on a shrub, insect exoskeletons, and the like. Record your observations in the "**Current wildlife**" box. Keep in mind that this is a qualitative assessment and if you want more detailed information of wildlife numbers or habitat you may have to monitor these in more detail. Here we are simply trying to get a "handle" on animal species diversity in addition to plant community diversity.

Finally, in the "**Current concerns**" box, record such items as excessive soil erosion, presence of noxious weeds, lack of forbs, and/or monoculture of shrub species. List anything that is a problem or is potentially a problem.

See the illustration on page 18 as an example.

What do we see now?

Current abundant plants: Western Wheatgrass, Idaho Fescue, Prairie Junegrass, Fringed Sage, Pussytoes, Western Yarrow, Sandberg Bluegrass
Current production: Around 600- 650 Lbs/Acre
Current wildlife: Elk, Mule Deer, Various songbirds, Raptors, Sage Grouse, Earthworms and Insects
Current Concerns: • Noxious weeds are present • Excessive bare ground • Low production

In this example, the observers walked around their study area and recorded those plant species they thought were most abundant. They then estimated plant production range in pounds per acre. They didn't see any elk or mule deer on the site, but found their droppings. They also heard songbirds, and saw the insects listed.

They were concerned with the amount of bare soil found in the area and thought it may provide opportunity for noxious weeds to germinate. They also saw some noxious weeds in the area. Finally, they thought that plant productivity was low compared with their objective.

Notice the difference between the stated goal in "What do we want to see here?" and the current situation in "What do we see now?" It will be the job of management to help minimize this difference through further management actions. The rest of this exercise will help users consider other indicators of rangeland health that suggest what is happening on the land. Importantly, they will also help guide management action for narrowing the gap between the stated objectives and current observations.

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Chapter 4: Rangeland Health Indicators

Rangeland Health Indicators

Qualitative indicators help us evaluate functionality of the four previously mentioned ecosystem process indicators: water cycle, mineral cycle, energy flow, and community dynamics. They are quite useful for evaluating processes that are not easily quantified. Indicators provide better understanding of dynamics within a particular ecosystem process. Their examination helps reveal concerns and also causes of change within the ecosystem processes.

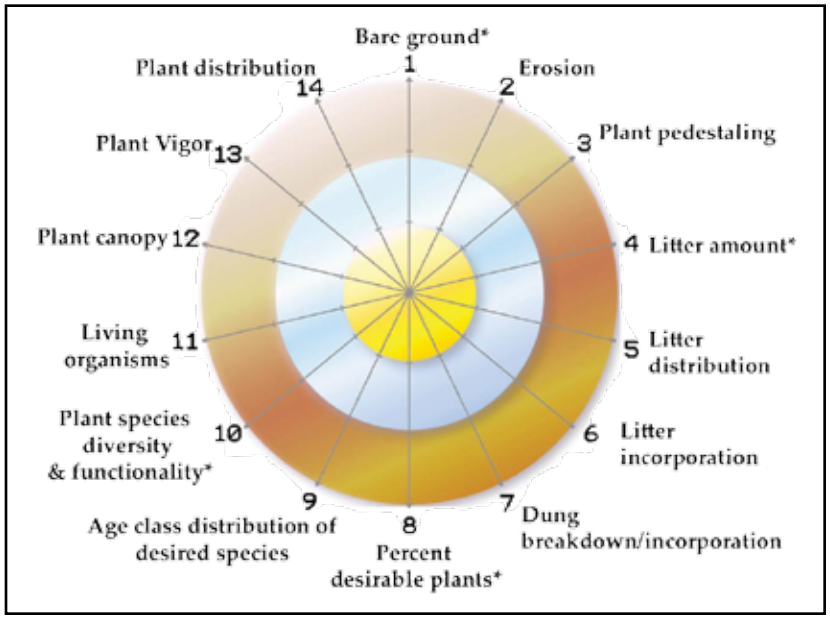


Figure 5.

The fourteen indicators of ecosystem process used in this manual are displayed below. These indicator terms are found in many ecology, rangeland management and monitoring books (Appendix A.) They can be seen on the lower left-hand side of the Rangeland Health Target evaluation form in Appendix B.

1) Bare ground*
2) Erosion
3) Plant pedestaling
4) Litter amount*
5) Litter distribution
6) Litter incorporation
7) Dung breakdown/incorporation
8) Percent desirable plants*
9) Age class distribution of desirable species
10) Plant species diversity and functionality*
11) Living organisms
12) Plant canopy
13) Plant vigor
14) Plant distribution

These qualitative indicators will be used to suggest how well the ecosystem processes are functioning. Users will examine the functioning level of each indicator using a scoring guide and then will portray the scoring of these indicators graphically on the Rangeland Target shown above.

The gold, silver, and bronze color scheme is meant to portray three levels of indicator function. The fourteen indicators will receive a "score" or a point on the Rangeland Target. An indicator whose function is considered desirable will receive a point on a target spoke in the gold or best area. Conversely, an indicator whose function is not performing as desired will receive a lower score with a point on a target spoke in the bronze color. Those indicators between gold and bronze will receive a score in the silver area.

When considering these indicator's function and then plotting them on the target, users gain a visual portrayal of ecosystem process function. Just like a practice target, the more marks that are close to the center, the closer you are to achieving

your rangeland health objectives. Problems are then more readily apparent and solutions more easily diagnosed. Observers of rangeland health also have means of recording their observations in a quick and user-friendly manner.

Evaluating Indicators of Rangeland Health

These evaluations are to be conducted when walking around your selected study area. They will not be completed when looking within a set plot on the soil, although you may want to look closely at a few spots. When performing the assessment, it may help to walk around the study area and consider it in different places to gain better perspective of the indicators.

The scoring guides on pages 26 & 27 will be used to evaluate each of the rangeland health indicators. Extra copies of the example scoring guides are are available in Appendix B.

Photo 6: Large areas of bare ground between perennial plants.

Indicator # 1: Bare Ground

With this indicator, consider how much bare soil is found in the area. Rather than worrying about the exact percentage of bare soil, consider if this amount is too much in relation to the potential of the site. Given the desired plant species, plant production, and wildlife objectives, does too much bare ground exist on this site?

Refer to Side One of the Scoring Guide on page 26. Indicator #1 is that for bare ground. Read across the scoring guide to the descriptions for scoring this indicator's function for gold, silver, and bronze. The gold area reads, "Amount and size of bare areas nearly to totally match that expected/desired for site." The wording, "expected for the site", is borrowed from the publication Interpreting Indicators of Rangeland Health (see appendix A). It is one of the four indicators listed that have direct references to the NRCS ESD's. Normally the ESD will list the range of bare ground percentage that should be expected for that site. Thus, this indicator has an asterisk to remind you to check the ESD for expected percentage of bare ground for the site.

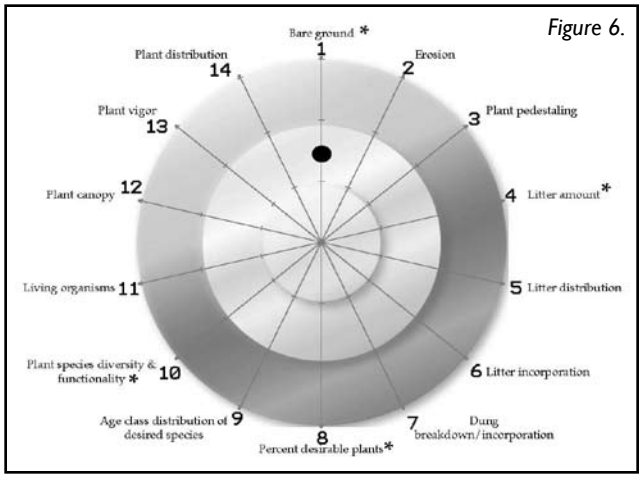
Ask yourself if the level of bare ground at your site is acceptable and expected for this site? If so, place a dot on the Rangeland Target on spoke number 1 in the gold area.

Conversely, is more bare soil being seen in this area than is expected and desired? Examine the bronze score for this area, which reads, "Amount and size of bare areas are much higher and larger than expected/desired for site. Bare areas are generally connected." If your site is represented by this description, place a mark on the Rangeland Target on spoke number 1 in the bronze area.

If the site is not represented by either the gold or bronze descriptions, consider that it probably falls in the silver area.

An example of how the score is plotted on the Rangeland Target is shown below, which shows a score in the silver. These observers believed that the amount of bare soil found on their site was higher than they would like. The amount was not

Figure 6.



so high as to warrant a low score in the bronze area.

The remainder of the indicators scored in this exercise will be plotted on the Rangeland Target in the same fashion. If you think an indicator falls in the bronze but is almost in the silver, place it near the boundary of these two colors.

Indicator # 2: Erosion

Erosion is soil movement on a site caused by wind or water. Symptoms of water erosion include obvious flow patterns, small rills, channels or the formation of gullies. Symptoms of water erosion also include sheet erosion (where soil washes away one layer or "sheet" at a time). Sheet erosion normally occurs on fairly flat areas with high rainfall and/or poor infiltration.

Photo 7: Erosion caused by water runoff.

Wind erosion symptoms include wind scoured areas where topsoil has been blown away to lower compacted areas. The collection of this material may result in the formation of small dunes and deposits of soil around obstructions and the bases of plants, sometimes known as hummocks. In extreme cases these can form large dunes around predominant shrubs such as mesquite. "Desert pavement" forms when wind blows finer soil particles away, leaving small pebbles (coarser materials) behind. The result is a layer of gravel that can resemble pavement. Wind erosion occurs most often when plant density is low and there are large spaces between the plants so that wind velocity forces move the soil particles.

When examining soil erosion, it is important to note whether or not soil is leaving a site. It is desirable to see soil held firmly in place by plant roots, but some soil can move around slightly in the wind without leaving the area. When soil is actively leaving an area, problems arise.

Examine erosion in your study area and assign a score for this indicator using the Scoring Guide. Record your score on spoke #2 on the Rangeland Target.

Indicator # 3: Plant Pedestaling

Pedestaling is another important water cycle indicator that is closely related to erosion. Pedestals form when the soil around a plant base erodes, leaving the plant crown elevated above the surrounding area. When such action is severe enough, plant roots become exposed to the detriment of the plant. The photo on the right shows such a plant that is heavily pedestaled after wind has removed surrounding topsoil. Note the exposed roots at the plant's base.

Photo 8: Obvious pedestaling with root exposure. Note pen for scale.

Using the Scoring Guide, rate pedestaling and record your score on the Rangeland Target on spoke #3.

Indicator # 4: Litter Amount

Evaluate the litter present on the site. The term "litter" refers to old plant material lying on the soil surface. How much litter is present on the site in relation to your landscape objectives? Too much? Not enough? Is litter cover so light that soil is eroding? Do you then want to see more litter? Conversely, is litter cover so heavy that it is choking out new plant growth? Using the Scoring Guide, consider litter cover prevalent on your site

and plot a mark on the Rangeland Target on spoke #4.

Photo 9: Dense litter covers the area between plant crowns.

The asterisk by this indicator again denotes that the NRCS has established percentages of litter cover that can be expected for various sites. If this resource is available, compare your observations to those in the Ecological Site Descriptions.

Indicator # 5: Litter Distribution

How well is litter scattered over the surface at your site? Is it evenly distributed, patchy, or is litter abundance so light that hardly any litter exists at all, resulting in very patchy litter cover? Movement by wind and water also creates a patchy litter distribution and is another indicator that erosion is taking place.

Depending upon your area, litter can play a vital role in helping to shade the soil surface from the drying effects of the sun. Simultaneously, litter breaks the force of raindrops falling from the sky at terminal velocity that might otherwise strike bare soil and create a surface crust. Having good uniform litter cover on arid rangelands can greatly benefit the function of all fundamental ecosystem processes. It is a critically important indicator of rangeland health.

Examine the litter at your site and evaluate its uniformity of cover. Consider items such as manure and insect exoskeletons as litter. Using the Scoring Guide, score this indicator and make a mark on the Rangeland Target on spoke #5.

Indicator #6: Litter Incorporation

This indicator examines how well previous years' plant material is being returned to the soil surface. Nutrients retained in this plant material should be recycled. In many arid environments, litter must contact the soil before it can be broken down biologically because many organisms of decay live within the soil itself. Thus, litter contact with the soil can greatly speed the mineral cycle.

Examine the litter in your study site. Is it elevated above the soil surface? Some sites display plenty of litter cover, but it is not touching the ground. The mineral cycle is slowed in this case, since organisms of decay cannot always reach elevated litter. In some areas termites play a major role in cycling of nutrients. They are sometimes referred to as "the earthworms of the desert." Typically they build soil cover over the material they cycle and this indicates their presences.

Is litter contacting the soil but not mixing with soil or breaking down? In the West, it is common to see litter on the soil surface that is not being decomposed by microorganisms. This litter is usually a gray color since the sun is oxidizing it and vital nutrients are being lost. Even if litter is not in contact with the soil, it can still help prevent soil loss caused by erosion. However, if it were contacting and mixing with the soil, the mineral cycle's rate would increase.

Finally, is the litter contacting the soil and breaking down? Dig down into the soil with your finger and determine where litter ends and soil begins. This should be evident with a change in color between litter and soil. If you have trouble determining where litter ends and soil begins, then your litter is incorporating nicely and helping to form new topsoil.

Photo 10: Recent manure (left) next to greater than one year old (right).

Using the Scoring Guide, determine how well litter is incorporating on the site and place a mark on the Rangeland Target on spoke #6.

Indicator # 7: Dung Breakdown and Incorporation

How well is dung from both livestock and wildlife decomposing? If dung is lying around idly on the soil surface for years, it may suggest a slower mineral cycle. Conversely, if dung appears to be breaking down more rapidly, this would indicate better insect and microbial activity and a more rapid mineral cycle. Since much of the nutrient cycle takes place underground, this above ground visual indicator can be one of the best clues to the cycling of nutrients in the system.

Try to find manure from cattle or other animals. Examine how well it is decomposing. How old does it appear to be? Older manure will usually be a lighter gray color due to oxidation by the sun (see ***Photo 10*** page 22). This determination is a great indicator of the mineral cycle's speed. Further, examine your grazing records and recall what time of year cattle have been on the site. Were they in the area when the forage was lush and growing? If so, you may expect this manure to contain more moisture, which may decompose more readily. Was the herd in the area when the forage growth had slowed, making it more rank and lignified? If so, then the moisture content of the fresh manure was likely lower. This material may break down more slowly. If however, this manure is breaking down more rapidly, you may be observing an indicator of a more rapid mineral cycle.

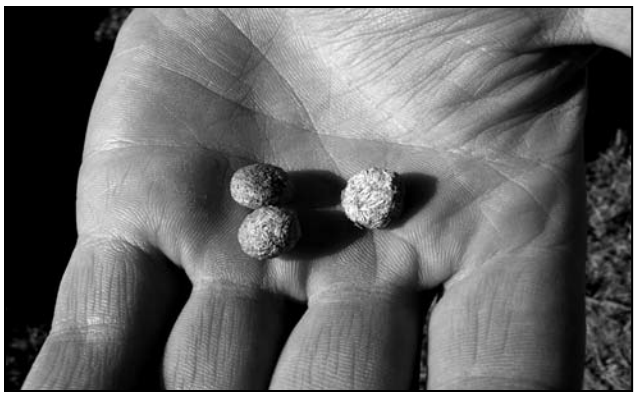


Photo 11: Note the different color of these rabbit droppings. The gray colored dropping on the right is over one year old while the two brown droppings on the left are from the current year.

Finally, keep in mind that manure deposited during winter or very dry weather may not break down very quickly regardless of the general rate of nutrient cycling in the system. Remember that the Indians and pioneers burned buffalo dung for fuel. However, it is likely that these were not from summer deposition.

Rapid breakdown may simply be seen as a lack of manure. If you know from your grazing records that livestock were in the area you are monitoring, but there is little or no evidence of dug, it probably has already been cycled. In areas with heavy dug beetle populations, this can happen in as little as a few days or even hours! If this is observed, it is also an indicator for #11, Living Organisms.

Using the Scoring Guide, evaluate the rate of dung breakdown on your site and place a mark on the Rangeland Target on spoke #7.

Indicator # 8: Percent Desirable Plants

This indicator examines the desirability of plant species at your study site. We recognize that the terms "desirable and undesirable" are highly judgmental terms for both plants and animals. For example a noxious weed may be more desirable than bare ground. But, in general you are being asked to consider if the plants you see there meet your production and landscape goals. Are they beneficial for wildlife and watershed goals? If so, they are desirable in this context.

Refer to your desired plant species list in the "What do we want to see here?" box. Those are your most preferred species. Some plants occurring in the area, such as noxious weeds, may be clearly undesired. Others found in the area may be intermediate species. That is, they are neither desired nor undesired. Consider what role these plants play in the "whole" ecosystem and if other plants that grow in the area could be better at helping achieve your goals.

SCORING GUIDE SIDE 1

		Gold: Achieving Goal	Silver: Moving Toward/Away from Goal?	Bronze: Not Achieving Goal.
1	Bare Ground*	Amount and size of bare areas nearly to totally match that expected/ desired for site.	Amount and size of bare areas higher and larger than expected/desired for site. Bare areas may be large and sporadically connected.	Amount and size of bare areas are much higher and larger than expected/desired for site. Bare areas are generally connected.
2	Erosion	Little to no evidence of wind or water erosion, including desert pavement, rills, and/or gullies.	Some signs of soil loss, including formation of desert pavement, rills, and/or gullies.	Soil is actively leaving the site. Advanced formation of desert pavement, rills, and/or gullies may be seen.
3	Plant Pedestaling	No or minimal plant pedestals present.	Some to moderate plant pedestals present. No signs of exposed roots.	Plant pedestaling obvious and tall. Root exposure seen.
4	Litter Amount*	Amount of litter nearly to totally matches that expected/ desired for site.	Amount of litter less than that expected/desired for site.	Amount of litter much lower than expected/desired for site.
5	Litter Distribution	Litter is uniformly distributed across site.	Less uniformity of litter distribution. Litter may be becoming associated with prominent plants or other obstructions.	Litter distribution not uniform. This may be due to general lack of litter and/or obvious patchy appearance of litter amount.
6	Litter Incorporation	Litter mixing well with soil, resulting in more rapid mineral cycle.	Some mixing of litter with soil. Litter may be elevated and its amount may be reduced. Mineral cycle not as rapid.	Litter not mixing with soil. Litter may be elevated and/or amount too little. Mineral cycle slower.
7	Dung Breakdown/ Incorporation	Dung breaking down rapidly, less than one year old.	Some dung breakdown, with most being around 2 years old.	Dung breaking down slowly, older than 2 years old.

*Refer to ecological site descriptions available from NRCS

SCORING GUIDE SIDE 2

		Gold: Achieving Goal	Silver: Moving Toward/Away from Goal?	Bronze: Not Achieving Goal.
8	Percent Desirable Plants*	Greater than 66% of plants in the area are desired. Remainder of plants are intermediate species (neither desired, nor undesired).	33% to 66% of plants species in the area are desired. Intermediate species (neither desired, nor undesired) have strong presence. Potential presence of undesired species.	Less than 33% of plant species in the area are desired. Intermediate plant species (neither desired, nor undesired) dominate. Undesired species also present.
9	Age Class Distribution	Variety of age classes seen in the area (seedling, young, mature, decadent).	More mature age classes present, seedlings and young mostly lacking.	Primarily old and/or deteriorating plants present.
10	Plant Species Diversity & Functionality*	Number of plant species in the area matches that expected for site. Plant forms (grass, shrub, forb, tree) also match that expected for site. Plants serving different functions.	Number of plant species in the area below that expected for site plant forms (grass, forb, shrub) reduced. Reduced functionality.	Number of plant species the area minimal. Plant forms (grass, forb, shrub) much below that expected for site. Poor functionality.
11	Living Organisms	Abundant signs of non-plant life.	Few to moderate signs of non-plant life. Something is missing from community.	Next to no signs of non-plant life. Components of the ecosystem are clearly missing.
12	Plant Canopy	Strong photosynthetic activity in the area. Canopy may cover greater than 66% of area.	Moderate photosynthetic activity in the area. Canopy may cover 33-66% of area.	Reduced photosynthetic activity in the area. Canopy may cover less than 33% of area.
13	Plant Vigor/ Color	Capability to reproduce (seed or vegetatively) not limited relative to recent climatic conditions. Growing plant exhibits bright green color.	Capability to reproduce (seed or vegetatively) is somewhat limited relative to recent climatic conditions. Growing plant exhibits pale green or may be yellowing.	Capability to reproduce (seed or vegetatively) is severely reduced relative to recent climatic conditions. Growing plant exhibits sickly yellow coloration.
14	Plant Distribution	Plants uniformly distributed across soil surface.	Distribution becoming fragmented, but some areas of uniformity.	Distribution obviously fragmented.

*Refer to ecological site descriptions available from NRCS

What percent of the plants do you see occurring in your study area is desirable? If more than two-thirds of the species are desirable, and you do have the presence of a few intermediate species, score this indicator in the gold. If one-third to two-thirds of the plant species are desirable, while many are intermediates and some may be totally undesirable, score this indicator in the silver. Finally, if the area contains less than one-third desired species and is dominated by intermediates, possibly with a strong component of undesired plant species, then score this indicator in the bronze.

This is another indicator that contains an asterisk by it to denote the linkage to expected conditions for your site that are detailed in the NRCS Ecological Site Descriptions. Here you will find a list of the various plants that are expected to be found on the site under different conditions. This may help in determining which are the desirable plants for your site.

After making the determination, place a mark on the Rangeland Target on spoke #8.

Indicator # 9: Age Class Distribution

The term "age class distribution" suggests that plants of different ages are placed into categories or classes. Four commonly used age classes are (1) **seedlings**, (2) **young**, (3) **mature**, and (4) **decadent**. A decadent plant is one that is in its final stages before death.

This may be one of the most difficult indicators to evaluate within the protocol. Here, we wish to know if a desired plant species is replacing itself within the plant community. As an example, you may find an area where many individuals of a desired plant species are decadent. This may not be a bad thing if you can also find younger plants of the same species that are moving into the community to replace those on their way out.

Evaluating age classes of grass plants can be extremely difficult. When judging bunchgrasses, for example, how do you know when a plant is young or mature? No true answer may exist for this question, but you can work backwards to provide yourself some clues. First, seedlings often appear as "hairs" or tiny filaments of grass newly growing on the soil surface. To see such hairs, your eyes must be quite near the soil surface or the hairs will be missed. Second, decadent grasses are those that are dying. They contain much dead leaf and stem material (not to be confused with last year's unharvested growth) and only a little living material. Third, when evaluating bunchgrasses, know that their plant crowns may increase in diameter through time. As an example, needle and thread grass will grow a circular base that gets quite large as the plant ages. In time, this base will separate into several smaller bases and will appear if several new plants have established. Don't use plant height alone as a reliable indicator of age class, for many variables determine how tall a bunchgrass will grow.

Rhizomatous (roots that travel horizontally through the soil and send up shoots to form a new plant) and sod forming species present a more difficult challenge for evaluating age structure. Some of these species can sprout from both seeds, stems, and root propagation. In this case, those plant tillers above and below ground may all be connected by the same mass of roots. If you can, try and follow the expansion of the root mass by examining the above ground plants. In general, if the plants are establishing young by any of these methods, this is desirable. If no new plants are establishing, this is generally an undesirable condition.

Two other tips are helpful in evaluating this indicator. First, examine the area during peak growth, when the plants have all produced seed. This will not only make plant identification easier, but you will also be able to examine which plants may be decadent more easily. Additionally, if a wet year has occurred, new seedlings can often be found more readily.

Second, don't get caught in the trap of evaluating only grasses. Examine your whole desired plant list and consider the trees, shrubs, and forbs whose presence you seek.

Unlike grass, a shrub's age class can be more easily distinguished by its size. Size is not the only indicator of plant age, but it can help. For example, if examining sagebrush, calibrate your eye to the age of plants and their height by cutting a plant stem with a fine-toothed saw. Then place a little oil on the freshly cut end. This makes the rings much easier to count and you will be provided with a better understanding of how plant size relates to its age.

Using the Scoring Guide, evaluate this indicator and place a mark on Rangeland Target spoke #9.

Photo 12: Photo showing low diversity and functionality on this area of rangeland site.

Indicator # 10: Plant Species Diversity and Functionality

This indicator assesses both the plant diversity and ecosystem functionality of plants at the study site.

The New Ranch Handbook effectively explains the importance of species diversity: "*Each species has particular requirements to survive: a certain range of climatic conditions, energy sources, etc. Where conditions are highly variable, as they are in Southwestern rangelands, high biodiversity increases the likelihood that some species will thrive no matter what conditions prevail at any particular time. Therefore, high biodiversity makes it less likely that all the species present will decline simultaneously during a time of severe stress or disturbance. A diversity of vegetation makes the rangeland as a whole more resilient: capable of recovering from whatever stresses or disturbances occur* (4)."

A plant species' functionality becomes important when we consider the different root structures of plants present in the study area. For example, grasses tend to have roots that grow relatively near the soil surface. Forbs often have tap roots that grow more deeply into the soil. Shrubs and trees have roots that extend deeply into the soil profile as well as extensive feeder roots near the surface. All of these different rooting strategies expose plant roots to nutrients stored at different soil depths. These nutrients can be brought to the surface by roots and used by succeeding generations of plants. Thus, this indicator tells us about how well the ecosystem is functioning.

Further, plant canopies play a role in functionality. Shrubs, for example, can play a large role in trapping snow as it blows across the landscape in winter. Canopies of forbs, grasses, and shrubs can also provide a role in shading the soil surface during the hot summer.

Some plants, known as legumes, have nitrogen fixing bacteria that form nodules on the root systems of these plants. The bacteria have the ability to fix nitrogen from the air and release it into the soil. Since nitrogen is often a limiting factor in rangeland production, a good mix of legumes can be important parts of the community. Nearly all rangelands have some kinds of native or introduced legumes that grow there. If they are totally absent, you are missing a functional group.

Count the number of plant species you find in your study area. Is this a desirable number in relation to your landscape objectives? Next, consider the growth form of the species found (grass, forb, tree, shrub). Do you think the variety of growth forms found represents the potential for the community as a whole? As an example, if your landscape objectives call for more forbs, are you finding them? Lastly, consider the functionality of the plant species. Do they have differing root structures that reach different depths in the soil? Will they help trap snow? Some plants, such as legumes help convert nitrogen from the air into nitrogen available for plants. Are these species absent from the community?

Using the Scoring Guide, evaluate plant species diversity and functionality and place a mark on the Rangeland Target on indicator #10.

Indicator # 11: Living Organisms

First, examine that list of living organisms you recorded previously. These species provide an excellent signature of land health through their presence and absence. The diversity of living organisms we see also provides us with a better understanding of the level of complexity our site currently exhibits. See the graph on community dynamics on page 14. The more species making a home at the study site, the more stable the area tends to be. Such diversity of life also provides an understanding of energy flow in the area. The more sunlight our plants are able to harvest, the more food is available to various consumers of that energy.

When making this evaluation, it is equally important to consider what is missing. What species should be on this site that you don't see? For example, after touring many acres of Colorado rangeland and hearing abundant bird song, we visited a rangeland study site in an area and noted the complete lack of any birds. No singing at all. Where had the birds gone? The managers had only recently applied a chemical herbicide to kill sagebrush in the area. Will the birds return? Do you see signs of termite activity, earthworm castings, ant colonies or dung beetle activity? Was the tool of technology properly applied? These are questions you must answer when considering this indicator.

Using the Scoring Guide, evaluate living organisms and make a mark on the Rangeland Target on spoke #11.

Indicator # 12: Plant Canopy

This indicator evaluates an area's ability to capture solar energy. On rangelands, sunlight energy that strikes the soil surface is lost to us. If solar energy is absorbed by living plant leaves, then it is captured and can be used in some way within

Photo 13: Dung beetles actively burying manure and speeding up the mineral cycle.

face, as well as leaf area. Leaves act as the plant's solar collectors. The Scoring Guide will ask you to consider the amount of photosynthetic activity in the study area as a percentage. The volume of living plant material and the leaf area are what this refers to.

Using the Scoring Guide, evaluate plant canopy and record a mark on the Rangeland Target on spoke #12.

Indicator # 13: Plant vigor

Plant vigor is an evaluation of how well plants are rooted to the soil surface, their stature, their color, and their ability to reproduce. This is another highly subjective category, but is basically asking if the plants you see look healthy.

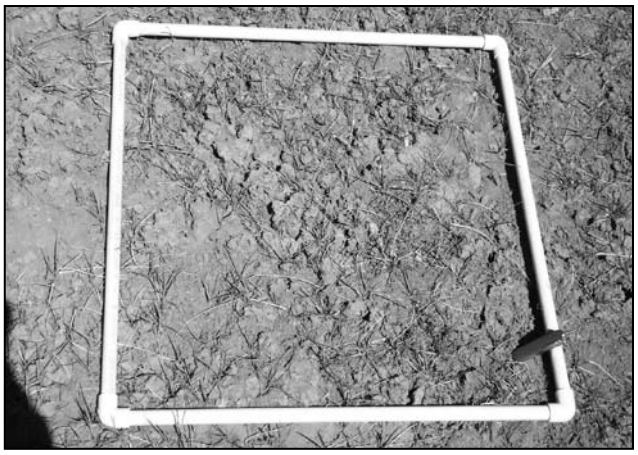


Photo 14: An example of low plant canopy. Red pocket knife included for scale.

Within your study area, are the plants solidly held by the soil? If not, this suggests their root structures are shallow and/or depleted. What tools have been used in the past to cause such a condition? Observe if the plants have produced much seed? If they have, this suggests their energy levels were sufficient for such production. Are the plants tall, green, and actively growing? A dark green color in plants indicates high rates of photosynthesis and adequate nutrients. A pale yellowish color often indicates nutrient deficiencies. Compare plant height and color with area soil moisture and recent precipitation events. Drought years can significantly influence plant production and the vigor of plants will be strong indicators of how well these plants are doing.

Using the Scoring Guide, evaluate plant vigor in your study area and place a mark on the Rangeland Target on spoke #13.

Indicator # 14: Plant distribution

This indicator examines how well plants are distributed across the soil surface within the study site or area. Note the above right photo and this plot's poor plant distribution. Much bare soil exists between plants where sunlight can strike and dry the soil surface and where drain drop action can cause erosion.

Some sagebrush plants, grass, and forbs are gathered near the corners of this quadrat, resulting in islands of vegetation called "refugia". Such islands represent the only uniform cover in this plot. The goal here is for increased plant cover over the entire area.

Using the Scoring Guide, evaluate plant distribution in the area and place a mark on the Rangeland Target at spoke #14.

Rangeland Completed Target

After working through all 14 indicators, the Rangeland Target spokes should all have a mark. ***Figure 7*** on page 30 is an example of a completed Rangeland Target.

This completed Rangeland Target represents a visual portrayal of rangeland health observations. Such observations capture a snapshot of the land in time. Such observations will change through time and may appear differently to different observers. The point of doing this exercise is for the observer to think through the current functionality of the water cycle, mineral cycle, energy flow, and community dynamics processes.

Photo 15: An example of poor plant distribution.

Now consider these points on the Rangeland Target in relation to both the function of the ecosystem process and the stated objectives for the site. In what ways is the site achieving objectives? Conversely, how is it not achieving objectives? View the Rangeland Target to help answer these questions. Look at the dots on the web spokes furthest from the center (those in the bronze and low silver). These are the areas where troubles lie.

Those indicators labeled in the bronze or low silver suggest symptoms of problems. As an analogy, a fever may be a symptom of an infection. Such symptoms help guide management to consider both the cause of those symptoms and how to correct them. If the exercise you completed shows a majority of the indicators lie in the bronze and low silver categories, you probably have already been thinking what to do to correct the situation. Should I reduce stocking rates? Do I need to change season of use? Must I better con-

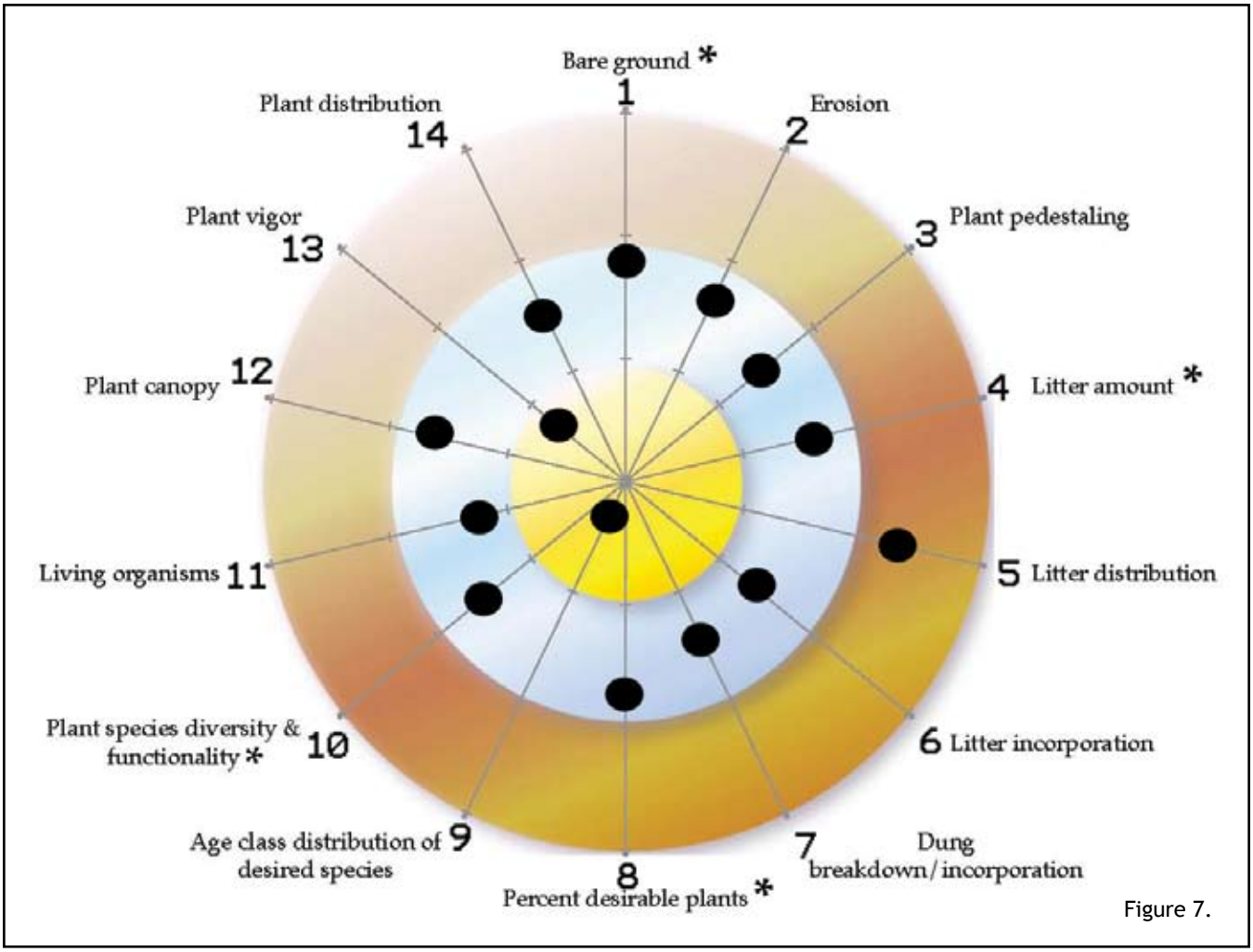


Figure 7.

What Symptoms do we see?

Water cycle?
Some bare ground
and erosion

Mineral cycle?
Litter amount too low
Litter poorly distributed

Community dynamics?
Clubmoss present, some
noxious weeds found
Good age class represented

Energy flow?
Production very low
Grass and shrub vigor high

Others?

trol noxious weed populations?

On the far right-hand side of the assessment form, find the area for recording these symptoms of problems.

The observers in this example saw bare soil and some erosion. They recorded these symptoms as special notes in the symptoms area of the target since they required extra attention. Also note these symptoms in relation to their dots on the target spokes. The observers were also concerned with the amount of litter being too low and also observed that it was poorly distributed over the soil surface. Within community dynamics, they noted the presence of dense clubmoss and were concerned with it, as well as the presence of noxious weeds in the area. However, they thought they found different age classes of perennial bunchgrasses in the area that offered a positive sign. Finally, in energy flow, the observers noted that production of this year's plant growth was much lower than they desired. However, they found that the vigor of grass plants and shrubs, both desired as part of their goal, was strong.

Management Action

How do you translate the results of this exercise into management action or should you? Answer this question by considering what tools management can use to improve these indicators' scores

in relation to ecosystem process function or if you have gathered enough information to warrant action.

Returning to the sample site, consider the following example of how these observers translated their observations into management action.

Their first two management actions were to "try to decrease grazing duration even further," and "prevent repeated severe grazing." With such solutions, they were thinking first about two problem symptoms already identified: soil loss and low amount of litter cover. By preventing repeated severe grazing, they intended to graze cattle in a way that abundant plant material was left behind after the grazing event. In this way, more standing plant material would be available following the grazing event to serve as a litter supply. This would increase the amount of litter and decrease the amount of bare soil in the area, which is part of their goal.

Their third management action was to "allow adequate recovery time between grazing periods." These managers wished to graze their plants, but then wanted to ensure that the grazed grasses had ample time to recover from that event before being bitten again. They reasoned that allowing such adequate recovery between grazings would help improve plant vigor through time. Ideally, desired increases in plant productivity would follow. Actually implementing such a strategy might require new information such as fences, water or herding with salt salt and mineral strategies.

Record your potential management actions in the "What are the potential solutions?" area.

For further information, an excellent discussion on potential tools to influence and correct observed symptoms can be found in Part V of *Holistic Management* by Allan Savory with Jody Butterfield (1).

Early-warning Indicators

Management solutions should change the function of ecosystem processes in a direction toward the stated objectives. The function of the mineral cycle, for example, should be improved in an observable way. Such improvements should be reflected through the indicators moving towards the gold or center of the bullseye. In time, if management actions are applied properly, the gap between your desired landscape goal and what is actually seen on the land should diminish. Thus, progress toward the goal can be observed.

Due to the complexities of nature, making management decisions on rangelands can be complicated. Management actions planned to improve the land can easily be thwarted by drought, unexpected fire, insect outbreaks, and a host of other factors. These can lead to plans being altered repeatedly. Thus, as management actions are implemented, managers must wonder if their plans will be successful or not.

Therefore, management must consider those indicators that will provide them early warning signs that their actions are either moving the land in a positive or negative direction. As an example, certain portions of the United States are known for receiving tornadoes. Meteorologists in these areas have long sought means of early-warning detection that a tornado has touched the ground where it can be highly destructive. With an early-warning system, it is hoped that people can find shelter with plenty of time before a devastating tornado strikes.

Rangeland Health Indicators can work in a similar fashion. The list of 14 indicators just considered may serve as early-warning signs that a management action has been properly or improperly applied. At your site, consider those indicators which might provide a means of allowing you to know if your plans are successful. If indicators

What are the potential solutions?

- Try to decrease grazing duration even further
- Prevent repeated severe grazing
- Allow adequate recovery time between grazing period

suggest that the ecosystem processes are not functioning as you intended, something must be changed.

In this example, these observers want to see improvement in the water cycle (by minimizing erosion), the mineral cycle (by increasing the litter and incorporation amounts), and energy flow (by increasing production). Thus, they will proceed with management actions as stated in the "potential solutions" section.

They also wanted to know if their actions were helping the land move toward their stated objective. If ecosystem functions were moving away from the objectives, they wished to change their management actions. They considered the following indicators as early-warning signs for their management.

Watching (1) plant vigor may help them understand the implementation of their third solution, which was "allow adequate recovery time between grazings." Declining plant vigor may mean that they are not allowing enough rest between grazing events. Altering management would mean lengthening the recovery period.

When performing the assessment, these observers noted some (2) plant pedestaling. However, it was not so excessive that plant roots were exposed. If their management actions were improperly applied, then roots may appear on the pedestals. Signs of erosion may also appear more readily. If plant pedestals become more severe and if erosion becomes more of a concern, their management actions have not taken them where they want to go.

Lastly, they considered the (3) amount of litter found lying on the soil surface as an early-warning indicator. One of their management actions was to "prevent repeated severe grazing." Through this action, they hoped to leave plenty of plant stubble after a grazing event to serve as a litter source. With heavy snow or animal trampling in the dormant season, stubble would fall to the ground as litter where it could be observed. With increased litter, they hoped to reduce the amount of bare soil and prevent soil erosion, all of which were recorded in their objectives statement.

Early Warning Indicators?

- Low plant vigor
- Pedestaling, erosion evident
- Low litter amount and poor incorporation

Consider those indicators that will provide you with information that management actions must be corrected in the "Early-warning indicators" section.

This is the last step in completing the rangeland health assessment process.

Assessment Frequency

How often should a rangeland health assessment be performed? No rigid answer exists for this question. Assessments should be used to provide information as needed for making management decisions. Thus, repeat the assessment whenever you need more information to help you make better management decisions.

Use the following guidelines for determining frequency of assessments:

- When land is recovering from a vegetative treatment (fire, herbicide, mowing, etc.), consider assessing the area twice in the same growing season.
- When a new grazing regime is being implemented, consider assessing a pasture at least once per season.
- For general information gathering and early-warning detection of troubles with management actions, consider assessing an area once every three years.
- In low precipitation areas (less than 10 inches of precipitation per year), consider performing an assessment once every five years.

Sixweeks Fescue grass

Chapter 5: Quantitative Monitoring

While the assessment methods described in previous sections of this manual focus largely on recording observations, this portion on quantitative methods focuses on gathering data. Both data and observations can be compared through time to reveal changes in rangelands. Collecting data to document such changes is probably most important if you need to show those changes to other people. These changes might show improvement, decline, and even stability. Problems may become apparent, as well as successes. Other reasons to collect data vs. observations alone include:

- Research documentation of various rangeland treatments.
- Supporting documentation for grazing permit processes.
- Documentation for grant project quality assurance verification.
- Confirmation that management actions are working as expected.

Unlike the rapid assessment process previously described, quantitative monitoring can be much more time consuming. Data must be gathered, tallied, tabulated, stored, and compared. As such, those performing monitoring should have allocated enough time and resources to make the effort worthwhile. See the Monitoring Matrix Method on page 8 for more information.

Getting Started

❒ *Coordination with Agencies*

When monitoring public lands, it is mandatory that those performing the monitoring coordinate with the federal and state land management agencies. After all, the agencies are the landlords and any data collected on public lands must be discussed with them. This is a statement made previously in this manual. It is repeated again here because of the importance of the issue.

If you deem that data collection is needed, at a minimum, have the agency representatives help pick study sites. Choice of study site is one of the most important facets in establishing a monitoring program. Having support from agency representatives on data collection site can prevent many headaches later in time.

❒ *Selecting a monitoring site*

See the steps in Chapter 3 for some strategies in establishing monitoring sites.

❒ *Monitoring methods*

This manual covers some variations of the following quantitative rangeland monitoring methods:

- Establishing a photopoint
- Basal cover, Relative basal plant spacing
- Basal cover by species

❒ *Gather tools and reference materials recommended for the work*

Now that you have study sites picked, gather the tools needed for the monitoring. They consist of the following:

☑ Metric tape measure. Use either a 50m or 100m, depending on your needs.
☑ Plastic stakes for marking transect beginning and end; We recommend heavy duty plastic survey stakes available from Forestry Suppliers. Phone 1-800-647-5368 or on-line at www.forestry-suppliers.com.
☑ Five-gallon bucket lids used for marking the transect beginning point. (Note these are available from many restaurants and painters.
☑ Nails - 10-inch spikes work well

- ☑ One-half inch pvc pipe frames. One of these fashioned into a 4.8 square-foot square frame and the other 9.6 square feet.
- ☑ Data sheets from this manual
- ☑ 35-mm camera and film
- ☑ GPS unit
- ☑ Survey flagging
- ☑ Metric ruler
- ☑ Pencil and eraser
- ☑ Clipboard
- ☑ Rubber bands (to steady your pages on the Clipboard when the wind is blowing)
- ☑ Calculator
- ☑ Compass
- ☑ Several sheets of pastel paper for photographing your study site. (White typing paper can cause reflection of light and a poorer quality photograph).
- ☑ Site goal
- ☑ BLM Standards & Guidelines (if applicable)
- ☑ Topographical map of site
- ☑ Plant Identification Books (see appendix A)
- ☑ Steel posts and pounder or other tools for locating study sites from a distance.
- ☑ Shovel
- ☑ Water bottle
- ☑ Clippers or scissors, and
- ☑ Insect repellent and sunscreen!

Recommended Reference Materials Include:

- ☑ A copy of your local soil survey
- ☑ A copy of the ecological site descriptions for your study area (ESD's).

Both documents available from your local NRCS office or on-line @www.nrcs.gov.

NOTE: Other map sources are also available for sale including aerial photos and topographical maps themselves on CD.

- www.delorme.com/quads
- www.mapping.usgs.gov/mac/isb/pubs/factsheets/fs22096.html, for pre 1996 maps
- http://edc.usgs.gov/Webglis/glisbin/glismain.pl, for post 1996 maps

Photo 16: Example of an assortment of some of the field supplies mentioned above.

Monitoring Location & Background Documentation

For all studies performed using this manual, it will be important to collect some background information. This includes such items as the date, location, observers, and like items. On the following page and in Appendix B you will find an example of the form, "Monitoring Location and Background Documentation."

There is also a standard form that has been used by the BLM, USFS, NRCS, and others to collect data on their study sites. It is available in the publication "Sampling Vegetation Attributes," which is available from most federal land management agencies (Technical reference BLM/RS/ST-96/002+1730) and downloadable at: http://www.blm.gov/nstc/library/pdf/samplveg.pdf.

When gathering data, a separate form will need to be used to record the data at each of your study sites. You may not complete all the fields on the form, but gather enough data to accurately record your actions during the study. When revisiting a study site in five years, for example, you will need enough detail on this form to be able to repeat the study. Use the form to enable your relocation of the study site and also to be reminded of the work you did previously.

At a minimum, complete the following fields on either form:

Monitoring Method:

Record the method you use. This may be "photopoint," "soil surface cover," or combinations of different methods. Refer to the monitoring matrix on page 8 for specific method names.

Monitoring Site ID Number:

Give your study a number for purposes of cataloguing, recording on a map, and report writing. Use a code that makes sense to you. As an example, if you are establishing a photopoint, use the code "PP" to designate the study appropriately. If you are establishing the first photopoint of many on Canyon Creek, you may label it PPCC01, where the "PP" designates the study as a photopoint, the "CC" represents Canyon Creek, and "01" means the first study.

If you are establishing a rangeland transect, use the letter "T" to designate the study as a transect. For example, if you are establishing the third transect in the Moose Creek Pasture, you may label it as "TMC03," where the "T" suggests a transect, the "MC" represents Moose Creek, and "03" means it is the third transect in the pasture.

Naming a Transect or Photopoint:

Some find it helpful to give their study a name, such as "Moose Creek Transect #3," or "Canyon Creek Photopoint #1." If you make this choice, record the name of the study in the blank space at the top of the page.

Allotment Name & Number:

If you are on federal land, you should record the name of the grazing allotment and its associated number.

Pasture:

If the pasture has a name, write it down.

Ecological Site:

The ecological site refers to the special characteristics of your study site. The ecological site descriptions provided by the NRCS contain the name of the ecological site.

Date Established:

Record the date the study was established.

Established by (Name):

Record the names of the observers present at the site.

Location, Description and UTM Coordinates:

Space is provided for recording the site's location. If available, record the site's legal description. You may also choose to take Universal Transverse

Example

Monitoring Location and Background Documentation

Monitoring Method: *Line point ~ Basal cover, spacing, composition*	Monitoring Site ID Number: *TBCO5*
Name Of Transect or Photo-point: *Bull Creek Basin*	Allotment Name and Number: _____
Pasture: *Bull Creek*	Ecological Site: *Sandy Loam Upland 16-20"*
Date Established: *8/17/05*	Established by (Name): *TG & TEG*
Location Description: *0.6 miles from junction of county road 628 and Bull Creek fence line; on west side of road; 50 paces to the east*	

UTM Coordinates:	Easting:	Northing:	DATUM:
13 N	*0473290*	*4073065*	*NAD83*

Transect Bearing:	Transect Length:	Sampling Interval:	Total Number of Samples:
90°	*100 M*	*1 M*	*100*

Notes: (Description of study location, diagram of transect/plot layout, description of photo points, etc. If more space is needed, use reverse side or another page.

Site is marked with bucket lid and transect runs east 90° towards Cornudo Hills

Mercator (UTM) coordinates using a Global Positioning System (GPS) for the site. This is a good place to record those as well. You should also record the datum type of the UTM you use. For example, NAD27 or NAD 83 are commonly used datum which stand for North American Datum 1927 or 1983. This will allow future transect readers to more accurately locate the site.

Distance and bearing between reference post or reference point and the transect location stake, beginning of transect, or plot: As will be described in a later section "Setting up a Transect," you may wish to use a reference post or "witness post" to aid in transect location. This is simply a steel post pounded in the ground that can be seen from some distance away. This space on the form is for recording the distance from this reference post to the transect's beginning point.

Transect Bearing:

When establishing the transect, use a compass and record the bearing from the transect beginning point to the transect end point. Note: this will be described in greater detail in the "Setting up a Transect" section.

Length of Transect:

Record the transect's length in meters.

Sampling Interval:

Record the sampling interval, such as one sample for every half meter.

Total Number of Samples:

Record the total number of samples taken on the transect line.

Notes:

Use this area to record more specific study location details. For example, "From the intersection of County Roads 31 and 10, proceed west for 1.3 miles. Look for witness post on north side of road."

Establishing a Photopoint

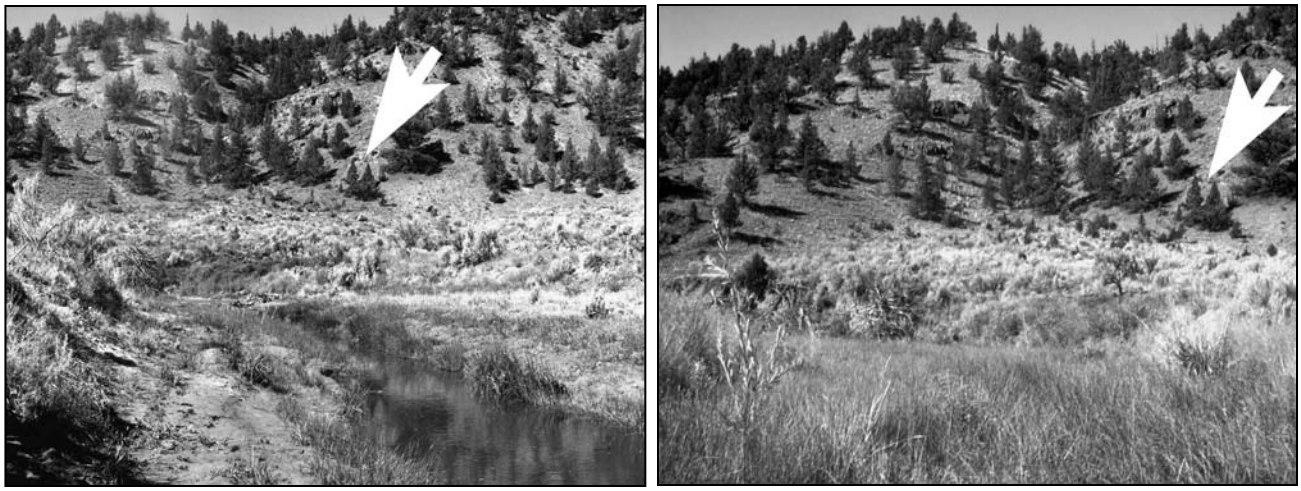
What is a photopoint?

A photopoint is simply a site where a photograph is taken repeatedly through time. Because the picture is always taken from the same location, change can be seen in photos taken in different years.

What uses does a photopoint have?

Photopoints and their accompanying photographs are best applied for portraying changes in vegetative structure. They have excellent application in riparian areas. In these settings, gathering quantifiable data can be quite challenging. Further, change may occur rapidly along water. Thus,

Photos 17 and 18: Photopoint example. Note that a different camera was used, no date recording device on photo #17 and that the photos were taken at different times of the year (April vs July).



Photos 19 and 20: These photos show remarkable recovery following management changes along Bear Creek, Oregon. Left photo taken August 1987, right photo taken August 1993. Photos Courtesy of Wayne Elmore.

establishing a photopoint in an area where change can easily be seen by looking at the photos can be a good indicator of changes in vegetative structure. Changes in willow/tree growth, bank stability, ground cover, and riparian expansion may all be seen in photos on page 40.

Further, photopoints may also be applied on rangelands where a vegetative treatment is anticipated. The visual effects of burning, brush beating, and herbicide treatments may be tracked with photopoints.

Steps for Establishing a Photopoint

1. *Select the study site.*

Refer to the tips for choosing a study site on pages 14-16 of this manual.

2. *Use the "Monitoring Location and Background" form to gather background information on the site.*

Use this form to record site information. Record enough information so that you or someone else in the future can return to this same area and repeat your initial work.

3. *Permanently mark the site.*

Using a steel post or some other means, permanently mark the area where the photographer must stand to take the photo. It will be imperative that photographers stand in the exact spot through time. One trick that works well is to use a combination of a steel witness post and a five-gallon bucket lid. Use the steel witness post for recognition of the site from a distance. Then, nail a five-gallon bucket lid to the ground using 10-inch nails. The bucket lid can serve as the point where photos are taken each year. See photo below. The UTM data point should also be collected on your GPS unit and recorded on the form. Save this point as a "Waypoint" in your GPS unit if you want to be able to have the unit guide you back to this point again in the future.

4. *Take the photos.*

If possible, stand on the bucket lid. If you stand on the bucket lid each time you take photos from this point, you are assured that each photo will be the same. Take pictures of those aspects of your site you believe to be most interesting. Photographically record those items you believe will change through time. The photos you take now will be compared with those from the same point in the future. Photos 19 and 20 are good examples of fixed point photographs. Note that only a small slice of sky is visible and an easily recognizable skyline and landscape features are in the photo. See tips below for more hints on setting up your photo points.

Photo 21: Photo of a transect examiner using the bucket lid to mark the spot where photopoint photos are taken through time.

Tips

1. One of the easiest ways of ensuring you get the exact photo framed each time is to bring your book of catalogued photos with you. Then use the appropriate photo you took before to help frame the current scene, and match it.
2. When taking the photographs, it is often helpful to have an easily recognizable object in view to help you recognize your angle through time. Such objects may include a large rock, highway, mountain peak, or something else that won't move.
3. If you don't have an easily recognizable object in view, use a compass and record the bearing in which the photo was taken.
4. Try to use the same camera with the same digital settings or the same brand and speed of film if possible.
5. Try to take photopoint photos at roughly the same time of year each year. For example, if a photo was taken in mid-July, try to take it again in mid-July in the future.
6. Taking the photos at the same time of day is also highly desirable to obtain the same lighting conditions.

5. *Create the pictures from your film or digital media and catalogue the prints.*

Create a binder or other storage device where your photos can be kept and viewed. Remember, your effort here is to depict change through time. Design your binder so that photos taken in the same spot in different years can be easily viewed. In this way, you stand a better chance of portraying change and making needed decision.

Mechanically Set Up a Transect

The following section describes how to establish a permanent rangeland monitoring transect.

Steps for setting up a transect

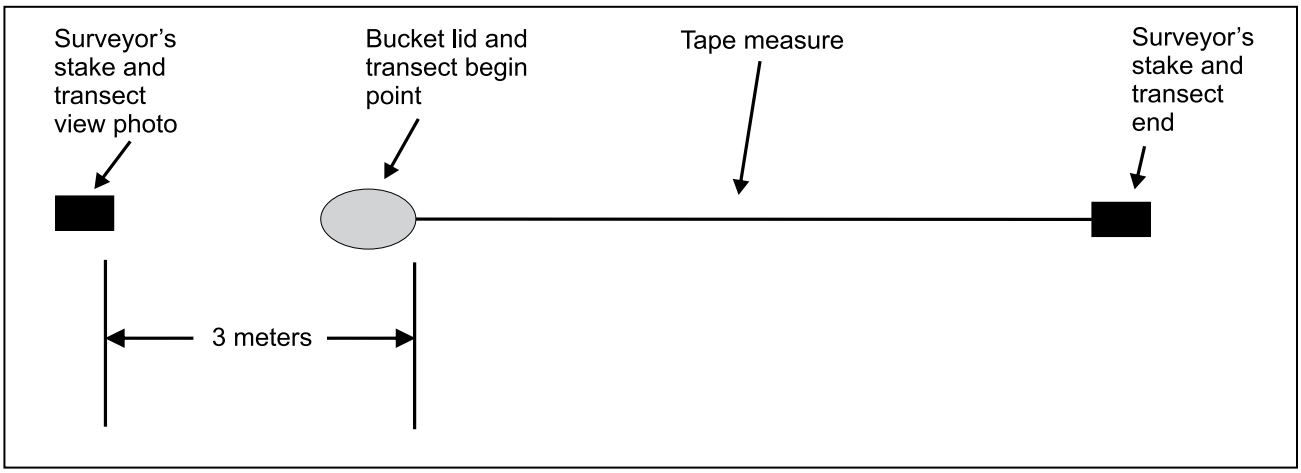
1. *Permanently mark the site.*

Once a study site has been chosen, it must be permanently marked. Use a steel post as a witness post if necessary. Drive this steel post in the ground in a place where it may be seen from a nearby road or other approach to the study site. Keep the post far enough away from the actual study site so that animals don't unduly rub on the post or in some other way affect the study site

Then, measure the distance and record the bearing from this post to the beginning point of the transect. The beginning point of the transect is a five-gallon bucket lid. These lids are advantageous in that they can be driven over, stepped

Photo 22: Five-gallon bucket lid used to mark the beginning point of a transect. The tape measure stretched out from this point can also be seen.

Figure 8.



on, easy to spot, and no one wants to steal them. If one of your lids becomes brittle through time, replace it with a new one. These lids can be obtained from most restaurants and well as almost any painter. Next, using three 10-inch spikes, nail the lid to the ground as shown in the photo below.

2. Roll out the tape measure.

Beginning at the bucket lid's edge, roll out the metric tape measure in the desired direction. The "zero" point at the bucket lid's edge marks the important beginning of your study. When rolling out the tape, ensure that it is straight and is not entangled in brush. If the wind is blowing, you will inevitably need help with this procedure and will probably need to straighten the tape by hand. Drive an orange surveyors' stake into the ground at the tape's end. Leave the tape unwound until the end of the study!

3. Record transect bearing.

Using a compass, stand on the bucket lid and record the transect bearing. This is the direction in which the tape measure runs in relation to your position on the bucket lid. Record the bearing in the "Transect Bearing" field of the Study Location & Documentation Data form.

4. Drive another surveyor's stake 3 meters in opposite direction of transect bearing.

At the "zero" point of the transect (the beginning of the tape measure), proceed 3 meters in the opposite direction as the tape measure and drive another orange surveyors' stake in the ground. This stake should line up with the bucket lid, the tape measure, and the surveyors' stake at the end of the tape. With this last stake driven into the ground, you have three permanent points marked on the soil surface: 2 surveyor's stakes, and one bucket lid. They should all be in a straight line as seen in the figure above.

With these three points, the transect will have three means of being located again in the future. Add to this a witness post and the GPS reading, and you or someone else should be able to find the site in the future.

5. Photographing the site.

Standing on the bucket lid, take four photographs in the cardinal directions in the order of north, east, south, west. Always take the photos in this order. If you do not get your film developed for a while, or forget what else you took pictures of, taking them in this order every time will help you label and identify them for cataloguing. These photos are taken to help future investigators find the site in the future and also provide a great visual portrayal of how the land appeared around your study site.

6. Take the "Transect View" photo.

Using a blank sheet of paper attached to a clipboard, record the date, transect ID code, and transect name in a legible style that will appear in a photograph. Next, prop the clipboard up on the bucket lid so that it can be seen from the surveyors'

Photo 23: Transect view. Photo taken kneeling from the surveyor's stake 3 meters away from the bucket lid and looking down the transect's tape measure. Notebook displays the date, ranch name, transect code, and transect name.

stake 3 meters away. You may need to use a nail or a stick to stand the clipboard up. Then, kneeling at the nearby surveyors' stake, you should be able to see the clipboard, the bucket lid, and the tape measure stretching into the distance. Take a photograph of this scene. It will be called the "Transect View" and can be compared through time as the site is re-examined. See photo #24.

7. Take the "Quadrat" photo.

Decide which pvc quadrat will be used for the study. The 4.8 square-foot quadrat works well in grasslands and where higher ground cover exists. The 9.6 square-foot quadrat should be used in more arid environments where plant spacing is wide and much bare soil can often be found.

Place the appropriate sized quadrat at the 3 meter mark along the tape measure. Place the quadrat on the "top" of the tape, meaning that it is on the opposite side of the tape measure if you are standing so that you can read the 3-meter mark on the tape (it is not upside down). Ensure that the lower, left-hand corner of the quadrat lies at the 3-meter mark.

Photo 24: Photo of "Quadrat" along tape measure. The quadrat's lower left-hand corner is placed at the 3-meter mark on the opposite side of the tape of the photographer. The photographer should stand so that the feet are nearly touching the tape measure. This will ensure that the photo is taken looking straight down on the quadrat. Place the notebook in the scene to help identify the photo.

See photo #24

Take a picture of the quadrat and clipboard with your feet at the 3-meter mark on the tape. This is the most important transect photo you will take, so make sure you can clearly see the clipboard and the plant material contained in the quadrat. Your camera angle should be directly down, perpendicular to the Earth, rather than having an angle. If your shadow falls within the quadrat when standing in this way, stand somewhere else so that you have an unobstructed photographic view of the quadrat.

The quadrat photo can also be compared through time as the site is re-examined.

8. OPTIONAL: Record area plant species.

Walk in an elliptical loop around your entire study site and record all the plant species you see. Divide them by grass, forb, shrub, and tree. If you don't know the plant species, at least count the numbers of grass, shrub, forb, and tree species you encounter. The numbers of these different plant forms may change through time.

After making your el-

liptical walk around the entirety of your study site, total the number of grass species, shrub species, forb species, and tree species you encountered. Your results may look something like the following:

Grass: 7 species
Shrubs: 4 species
Forbs: 14 species
Trees: 1 species

If you **do** know the species, you may wish to make a list of all these species so that you can compare their presence through time. An example of a form to list both the plant and animal species you might encounter at your site is included in Appendix B called Species ID and Observations Form. In recording your data, you should obtain forms that best suit your needs, making such modifications as may be necessary if they prove to be inadequate. ***Keep in mind that your recorded observations are often as important as the actual data you might collect.***

This completes the transect set up phase. You are now ready to move onto using different transect methods.

Smooth Brome grass

Chapter 6: Quantitative Methods: Basal Cover, Basal Cover by Species and Relative Basal Plant Spacing

What does it do?

Basal cover is a measure of what is covering the soil surface: live plants, litter, rock, or bare soil. Basal cover by species measures changes through time in the species covering the soil surface across an outstretched tape measure. Relative basal plant spacing uses the same method to arrive at an average distance to the nearest perennial plant measure than can be compared through time.

Using an outstretched tape measure, observers will drop a steel rod to the soil surface at regular intervals and record what the tip of the rod strikes as it reaches the soil surface. Observers will record these hits and compare the results through time to display changes in basal cover.

Simultaneously, from this dropped rod, a measurement can be taken to the base of the nearest perennial plant. When repeated along the tape measure, an average distance to the nearest perennial plant is again determined. This relative basal plant spacing unit can be compared through time. Further, the species of the nearest perennial plant can be recorded. As these species change through time, relative basal cover by species can be compared.

Why include this methodology?

Basal cover and the variations included under this heading are some of the most important characteristics of rangeland health as they relate to the 14 indicators listed earlier. These measures of cover do not usually change rapidly from year to year with rainfall variations, so that measured changes over time often indicate the relative impacts of management influences. Also, they share the advantage of being fairly rapid and repeatable over time.

Materials needed

See the materials list on pages 33-34 for a general list of recommended materials.

For this study, the following are necessary:

- Metric tape measure
- Bucket lid and surveyor's stakes for permanently marking the site
- Study Location & Documentation Data form, GPS unit, map of area, compass, and camera
- Steel rod: (Use wire flagging, baling wire, or some other small diameter, yet rigid material to serve as a rod.)
- Metric ruler
- Pencils and eraser
- Basal Cover data sheet

Using the method

1) **Follow the steps for mechanically setting up a transect outlined on pages 41-44.**
2) **Determine the number of data points to be collected.**

If you are monitoring public lands, tracking vegetative treatments, or are anticipating some other change in the vegetative community of your site, consider collecting 100 data points with this method. If your tape measure is stretched out to 100 meters, collect data at intervals of every one meter.

3) **At meter number one, lower the steel rod to the soil surface.**

Without aiming where the rod will hit, lower the rod to the soil surface while lining up its descent with the first unit on the tape measure.

4) **Data recording**

For collecting data on basal cover, record what the rod struck as it reached the soil surface. This

Photo 25: Left photo of lowering the steel rod to the soil surface. Photo 26: Above, photo shows a close up of the contact between the point of the rod and litter cover at the 5 meter mark on the tape.

could be bare soil, rock, litter cover (old plant material and dung lying on the soil surface), or a live plant. Note that to be considered "live cover," the rod must have struck the plant base, and not its stem, branches, and/or leaves. That is, do not record any of the plant canopy when making this measurement. Record only what the rod strikes when it reaches the soil surface.

Other methodologies such as those outlined in Quick Start in Appendix A present similar monitoring methods that do collect information on canopy cover. We do not use it here because canopy cover changes rapidly in response to the time of grazing or precipitation. If you find a need to collect canopy information, then use the variation outlined in Quick Start Guide referenced in Appendix A.

As shown on page 47, the Basal Cover Data Sheet indicates each hit is recorded using a dot tally in the appropriate basal cover box. A dot tally is a simple means of recording data using a combination of dots and lines that can be "counted" up to 10 hits in a simple fashion (Figure 9).

Next, from the rod on the soil surface, find the nearest perennial plant. Ignore annual and biennial species. (The method can be modified to include annuals, but they normally change rapidly in response to precipitation and make determining changes due to management more difficult.)

Measure the distance in centimeters from the rod to that nearest perennial plant. Record the distance in the "Distance" column on the Basal Cover Data Sheet under the columns marked "Relative Basal Plant Spacing and Basal Cover by Species."

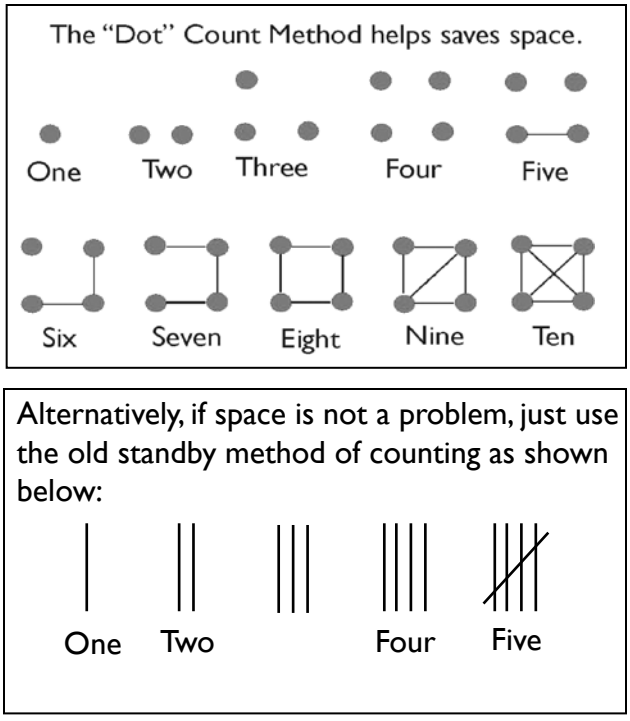
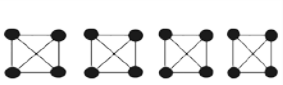
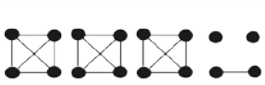
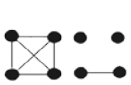


Figure 9.

Basal Cover Data Form

Site Name Bull Creek Basin
Transect Number TBC05
GPS- UTM Location

Examiners: KLG & TEG
Date: 8/17/08
DATUM: NAD 83

Category	Bare Ground	Litter Cover	Live (Basal) Cover	Other Cover	Total
(Dot Count)				Rock 	
Total Hits	40	35	15	10	100
% Cover	40%	35%	15%	10%	100%

Distance = Distance to Nearest Perennial Plant

	Distance	Species		Distance	Species		Distance	Species		Distance	Species
1	12	PASM	29	3	ORHY	57	1	STCO	85	1	PASM
2	7	PASM	30	5	PHHO	58	10	STCO	86	12	STCO
3	3	PASM	31	1	BASA	59	7	STCO	87	1	SPCO
4	4	BASA	32	9	ORHY	60	10	POSE	88	5	POSE
5	0	BASA	33	5	PASM	61	3	STCO	89	0	STCO
6	1	POSE	34	6	STCO	62	6	ORHY	90	5	ARTR
7	5	STCO	35	3	ARTR	63	3	STCO	91	8	POSE
8	4	PASM	36	4	SPCE	64	2	PASM	92	10	PHHO
9	3	POSE	37	0	PASM	65	1	STCO	93	16	STCO
10	3	STCO	38	2	STCO	66	7	PASM	94	5	POSE
11	2	PASM	39	4	ARTR	67	1	PASM	95	4	POSE
12	1	ANPU	40	9	SPCO	68	1	POSE	96	16	ARTR
13	3	ANPU	41	0	PASM	69	3	PASM	97	5	ARTR
14	6	PASM	42	2	STCO	70	1	PASM	98	14	STCO
15	3	PASM	43	10	PASM	71	4	PASM	99	10	POSE
16	3	ANPU	44	0	POSE	72	4	POSE	100	6	STCO
17	11	STCO	45	4	ARTR	73	1	SPCO	Total	**118**	
18	5	POSE	46	8	BASA	74	1	STCO			
19	2	POSE	47	7	ORHY	75	3	ARTR			
20	9	ARTR	48	2	PASM	76	4	PHHO			
21	5	TOSE	49	1	PASM	77	1	PASM			
22	0	ARTR	50	5	ARTR	78	6	STCO			
23	5	PHHO	51	1	PASM	79	5	PASM			
24	3	PASM	52	1	STCO	80	12	PHHO			
25	4	ARTR	53	8	STCO	81	5	SPCO			
26	12	ORHY	54	1	SPCO	82	9	PASM			
27	0	ORHY	55	5	PASM	83	3	SPCO			
28	1	SPCO	56	5	STCO	84	1	PHHO			
Total	**117**		Total	**111**		Total	**115**				

Dist. Total (cm)	**461**
Avg Dist.(cm)	**4.61**

10 Closest Plants

1) PASM = 27
2) STCO = 23
3) POSE = 14
4) ARTR = 11
5) SPCO = 7
6) ORHY = 6
7) PHHO = 5
8) BASA = 4
9) ANPU = 3
10)

Total 100

Notes

PASM = Western wheat; STCO = Needle and Thread; POSE = Sandberg bluegrass; ARTR = Big sagebrush; SPCO = Scarlet globemallow; ORHY = Indian ricegrass; PHHO = Hood's flox

Then, record the species of that plant under the "Species" column.

Often a species code is used as an abbreviation using the first two letters of the genus and then the second two letters of the species for example ***Or***yzopsis ***hy***menoides, Indian ricegrass. Check with your local NRCS office for a regional list of plant species and their standardized code. You can also use the common name or create a code that works for you such as WW = western wheat.

A completed sample Basal Cover Data Sheet is shown on page 47. Blank copies can be found in Appendix B.

5) Tally the Data

Tally the basal cover data by adding up the hits of each particular soil surface cover category. Divide this total by the number of data points taken to arrive at the percentage of basal cover categories.

Tally the relative basal plant spacing data by simply adding up all the measurements to the nearest perennial plant in the "Distance" column. Divide by the number of data points to arrive at the average distance to the nearest perennial plant.

Tally the basal cover by species data by counting the occurrences of each species in the "Species" column. Show the top 10 species (if you had that many) in a list for comparisons through time.

Other Quantitative Methods:

There are essentially three basic vegetational properties that are commonly measured. These are:

1) cover and species composition of the plant community
2) number (density or frequency) of various members of the plant community
3) production or weight of the plant community

This section of the manual briefly describes some of the broad techiques that are used to measure the above characteristics. The list is by no means exhaustive, but contains some of the most important options you might want to consider if you need to collect this type of information.

The purpose of each measurement type has been outlined, but you will have to determine if that is an attribute you feel you need to collect data about. Again, the references where you can find the details on most of the methods used to collect quantitative information on these vegetational attributes are found in Appendix A, immediately following this section.

Cover and Composition

The method included in the previous chapter outlines one potential way of measuring cover and composition using the point intercept technique along a pre-determined line. Another common way of determining this is the use of line intercept. The advantage of using line intercept is that it is an accurate way of getting basal cover and composition, especially in areas of sparse cover. The drawback is the time consuming nature of the measurements. The third way of measuring this attribute is by using plots or quadrats.

Density and Frequency

The number and distribution of plant species, and individuals of those species, are other important attributes that are often measured. Both line and point intercept can give some measure of these attributes, but typically some use is made of plots and quadrats to increase the sample area size. Density is simply a measure of the number of plants in a given sized plot, while frequency is the number of times a particular plant occurs in the plot.

Another variation of using plots to measure density and frequency is called the belt transect. The belt transect is particularly useful for determining growth patterns of shrubs. It can also be used to record characteristics of shrubs or other plants encountered along the intercept such as age, growth form, and height.

Production or weight of the plant community

The production weight of the vegetation in an area is often measured as a way of determining primary productivity. This productivity is then usually related in some way to the availability of the production for use by livestock and/or wildlife. Productivity is usually divided into categories of herbaceous and woody vegetation, because the methods for estimating production are necessarily different.

Most methods used to estimate production involve actual measurements of sampled clippings in addition to estimated weights. The reason that most measurements are estimated and not clipped and weighed has to do with the time involved for collecting and processing these samples. Thus, the most common way of estimating production is some variation of the weight-estimate method.

In this method, weights of various size samples of vegetation are estimated, then actually weighed to compare the estimate to the actual. The estimator then learns to correct their estimate by adjusting it in relation to the actual observed weights as they are measured. The estimator using this corrective technique can be very accurate, given practice, in a particular vegetation type.

The most common use of this production information is to help set stocking rates. Production is usually expressed in pounds per acre of total production or "useable" production. The term useable often refers to the palatability of the plant species measured for the grazing animals on the rangeland. For example, a rangeland sample may have produced 700 pounds per acre of sagebrush, but most of that will not be able to be consumed by cattle, so it is not counted in the stocking rate estimate.

Production estimates for stocking rates also normally take into consideration the amount of this production that can safely be allocated to consumption by the animals without harming the plant community or detracting from other uses of the land such as watershed, or wildlife habitat.

Summary of Quantitative Methodologies

As you will see if you investigate the myriad of ways of collecting information on rangelands that are referenced in Appendix A, this is a subject that has, and continues to be, extensively and exhaustively researched and studied. You should also be aware that there is disagreement by many professionals on which are the most useful and accurate methods. Currently there is no clear standard of quantitative measurement techniques used for all agencies in part because the needs for that information are quite varied.

If you are collecting information on public land you will probably need to use the techniques acceptable to that agency responsible for land management. But this does not mean you should limit yourself to that technique. You may find that your goals and objectives for the land are better served by some other monitoring methodology. Your agency personnel may

be open to this different look if you work with them closely.

In short, if you need to use quantitative methods to get information about the rangeland the biggest question should be what will the information be used for. If you answered this question when you used the Monitoring Methodology Matrix, it may have helped you clarify this point already. In many cases, qualitative monitoring with photographs and information on species composition may provide all the detail you need.

Photo 27: Checking pasture production on the Sun Ranch in Montana.

Barnyard grass

Appendix A: Monitoring Reference List

The following list is a limited group of resources to help guide you to other sources of information if you need to look beyond the scope of this manual. Within many of these resources, additional monitoring references are cited, as well as alternate methods to help you choose the ones that are right for you. Be aware that many of the quantitative references are quite detailed.

Qualitative

It is important to note that the NRCS and nearly all the Federal land management agencies have adopted the following qualitative methodology for measuring attributes of rangeland health. The biggest differences between this method and that which we have presented in this publication are:

1) The graphic target representation of the information collected.
2) The use of a predetermined goal to help interpret the information collected.
3) The use of the information to help you determine management changes that will move you closer toward your goal for the land.

📖 **Interpreting Indicators of Rangeland Health, Version 4**. Technical Reference 1734-6. U.S. Department of the Interior, Pellant, M., P. Shaver, D.A. Pyke, and J.E. Herrick. 2005. Bureau of Land Management, National Science and Technology Center, Denver, CO. BLM/WO/ST-00/001+1734/REV05. 122 pp. http://usda-ars.nmsu.edu/Monit_Assess/PDF_files/IIRHv4.pdf.

Quantitative

📖 **Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems Volume I; Quick Start.** USDA - ARS Jornada Experimental Range Las Cruces, New Mexico, 2005 http://usda-ars.nmsu.edu/monit_assess/PDF_files/Quick_Start.pdf.

📖 **Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems Volume II.** Design, supplementary methods and interpretation. USDA - ARS Jornada Experimental Range Las Cruces, New Mexico, 2005 http://usda-ars.nmsu.edu/monit_assess/PDF_files/Volume_II.pdf (Go to the following website to download selected portions or all of these monitoring manuals) http://usda-ars.nmsu.edu/Monit_Assess/monitoring.php).

📖 **National Range and Pasture Handbook | NRCS GLTI Inventorying and Monitoring Grazing Lands Resources.** http://www.glti.nrcs.usda.gov/technical/publications/nrph.html - 2005-11-08 (Go to the following website to find and download any of these (and other) NRCS monitoring manuals): http://www.glti.nrcs.usda.gov/technical/publications/index.html.

📖 **Measuring and Monitoring Plant Populations**. Caryl L. Elzinga Ph.D., Daniel W. Salzer, John W.Willoughby, BLM Technical Reference 1730-1 BLM/RS/ST-98/005+1730. http://www.blm.gov/nstc/library/pdf/MeasAndMon.pdf.

📖 **Sampling Vegetation Attributes**, Interagency Technical Reference Cooperative Extension Service U.S. Department of Agriculture — Forest Service — Natural Resource Conservation Service, Grazing Land Technology Institute U.S. Department of the Interior — Bureau of Land Management — 1996 Revised in 1997, and 1999http://www.blm.gov/nstc/library/pdf/samplveg.pdf (Go to the following website to find and download any of these (and other) BLM monitoring manuals: http://www.blm.gov/nstc/library/techref.htm.)

📖 **Monitoring the Vegetation Resources in Riparian Areas.** Alma H. Winward, General Technical Report RMRS-GTR-47, April 2000. USDAFS, Rocky Mountain Research Station.

Literature Cited

📖 (1) **Holistic Resource Management,** Allan Savory, Island Press, Washingon, D.C., 1988. ISBN 0933280-61-0. Updated and reprinted as **Holistic Management: A New Framework for Decision Making,** Allan Savory with Jody Butterfield, Island Press, Washington, D.C. 1999. ISBN 1-55963-487-1.

📖 (2) **Holistic Resource Management Workbook,** Sam Bingham with Allan Savory. Island Press, Washington, D. C., 1990. ISBN 0-93-280-69-6. Updated and reprinted as **Holistic Management Handbook: Healthy Land, Healthy Profits**, Jody Butterfield, Sam Bingham and Allan Savory. Island Press, Washington, D.C., 2006.

📖 (3) **Rangeland Health: New Methods to Classify, Inventory and Monitor Rangelands**. Committee Rangeland Classification. National Academy Press, Washington, D.C., 1994. ISBN 0-309-04879-6.

📖 (4) **The New Ranch Handbook: A Guide to Restoring Western Rangelands**, by Nathan F. Sayre, The Quivira Coalition, Santa Fe, NM, 2002. ISBN 0-9708264-0-0.

Additional Readings

- **Ecology: The Experimental Analysis of Distribution and Abundance,** Krebs, Charles. Harper & Row Publishers, New York, NY, 1972. ISBN 06-043770-7.
- **Fundamentals of Ecology.** Odum, E. P. and W. B. Sanders Co., Philadelphia, PA, 1971. ISBN 0-72166941-7.
- **General Ecology**. McNaughton, S. J. and L. Wolf. 1973. Holt, Rinehart and Winston. ISBN 0-03-086218-3.

Optional ***Plant species identification books*** include:

- A Field Guide to the Grasses of New Mexico, 2nd Edition, Allred, Kelly W. 3rd Edition. New Mexico State University, Las Cruces, NM, 2005.
- Flowering Plants of New Mexico, deWitt Ivey, Robert. 4th Edition, 2003. ISBN: 0-9612170-2-2.
- Shrubs & Trees of the Southwest Uplands, Elmore, Frances H. & Janish, Jeanne R., Southwest Parks and Monument Association. Tucson, AZ. 1976. ISBN: 0-911408-41-X.
- Grasses of Wyoming, Hallsten, G.P., Skinner, Q.D. and A.A. Beetle. 4th Edition. RJ-202. Agricultural Experiment Station, University of Wyoming. Laramine, WY, 1999. ISBN: 0-941570-07-x.
- Manual of the Grasses of the U.S Vol I & II, Hitchocok, A.S. & Agnes Chase. Dover Publications Inc., 1971. ISBN: 0-486-22717-0.
- Plants of the Rocky Mountains, Kershaw, Linda J., MacKinnon, Andy and Jim Pojar. ISBN: 1-55105-088-9.
- Field Guide to the Grasses, Sedges and Rushes of the United States, Knobel, Edward. Dover Publications, Inc., New York, NY, 1977. ISBN 0-486-23505-X.
- North American Range Plants, Stubbendieck, James L., et al. 5th Edition, University of Nebraska Press, NB. ISBN: 0-8032-4260-3.
- Weeds of the West by Whitson, Burril, Dewey, Cudney, Nelson, Lee, and Parker. The Western Society of Weed Science, 1999. ISBN: 0-941570-13-4. Fifth Edition currently in print.
- Regional books on wildflowers can be helpful as well. Two are recommendable by Richard J. Shaw: Utah Wildflowers (ISBN 0-87421-170-0) and Wildflowers of Grand Teton and Yellowstone National Parks (ISBN 0-937512-05-2).

Most of the plant identification books mentioned here have pictures, some with color photographs of plants, making identification much easier. Visit your local bookstore and inquire about more regional reference books.

Appendix B: Data Sheets

Showy Windmill grass

Examples of the data sheets discussed in this manual can be seen on the following pages:

- ☑ Monitoring Location and Background Documentation
- ☑ Rangeland Health Target
- ☑ Scoring Guide Side 1
- ☑ Scoring Guide Side 2
- ☑ Basal Cover Data Form
- ☑ Species ID and Observation Form

Monitoring Location and Background Documentation

Monitoring Method:	Monitoring Site ID Number:
Name Of Transect or Photo-point:	Allotment Name and Number:
Pasture:	Ecological Site:
Date Established:	Established by (Name):
Location Description:	
UTM Coordinates: Northing:	Easting: DATUM:

Transect Bearing:	Transect Length:	Sampling Interval:	Total Number of Samples:

Notes: (Description of study location, diagram of transect/plot layout, description of photo points, etc. If more space is needed, use reverse side or another page.)

Rangeland Health Target

Ranch: _____ Observers: _____

Site Name: _____ Date: _____

What do we want to see here?

Desired plants:	
Desired production:	
Desired wildlife:	
Other special objectives:	

What do we see now?

Current abundant plants:	
Current production:	
Current wildlife:	
Current concerns:	

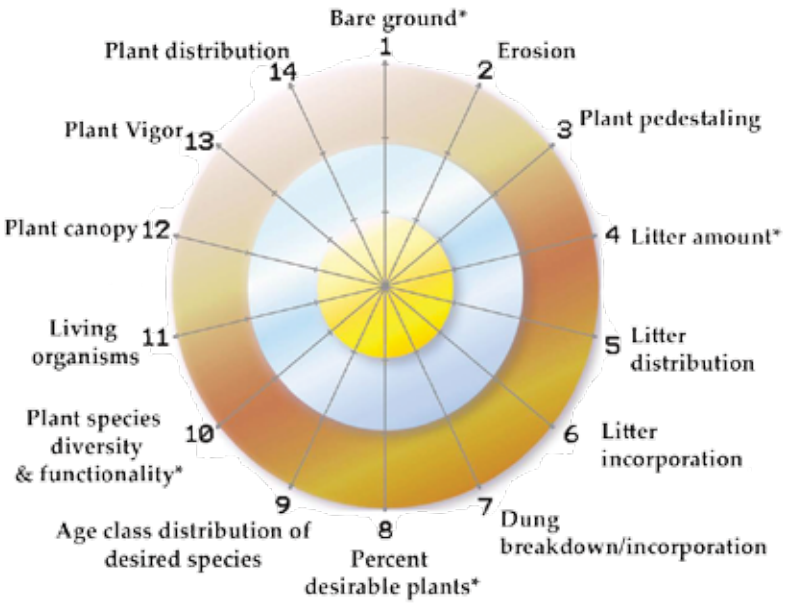
Rangeland health indicators:

1) Bare ground *
2) Erosion
3) Plant pedestaling
4) Litter amount *
5) Litter distribution
6) Litter incorporation
7) Dung breakdown/incorporation
8) Percent desirable plants*
9) Age class distribution of desired species
10) Plant species diversity & functionality*
11) Living organisms
12) Plant canopy
13) Plant vigor
14) Plant distribution

Notes and observations:

Mark a dot on the Web spokes:

Gold: Achieving goal.
Silver: Moving toward/away from goal?
Bronze: Not achieving goal.



What symptoms do we see?

Water cycle?

Mineral cycle?

Community dynamics?

Energy flow?

Other?

What are the potential solutions?

Early-warning indicators:

SCORING GUIDE SIDE 1

		Gold: Achieving Goal	Silver: Moving Toward/Away from Goal?	Bronze: Not Achieving Goal.
1	Bare Ground*	Amount and size of bare areas nearly to totally match that expected/ desired for site.	Amount and size of bare areas higher and larger than expected/desired for site. Bare areas may be large and sporadically connected.	Amount and size of bare areas are much higher and larger than expected/desired for site. Bare areas are generally connected.
2	Erosion	Little to no evidence of wind or water erosion, including desert pavement, rills, and/or gullies.	Some signs of soil loss, including formation of desert pavement, rills, and/or gullies.	Soil is actively leaving the site. Advanced formation of desert pavement, rills, and/or gullies may be seen.
3	Plant Pedestaling	No to minimal plant pedestals present.	Some to moderate plant pedestals present. No signs of exposed roots.	Plant pedestaling obvious and tall. Root exposure seen.
4	Litter Amount*	Amount of litter nearly to totally matches that expected/ desired for site.	Amount of litter less than that expected/desired for site.	Amount of litter much lower than expected/desired for site.
5	Litter Distribution	Litter is uniformly distributed across site.	Less uniformity of litter distribution. Litter may be becoming associated with prominent plants or other obstructions.	Litter distribution not uniform. This may be due to general lack of litter and/or obvious patchy appearance of litter amount.
6	Litter Incorporation	Litter mixing well with soil, resulting in more rapid mineral cycle.	Some mixing of litter with soil. Litter may be elevated and its amount may be reduced. Mineral cycle not as rapid.	Litter not mixing with soil. Litter may be elevated and/or amount too little. Mineral cycle slower.
7	Dung Breakdown/ Incorporation	Dung breaking down rapidly, less than one year old.	Some dung breakdown, with most being around 2 years old.	Dung breaking down slowly, older than 2 years old.

*Refer to ecological site descriptions available from NRCS

SCORING GUIDE SIDE 2

		Gold: Achieving Goal	Silver: Moving Toward/Away from Goal?	Bronze: Not Achieving Goal.
8	Percent Desirable Plants*	Greater than 66% of plants in the area are desired. Remainder of plants are intermediate species (neither desired, nor undesired).	33% to 66% of plants species in the area are desired. Intermediate species (neither desired, nor undesired) have strong presence. Potential presence of undesired species.	Less than 33% of plant species in the area are desired. Intermediate plant species (neither desired, nor undesired) dominate. Undesired species also present.
9	Age Class Distribution	Variety of age classes seen in the area (seedling, young, mature, decadent).	More mature age classes present, seedlings and young mostly lacking.	Primarily old and/or deteriorating plants present.
10	Plant Species Diversity & Functionality*	Number of plant species in the area matches that expected for site. Plant forms (grass, shrub, forb, tree) also match that expected for site. Plants serving different functions.	Number of plant species in the area below that expected for site plant forms (grass, forb, shrub) reduced. Reduced functionality.	Number of plant species the area minimal. Plant forms (grass, forb, shrub) much below that expected for site. Poor functionality.
11	Living Organisms	Abundant signs of non-plant life.	Few to moderate signs of non-plant life. Something is missing from community.	Next to no signs of non-plant life. Components of the ecosystem are clearly missing.
12	Plant Canopy	Strong photosynthetic activity in the area. Canopy may cover greater than 66% of area.	Moderate photosynthetic activity in the area. Canopy may cover 33-66% of area.	Reduced photosynthetic activity in the area. Canopy may cover less than 33% of area.
13	Plant Vigor/ Color	Capability to reproduce (seed or vegetatively) not limited relative to recent climatic conditions. Growing plant exhibits bright green color.	Capability to reproduce (seed or vegetatively) is somewhat limited relative to recent climatic conditions. Growing plant exhibits pale green or may be yellowing.	Capability to reproduce (seed or vegetatively) is severely reduced relative to recent climatic conditions. Growing plant exhibits sickly yellow coloration.
14	Plant Distribution	Plants uniformly distributed across soil surface.	Distribution becoming fragmented, but some areas of uniformity.	Distribution obviously fragmented.

*Refer to ecological site descriptions available from NRCS

Basal Cover Data Form

Site Name_____ Examiners:_____

Transect Number _____ Date: _____

GPS- UTM Location DATUM:

Category	Bare Ground	Litter Cover	Live (Basal) Cover	Other Cover	Total
(Dot Count)					
Total Hits					
% Cover					

Distance = Distance to Nearest Perennial Plant

	Distance	Species		Distance	Species		Distance	Species		Distance	Species
1			29			57			85		
2			30			58			86		
3			31			59			87		
4			32			60			88		
5			33			61			89		
6			34			62			90		
7			35			63			91		
8			36			64			92		
9			37			65			93		
10			38			66			94		
11			39			67			95		
12			40			68			96		
13			41			69			97		
14			42			70			98		
15			43			71			99		
16			44			72			100		
17			45			73			Total		
18			46			74					
19			47			75			Dist. Total (cm)		
20			48			76			Avg Dist.(cm)		
21			49			77			10 Closest Plants		
22			50			78			1)		
23			51			79			2)		
24			52			80			3)		
25			53			81			4)		
26			54			82			5)		
27			55			83			6)		
28			56			84			7)		
Total			Total			Total			8)		
									9)		
									10)		
									Total		

Notes	

Species ID and Observations Form

Site Name _____

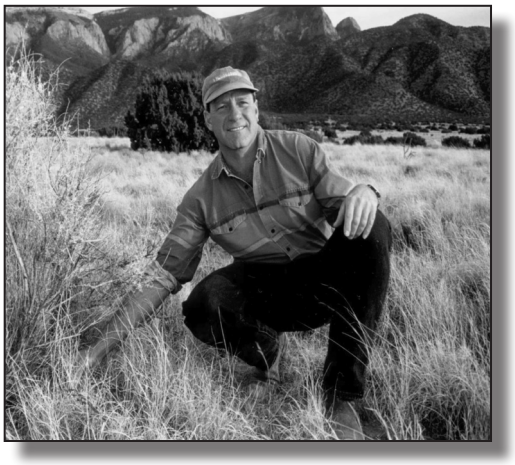
Transect Number _____ **Date**_____

	Plants	Animals	Notes and Observations
	Grass	**Insects**	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
	Forbs	**Birds**	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
	Brush	**Small Animals**	
1			
2			
3			
4			
5			
6			
7			
8			
	Tree	**Large Animals**	
1			
2			
3			
4			
5			
6			

About the Authors

Kirk Gadzia

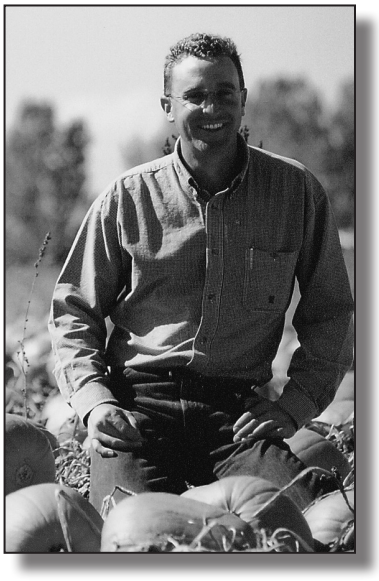
Kirk Gadzia works with ranchers across the United States and internationally to improve the sustainability of their operations. In looking at each business as a whole, his work involves financial planning, grazing management, wildlife interactions, improving land health and management-training courses on a public and private basis. Kirk has more than 25 years experience in working on rangeland-health and grazing issues. He was a field staff for Holistic Management International from 1987 to 1994 and is now a Certified Educator in Holistic Management. Kirk served on the Rangeland Classification Committee and is co-author of Rangeland Health (National Academy of Sciences 1994). He has developed and implemented range-monitoring techniques to provide early-warning indicators of deteriorating rangeland health. Kirk has a B.S. in Wildlife Biology and an M.S. in Range Science.



Contact Information:
Resource Management Services, LLC
PO Box 1100
Bernalillo, NM 87004
Phone: 505-263-8677
E-mail: kirk@rmsgadzia.com
www.rmsgadzia.com

Todd Graham

Todd Graham is the President of Ranch Advisory Partners, a Montana-based firm providing ranch management, grazing planning, and rangeland health monitoring services to landowners and livestock producers. Born and raised in Wyoming, Graham obtained a degree in rangeland science from the University of Wyoming and has been focusing on ranch management ever since. While living in central Wyoming, he managed in partnership two ranches for improvement of land health and wildlife habitat for absentee landowners. Simultaneously, he provided ranch management consulting services to landowners on roughly 2.5 million acres in Northern Rockies states.



Contact Information:
Ranch Advisory Partners, LLC
PO Box 11053
Bozeman, MT 59715
Phone: 406-585-3407
E-mail: tgraham@ranchadvisory.com
www.ranchadvisory.com

Quivira Coalition
1413 2nd Street Suite #1
Santa Fe, NM 87505
505.820.2544
admin@quiviracoalition.org
www.quiviracoalition.org

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Santa Fe, NM 87505
www.ptig.com
505-983-3101