Ranchers' Monitoring Guide

EXTENSION
College of Agriculture,
Biotechnology & Natural Resources

PEER REVIEWED

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Produced in partnership with:

University of Nevada, Reno

College of Agriculture,
Biotechnology & Natural Resources
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USDA

FOREST SERVICE US DEPARTMENT AGRICULTURE

NDA
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of Agriculture

Nevada Cattlemen's Association

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

NRRC

NEVADA FARM BUREAU®

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Some of our valuable partners have had the opportunity to review and support this guide. Many of those individuals and organizations are a significant part of the sustainable management of Nevada's rangelands. Thank you for your interest, and we hope this guide serves you well.

All photos by Brad Schultz, unless otherwise noted.

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INTRODUCTION

Rangeland monitoring is the orderly repeated collection, analysis and interpretation of resource information (data). Ranchers and/or others can use the data to make both short- and long-term management decisions. This guide provides individuals who want to monitor rangeland vegetation with information and methods that are useful, simple, quick and efficient. The use of any of these methods is voluntary.

When individuals apply the procedures in this guide with professional integrity, the information gathered is acceptable to federal and state cooperating agencies. It is important to coordinate monitoring of public lands with the appropriate public land manager, and jointly collect the information whenever possible. Everyone who collects monitoring information should properly reference/document the data so it may contribute to evaluating whether rangelands are meeting management standards, goals and/or objectives.

GOALS AND OBJECTIVES

Before beginning to monitor any allotment or pasture, carefully define the unit's management goals and objectives. The first step in the management planning process is to identify existing resource concerns and potential opportunities. A land health assessment (Pellant et al. 2005; Dickard et al. 2015) may help identify or clarify resource conditions. Accurate knowledge about resource conditions may help identify the most important management goals and objectives. Management goals are broad statements of desired conditions. Management objectives are clear quantifiable statements of expected results that are the outcome of strategic management activities, applied within a stated period, at a specific site. They are the important steps needed to achieve a management goal.

Resource objectives must be site-specific, measurable and attainable statements of the desired resource attributes. For example, "increase native perennial grass density from one per square meter to three or more per square meter over the next 10 years, at key area #1." Additional examples are available in Appendix D of the *Nevada Rangeland Monitoring Handbook* (Swanson et al. 2018). Written goals and objectives focus attention on desired conditions and the management strategies needed to achieve goals and objectives. Management goals and objectives are invaluable for understanding "why, where and when" to monitor rangelands, and the specific attributes to measure (e.g., plant cover).

An effective monitoring program also requires organized recordkeeping. A rancher or any other end-user of monitoring data can easily retrieve well organized and properly stored data for subsequent evaluation to determine if their management is meeting their management goals and objectives. If not, they are more likely to understand the probable reasons why.

Each monitoring method presented includes instructions, and an example of a completed form. Make copies of the blank forms (at the end of this guide) for field use, or use the NDA application.

WHY MONITOR

Among the reasons to monitor rangelands are:

- *To determine whether management objectives are realistic and achievable.*
- *To evaluate when one should change a management strategy to increase the probability of achieving identified objectives.*
- *To provide a record of environmental and resource conditions, events and management practices unrelated to livestock grazing, and which may influence rangeland vegetation and soils, independent of grazing management.*
- *To determine whether the grazing management strategy employed meets the management objectives established for resource conditions and livestock.*
- *To provide information to improve short-term decisions related to livestock management (e.g., determining when to move livestock).*

- *To determine whether you are following management plans (grazing or another focus) and to track when, how and why management or operating plans need modification.*

WHERE TO MONITOR

It is neither practical nor necessary to monitor every acre of rangeland. Monitoring locations should be located at key sites (i.e., key areas) that best represent the effects of management actions and environmental conditions across the larger management unit. Monitoring sites also may occur at special or critical areas of concern. The proper selection of key areas is critical for implementing a high-quality monitoring program. Collecting abundant and high-quality data will never mitigate poor site selection (i.e., not representative of management or environmental conditions on the management unit), as the conclusions probably will not improve management.

Typically, each pasture or management unit has at least one key area. Each key area should be located entirely within one ecological site (an area with similar soil, precipitation and landform; thus, potential for the same plant community) and away from its boundary. The location must be representative of the larger management unit (or appropriate portion thereof), and capable of responding to the management actions applied.

Key areas should avoid locations near fences, salt locations, stock trails, ridges, or areas livestock cannot or do not graze. When management concerns or goals frequently change across a landscape, two or more key areas may be necessary to determine the effects of management actions across the entire management unit.

When monitoring occurs on public lands, monitoring activities (including methods) and key area locations should be coordinated with the appropriate agency specialist.

WHEN TO MONITOR

When scheduling monitoring activities, consider the grazing and browsing impacts from all animal species, as well as impacts from other land uses. It may be necessary to conduct short-term monitoring before, during and after grazing or browsing occurs by the species of concern. If multiple monitoring periods are not feasible, monitor each year at the same stage of plant growth (mid- to late-growth stages would be preferred), regardless of the calendar date. When a grazing unit potentially has competitive grazers, it is beneficial to monitor important features both before AND immediately after livestock use the allotment.

MANAGING MONITORING DATA

All monitoring data must be stored, preserved, summarized and turned into useful information to improve decision-making. Upon returning to the ranch, office or home after collecting monitoring data, create one or more copies of the data and store them in separate, secure places. That prevents either an unfortunate disaster or mere unintended negligence from destroying (or losing) your data. For paper copies, at least one set should be stored in a fireproof safe or other structure. Scanning data forms into a digital format allows you to store them on your computer, with a second copy easily saved to an external device (often stored in the fireproof safe), or even offsite in a cloud-based facility. For data from public rangelands, or projects funded by Natural Resources Conservation Service or other agency (private or public rangelands), provide your partners copies of any data you collect.

Take time to think about how to best organize and store your data (and its backup copies) to best fit your needs. There is no one best approach for everyone, but everybody has a best approach for their needs, thought processes and style of organization. It may be by allotment, pasture, monitoring site, and/or year or some other approach. It is important that you pick a method or approach that works best for your mindset, and how you process and organize information.

Review your data sheets and forms as quickly as possible upon your return from data collection. This may be that day, the next day or the next week, but should not be weeks or months down the road. Pair any external

notes on other sheets of paper with the appropriate data forms. Review your notes for any points of confusion and clarify them as quickly after initial collection as possible.

When you must summarize many individual data points to obtain your final data value (e.g., averages), complete this task quicker rather than later, particularly if the data is important for evaluating trends of an important attribute across time. Input the data into the database or spreadsheet you use to record trend data and start thinking about the implications of the data while your observations, notes and memories are fresh and likely more accurate. Also, this provides you more time to think about how data and information collected this year should be incorporated into the decision-making for next year's operations. There may be important and valuable decisions that require long lead times to implement well, and waiting until late winter or early spring to adequately review your monitoring data and make the decisions at that time may be too late for an optimal outcome. Furthermore, it prevents something from "getting in the way" of reviewing and analyzing monitoring data.

Always review your monitoring data from the perspective of how the information will help you achieve your management goals and objectives. Are you making progress toward them or not? Regardless of the answer, the follow up question becomes, do you need to make one or more management changes to continue progress toward your goals, or to just get back on track toward the intended outcome. If the data you have collected is not providing an answer, the logical questions become: 1) have you selected an appropriate goal and supporting objectives, 2) have you made the appropriate management decisions to achieve the goal and objective, and/or 3) are you collecting the appropriate data to document whether you are achieving the goal and objective.

SHORT-TERM MONITORING

Short-term monitoring addresses data collection that should occur annually or more frequently. These types of data facilitate many short-term grazing management decisions that occur within the current year, and/or before the next grazing season. Short-term changes in management respond to immediate needs and collectively improve the odds that a rancher will achieve their long-term management goals and objectives. Just a few examples of short-term data collection are: short but intense disease or insect outbreaks that kill or seriously injure key species, calendar dates of important management actions, weather data that affects growing conditions, grazing use-intensity, pasture rotations, actual livestock use of an area, wildlife use, and impacts from recreation or vandalism that harm critical infrastructure used to implement grazing management. In essence, short-term monitoring data may be any event, incident, activity or action that can help explain why your management actions work or do not work, and/or desired or undesired changes in important resource attributes.

Short-term monitoring data and information also may help identify the factors behind the changes detected by long-term monitoring of vegetation or soils. It is difficult to impossible to confidently adjust grazing management strategies without a good record of annual conditions, events and/or management practices that influence long-term, but usually slow changes in vegetation and/or soil conditions. Short-term monitoring also helps the producer determine when, where and how to move livestock within the grazing season or year.

The collection of both short- and long-term monitoring data provides ranchers the best opportunity to make informed decisions that improve the management of their rangelands, regardless of ownership.

LONG-TERM MONITORING

Long-term monitoring focuses on the measurement of plant and/or soil attributes that typically change slowly (e.g., density, species composition, soil stability). Once management changes occur, it may take five to 10, or perhaps even more years before a measurable outcome (desired or undesired) occurs. These important population, community or landscape characteristics provide valuable information about whether or not management is progressing toward meeting management goals and objectives. The timeframe to achieve the goals or objective must be sufficient (usually five or 10 or more years) to separate real ecological change or trends from short-term annual influences due to either variable growing conditions and/or grazing effects. Both factors may

vary greatly among years, and the influence from one adverse year seldom has a permanent effect on the plant community. Conversely, the time period must be short enough to detect changes in rangeland conditions due to management, so that ranchers (or other land users) can adjust their management strategy and/or management practices to achieve the management objectives. Long-term rangeland condition and trend information is necessary to make informed adjustments that have a good probability of achieving the desired outcome.

The emphasis in this guide is short-term monitoring. We strongly suggest that the primary responsibility for long-term monitoring is with the land management agencies. We realize, however, that some ranchers may want to establish their own long-term monitoring program. This approach may better inform themselves about the effectiveness of their management strategies and actions. Regardless of who has primary or secondary responsibility for monitoring grazing management on rangelands, the livestock permittee should be actively engaged in the process, and whenever possible, should also be part of a Cooperative Permittee Monitoring effort.

The long-term monitoring procedures described in this guide are repeat ground photography, cover-by-life-form transects, plant density and streamside stability in riparian areas. The federal management agencies have often used the species frequency method, but in this guide we do not address this method (see the *Nevada Rangeland Monitoring Handbook* for a thorough discussion of frequency and other monitoring methods). Frequency and other long-term monitoring data/methods may provide ranchers additional important information even when the data are not part of the formal monitoring implemented on the allotment (i.e., it is supplemental).

MONITORING METHODS

The methods discussed in this guide are only a few of the potential monitoring techniques available to a rancher. The *Nevada Rangeland Monitoring Handbook* (Swanson et al. 2018) describes a more extensive collection of monitoring methods.

You do not have to apply all of the methods discussed here at every monitoring location. Likewise, one or more techniques not presented may be better suited to address a specific objective. To determine if you are meeting management goals, objectives and standards, choose the best suite of applicable methods, or only one, if that is all that is necessary. It is imperative that the monitoring methods selected always match the management goals, objectives and management strategies of the grazing unit.

While not a monitoring method per se, the collection and storage of information about livestock movements and pasture use enhances a monitoring program. This information is invaluable when used with the range monitoring techniques outlined in this guide. If you do not use a pocket herd book or some other type of record-keeping system, you can track that information with the form, Actual Use Record for Livestock Operators, located at the end of the Forms section of this guide.

We selected the methods described in this guide because they are generally easy to use, do not take an excessive amount of time and tend to produce consistently reliable results. One person can easily collect the information and data needed to improve your decision-making to effectively maintain or improve the rangelands you manage. The methods presented fall into four categories:

- BASIC INFORMATION
- SHORT-TERM METHODS
- LONG-TERM METHODS
- PLANNING TOOLS

BASIC INFORMATION

Site Location Form - This is a ranch scale map used to display the location of each monitoring site (plot) on the ranch. It may be hand drawn or plotted on a map or aerial photo, including Google Earth. When possible, record monitoring site coordinates with a geographic positioning system.

Site Information Form - Provides information specific to the monitoring location every time data collection occurs (especially for transect and photo data). This form also helps organize monitoring photos.

Vegetation Form - Documents dominant forage species, all grazers that have used the area, other disturbances and the degree of use in the area. Use this form with the Site Information Form.

Photo Information Sheet - Every time you take a photo, include information to document when and where the photo occurred.

Actual Use Record of Livestock Form - Documents important information about the operation of your ranch (e.g., turn out dates, numbers in pastures, supplement record, etc.).

SHORT-TERM METHODS

Landscape Appearance - This technique estimates general forage utilization. There are separate forms for herbaceous and browse species. Either may be appropriate in an upland and/or a riparian setting.

Key Species Method - An estimate of forage utilization focused on key species identified in management goals and objectives.

Grazing Use Map - A map created to depict use intensity categories (e.g., light, moderate, heavy) in a pasture or other grazing unit.

Stubble Height - Used to estimate/monitor the post-grazing vegetation height of key herbaceous species (i.e., the average height above the soil surface of the residual vegetation after grazing ends).

LONG-TERM METHODS

Permanent Landscape Photos - A series of photos across time, from the same photopoint, looking toward the same landscape. Photos may be taken either annually or at longer intervals, but should occur (to the extent possible) at or near the same growth stage, time of day and weather conditions. These three criteria apply for all monitoring methods that integrate photography into the monitoring process.

Photo-Point Transect - A permanently marked transect that tracks vegetation and overall site condition/appearance across time in quadrats at specific distances along the transect. Photographs occur on several permanent quadrats on the transect each time data collection occurs.

Photo Plots - A permanent plot, one to several acres in size, where you use photos to observe changes in vegetation and soils through time. The method uses a permanently marked plot and a portable frame to help relocate the same photopoint. You may take monitoring photos annually or at longer intervals.

Cover-by-Life-Form Transect - A method to estimate canopy cover by life-form (e.g., perennial grass, annual grass, shrub, forb) on a permanently marked transect.

Plant Density - A simple count of individual plants in a specified unit of area (e.g., one square yard or 300 square feet). The count may be for key species, all plants or some other specific group. The entity selected reflects management goals and objectives.

Streamside Stability (Riparian) - A riparian monitoring method that records the streambank vegetation, by vegetation type, along the stream's greenline (first perennial vegetation on or near the water's edge).

PLANNING TOOLS/STRATEGIES

Grazing Response Index - A planning tool that describes annual grazing use in the current grazing season. The probable effects are inferred through integration of information about defoliation (utilization) intensity, frequency of repeated defoliation of the same plants during the growing season, and the amount of growth or regrowth before and after the grazing period.

Altering the Season of Use Across Consecutive Years - This strategy attempts to avoid using highly palatable forage plants at the same stage of plant growth, particularly the early boot to flowering growth stages, in consecutive years. Additionally, grazing animals' preference for a plant species or specific plant parts often changes as the year progresses. Grazers and/or browsers often select different plant species, or plant parts, at different times of the year, and grazing's intensity and/or frequency can have different biological effects (none too substantial) on the plant in different seasons. By altering the season of use across years, the potential adverse effects of excessive grazing of the primary forage species is less likely to occur, and all plants will have more opportunity for growth/regrowth and reproduction over time.

BASIC MONITORING INFORMATION

The Basic Monitoring Information described below is used to identify discrete monitoring locations that are used across time.

SITE LOCATION SHEET AND SITE INFORMATION FORM

You should complete the Site Location Form (*Figure 1*) and the Site Information Form (*Figure 2*) every time you use one of the methods described in this guide. Use this information when analyzing data collected from different sites to prevent inappropriate comparisons and conclusions. The information described is basic and should not require a significant investment of time and decision-making by the observer. There are mapping applications (e.g., *Avenza Maps*, *Terrain Navigator*, perhaps others) that may be able to capture some or all of the information on the Site Information Form. They may be very adequate substitutes or complementary additions for the forms described in this section. The end-user should always use the form and/or software with which they are most comfortable and provides them the information they need to address their management (and monitoring) issues and concerns. The Site Location Form should include a photo of the monitoring site, preferably with an identifiable feature in the background. This helps ensure data always are collected at the same location. Accurate GPS coordinates and a compass bearing for the direction of a transect or photo also can adequately document a site's location.

General and Site Location Information

- ***Unit Name -*** *Record the name of the allotment, management area or other geographic description of where the monitoring occurs.*
- ***Pasture Name -*** *Record the name of the pasture or subunit where the monitoring occurs.*
- ***Study Site -*** *Record the number or name of the specific site where monitoring data or photographs are collected.*
- ***Date -*** *Record the date the information is collected.*
- ***Observer -*** *Record the name of the individual(s) collecting the monitoring information.*
- ***Monitoring Method(s) -*** *List the method(s) by which the collection of monitoring information occurs.*
- ***Date Study Established -*** *Record the first date for the site on which data collection occurred. This facilitates tracking trend information across periods from several years to decades.*
- ***Study Location -*** *Record the legal description of where the study site is located and how it is marked. Be as specific as possible. If possible, use GPS so that others can easily relocate the site in later years.*
- ***Access -*** *Optional. Describe the easiest way to drive or ride to the study site vicinity.*
- ***Ownership -*** *Optional. Record the land ownership (and management responsibility) for where the monitoring site is located.*

Site Characteristics

- ***Landform -*** *Record the best landform description of the general area of the plot location.*
- ***Elevation -*** *Record the elevation of the study site to the nearest 100 feet.*
- ***Percent (%) Slope -*** *Optional. Record the average percent slope of the general terrain of the study site.*
- ***Average Annual Precipitation -*** *Record the approximate annual precipitation to the nearest inch. Do not record the current year's precipitation.*
- ***Ecological Site -*** *Specify the ecological site and state. Specify whether the study site is representative of upland or riparian conditions. For additional information, consult the Natural Resources Conservation Service website.*

- ***Current Growing Conditions -*** *Record any applicable remarks regarding the growing conditions including temperature and moisture. Report any conditions or situations that are out of the ordinary for the current year, or the past several years (e.g., a prolonged drought or wet period).*
- ***Exposure (aspect) -*** *Indicate the general direction the slope faces (e.g., north, southwest) at the location of the study site.*
- ***Soil -*** *Indicate the general soil characteristics of the study site. Note: Mark more than one soil texture if appropriate. For example, if the soil is a sandy loam, then check both sand and loam. The internet site, Web Soil Survey, contains excellent soil information, but should always be verified with a site visit.*
- ***Other Information -*** *Record any information (positive or negative) that you believe may improve interpretation of short- and/or long-term monitoring data, and/or has had an influence on the management of your operation and its ability to achieve management goals and objectives.*

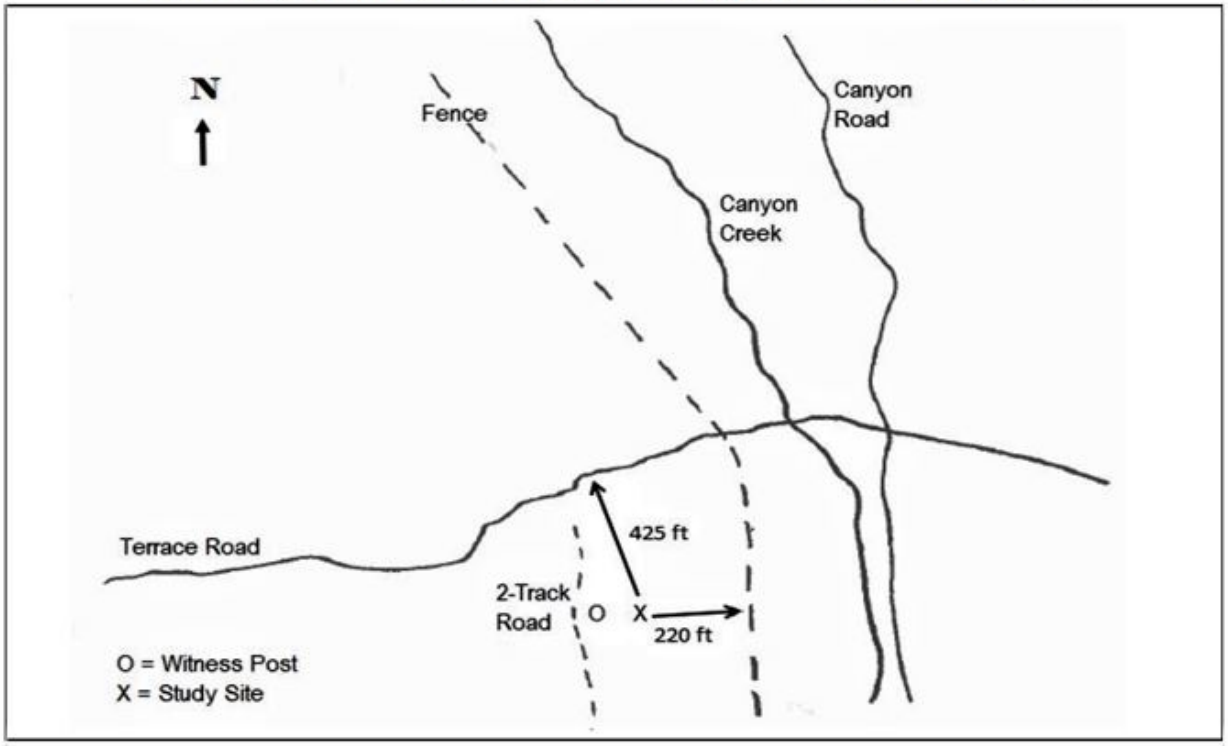
Unit/Pasture Use Information

- ***Kind and Class of Animal -*** *Identify the kind and class of livestock that grazed the unit and pasture this grazing year.*
- ***Season of Use -*** *Record the on and off dates for the pasture, and the stage of plant growth at those times. Examples of growth stage include: leaf emergence, first two to three leaves per tiller (i.e., stem, seed stalk), rapid vegetative growth (many leaves but no elevated tillers or stems present), tillers being elevated, boot stage, seedhead emerging, flowering, seed developing, seed-set, summer dormancy, winter dormancy). Plants respond to grazing differently at different growth stages, not dates of the year. Also, the same growth stage may occur on very different dates in any two years. If movement of animals occurs on more than one date, record the head count of each move. Also, note whether livestock completely vacated pasture, and the date when the last animals exited the unit.*
- ***Number -*** *Record the number of livestock animals grazing the unit this year.*
- ***Grazing System -*** *Record the type of grazing system used in the management area.*
- ***Current Year Grazing Management -*** *Describe the grazing schedule for this year (e.g., order of pasture use, which pasture rested or deferred, etc.).*
- ***Other Notes -*** *This section is optional, but consider recording any other pertinent information about the grazing system or other information (e.g., plant growth stage, soil moisture in the root zone, recent precipitation events, etc.) worth capturing. Include any information that benefits interpretation of the short- and long-term monitoring data collected for your monitoring program.*

SITE LOCATION FORM

Site Location Map

Show witness mark location, study site, or other information to aid in locating site.



Site Location Photograph

Show Photo Information Sheet in all photos if possible.

Figure 1: Site Location Form Example

SITE INFORMATION FORM

Complete this form when conducting any of the study methods in this booklet as a summary of site information. If no study methods are conducted, completing this form alone will still provide a record of valuable information. All fields are required unless otherwise indicated with an "oot." Complete the blanks to the best of your knowledge.

Initial:	X	Annual:	

General and Site Location Information

Unit Name:	Lake Creek	**Pasture:**	Baldy		
Study Site (# or Name):	#1 Billy Creek	**Date:**	04/09/21	**Observer:**	R. Jones
Monitoring Method(s):	Landscape Appearance	**Date Study Established:**	06/20/21		
Study Located:	N S E x W trail crossing on Lake Creek, 200 feet				
NW **1/4 of:**	SW	**1/4 of Section:**	16		
Township:	14N	**Range:**	26E		
Access:	Highway 66 to County Road 241				
Ownership (opt.):	Bob Robertson				
GPS Coordinates:	**Latitude:**		**Longitude:**		

Site Characteristics

Landform:	mountain meadow				
Elevation:	5500 feet	**% Slope:**	1	**Avg Annual Precipitation:**	1 inches
Note:					

Range Site		Current Growing Conditions		Exposure (opt.)				Soil (opt.)	
Upland (U)	X	Above Average (1)		N		S		Sand (1)	X
Riparian (R)		Average (2)		NE		SW		Silt (2)	
		Below Average (3)	X	E		W		Clay (3)	
				SE		NW		Loam (4)	

Other Climatic Information (opt. snow depth/persistence, temperatures, storms, flooding, etc.):

Temperatures during May were cooler than normal.

Unit/Pasture Use Information

Animal (Kind & Class):	Cattle (steers)	**Season of Use:**	1-Jun	**to**	1-Jul
Number:	175	**Grazing System:**	rest rotation		
Current Year Grazing Management:	Baldy to Iron Creek - rest Willow Creek				
Other Notes (optional e.g., growth stage of plants at time of use):	Counted 22 head of elk				

in pasture when cattle went on. Use levels in riparian areas were light to moderate.

Figure 2: Site Information Form Example

VEGETATION FORM

The Vegetation Form (*Figure 3*) documents dominant forage species, grazers that have used the area, other disturbances, and the general degree of grazing use or effects of land uses on the vegetation in the area. Vegetation data collected annually, across time, can help paint a picture for how different fauna (animals) and land uses have changed. These data help land managers (including grazing permittees) understand how all land uses may be affecting the vegetation (annually and long term) on a landscape, in a defined management unit or a specific area of concern. Managers use this data to help interpret the data collected with short-term and long-term monitoring methods, which helps improve decision-making. Use this form whenever you complete a site information form, and anytime you believe there is value in having additional data for land uses occurring in your area of concern.

Vegetation

- ***Dominant Plants -*** *Identify the three to five most abundant and/or ecologically dominant species on the study site. An ecologically dominant species is one that strongly influences vegetation dynamics on the site. It may or may not be the most abundant species on the site but is sufficiently present to exert the most influence on ecological processes on the site. For example, a widespread population of juniper trees that is slowly increasing in canopy cover, hence plant size, can cause a slow decline in sagebrush and perennial grasses. The ecological effect of the comparatively few juniper trees toward the more abundant understory shrubs and perennial grasses is much greater than are the latter toward the trees. Mere abundance does not automatically confer ecological dominance. Ecologically dominant species are those that largely determine future change in the abundance of the desired species. They may be few and large, small and many, or some combination in between, but they are the ones that largely influence vegetation dynamics (change) on the site, in the absence of catastrophic disturbance (e.g., fire, insect infestation, flooding, etc.). Be as specific as possible when completing this section.*
- ***Primary Forage Species -*** *Identify the three to five primary forage species. These are often the species that experience the most use when grazing occurs (may vary by year if the season of use changes from year to year). Consult your agency range specialist to determine the agency's primary forage species of concern and key species for this site or allotment. Key plant species may or may not be a primary forage species.*

Vegetation Use

- ***Degree of Use -*** *Indicate the general use (e.g., heavy, moderate) for one or more of the categories listed. Write NA in the appropriate row if that use is absent. If appropriate, you may identify other use categories that do not appear on this list. Be as specific as possible. Use the comments section to capture important or unique information about land use on this site that may affect the vegetation. Consult your agency range specialist to determine the correct definition of heavy, moderate or light degree of use. Appropriate degree of use may vary from agency to agency and between field offices within an agency, and be specific to your management plan. Clearly record differing definitions in the "Notes" section at the bottom of the data form.*

Notes: Record any other important comments that may help with later interpretation of the data. Most often, the mental observation you made when you saw the site, or the first topic that you discussed with others, are those concepts that merit capture. If use by horses is worth noting, properly identify the type of horse (wild versus domestic).

VEGETATION FORM

Dominant Plants:	bluebunch wheatgrass and Nevada bluegrass

Primary Forage/Indicator ("Key") Species:	bluebunch wheatgrass

VEGETATION USES

	Degree of Use			
	High	Moderate	Low	Optional Comments
Livestock		X		cows & calves
Big Game		X		elk use
Rodent			X	pocket gophers
Insects	X			Mormon crickets
Recreation	X			primarily foot traffic
Motorized			X	off highway vehicle primarily
Horse			X	
Dispersed Camping	X			habitual camps
Other (e.g., Fishing)	X			some banks trampled by fishermen
Other				
Other				
Other				

Notes (Use additional pages as needed.)	Weather was cool and wet while cattle were in the pasture.
Because of that, cattle are not using this site as much as they normally do.	

Figure 3: Vegetation Form Example

PHOTO INFORMATION SHEET

Display the Photo Information Sheet (*Figure 4*) in every photograph you take to provide a clear and credible record of when and where you took the photo. Use a wide-tipped black marker to write on the sheet. If possible, use yellow or blue colored paper, as they reduce reflectiveness and glare, which improves visibility of the writing.

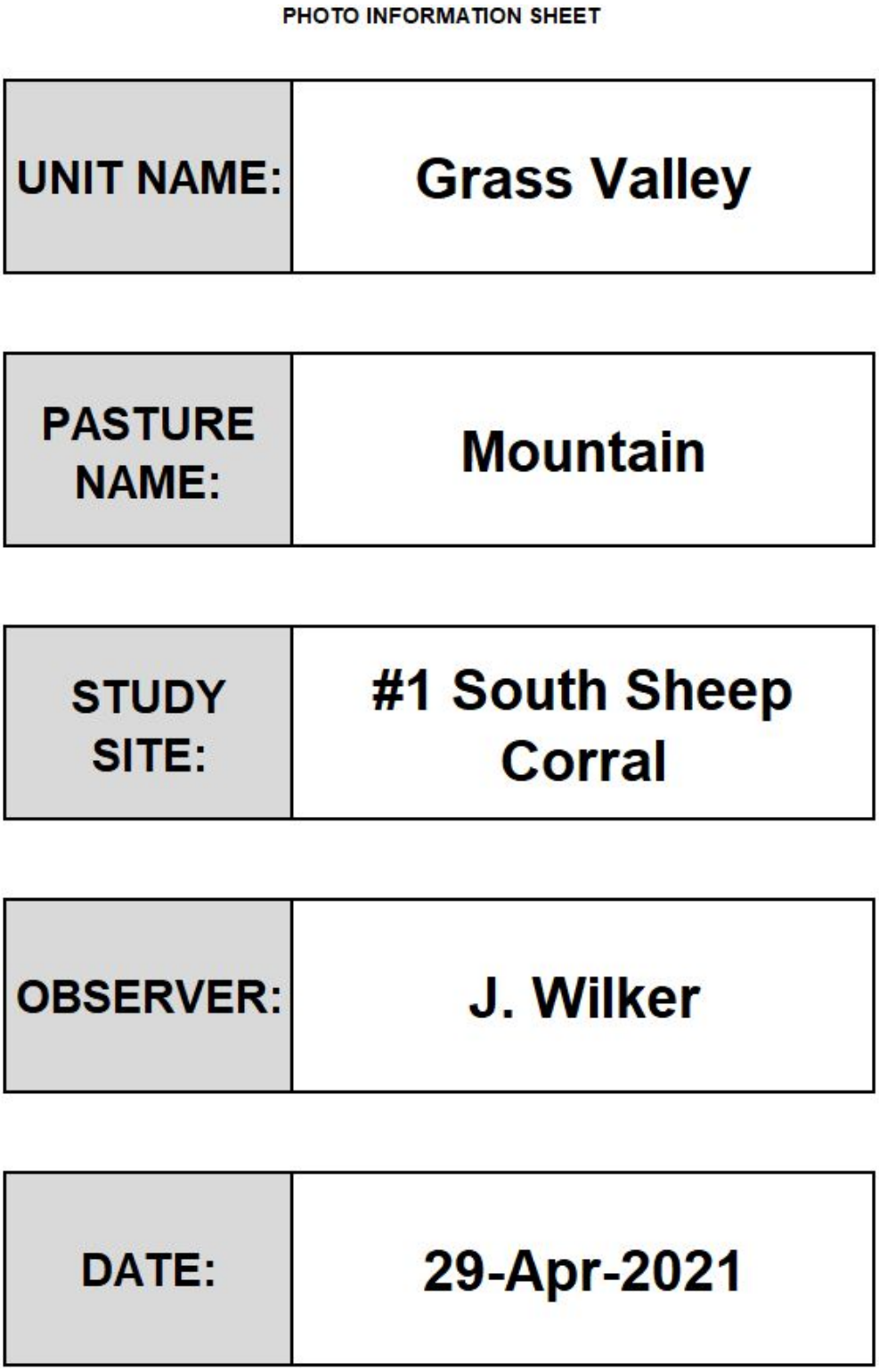


Figure 4: Photo Information Sheet Example

SHORT-TERM MONITORING METHODS

LANDSCAPE APPEARANCE (HERBACEOUS AND BROWSE)

This method estimates general forage utilization. One may evaluate forage utilization from two perspectives. The first is to look at the potential impact of animal use (domestic and/or wild) on plants that growing season. Grazing animals potentially affect plants when grazing removes leaf and stem material during the growing season. The process of grazing reduces the amount of leaf (hence, photosynthetic) area, which reduces carbohydrate production and potentially the storage of energy reserves used to keep the plant alive during dormant periods and initiate regrowth the next growing season. Once perennial herbaceous plants (grasses and forbs) have completed their lifecycle for the year (i.e., completed seed production), they rapidly go dormant and the removal of dead leaf and stem material has few, if any adverse physiological effects on the plant. The amount of residual material may have other important ecological implications (typically determined on a site-by-site basis), but additional use of the forage has virtually no adverse effects on the plant. Forage utilization, therefore, should always be evaluated with respect to the stages of plant growth in which it occurs. A second general use of forage utilization is to understand the pattern of use (distribution of animals) across the landscape during the grazing period, regardless of stage of plant growth. This concept is addressed through use-mapping and is covered in greater detail in the section below titled, Grazing Use Mapping.

The Landscape Appearance Method is especially helpful for two situations: 1) when grazing or browsing estimates must occur for large areas and there are few individuals available to collect the data, and 2) for rangelands with many palatable species instead of only a few key species.

This method makes an ocular estimate of forage utilization based upon the general appearance of the rangeland. The data recorder determines utilization levels by comparing observations with the written description for specific utilization classes, and selecting the category with the best fit. All interested parties then evaluate the utilization data with respect to the management unit's standards, goals, objectives, triggers, or end-points. This evaluation may (or may not) suggest the need to change management actions and/or decisions.

This method often focuses only on key areas. When the objective is to develop a utilization map, application of this method throughout the grazing unit can provide the basis for creating the final utilization map.

Equipment

- *Vegetation Form.*
- *Site Information and Landscape Appearance Forms – there are separate forms for herbaceous and browse.*
- *Camera, and Photo Information Sheet.*
- *Transect reference stake (optional). This procedure establishes one or more transects and data collection occurs on those transects. One or both ends of each transect may be permanently marked with stakes, but staking is not required.*

Procedure

This technique can use several approaches. It may focus on one or more key areas, or be used to help develop use maps of an entire pasture, use area, or allotment. For the latter approaches, data collection would occur at specified intervals along transects associated with a well dispersed road system, or if riding horseback, at specified intervals along a track identified with a GPS. Roads may provide access to monitoring areas, but be sure to place transects far enough from the road to eliminate any influence the road has for livestock movement and congregation.

Select a beginning point in the key area for a paced transect. A paced transect does not have fixed start and endpoints marked with permanent stakes, although a general starting point can be delineated with a stake or GPS point. Collect one data point at each pre-defined distance along the transect (more detail provided in next paragraph). It is important to ensure that the transect remains within the same ecological site (e.g., Loamy 12-16), not just the same type of plant community (e.g., mountain big sagebrush). To the extent possible (and

appropriate), always locate transects perpendicular to the slope of the landform. Transects perpendicular to the slope capture more of the site's micro-topography (e.g., shallow swales and ridges) and its influence on vegetation composition and response to management actions. Complete the *Site Information Form*, and determine whether to use the herbaceous or browse species descriptions, and then select the appropriate form (*Figures 5 and 6*, or both if they each reflect management goals and objectives).

Take a photograph looking down each transect. If possible, include a relocatable, prominent feature (rocky point, tree, distinctive horizon) behind the back end of each transect.

Observe and record at least 25 samples per transect. Generally, an interval of 30 feet between each sample (data point) works; however, the increment may be shorter, if needed. The key is to have the increment long enough to ensure that each sample point is separate (independent) from both the previous and subsequent sample points. *Record the sample interval on the form*.

Determine how many paces or steps (use either paces or steps – one pace is simply two steps) will give you the selected sample interval and walk accordingly along each transect. When you reach the predetermined number of steps or paces, examine the area immediately in front of you and determine which landscape appearance class accurately represents the vegetation use (*Figures 5 and 6*). At each observation point, it is helpful to visualize a 5- to 20-foot radius (depending upon interval between sample points) in a 180-degree arc from your immediate left to your immediate right. Record your finding as a dot tally in the appropriate row.

In addition to the used categories on the data form, other indicators may aid in your classification of use levels. Some examples may include (but are not limited to): few seed heads on the key species may reflect poor growing conditions that year or use by livestock or other grazers; what is the degree of use on forage species beneath shrubs; do short forage plants reflect use or was the area used by resting animals and when they laid down they broke off brittle seedstalks. Assess the entire situation. Do not fall into a trap of following written categories that may or may not accurately reflect the actual grazing use that year.

After collecting all of the data points, summarize the data for each row (*see Figures 5 and 6*). Count the number of dots in the dot tally column and transfer that number to the "count" column (third column on form). In the fourth column (# x midpoint), multiply the count value in column three by the midpoint of the utilization class shown in column one (the number in the parentheses). Write the value in the corresponding box of the "midpoint" column (fourth column). Next, summarize data in the count and midpoint columns. Add the values in the count column and record the sum in box A at the bottom of the count column. For the "midpoint" column, add all of the values and write the sum at the bottom in box B. Calculate the average percent utilization by dividing the sum of the "midpoint" column (box B) by the total count (box A).

LANDSCAPE APPEARANCE METHOD (HERBACEOUS) FORM

Unit Name:	Lake Creek	Pasture Name:	Baldy

Transect ID:	#1 - Billy Creek	Date:	04/09/21	Observer:	R. Jones

Animal Kind/Class:	Cattle	Season of Use:	1-Jun to 1-Jul	Sample Interval:	30 ft

Class (Midpoint)	Dot Tally	(#) Count	# x Midpoint	Description of Landscape Appearance
0-5% (2.5%)		3	7.5	The rangeland shows evidence of no grazing, or of negligible use.
6-20% (13.0%)		11	143	The rangeland has the appearance of very light grazing. The herbaceous forage plants may be topped or slightly used. Few current seedstalks and young plants are grazed.
21-40% (30.0%)		18	540	The rangeland may be topped, skimmed, or grazed in patches. The low-value herbaceous plants are ungrazed, and 60-80% of the number of current seedstalks of herbaceous plants remain intact. Fewer than 50% of the young plants are grazed.
41-60% (50.0%)		9	450	The rangeland appears entirely covered as uniformly as natural features and facilities will allow. 15-25% of the number of current seedstalks of herbaceous species remain intact. No more than 10% of the number of low value herbaceous forage plants have been untilized.
61-80% (70.0%)		2	140	The rangeland has the appearance of complete search. Herbaceous species are almost completely utilized, with less than 10% of the current seedstalks remaining. Shoots of rhizomatous grasses are missing. More than 10% of the number of low-value herbaceous forage plants have been utilized.
81-94% (88.0%)		3	264	The rangeland has a mown appearance, and there are indications of repeated coverage. There is no evidence of reproduction or current seedstalks of herbaceous species. Herbaceous forage species are completely utilized. The remaining stubble of preferred grasses is grazed to the soil surface.
95-100% (97.5%)		1	97.5	The rangeland appears to have been completely utilized. More than 50% of the low-value herbaceous plants have been utilized.
	Total	A 47	B 1642.00	
Average Utilization = B/A			34.94%	

Figure 5: Landscape Appearance Method (Herbaceous) Form Example

LANDSCAPE APPEARANCE METHOD (BROWSE) FORM

Unit Name:	Lake Creek	Pasture Name:	Baldy

Transect ID:	#1 Billy Creek	Date:	04/09/21	Observer:	R. Jones

Animal Kind/Class:	Cattle	Season of Use:	1-Jun to 1-Jul	Sample Interval:	30 ft

Class (Midpoint)	Dot Tally	(#) Count	# x Midpoint	Description of Landscape Appearance
0-5% (2.5%)		4	10	Browse plants show no evidence of use; or browse plants have the appearance of negligible use.
6-20% (13.0%)		3	39	The available leaders of palatable browse plants have the appearance of very light use.
21-40% (30.0%)		3	90	There is obvious evidence of leader use. The available leaders appear cropped or browsed in patches, and 60-80% of the available leader growth of the palatable browse plants remain intact.
41-60% (50.0%)		6	300	Browse plants appear rather uniformly utilized, and 40-60% of the available leader plants remain intact.
61-80% (70.0%)		8	560	The use of the browse gives the appearance of complete search. The preferred browse plants are hedged, and some plant clumps may be slightly broken. Nearly all available leaders are used, and few terminal buds remain on palatable browse plants. 20-40% of the available leader growth of the palatable browse plants remain intact.
81-94% (88.0%)		8	704	There are indications of repeated coverage. There is no evidence of terminal buds, and usually less than 20% of available leader growth on the palatable browse plants remain intact. Some patches of second and third years' growth may be utilized. Hedging is readily apparent, and the browse plants are more frequently broken. Repeated use at this level will produce a definitely hedged or armored growth form.
95-100% (97.5%)				Less than 5% of the available leader growth on browsed plants remain intact. Some, and often much, of the more accessible second and third years' growth of the browse plants has been utilized. All browse plants have major portions broken.
	Total	A	32	B 1703
Average Utilization = B/A				53.22%

Figure 6: Landscape Appearance Method (Browse) Form Example

KEY SPECIES METHOD: FORAGE PLANT UTILIZATION

Measurements of key plant forage utilization only occur in key areas and with a limited number of key species. Measurements should occur after the grazing and growing periods have ended, unless monitoring or management plans call for different timing. Forage utilization studies are used 1) to supplement use maps for further documentation of any need to change livestock use, and 2) at trend study sites to help interpret the causes (and potential concerns) of documented changes in plant species density, frequency, ground cover, species composition and/or other attribute measured.

Description of Use Classes

Use the six utilization classes described below for each key species. The percent use refers to the percent of the species biomass used at each sample point.

- ***No Use (0%, midpoint is 0%):*** *The key species show no evidence of grazing use, or barely detectable.*
- ***Slight (1-20%, midpoint is 11%):*** *For most key forage plants, utilization has been little to none, with no grazing on many plants. Most plants are unused, or if grazed, grazing has not affected most of their tillers and leaves. Current year seedstalks and small plants (of the key herbaceous species) remain largely ungrazed. For key browse species, the vast majority of the available leaders are ungrazed and not physically damaged by livestock or other ungulates.*
- ***Light (21-40%, midpoint is 31%):*** *For key herbaceous species, grazing appears to have topped or skimmed the larger key species plants, or occurred in patches. Most small herbaceous plants are ungrazed. Most (60 to 80%) of the current year's seedstalks remain intact through seed ripe (see note at end of section). The low-value herbaceous species are largely ungrazed (an occasional bite may occur). For key browse species, herbivores removed 21 to 40% of the available leader growth. There is obvious evidence of browsing on some, but far from all, leaders. Often, browsing on the available leaders appears to have been patchy, for both individual plants and clusters of plants.*
- ***Moderate (41-60%, midpoint is 51%):*** *Grazing has used about half (by weight) of the available forage of key herbaceous species. Fifteen to 25% of the current seedstalks remain intact through seed ripe. After seed ripe, many tillers may be broken off near their base and subsequently lay prostrate on the ground's surface, but otherwise intact. If low-value forage plants are present, their overall utilization remains slight to absent. Browse plants appear rather uniformly utilized (i.e., most plants, not necessarily leaders, have been browsed to some extent). Collectively, grazers removed 41 to 60% of the current year's leader growth. Many leaders, however, remain unbrowsed and have intact terminal growing points.*
- ***Heavy (61-80%, midpoint is 71%):*** *In accessible areas, grazers have consumed 61 to 80% of the current year's growth. Almost every desired forage plant shows some level of use, and low-quality forage plants have slight to moderate use. Often, few (10% or less) of the current year's stalks remain ungrazed, although some may have been broken off near the base and laying on the ground's surface, largely intact. Grazing has removed most shoots from rhizomatous grasses, except for an inch or two of stem protruding from the soil. For key browse species, grazers appear to have completely searched the area for feed. Nearly all available leaders show use, and few terminal buds remain at their tip. Many plants appear hedged, with physical breakage occurring on some plants. Only 20 to 40% of the current year's leaf growth remains across the site.*
- ***Severe (81-100%, midpoint is 91%):*** *Grazers have consumed over 80% of the current year's growth of the key herbaceous species. The perennial herbaceous component has the appearance of a mown landscape, with residual plant height being short for all key forage plants. Grazing of the less-preferred forage plants is moderate to heavy. There are indications of extensive use of the regrowth on previously grazed plants (an indicator may be different leaf length on different parts of the regrowth). There are few if any seedstalks from the current year (standing or prostrate on the soil surface). For key browse species, browsing has occurred on all of the current year leaders, and browsing is likely evident on growth from previous years. There are very few, and possibly no, terminal buds on the twigs and branches (within reach of grazing animals). Hedging is readily apparent, and broken stems are common on most of the key species.*

Note: The absence of standing seedstalks may or may not indicate heavy or severe grazing. Grazing or loafing in riparian (or other) areas that occur near (or after) seed maturity often result in many seedstalks being broken off near their base. The stems and seedstalks subsequently lay prostrate on the soil surface, with seed heads often intact, or nearly so. The seed is viable, and there is little, if any, damage to the plants physiological state or processes. The plants are able to tolerate the grazing event, survive the upcoming dormant period, and regrow the next growing season. Also, in some years, weather patterns may preclude the development of seed heads on most tillers. Vegetation data should always be collected with a formal (written notes) understanding for how the plants likely grew and responded to weather that year.

Equipment

- *Site information Form, Vegetation Form, and Range Utilization - Key Forage Plant Method Form.*
- *Transect reference stakes (optional).*

Procedure

It is important to work closely with agency range professionals to determine: 1) which species should be key species for measurement; 2) where to establish transects; 3) how long transects should be; and 4) what observation intervals are most appropriate for each specific site.

Establishing a transect - The starting point is at a known reference marker or permanent witness post and is documented on the field form. If desired, use GPS coordinates to identify each transect's starting and end points. Select a permanent transect direction and record the compass bearing. The entire transect must remain within the ecological site selected as a key area. Document the location, starting point and direction of the utilization transect so that future utilization studies will occur in the same area.

Utilization transect observations - Select an interval to pace between each sample point (the specific points to record utilization). Intervals must be long enough to ensure each sample is independent of other samples, but short enough to locate the entire transect within the ecological site. Record the interval on the field form each time you collect data. A common observation interval is five paces (roughly 30 feet) but may vary depending on the type and/or size of the key area. At each observation point, record the utilization of the nearest key forage plant within a 5-foot, 180-degree arc that originates from the toe of your boot (Figure 7). Classify the utilization level into one of the six classes described at the beginning of this section (far right column of the Range Utilization – Key Forage Plant Method Data Form), and record the data in the appropriate row (utilization class) and column (key species frequency) using the dot tally method. (For illustration purposes the Range Utilization – Key Forage Plant Method Data Form below shows the summary value of all dots, not individual dots.) If no key species are present in the 5-foot arc, continue moving down the transect until a key species occurs within the arc. For data collection to remain consistent, the key species plant must occur within 5 feet of either side of the transect. Continue toward the next data point at the previous (original) sample interval.

For adequate data collection (sample size) there should be a minimum of 20 "hits" (data points) on each key species. To obtain 20 "hits" for each key species, the length of each transect will vary, and will depend upon topography, the variability of the vegetation and the best judgment of the examiner. Often, you will need 25 to 40 or more sample points to obtain 20 "hits" (data points) for each key species.

On the data form (Figure 7), to calculate forage utilization, for each key species, multiply the midpoint value for each utilization class (column 1), by the number of times (frequency – columns 2 or 4) that species occurred in that utilization class. Write the calculated value for each species in the appropriate column (i.e., column 3 or 5). To determine utilization, add the values in each respective column (columns 2-5), and write the summary value in the row labeled "Totals," for each column. Then, divide column 3 by column 2, and column 5 by column 4, and round each value to the nearest whole number. Write the value for each species in the row labeled **Σfx/Σf**. **Σ** is a mathematical label that means the "sum of."

RANGE UTILIZATION - KEY FORAGE PLANT METHOD FORM

Unit Name:	Perryman's Paradise	Pasture Name:	Swanson's Riparian

Transect ID:	1	Date:	04/09/21	Observer:	Sherman

Animal Kind/Class:	cow calf pairs	Season of Use:	6/3/2020	to	7/12/2020	Vegetation Type:	rip meadow

Midpoint (x)	Key Species: Neb Sedge Frequency (f)	Neb Sedge f*x	Key Species: Willow Frequency (f)	Willow f*x	Description of Use Classes
0	1	**0**	3	**0**	**No Use (0%)**: The rangeland shows no evidence of use by grazing animals.
11	4	**44**	4	**44**	**Slight (1-20%)**: The rangeland has the appearance of very light grazing. The key herbaceous forage plants may be topped or slightly used. Current seedstalks and young plants of key herbaceous species are little disturbed. The available leaders of key browse plants are little disturbed.
31	7	**217**	7	**217**	**Light (21-40%)**: The rangeland may be topped, skimmed or grazed in patches. The low-value herbaceous plants are ungrazed, and 60-80% of the number of current seedstalks of key herbaceous plants remain intact. Most young plants of key species are undamaged. The available leaders appear cropped or browsed in patches, and 21-40% of the available leader growth of the key browse plants has been removed.
51	9	**459**	6	**306**	**Moderate (41-60%)**: The rangeland appears entirely covered as uniformly as natural features and facilities will allow. 15-25% of the number of current seedstalks of key herbaceous species remain intact. No more than 10% of the number of low-value herbaceous forage plants are utilized. Browse plants appear rather uniformly utilized, and 41-60% of available leader growth of key browse plants has been removed.
71	3	**213**	2	**142**	**Heavy (61-80%)**: The rangeland has the appearance of complete search. Key herbaceous species are almost completely utilized, with less than 10% of the current seedstalks remaining. More than 10% of the number of low-value herbaceous forage plants has been utilized. Approximately 61-80% of the available leader growth of the key browse plants has been removed.
91	1	**91**	0	**0**	**Severe (81-100%)**: The rangeland has a mown appearance, and there are indications of repeated coverage. There is no evidence of reproduction of current seed stalks of key herbaceous species. There is no evidence of terminal buds, and 81-100% of available leader growth on the key browse plants has been removed. Some, and often much, of the second and third years' growth on the browse plants has been utilized.
Totals	**25**	**1024**	**22**	**709**	**Remarks:** Recent ATV tracks through meadow. Many caterpillars in willows upper end of meadow.
Σfx/Σf	**41**		**32**		

Figure 7: Range Utilization - Key Forage Plant Method Form Example

GRAZING USE MAP

Livestock use maps are an important management tool. They may help identify key areas for long-term monitoring sites, demonstrate distribution problems and/or identify management opportunities. Also, they may indicate the need to modify a grazing management plan to improve the likelihood of achieving management goals and objectives. Grazing use maps should not be used to infer how that year's grazing may affect key species or the vegetation in general, unless one also collects good data about the stages of plant growth that occurred during the grazing period. Plants respond to grazing differently at different growth stages; thus, heavy use (e.g. 70%) for herbaceous species has an entirely different interpretation when it occurs at the boot growth stage, as compared to when plants are dormant in the late summer or fall.

To map use, examine the grazing unit and sketch utilization patterns (polygons) on a map. Other data from landscape appearance observations or other monitoring methods (e.g., stubble height, key species, residual dry matter) can help refine use maps. The size and number of grazing use polygons on any grazing use map must reflect their value for providing accurate and useful information for how livestock use an area. Small polygons, particularly if they are merely inclusions within much larger polygons, generally provide little value unless they reflect use in an area of high value (e.g., small meadow, wetland, critical habitat area, etc.). Likewise, polygons that are excessively large, and include large inclusions of other use levels, may not provide valuable information for how livestock use the landscape. Always ask yourself if your data is providing you the answers you need. If not, strongly assess if the polygons are the appropriate size, with the appropriate level of lumping and/or splitting areas with different use levels.

Equipment

- *Site Information Form and Vegetation Form.*
- *Topographic or other map of the grazing unit/allotment (or overlay).*
- *Camera and Photo Information Sheet.*
- *GPS if specific coordinates are desired.*

Procedure

Grazing use mapping (*Figure 8*) should occur shortly after the end of the grazing period. It is helpful for the examiner to obtain a map (e.g., aerial photos) showing the boundaries of different plant communities or ecological sites. When using the Landscape Appearance Method, map use according to the following classes:

0-5%	41-60%
6-20%	61-80%
21-40%	81-100%

In most cases, do not attempt to map excessively small areas (e.g., < 5-acre scale or 1% of the pasture area) unless the small patches have a high resource value or importance (e.g. creeks, springs, seeps).

Complete the map with a legend that includes the name of the management unit, and whether the data are percent utilization and/or stubble height. Complete the Site Information Form and Vegetation Form for each grazing unit (pasture) mapped, and take field notes of conditions observed while creating the map. Clearly note any events, activities or other factors that may have influenced use patterns. The map should also include any features that act as attractants or barriers for livestock, including turnout and gathering locations.

Take photographs in areas of the grazing unit that show representative use intensities. Take additional photographs to document unique concerns, opportunities and comparisons. Label photos and maps so there is a clear link to the appropriate utilization map, and the specific map location.

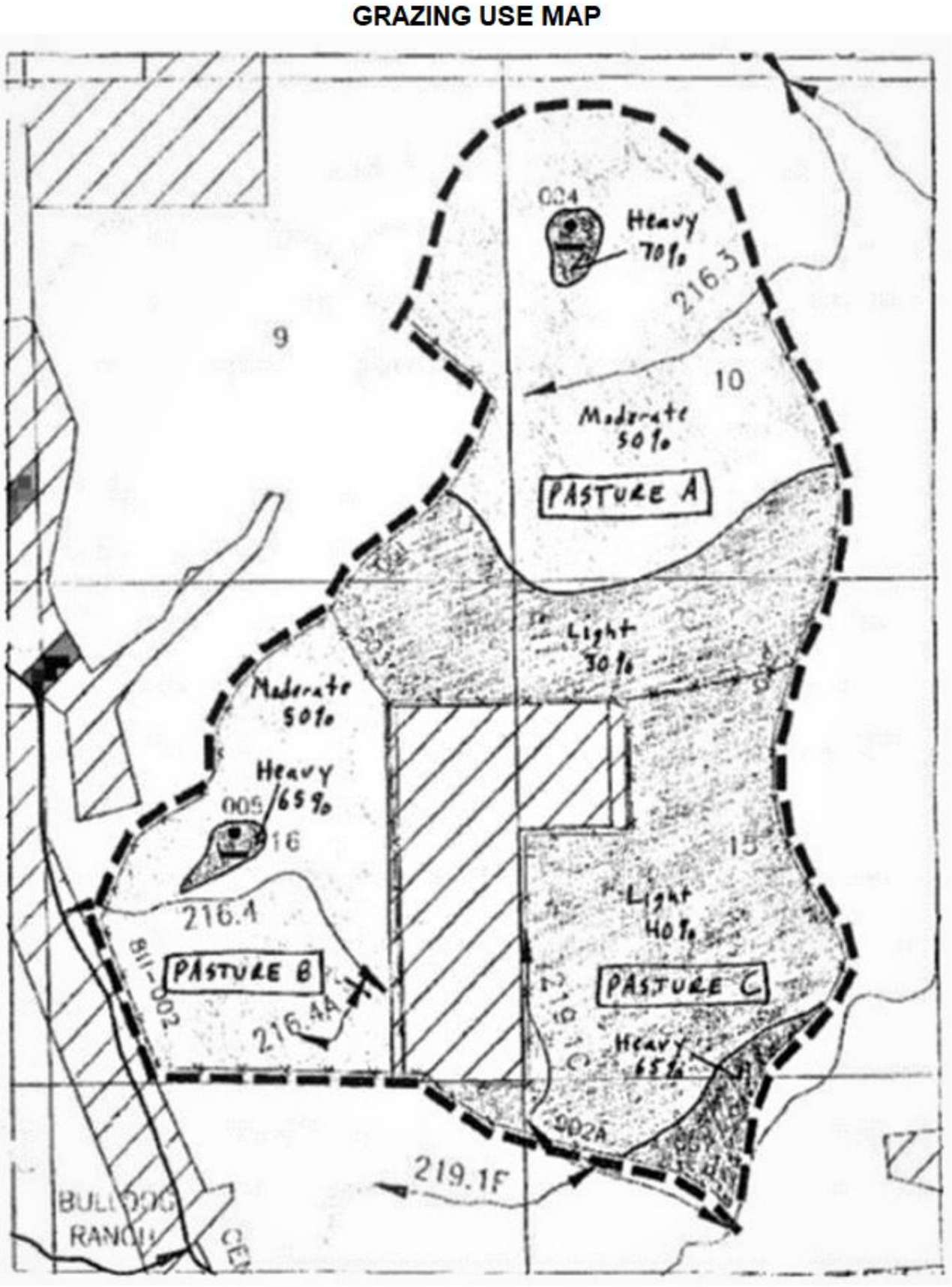


Figure 8: Grazing Use Map example***. Documents zones or areas of different use levels and features that may attract (e.g., water sources) or retard use.***

STUBBLE HEIGHT

Vegetation provides streambank protection, traps sediment, contributes to rebuilding degraded stream channels, and ensures residual forage and habitat for wildlife. Retaining an adequate amount of standing herbaceous vegetation (stubble) along the streambanks and across the primary floodplain helps reduce the velocity of overland flow during high runoff events. Overland flows with a slow velocity increase sediment deposition, which builds and maintains streambanks.

Short and stiff stubble (often 1 to 2 inches tall) typically traps more sediment than long, flexible stubble. Long (tall) and flexible stubble tends to bend in the current and does not create the turbulence that leads to abundant sediment deposition. Tall stubble, however, can help retain deposited sediment much better than short stubble. This may be more important for sites with repeated high flows (flash flooding) throughout the growing season, than for sites with one sustained peak flow (i.e., spring snowmelt hydrologic systems). Stubble-height objectives should be related to a needed ecological process, function or mechanism, and the specific resource situation present. One blanket stubble height across all areas of concern is seldom, if ever, appropriate: ecological conditions, therefore objectives, are seldom the same every place.

Stubble-height monitoring typically occurs for predetermined key species in key areas. Depending on the resource objectives and concerns, key areas may be along the streamside, in wet or dry meadow sites within the riparian area, or in meadow sites embedded in upland areas. In some instances, monitoring may focus on species groups, such as sod-forming species with similar growth form and response to grazing.

Stubble-height, key-species-utilization, and landscape-appearance monitoring may consist of two closely related but distinct concepts and processes: trigger and end-point indicator monitoring. We discuss these two concepts here because of their importance to stubble height, but both trigger and end-point indicator monitoring are applicable with other monitoring techniques.

Stubble Height as a Trigger for Management Action

A management action is triggered when the stubble height reaches a predetermined point (e.g., minimum height). Frequently, the action is to move livestock from one pasture to the next. The trigger occurs when monitoring of a predetermined attribute (for one or more key species or groups of similar species in a key area) demonstrates that the attribute has reached an accepted target or value. Once the target value is reached, a management action is triggered (i.e., must occur) to prevent an undesired resource change.

The intent of stubble-height guidelines for key areas is to promote long-term maintenance or recovery of the vegetation, soil, stream and/or other resource. In addition, meeting trigger stubble- height guidelines within a grazing or growing season should also facilitate meeting residual stubble- height guidelines at the end of the growing season or year.

Stubble Height as an Endpoint Indicator

Residual stubble-height monitoring occurs for herbaceous communities along the greenline (streamside) or other important locations. Measurement occurs near the end of the grazing or the growing season, whichever occurs later. Leaving grazed vegetation tall, or taller than a specified minimum height, along the greenline (streamside monitoring), reduces erosion potential, and helps trap and retain sediment. Sediment accumulation builds soils and effectively increases a site's water-holding capacity and ultimately forage production potential. As with trigger monitoring, compare the actual residual stubble height with a defined site-specific standard for residual stubble height. There should be an intended purpose for establishing a stubble height. Across time, data for residual stubble height can help interpret long-term changes in channel width, greenline to greenline width, or the amount of stabilizing species on streambanks.

Multiple species may graze any area before, during or after livestock use a site. Multiple stubble height measurements may be necessary to understand which species may be responsible for less than desired stubble height going into the winter and spring months, when high flows are most likely.

Equipment

- *Site Information Form, Vegetation Form and Stubble Height Form.*
- *Tape measure or folding carpenter's ruler.*
- *Camera and Photo Information Sheet.*
- *GPS.*

Procedure

Measurements typically occur on designated key areas, normally in riparian areas (and meadows) and for predetermined key species. Alternatively, stubble height may be determined for a group of functionally similar species, such as wide-leaved sedges or rushes (wet site) or narrow-leaved grasses or sedges (dry meadow).

For streams, sampling occurs along the greenline, on both (opposing) banks of a single stream segment within the same reach. For upland or meadow sites, measurements could be taken along a predetermined course or transect located to address identified management goals and objectives. For a wet meadow, the greenline transect typically occurs along the lowest and wettest line where overland flows typically would be the deepest and the soil usually stays wettest. This location emphasizes the area where erosion most likely will occur if perennial herbaceous species that stabilize the soil decline and become few or absent. Stabilizing species are those that can develop deep and dense root systems, which provides strong binding of the soil particles and reduces erosion potential.

Determine the stream segment or transect site for measurement. Take a photograph looking down the stream segment or transect, being sure to include a prominent and permanent feature in the photo's background (e.g., a rocky point, distinct tree, unique horizon). Determine the distance between the starting and endpoints of the greenline being monitored and divide this length by 30. This is the interval walked between each sampling point. Record the sample interval on the top of the data form. To have a valid sample, collect at least 30 stubble height values on each side of the stream. If the estimates are highly variable, collect more samples (measurements) to obtain a more precise estimate of the mean/median. The agency riparian monitoring method (Burton et al. 2011) recommends 40 measurements on each side of the stream.

Begin pacing (or measuring) along the greenline or across the predetermined transect course. Stop at each sample interval and do the following:

- ✓ *For each key species, locate the individual plant nearest the toe of your boot. The nearest plant may not be at or near your toe.*
- ✓ *Stubble height is the vertical distance from the soil surface (at the base of the plant) to the average length of the plant parts (e.g., grass stems/leaves, see Figure 9).*
- ✓ *Record the average stubble height to the nearest inch for each key species on the data form (Figure 10).*
- ✓ *If no key species occur at a sampling location, do not record zero (record NA), recording zero could bring down the calculated average.*
- ✓ *Where it is difficult to tell where one plant starts and another stops, visualize a 3-inch circle and sample the plants within that circle. Estimate and record the average stubble height within the 3-inch circle.*
- ✓ *Summarize all of the measurements to obtain one total value and divide by the total number of plants measured (Figure 10). This calculates the average stubble height.*

Note: Both the Landscape Appearance Method (for riparian browse species) and the Streamside Stability Method can be taken along the same streambank stubble-height transect.

Figure 9: Stubble height for these sedges would be 11 inches, the typical height of the leaves and seedheads.

STUBBLE HEIGHT FORM

Unit Name:	NE Pine Creek	Pasture Name:	Upland

Transect ID:		Date:	04/09/21	Observer:	Bruce Perryman

Animal Kind/Class:	cow/calf	Season of Use:	4/1/20 to 7/15/20	Sample Interval:	2 paces

Record at least 36 stubble heights for each species or species group. More readings can be taken if desired.

Species (Group):	Carex			Species (Group):				Species (Group):			
	Column A		Column B		Column A		Column B		Column A		Column B
1	14	26	9	1		26		1		26	
2	14	27	13	2		27		2		27	
3	10	28	8	3		28		3		28	
4	14	29	7	4		29		4		29	
5	12	30	6	5		30		5		30	
6	8	31	6	6		31		6		31	
7	16	32	10	7		32		7		32	
8	18	33	8	8		33		8		33	
9	10	34	10	9		34		9		34	
10	8	35	8	10		35		10		35	
11	8	36	16	11		36		11		36	
12	6	37	13	12		37		12		37	
13	12	38	10	13		38		13		38	
14	12	39	8	14		39		14		39	
15	12	40	11	15		40		15		40	
16	10	41	6	16		41		16		41	
17	14	42	6	17		42		17		42	
18	5	43	9	18		43		18		43	
19	12	44	10	19		44		19		44	
20	16	45	9	20		45		20		45	
21	13	46	8	21		46		21		46	
22	10	47	6	22		47		22		47	
23	13	48	3	23		48		23		48	
24	10	49		24		49		24		49	
25	10	50		25		50		25		50	
Sub	287		200	Sub				Sub			
Grand Total			487	Grand Total				Grand Total			
#			48	#				#			
Avg. Height (Tot/#)			10	Avg. Height (Tot/#)				Avg. Height (Tot/#)			

Figure 10: Stubble Height Form Example

LONG-TERM MONITORING METHODS

PERMANENT PHOTO MONITORING METHODS

For important places or pastures that lack an existing photo, the oldest and most important photo you will ever have, for future comparison, is the photo you take today! Start taking well located pictures!

There are three permanent photo monitoring methods, with each varying in scale. Landscape photos record data at large scales, often covering hundreds to thousands of acres. Photo plots record the vegetation and soils on only one to several acres, and include at least one 3-foot-by- 3-foot quadrat in the photo record. Photo-point transects take photos of several permanent 3-foot-by-3-foot quadrats along a 100-foot transect, and thus, provide more detailed data, but at a much smaller spatial scale.

Repeat photography at permanent locations can help interpret vegetation trends on rangelands, while reducing the potential for subjectivity or personal bias. Photographs can record numerous important indicators on rangelands. These may include the expansion or contraction of patches of desired (e.g., aspen, mountain mahogany, willows) or undesired (e.g., pinyon-juniper trees, noxious weeds such as leafy surge or medusahead) plant communities, changes in density or cover within the aforementioned patches, head cuts or downcutting in riparian areas, stream channel width and depth, and relative cover of different life-forms (e.g., shrubs, perennial grasses, forbs, annual weeds). The indicators are nearly unlimited, but should relate to management goals and objectives, and their change should have the potential to be the result of the management actions applied.

When using this method, it is important to:

- *Use consistent techniques.*
- *Identify the date and location of the picture.*
- *If possible, take the picture during the same stage of plant growth (phenological growth stage), not on the same date. This makes the photos more comparable and improves interpretation of the picture.*
- *Try to retake each picture at the same time of day and in same/similar weather conditions (preferably ample sunlight).*

LANDSCAPE PHOTOS

Landscape photos are valuable for tracking change in large-scale features that often form important habitat patches. This may include stands of aspen, mountain mahogany, pinyon-juniper trees, mountain brush or long riparian corridors. Across time, these patches of habitat may change in size, internal density and/or structure, overall abundance, or some other feature. Such changes may or may not be related to management actions, but affect a suite of resource potentials (e.g., wildlife habitat, livestock forage, resting areas), as well as ecological risks (e.g., catastrophic fire, loss of perennial herbaceous understory). Documenting landscape level change can help determine management direction and changes at multiple levels, from changes in grazing management to controlling wildlife (and insect) numbers, to manipulative treatments of the vegetation to obtain better habitat structure, function and quality.

Equipment

- *Site Information Form.*
- *Vegetation Form.*
- *Photo Information Sheets*.
- *Digital camera or smartphone with high-quality lens (Color film equivalent may be used if desired.) If possible, use an exposure index of 100 (ISO or ASA).*

Procedure

Carefully relocate and reframe the same photo point (landscape) each time. This is easier if you include one or more permanent features (e.g., a distinct rock outcrop, mountain peak) in the photo's background (*Figures 11a and 11b*). If permanent GPS coordinates have not been recorded, obtain them if at all possible. This can save valuable time when the individual tasked to record the next photo is different than the individual who visited the site prior.

It is difficult to locate previously established photo points without a distinct portion (locatable feature) of the horizon in the photograph. Comparing previous photographs (or their photocopies) can also be helpful in "framing" the photos consistently from year to year. The same or a similar camera and lens (not wide angle and telephoto) is useful for making it obvious that photo location is consistent. Take several photos at each site to ensure at least one is of acceptable quality (not blurry, no fingers in the image, fewest shadows, etc.).

Figure 11: ***An example of how repeat photography can document landscape change. These photos show the same location on Martin Creek, 40 years apart. Figure 11a was taken on Aug. 6, 1975, and Figure 11b on Sept. 3, 2015. Woody riparian cover has increased dramatically providing nearly complete thermal cover of the stream. (In 2015, water flow could be heard while the stream was not observable.) Sagebrush cover has increased on the canyon slopes. Photo a. provided by the US Forest Service. Photographer unknown.***

PHOTO-POINT TRANSECT

The photo-point transect collects detailed data at discrete locations. Data resolution is sufficient to address changes in both life-form and species composition. This method collects photographs in several 3-foot-by-3-foot quadrats, along a 100-foot-long transect, and at both ends of the transect, looking back toward the middle. Typically, photos of a 3-foot-by-3-foot quadrat have good enough resolution to track changes in specific species. These changes may be their actual numbers, but also their size, shape and vigor. Photos of the entire transect may or may not be able to identify specific species, but can provide data about changes in general life-form abundance, and the typical size, shape and vigor of those life-forms. This monitoring methods may be appropriate when management objectives relate to specific species or structure of the vegetation.

Equipment

- *Site Information Form and Vegetation Form.*
- *Photo Information Sheet.*
- *Two folding 6-foot carpenter's rulers;*
- *Two transect stakes (rebar or angle iron work best, with 18-24 inches left above ground), 100-foot tape.*
- *Digital camera or smartphone with high quality-lens. (Color film equivalent may be used if desired.) If possible use an exposure index of 100 (ISO or ASA).*

Procedure

Establish a 100-foot transect and install permanent stakes at both ends (if possible). To the extent possible, place the transect perpendicular to the slope, but with sufficient landscape features in the background to help its relocation should one of the endpoint stakes be lost. Transects located perpendicular to the slope capture more site variability than those placed parallel with the slope. Record each transect's compass bearing. Complete the Site Information Form for the site.

Stand behind the stake at the start of each transect (zero mark) and take a landscape photograph looking towards the other end. This is Photo 1 of five photos that occur on each photo transect (*Figure 12*). If possible, include a permanent relocatable feature on the horizon (*Figure 12*).

Create a 3-foot-by-3-foot square frame with two 6-foot carpenter's rulers (*Figure 13a*). Each ruler forms one-half of the frame. Bend each ruler at the 3-foot mark to form a 90-degree angle. Place the middle of one side of each ruler (e.g., the 18-inch mark) on the tape, so that the tape measure bisects the 3-foot-by-3-foot frame. Create the frame at the 5-foot and 8-foot marks (*Figure 13b*).

Stand over the tape and take a photograph looking down at the framed section with the 5-foot mark in the foreground (closest to you) and 8-foot mark in the background (*Figure 13b). T*his corresponds with Photo 2 of five for the transect). Repeat this step with the frames at the 50- and 53-foot (Photo 3), and the 92- and 95-foot marks (Photo 4). At the end of the 100-foot transect, take a photograph looking back down the transect toward the 0-foot mark (Photo 5). If possible, permanently mark at least two corners of each 3-foot-by-3-foot photo plot with an animal safe feature (e.g., flat survey cap). Tape measures are not always straight and tight; thus, phot plot locations may shift over time, unless permanently marked. Relocation of the exact quadrat across time improves interpretation of changes in the vegetation and/or soil.

If possible, use the Photo Information Sheet in all photographs. A complete photo transect will obtain five photos.

Figure 12: An example of a 100-foot photo-point transect aligned largely perpendicular to the slope with a prominent landscape feature (mountaintop) behind the far endpoint. The endpoints have been marked with tall stakes and pink flagging to better illustrate the transect. This photo (as shown) would be the first of five photos obtained on a photo transect. Photo 5 of the transect would have a similar aspect, but would be from the far end looking back toward the near stake. Note that placing the tape measure as close to the ground surface as possible helps keep it tight. A tight tape measure (no sags from the top of a plant to the ground) will help keep each quadrat used to obtain photos (or other data, e.g., density) at its truest location on the transect, each time data collection occurs. Large wooden stakes were used as transect endpoints in this photo for illustrative purposes only. Permanent transects should use rebar or angle iron which do not rapidly decompose, as does wood.

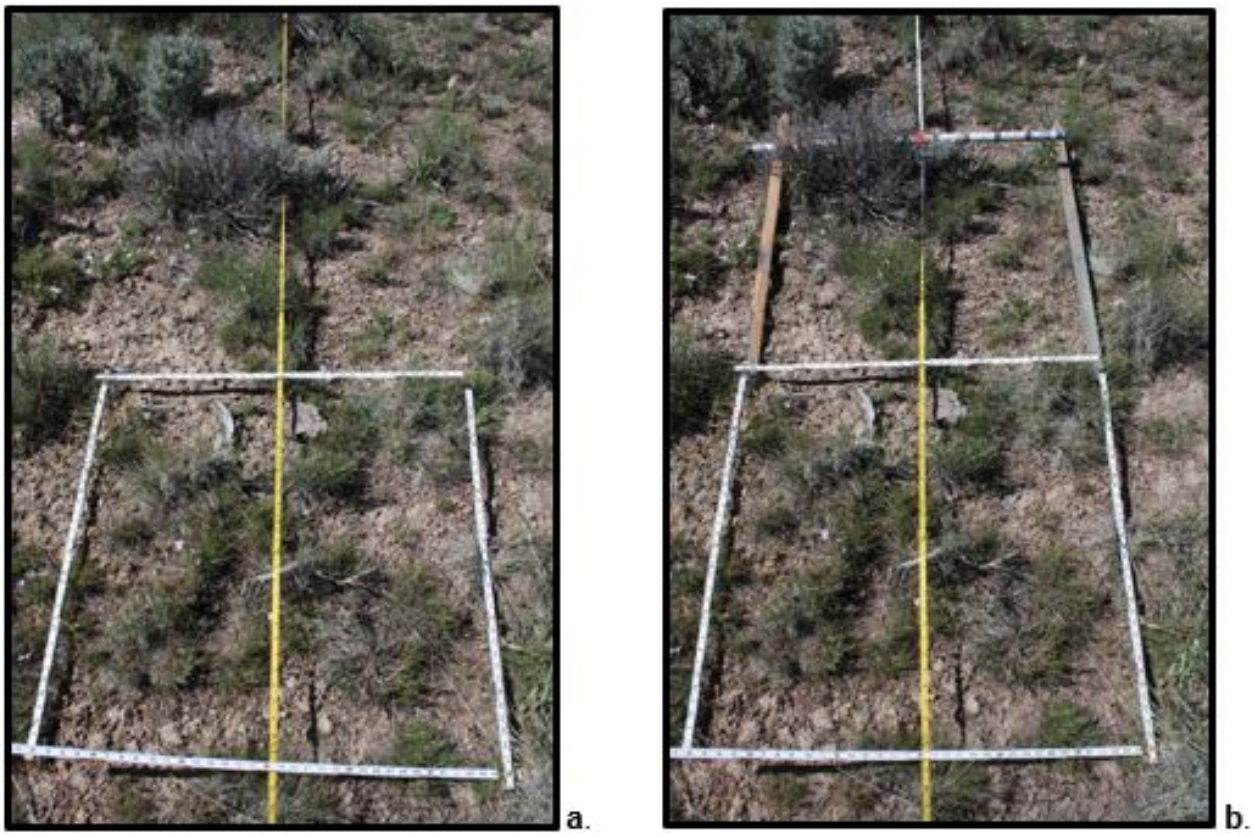


Figure 13: a. Creation of a 3foot-by- 3-foot square frame (quadrat) with two carpenter's rulers. Center the frame over the tape measure, with the midpoint of each perpendicular 3-foot section residing directly on/above the measuring tape.

b: The 3-foot-by-3-foot quadrats created at the 5-foot and 8-foot marks on the tape measure. On photo-point transects also establish these paired quadrats at the 50- and 92-foot marks. This figure illustrates how Photos 2, 3 and 4 of the transect would appear. You may create these two quadrats from four carpenter's rulers, or as shown in this photograph, with any straight material that is accurately marked into 3-foot segments, and corresponding midpoints (pink flag on PVC pipe that marks the top of the upper quadrat).

PHOTO PLOTS

The photo-plot monitoring method, is intermediate in scale between the two previous methods described. The photo plots cover an area about one to several acres in size and include a permanently marked 3-foot-by-3-foot quadrat. These plots cover much less area than the landscape photos, but an area larger than the 100-foot long photo-point transect and its 3-foot-by-3-foot quadrats (photo points). This size monitoring plot can be useful for tracking the relative change in life-forms (e.g., annual grasses, perennial grasses, sprouting shrubs, nonsprouting shrubs, trees, etc.) following an unplanned disturbance (e.g., fire, insect infestation) or planned vegetation treatment (e.g., mowing, herbicide application, prescribed fire, etc.). For the latter, take the first photo before the treatment occurs. Larger plot sizes are useful when data about the change of specific species actual plant numbers by species is not the attribute of concern.

Equipment

- *Site Information Form and Vegetation Form.*
- *Photo Information Sheet.*
- *Digital camera or smartphone with high quality lens. (Color film equivalent may be used if desired.) If possible use an exposure index of 100 (ISO or ASA).*
- *A 3-foot-by-3-foot frame created from two carpenter's rulers or PVC pipe (both work).*
- *Stakes or other features to permanently mark corners of the 3-foot-by-3-foot frame.*

Key Points to Remember

- *Select an area one to several acres in size, that is representative of the grazing situation (e.g., important ecological site, accessible to livestock but not an active concentration area, etc.), and includes vegetation and/or soil features or attributes relevant to management goals and objectives (Figures 14a and 14b). Whenever possible, have and identifiable feature in the horizon (to help reframe future photos), or GPS coordinates for the point where the photographer stands.*
- *If the photo plot is difficult to locate, use a witness post. Make sure the nearest edge of the photo plot is at least 20 feet away from the post. For all photo plots, clearly and consistently document the photo plot location with respect to the witness post.*
- *Permanently mark at least three corners of the 3-foot-by-3-foot plot with stakes. Paint steel stakes a bright color, such as orange. Flat survey caps, staked at ground level often provide the least influence for how animals may graze around the plot (which can affect vegetation change in the plot), while also preventing damage to hooves.*
- *When retaking a previous photo, reframe the new photo as close as possible to the previous photo(s).*
- *Include the Photo Information Sheet in the photo.*
- *If possible, take the photo from the north side of the 3-foot-by-3-foot plot to avoid casting a shadow into the photo.*
- *Establish at least three photo plots per pasture to capture the range of variation.*
- *Repeat photos should occur at the same stage of plant growth, regardless of the calendar date.*
- *The 3-foot-by-3-foot photo may occur at an oblique angle or vertically above the plot. Just be consistent every time you retake a photo! Most of the time, the most complete data will consist of an oblique photo of the entire one-plus acre plot, and a photo looking directly down on the 3-foot-by-3-foot quadrat.*

Figure 14: a. Example of a photo plot covering several acres; and, b. the 3-foot-by-3-foot quadrat in the plot. Angle iron, survey caps or other permanent markings would be used instead of the temporary survey stakes shown in this sample. For this plot, GPS coordinates (N40° 55' 728' and W117° 41' 586") and elevation (5,442 feet) permanently mark the photographer's location. The two photos can easily track changes in rabbitbrush, sagebrush (not yet present), perennial grasses and annual grasses since the site burned in 2007.

COVER BY LIFE-FORM TRANSECT

Cover by life-form transect estimates the relative amount of ground cover from different life-forms on a site. Data about cover by life-form across time provides information about vegetation trends. It is a valuable measurement tool when one or more management objectives is the increase or decrease in specific types of plants, and/or other attributes that protect soils (e.g., plant litter). Information about ground cover provides important knowledge about how susceptible a site is to erosion. The less vegetation present and the greater the amount of bare mineral soil, the greater the probability of erosion and loss of site potential, hence less forage production. Understanding the amount of cover by life-forms provides useful knowledge about habitat quality for many wildlife species, how close current vegetation composition and structure may be to site potential, how a site may respond to disturbance and different land uses, and whether a site is at risk for transition to a less desired state. The Nevada Rangeland Monitoring Handbook (Swanson et al. 2018) provides additional information about vegetation states and transitions among them.

Equipment

- *Cover by Life-Form Transect Form.*
- *Site Information Form.*
- *Vegetation Form.*
- *Camera and Photo Information Sheet.*
- *100-foot tape measure.*
- *Transect stakes.*
- *Wire pointer or plumb bob.*
- *Two folding carpenter's rulers.*

Procedure

Select the monitoring site and ensure that the transect will reside entirely in one ecological site. Complete the Site Information Form. Install two transect stakes 100 feet apart, with the tape measure's zero mark directly over the first transect stake. To the extent possible, place the transect perpendicular to the slope to accurately capture the variability of the site. Tightly stretch the tape tight between the two stakes and keep it as close to the ground as possible. Try to keep the vegetation from shifting the tape measure away from being in a straight line between the stakes.

Photos: Take two photographs of each transect. For Photo 1, stand over the zero-mark end of the tape and take the picture looking toward the far end (*Figure 15*). In each photo, include the Photo Information Sheet, each transect's compass bearing, and/or a landscape feature you can use to relocate each transect and photo. Photo 2 will occur at the 5-foot mark. Create a 3-foot-by-3-foot frame with two carpenter's rulers and place the center of the frame's bottom segment on the 5-foot mark (i.e., 1.5 feet of the frame will occur on each side of the tape measure, with the frame's top segment crossing the tape at the 8-foot mark). Center the frame and the transects' remaining 95 feet in the photo (*Figure 15*). To the extent possible have a prominent point in the photo's background.

Vegetation Cover: Start at the 1-foot mark on the tape measure and lower a plumb bob or sturdy wire pointer (plumb bobs are heavier, move less in the wind and are more likely to remain close to vertical than a hand-held wire or thin steel rod) until the point contacts either the vegetation or the ground surface (*Figures 16a and 16b*). Always lower the plumb bob (or pointer) on the same side of the tape. The life-form categories recorded are grasses (including grass-like plants such as rushes and sedges), forbs or shrubs. Identify grasses and forbs as annual or perennial. If the plant is a noxious weed, place the dot within that category and within the appropriate life-form. When the plumb bob does not hit a live grass, forb or shrub, record whether it touches dead plant material (litter), moss and lichen, rock (greater than 0.75 inches in diameter), or bare ground. Record the data by dot tally in the appropriate

column and row (*Figure 17*). Repeat this step at each 1-foot mark interval on the tape measure until you have sampled 100 points. When you have exactly 100 readings, the total number of tallies in each column converts directly to the percent cover for each life-form or soil surface feature.

Two people make the process easier and quicker but are not required. One person can lower the plumb bob and call out the "hit" and the other can record the contact on the data sheet.

Figure 15: Example of a line transect used to collect cover by life-form data. The 3-foot-by- 3-foot quadrat is established at the 5-foot mark with the photo showing the transect from its 5-foot mark to the other end. Cover data are taken at each 1-foot mark on the transect. See the following figures.

Note: *Repeating this data collection periodically over time (e.g., every three years, five years) provides an indication of trends on the site.*

a.

b.

Figure 16a and 16b: The collection of cover by life-form data at the 14-foot (16a) and 28-foot (16b) markings on the 100-foot transect. This type of cover data is called "*point-intercept*" because a fine point contacts the attribute measured. In 16a, the "point" of the plumb bob came in contact with a leaf of a perennial grass plant; thus, the data recorder puts a dot (or line) in the perennial grass box on the data form (Figure 17). In Figure 16b, a sturdy steel rod was held loosely in the fingertips and allowed to drop straight down at the 28-foot mark, until it intercepted a perennial forb.

COVER BY LIFE-FORM TRANSECT FORM

Unit Name:	Moonshine	Pasture Name:	Riparian

Transect ID:		Date:	04/09/21	Observer:	Conley

Notes:

***Litter** includes everything but rock soil, moss/lichen or live plants.

***Other** categories below may be used for specific species or groupings of interest.

You may record dot counts optionally for separate species (e.g., perennial versus annual species, desirable versus undesirable species, noxious weeds versus native forbs) if doing so will help meet objectives.

	Grasses	Forbs	Shrubs	*Litter	Moss/ Lichen	Rock	Bare Ground
Perennial	☒ ☒ ☒ ☒ ☐ 48	☒ ☒ 20	☐	4		2	
Annual	3	☒ 15					
Noxious							
Other:							
Other:							
Other:							
Total (=100%)	51%	35%	8%	4%	0%	2%	0%

Figure 17: Cover by Life-form Transect Form Example

PLANT DENSITY

Plant density is the number of individual plants per unit area. You may group the data by species, life-form, or some other category, based upon management goals and objectives. The unit of area in which the measurement occurs (e.g., square foot, square yard, square meter) is less important than making a good repeatable measurement at a reasonable time interval. Repeated and reliable measurements at the same location provide an estimate of long-term vegetation change, but also trends between consecutive sample dates.

Research has shown that counting plants has particular value in assessing changes in plant succession or changes caused by management treatments, such as changes in grazing season, weed control or control of excessive woody vegetation. This long-term monitoring method is useful on many shrub-bunchgrass rangelands where the plants often are sparse and there is a need to know changes in species or life-form abundance over time. One or more key species are the focus of this simple, direct and practical method.

An important decision is to clearly define what qualifies as an individual plant, document those criteria, and apply them consistently every time you record plant density. This is seldom an issue for most bunchgrasses (dense Sandberg's bluegrass is a common exception), due to their usually distinct circular base, but is problematic for rhizomatous grasses and multi-stemmed shrubs. For dense bunchgrasses, very close to one another, it is difficult to tell them apart. Develop a rule set to follow for determining individual plants. For example, if the centers of root crowns are obvious, each center will correspond with one plant. When the centers of root crowns are not obvious, then plant clusters that are separated by the width of your forefinger become individual plants, and plants closer together than your forefinger are considered one plant. Make sure you write down your rule set so it is applied the same way each time data collection occurs. For rhizomatous grasses, count each individual tiller that emerges from the soil as an "individual" plant. For shrubs, when all of the stems at the soil surface appear to be converging (angled) toward one central point, consider all of the stems as part of the same plant. Most likely, the stems connect at an unseen but central root crown.

A second important question encountered during sampling is when and when not to count a plant. The basic criteria to use focuses on the root crown. Plants are counted when one-half or more of their root crown occurs on the inside the quadrat. Sometimes, most, and occasionally all of the stems and leaves may reside outside the quadrat, but one-half or more of the root crown resides in the quadrat. Leaf and stem location are irrelevant: the deciding criteria is the location of the root crown that supports those leaves and stems. When one-half or more of the root crown occurs inside the quadrat then count the plant (*Figure 18*).

For density, you must collect data in many quadrats to have a large enough sample size to perform statistical tests, and have with enough "statistical" confidence that any change detected for plant composition or abundance was due to the management applied. There is no set formula for determining adequate sample size, but the larger the sample size, the more confidence one typically has that the statistical result accurately reflects the data collected. (*See Nevada Rangeland Monitoring Handbook section on statistical analysis for more details.*)

Equipment

- *Plant Density Form, Site Information Form and Vegetation Form.*
- *100-foot long tape.*
- *Transect stakes to permanently mark endpoints.*
- *Carpenter's ruler or other 3-foot long stake.*
- *Digital camera (optional).*

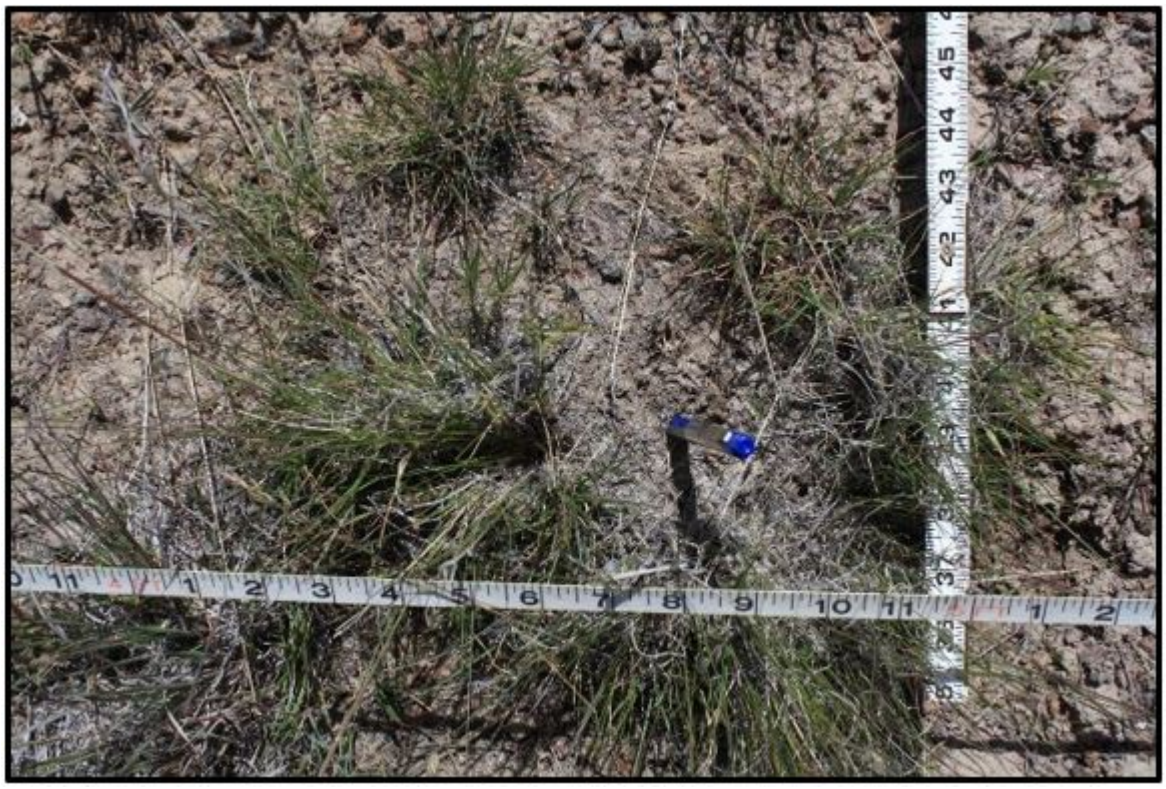


Figure 18: The lower right section of a 3-foot-by-5-foot quadrat. The blue pen marks an old bunchgrass that has split into four plants (A, B, C, and D). Plant B has most of its base inside the quadrat and most of its leaves outside the plot boundary. For density, the plant is in the quadrat

Procedure

For discussion purposes, we will assume the typical site monitored will use a 3-foot-by-100-foot belt transect (*Figure 19*). This is a common size in many vegetation studies. You may use a different size belt transect if it is more appropriate to document your management goals and objectives. The approach to establish a belt transect and recording density data is the same, regardless of transect size.

The plant density method requires the establishment of three belt transects in each key area. Each transect can be located near one another but must be far enough apart that they are independent samples. In essence, the plants located on one transect cannot have any biological

or ecological influence on the plants in an adjacent transect. This may include the effects of roots or shading. Counting density in three or more belt transects at each site provides a set of "independent" samples for key area. Multiple samples allow for statistical analysis of the data, to help determine if change is for detecting change through time.

For each belt transect, permanently mark one side (the permanent baseline) of the 3-foot-by-100-foot, by stretching out a 100-foot tape measure (*Figure 19*). To the extent possible, place the transect perpendicular (across) the slope of the land-form to capture as much site variability as possible. Also, attempt to locate each transect where there is an identifiable landmark behind (more or less) each transect's endpoint.

Once the permanent baseline is marked, establish two temporary corners to create the belt transect. These corners are 3 feet from the two permanent endpoints (zero and 100-foot marks on the baseline) and create a line perpendicular to the tape measure. Temporarily identify the two corners with a rock or pin flag, or by the end of a 3-foot-long piece of PVC (*Figure 19*).

Figure 19: A 3-foot-by-100-foot long belt transect used to measure plant density. The side of the belt with the tape measure shows the permanently marked side of the belt transect. The tall stakes show the temporary corners. The distinct mountain behind the transect can help with site relocation.

You may establish the 3-foot-wide belt on either side of the tape measure, but you must note the location in your field notes to ensure that each subsequent measurement uses the same belt each time data collection occurs. It often is best to develop a simple decision support system for how to create your belt transects. For example, on sloping ground always place the belt on the upslope side of the tape measure, with the zero mark on the left end of the transect (as you look at the transect from its downslope side). On flat ground, when standing at the zero mark and looking toward the 100-foot mark, the belt can always occur on the left side of the tape measure. These types of simple rules reduce the chance of recording data on the wrong side of the tape measure. Whatever rule system you decide to use, write it down each and every time you collect data to ensure the same method is used each time.

Starting at the zero mark, move down the transect and count the important (key) perennial plants (or life-forms) identified in the management goals and objectives. For each counted plant, mark a dot or tally on the data form. It helps to move down the transect with a 3-foot-long piece of PVC pipe placed perpendicular to the tape measure, to help identify the unmarked leg of the belt transect (i.e., it is the end of the pipe provided, the other end is directly over the tape measure).

You can express the count as the number of individual plants (total number) by species, or by life-form, or by other important criteria related to the management goals and objectives) per unit area measured. For a 3-foot-by-100-foot belt transect, that would be number of plants per 300 square feet. For reporting purposes, this value could be stated as plants per transect, or converted to plants per acre, plants per square yard or plants per square foot by using an appropriate conversion factor. The selection of an appropriate reporting format ultimately depends upon what makes the most sense (easiest to interpret) for those who are the end users of the data.

In addition to forage plants, it may be valuable to count other species that may help determine if you are meeting management goals and objectives. These may include noxious weeds, less desired species, or some other plant species or group of species (e.g., forbs) that provides valuable information to the monitoring program.

When a transect has many plants, you may find it easier to break the belt transect into smaller units (quadrats) of equal size and count the plants in each quadrat. For example, a 3-foot-by-100-foot belt transect could be divided into 50, 2-foot-by-3-foot quadrats; 25, 4-foot-by-3-foot quadrats; or 20, 5-foot-by-3-foot quadrats (*Figure 20*). Counting a large number of plants often is easier in small compared to large quadrats. Regardless of whether data are recorded at the scale of the transect (3-foot-by-100-foot) or in smaller quadrats that cumulatively constitute the entire belt transect (e.g., 50, 2-foot-by-3-foot quadrats), always record the size of the area in which you collect the data. Keep the unit of measurement (quadrat size) the same each time data collection occurs. You can always sum many small quadrats and scale up the value to a larger area of measurement (e.g., the entire transect).

Figure 20: A 3-foot-by-100-foot belt transect, showing one 3-foot-by-5-foot quadra used to collect density data. The two, 3-foot-long carpenter's tape measures outline the quadrat from the 5-foot to 10-foot marks, on the permanently marked side of the belt transect.

Figure 21 is an example of a completed data form for density. Data were collected on three transects, subdivided into 10 quadrats. The raw data show the number of bluebunch wheatgrass plants in each quadrat, in each transect. For each transect, to summarize the data, add the values from each quadrat to get the total number of plants for the key species in the entire belt transect (i.e., 61 for Transect 1). Divide that number (61) by the total number of quadrats on the transect (i.e., 10 in this example). This value, 6.1 for Transect 1, is the average number of plants (of the key species) per quadrat for the transect. Repeat this process for each transect.

To obtain the average density per quadrat for the study area, add together the average for each transect (6.1, 5.3, and 5.2 in this example). Next, divide that value by the number of transects (3 in this example). That final value is the average number of plants of the key species per quadrat, for the study area: 5.5 in this example. For trend monitoring, the density values for a study site would be compared across time. Data from one transect are not compared to another transect.

Carefully record the averages on the form and place them in a secure file for future reference. Also, you can input data forms into a computer and store them electronically, preferably on at least two different media (hard drive, CD, USB drive or cloud storage location). Any single piece of data is always subject to damage or loss; thus, two or more copies in a different format will act as an insurance policy.

You may select a subgroup of quadrats in which to take photos from directly overhead. A series of photos of the same quadrats across time may provide additional information not found when you only record density. For example, there often is an inverse relationship between density and plant size. As plants become larger there often is a corresponding decline in their number. A series of photos can help interpret the overall ecological meaning of a change in density across time. The first time any photographs of quadrats occur, note their location on the transect and record the value on the data form, at the bottom in the remarks section. This permits all subsequent photos to occur for the same quadrats.

Provide a map of the key area locations, and if possible, GPS coordinates.

PLANT DENSITY FORM

Unit Name:	Milligan	Pasture Name:	Scraper

Transect ID:		Date:	04/09/21	Observer:	Gary Voth
Animal Kind/Class:	Cow calf pair	Season of Use:		Vegetation Type:	sagebrush grass

Quadrant Sample Size (check):			
	25	2' x 5'	
	10	3' x 5'	
	25	2' x 5'	
			Other

KEY SPECIES	TRANSECT 1 Numbers					TRANSECT 2 Numbers					TRANSECT 3 Numbers					AVERAGE Per Quadrant
Bluebunch Wheatgrass	9	3	6	8	4	7	5	3	6	7	4	9	7	3	6	$\frac{(6.1 + 5.3 + 5.2)}{3} = 5.5$
	7	6	4	9	5	4	5	3	9	4	7	5	2	0	9	
Total	61					53					52					
Avg.	61/10 = 6.1					53/10 = 5.3					52/10 = 5.2					
Total																
Avg.																
Total																
Avg.																
Total																
Avg.																

Note: Check the appropriate quadrant sample size; use a dot-count procedure to record the plant numbers.

Remarks:	

Figure 21: Plant Density Form Example

STREAMSIDE STABILITY

The greenline (*Figure 22*) is the first line of perennial vegetation on or near the water's edge (typically within 30 feet of the water's edge). The greenline often forms near the elevation of the average high flow but may be close to the low flow elevation when flow velocity and volume are not excessively high (and scouring). Riparian plants, especially stabilizing plants with strong dense root systems, stabilize streambanks and reduce flow velocity near the soil surface. This allows streams that have widened to become narrower and form floodplains. This in turn encourages groundwater storage, and greater base flows or a longer duration of flow for seasonal streams.

If a stream downcuts into a gully, the greenline is perched above the stream (*Figure 21*), and the vegetation changes to plants that prefer drier soils and often lack large dense (strong) root systems. With time and proper management, pioneering riparian plants slowly establish near the water, and then stabilizing riparian plants take hold and reduce erosion of the streambank. Monitoring riparian or other species on the greenline guides management to improve water quality, fish and wildlife habitat, and riparian forage. Abundant riparian plants on the greenline, especially those with large and dense root systems, drive recovery and maintenance of riparian areas.

Equipment

- *Site Information Form, Streamside Stability Form and Vegetation Form.*
- *Camera and Photo Information Sheet.*
- *Stakes to permanently mark the transects*

Procedure

Establish the streamside monitoring transect along a stream reach that is representative of the area of concern. These areas normally have deep, fine-textured soils in wider valleys with lower gradients. This method is not appropriate when streambanks are bedrock or have long continuous areas with large boulders. Those features provide streambank stability, and grazing management cannot influence the presence or abundance of riparian vegetation along the stream.

The entire section of stream used to monitor streamside stability should be the same stream type. That is, the gradient, valley width, soil conditions and stream shape are consistent throughout the entire area sampled.

Looking downstream, start each transect on the right-hand side of the stream, beginning at a random spot far enough upstream to collect all data in one stream reach. Permanently mark the beginning of each transect and take a photograph looking down the transect. Try to include a rocky point or other distinct and permanent feature (at least semi-permanent) in the background of the photo, to ensure you can accurately relocate each transect's starting point during subsequent sampling events. You may take additional photos of plant communities along each transect, as needed or desired.

Sample along the greenline. Every two steps, identify the community present on the greenline and place a dot on the corresponding line and column (third column) of the data form (*Figure 23*). For clarity purposes, dots are not shown, just the equivalent count values. The plant community recorded at a spot is identified by the biggest and most abundant plants growing on or directly above (e.g., a tree directly above the greenline) the segment of the greenline that covers one step. Continue sampling down the stream until you have recorded greenline vegetation at 50 spots. At the end of the downstream transect (right side), cross the stream and repeat the process for moving upstream along the greenline for 50 more samples.

There are differences between the data collection procedure used now and the one described in the *2006 Nevada Ranchers' Monitoring Guide* (Perryman et al. 2006). First, the current procedure records a sample point at every other pace (i.e., two steps), rather than every step for 363 feet. Collecting a data point every other step (one pace) provides many independent samples (not one continuous measurement), which allows for a valid statistical analysis (i.e., statistical assumptions and rules are not violated) of change through time. The second change involves monitoring on the greenline, whereas instructions in the *2006 Nevada Ranchers' Monitoring Guide* had monitoring occur on the streambank even where it was bare. This change provides data that is more consistent with current agency greenline monitoring protocols and puts the monitoring focus on the plants growing at a location that most people can more readily identify.

On the data form, for each community type, its value for stabilizing the bank (column 2) is multiplied by the count data (column 4) to obtain the rating value for that community type (the value in column 5). Add the values in the count and rating columns, and write their respective values in the row titled, total. Divide the total value of the rating column by the total value from the count column to obtain the Numerical Rating for Streamside Stability. The table at the bottom of the data form (*Figure 23*) shows the relationship between the numerical rating and streamside stability.

White curved connector on a picture showing the edge of a stream which indicates the "greenline".

Figure 22. The white lines depict the greenline along a stream.

STREAMSIDE STABILITY FORM

Unit Name:	Moonshine Creek	Pasture Name:	

Transect ID:		Date:	04/09/21	Observer:	Bruce Perryman

Existing Community Type	Value	Dot Tally	Count	Rating
Anchored rock and logs and wet woody overstory with stabilizing riparian grass or grasslike understory	10		11	110
Wet woody - willow, aspen, cottonwood, birch, alder, dogwood, mesquite, seep willow and salt cedar	9			0
Moist woody - buffalo berry, chokecherry, coyote willow, current, rose, service berry	6			0
Dry woody - juniper, pinyon, rabbitbrush, sagebrush	3		2	6
Stabilizing riparian grass and grasslike - bulrush, cattail, mannagrass, reedgrass, water-loving sedge/rush, wiregrass	9		15	135
Moist riparian grass and grasslike - ryegrass, saltgrass, sakaton, rhizomatous wheatgrass, spikerush, horsetail	5			0
Dry, shallow-rooted or colonizing grass or grasslike - bentgrass, bluegrass, bunchgrass, Douglas sedge, foxtail barley, rabbitsfoot grass	2			0
Water-loving forbs - bluebell, camas, corn lily, hemlock, iris, meadow-rue, ragwort, shooting star, stinging nettle	5		81	405
Other, dry or tap rooted forbs - aster, buttercup, clover, cinquefoil, curly dock, dandelion, knotweed, monkeyflower, sweetclover	2		24	48
No greenline - bare ground or annuals for 30 feet	1		7	7
		Total	147	711
		Numerical Rating*		5

*Note: To determine the **rating**, multiply the value for each community type by the number of tally points **(count).** To determine the **numerical rating**, sum all the **ratings** and divide by the **total count** (number of places).To determine the overall **stability rating** for the riparian/stream reach sampled, use the table below.

Numerical Rating	Stability Rating
9-10	Excellent (very high)
7-8	Good (high)
5-6	Moderate
3-4	Poor (low)
0-2	Very Poor (very low)

Figure 23: Streamside Stability Form Example

PLANNING TOOLS

GRAZING RESPONSE INDEX

An Assessment Tool to Improve Understanding of How Grazing May Be Affecting Plants.

GENERAL DISCUSSION

Grazing animals require plants for their survival, and plants have numerous adaptations to tolerate or avoid grazing, but no plant can withstand regular, intensive defoliation and remain alive, let alone productive. No grazing animal, however, shows any concern about the fate of any plant it may consume. Only livestock producers and managers can, and should have concern about both the forage plants and the grazing animal. They must consider their respective effects toward and benefits upon one another when planning grazing management.

How grazing animals may adversely affect forage plants requires an understanding of plant physiological concepts related to energy production in leaves (photosynthesis); growth of leaves, stems and roots; and energy storage in buds and roots to meet future needs of the plant. These processes interact with defoliation, including how many times it occurs in a growing season, overall intensity of use of the plants, and the amount of rest from grazing during the growing season (i.e., recovery periods). The plant-animal interaction influences overall plant productivity or health, and understanding this interaction is essential for developing management plans (especially annual grazing plans) that minimize the potential adverse effects of grazing, while providing an opportunity for grazed plants to recover, across time, and continually meet the forage quantity and quality needs of the livestock.

The Grazing Response Index (GRI) is a tool used to assess grazing management within and between years. It can be a helpful assessment tool when unforeseen factors may complicate the potential effects of grazing on plant communities. Application of the GRI can help evaluate how grazing may have affected desired forage plants during the current year, while also clarifying management opportunities for the coming year, to mitigate any potential adverse effects from prolonged improper grazing. Data from several or more consecutive years can address the potential cumulative effects of grazing in an allotment.

The basic components of the GRI are: 1) the frequency or number of times livestock defoliate plants during the growing season; 2) grazing intensity during the growing season; and 3) the opportunity for growth before grazing occurs, and/or for regrowth after grazing ends. These factors influence the plant's total leaf area when soils are wet enough for growth/regrowth to occur, so that grazed plants can recover and complete their annual growth (physiological) requirements.

Growing seasons on Nevada's rangelands are relatively short. When plants have abundant leaves during most of the short growing season, the plants tend to become larger, effectively producing more forage across time. When grazing ends during the growing season, plants with an adequate leaf area continue to have relatively high rates of photosynthesis and produce a large amount of stored energy. This stored energy allows plants to keep their roots and buds alive for long dormant periods and initiate growth the next growing season, which may be six to nine months away. Large plants with large root systems also can extract more of the water and nutrients in the soil, leaving fewer nutrients available for noxious and invasive weeds, which likely reduces their establishment potential.

The Grazing Response Index assesses grazing use that occurs during the growing season. This assessment tool provides less utility when grazing typically occurs during periods of plant dormancy. Dormant-season grazing usually occurs after plants have had full opportunity to grow and produce large amounts of stored energy in

their roots and basal buds. Their opportunity for growth always receives the maximum positive value (+2). During the dormant season, intensity of defoliation is not as critical a parameter because there is no concern about allowing regrowth to benefit plant health. Residual stubble for other resource values typically becomes more important, and the amount required to meet ecological functions may vary widely among locations. During years with fall green up, the forage plants are no longer dormant, and application of the GRI may help interpret the effects of grazing at this time.

Range management specialists in Colorado developed the GRI, in locations where the annual precipitation typically is greater than in Nevada, and precipitation typically is greater throughout the potential growing season. The longer growing season in Colorado potentially extends the period for potential regrowth. Despite these differences between Colorado and Nevada, the concepts of the GRI assessment are still applicable in Nevada. One just has to recognize that the potential for regrowth in the current growing season, once grazing ends, may not exist or be quite limited. Accurate understanding of growth/regrowth potential in any given year is critical for successful use of the GRI.

DEFOLIATION FREQUENCY

Frequency of Defoliation is the number of times plants are defoliated. The period of concern is during the period of plant growth (leaf emergence through seed production), within the same growing season. Plants that have completed their annual growth cycle and are dormant (or nearly so) are physiologically unaffected (or largely so) by the removal of their leaves and stems, provided there is insufficient hoof action to damage buds on the root crown and at the base of last year's tillers. Dormant season use has little, if any, effect on basic plant health and growth potential. During the growing season, defoliation frequency depends largely upon the length of the grazing period (i.e., the duration of time that livestock can consume plants). The longer an area has livestock present during the growing season, the greater the likelihood that livestock will reuse previously grazed plants.

Approximately seven to 10 days are required during the spring and early summer for a plant to regrow enough leaf material for regrazing to occur. This is the period when plant growth is most rapid, but also a period in Nevada when most soils are becoming drier, and the probability of additional precipitation is declining. The result is a declining potential for substantial regrowth the later grazing occurs in the spring/early summer period. Local area knowledge, therefore, is essential for determining how fast the plants are growing and whether there was adequate soil moisture to provide for regrowth following grazing. Similarly, plant growth may be slow in the early spring when soil and air temperatures are cold, despite soil moisture being quite ample.

To obtain an estimate of how many times plants were likely to have been defoliated during a grazing period, divide the number of grazing days by seven (or up to 10 if growth was slow). Using seven is more conservative, because it will give the highest probable number of times livestock grazed the plants. Use the chart below to assign an index value (ranges from +1 to -1) for the probable number of defoliations that occurred.

Number of Defoliations	Value
1	1
2	0
3 or more	-1

GRAZING INTENSITY

Grazing intensity is the amount of leaf material removed during the period for which the grazing and growing periods overlap one another. The primary concern is the amount of green leaf material remaining on the plant after grazing (i.e., the photosynthetically active part of the plant) to facilitate its recovery through regrowth. This is an estimate of percent utilization at a specific point in time (i.e., seasonal use). Seasonal use is an estimate of percent of utilization for the entire growing season, or the entire grazing season, which may include consumption of plants when they are dormant. Generally, less than 50 percent defoliation of growing plants will not inhibit plant growth, including the root system. An index value of +1 to -1 is assigned based on the following use levels:

Amount of Use	Percent	Value
Light	<40%	1
Moderate	40-50%	0
Heavy	>50%	-1

OPPORTUNITY FOR GROWTH AND/OR REGROWTH

Opportunity is twofold: 1) the amount of time that forage plants have to grow before grazing begins, and/or 2) the amount of time the plant has to regrow once grazing ends. The opportunity for forage plants to grow and/or regrow is the most important factor with respect to the long-term health and vigor of the vegetation. A plant's opportunity to grow and complete its lifecycle, including storing adequate energy to meet future needs, is related to several factors: 1) the stage of growth at which grazing occurs (including dormant periods); 2) the duration that livestock are in the area being grazed, and 3) sufficient soil moisture, for regrowth to occur after grazing ends. For example, when grazing starts in the middle of the plant's growth phase and ends just before seed maturity, there was some chance for growth to occur before grazing started (roughly half the growing season). The opportunity for regrowth, however, would be none, or at best, a little, because soil moisture at seed maturity is low and declining. This results in potential negative consequences for the plant, especially when grazing is heavy or severe. The growth/regrowth factor is so important for sustaining healthy plants, the relative rankings for this attribute carry greater weight. index values for opportunity to grow or regrow forage are:

Opportunity to Grow or Regrow	Value
Full season	2
Most of season	1
Some chance	0
Little chance	-1
No chance	-2

Determining the growth/regrowth opportunity is often a judgment call based on the appearance of the vegetation at the end of the growing season and adequate knowledge about local growing conditions that year. This highlights the importance of taking good "field notes." If the plants look like they were not grazed or just barely used, then a value of +2 is appropriate. If the plants look like they were used, but grew/regrew fairly well, then use +1. When an area has a heavily grazed appearance, assign a value of -2.

There are some general guidelines for helping one make the determination. For example, a rangeland grazed season-long probably has no chance for regrowth; thus, a reasonable rating would be -2. An allotment with two or more pastures, where neither receives grazing for the entire growing season, is likely to rate between +1 (most of season) to -1 (little chance). The individual pastures or units may receive very different ratings. Units with three to many pastures that livestock graze at different times each year (i.e., some are deferred or rested) will usually receive higher ratings of +2 or +1. These guidelines can help one get started, but the final rating incorporates the time (growth stage), timing and duration of grazing in relation to growing period. You can integrate data from other monitoring techniques (e.g., vegetation appearance, photo monitoring, etc.) into this assessment.

OVERALL RATING

The values for defoliation frequency, grazing intensity and opportunity for growth/regrowth are additive. The overall rating of the expected response to grazing is the sum of all three values. This result is a numerical value that is positive, neutral or negative. The index is a simple method to evaluate whether the grazing that occurred in the current year is more or less likely to have long-term beneficial, neutral or harmful effects to the rangeland forage. When effects are likely to be harmful, managers can address the causal factors (i.e., where negative values occurred), and better understand the potential management actions needed to prevent the same potentially harmful events from happening on the same site for consecutive years. The GRI provides a more comprehensive basis to plan future use that will maintain or improve plant health and vigor.

The value of the GRI as an assessment tool is for planning or adjusting grazing management the next grazing season. By knowing which aspect of grazing (frequency of defoliation, intensity of use and opportunity for regrowth) contributes to a negative score, one can evaluate management alternatives with a greater probability of improving plant growth and plant tolerance of grazing the next year.

This tool also emphasizes that it is important to select the short-term monitoring method(s) that evaluate the management strategies used to meet long-term objectives. If the strategies are season of use and short duration of use, it may be more important to focus on when animals graze in each pasture or use area, than the amount of utilization or residual. The many methods focused on utilization (in this guide and by agencies) reflect a time when stocking rate was the primary tool for grazing management because grazing often occurred across the entire growing season, year after year. Where this is the case, stocking rate and utilization remain fundamentally important. Short-term monitoring should focus on the application of your strategies.

GRAZING RESPONSE INDEX FORM

Use this method to evaluate each pasture, or several sites within a pasture. Each row represents one GRI rating. **To determine the GRI, add all three values (frequency, intensity and opportunity) and record the sum in the total column.** Several sites within a pasture can be averaged to obtain an overall rating for the entire pasture. Complete the **Site Information Form** for each site or pasture.

Unit Name:	Robber's Roost	Pasture Name:	Butch Cassidy

Transect ID:		Date:	04/09/21	Observer:	Ernest Tubb

Grazing System:	rest rotation	Season of Use:	1-May to 1-Jul

Frequency		Intensity		
1	+1	Light	<40%	+1
2	0	Moderate	40-55%	0
3 or more	-1	Heavy	>55%	-1

Opportunity	
Opportunity to Grow or Regrow	Value
Full Season	+2
Most of Season	+1
Some Chance	0
Little Chance	-1
No Chance	-2

Pasture Name	Site ID	Frequency	Intensity	Opportunity	GRI (Total)
Butch Cassidy	1	1	-1	1	**1**
Butch Cassidy	2	0	0	-1	**-1**
Butch Cassidy	3	0	0	1	**1**
Butch Cassidy	4	-1	-1	-2	**-4**
Butch Cassidy	5	1	0	-2	**-1**
Butch Cassidy	6	0	0	1	**1**
Butch Cassidy	7	1	1	-1	**1**
Butch Cassidy	8	-1	0	-1	**-2**
Butch Cassidy	9	0	1	0	**1**
Butch Cassidy	10	0	-1	1	**0**
Butch Cassidy	11	-1	0	1	**0**
					0
					0
					0
					0
Total		**0**	**-1**	**-2**	**-3**

Remarks:	

Figure 24: Grazing Response Index Form Example

GLOSSARY

BARE GROUND - All land surface not covered by vegetation, rock or plant litter. See ground cover.

BELT TRANSECT - A transect (i.e., a line) that has both length and width to create a long, linear area/belt (e.g., 3-foot by 100-foot) in which data are collected.

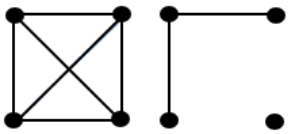
COVER, CANOPY - The percentage of ground covered by a vertical projection of the outermost perimeter of the natural spread of plant foliage. Small openings within the canopy are included. Total canopy cover may exceed 100 percent because plant canopies overlap one another. *Synonymous with crown cover.*

COVER, GROUND - The percentage of material, other than bare ground, covering the soil surface. It may include organic material, such as vegetation basal cover (live and standing dead), mosses and lichens, and litter; and inorganic material, such as cobble, gravel, stones and bedrock. Ground cover plus bare ground will total 100 percent.

DENSITY - Number of individuals or stems per unit area. Density **does not** equate to any kind of cover measurement.

DESIRED PLANT COMMUNITY - A plant community whose composition, structure and annual production meet the management goals/objectives of the site and protects the soil resource from accelerated erosion during typical climatic cycles. The desired plant community must be consistent within the capability of the area to produce vegetation through management, land treatment, or a combination of the two.

DOT TALLY SYSTEM - A count system that uses dots and lines to record data. The first four data points create the corners of a square. The next four data points are lines that connect the dots. The next two data points connect opposing corners. Each complete box represents 10 data points for the attribute measured. More boxes identify additional data points for the attribute measured.



N=10 + N=6 TOTAL= 16% Coverage

ECOLOGICAL SITE (DESCRIPTION) - An ecological site is a distinctive kind of land with specific characteristics (e.g., soil, landform, climate,) that differs from other (adjacent) kinds of land. Different ecological sites, therefore, produce different amounts and composition of plants. An Ecological Site Description is a formal document that contains all of the information about a specific ecological site, including similarities and differences with comparable sites. Ecological sites differ from one another because of one or more important ecological attributes that influence how that site responds to use, management actions and disturbance.

END-POINT INDICATOR - Guides for land managers to assess resource use impacts at the end of the grazing and growing season, whichever comes last. The assessment is to determine if grazing use left the resource in an appropriate condition for moving toward objectives. Commonly, stubble height or utilization indicate the desired degree of use. Synonymous with end-of-season indicators.

FORAGE - Browse and herbage that is available for use as a food item. Forages may be standing feed (rangeland and pasture settings) or harvested forages obtained from hay fields and fed at a later date.

FORB - Any herbaceous flowering plant that lacks significant woody tissue at or above the ground, and is not a grass (*Poaceae*), sedge (*Cyperaceae*) or rush (*Juncaceae*). Often referred to as wildflowers.

FREQUENCY - The ratio between the number of sample units (of a given size) that contain a species and the total number of sample units. For example, five of 20, 8-inch-by-20-inch quadrats contain squirreltail bunchgrasses. The frequency would be 5 ÷ 20, which is 20%.

FREQUENCY OF DEFOLIATION - The number of times herbivores graze forage plants during the (actual or planned) grazing period. How frequently plants are grazed is a function of their growth rate and the length of time grazers have access to the area within the growing season.

GOAL - A clear description of a desired state or condition of a landscape. A well-defined goal answers the question, "What should the land look like?" A clear goal helps articulate the specific management objectives and measures needed to achieve success.

GREENLINE - The first perennial vegetation on or near the water's edge. When viewed from an oblique angle, it often has the appearance of a line of green plants along the stream corridor. Where the first line of perennial vegetation is upland vegetation, not near the water, the upland plants may suggest an opportunity for riparian plants closer to the water.

KEY AREA - A portion of representative rangeland selected to serve as a monitoring and evaluation point for range condition, trend or degree of grazing use. The selected area is representative of a much larger area for both land use and response potential to management. Properly selected key areas reflect the overall acceptability of current grazing management over the rangeland. The response of a key area to grazing guides the general management of the entire area of which it is a part.

KEY SPECIES - Forage species whose use serves as an indicator to the degree of use of associated species. In many cases, key species include indicator species and species traditionally referenced as increasers, decreasers, desirables or intermediates. Key species are important species that guide the management program.

LITTER - Dead organic debris on the soil surface. Most litter is dead plant material in varying stages of decomposition.

MONITORING - Monitoring is the orderly collection, analysis and interpretation of resource data to evaluate progress toward meeting management objectives. Monitoring must occur over time to determine if management is meeting objectives and moving the area of interest toward or away from management goals.

OBJECTIVE - A clear, quantifiable statement of planned results management wants to achieve within a stated time frame. An objective is achievable, quantifiable, explicit, relevant to management and documentable.

OCULAR ASSESSMENT/DATA COLLECTION - A visual estimate of one or more attributes at a monitoring site. Ocular assessment most often measures plant or vegetation cover. The smaller the area observed (e.g., a series of small quadrats versus a landscape), the more reliable the visual estimate or assessment. Ocular estimates usually are more subjective than most quantitative methods, but data collection can occur much faster. This can result in a larger sample size at each sampling location and/or more sites sampled, given the same amount of time spent collecting data.

PERCENT USE - The percentage of the current year's forage production that grazing animals consume or adversely damage. May refer to a single species or to a plant community. See also, utilization.

PHOTO POINT - A permanently identified location to obtain the same photograph at periodic intervals. Sometimes called a camera point.

SOIL STABILITY - The capacity of soils in an area to limit the redistribution and loss of soil and its resources (e.g., organic matter, nutrients) by water and wind.

SPECIES COMPOSITION - All of the species present in a key area where monitoring occurs. Species composition may be presented as a mere list of all species, but has greater value when the data show the percentage of each species. For example, of all the plants present, bluebunch wheatgrass is 10% of the composition. All species together would add up to 100%.

STANDARD - An agreed upon way of doing something or managing a process. Something established by authority, law, custom or general consent as a model, practice or example.

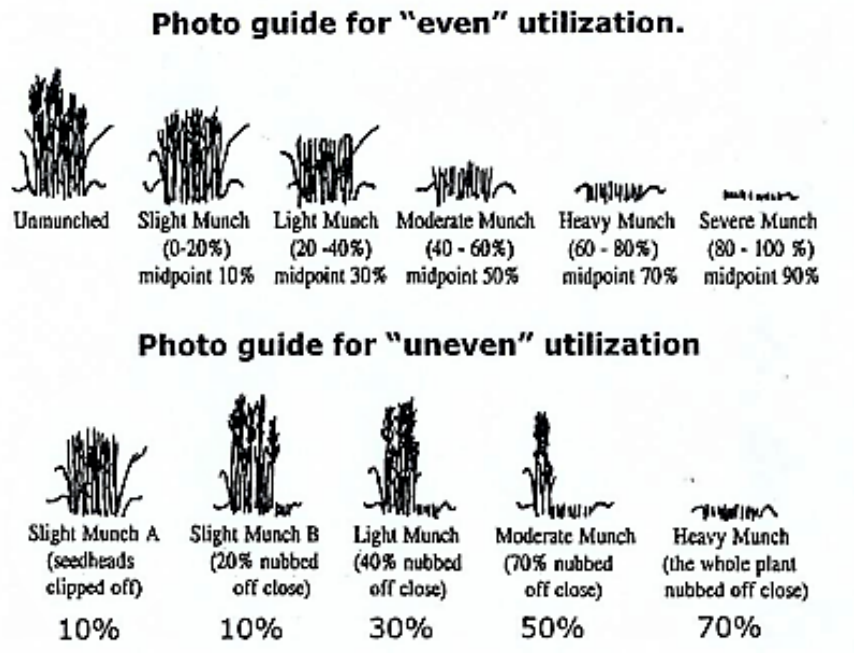
STREAMSIDE - Often this is where the greenline occurs. The greenline is the first line of perennial vegetation that forms a lineal grouping of community types (at least 6 inches wide and a step long) on or near (within 20 feet of) the low water edge. Where there is no greenline close to the water (such as on a bare bank), the streamside stability that was monitored according to the 2006 *Ranchers' Monitoring Guide* is between the high-flow water edge and the low-flow water edge or often at the water edge. These bare bank areas probably have an upland plant community as their greenline vegetation.

TRANSECT - A linear plot, usually represented by a line, along which data are collected. Along each transect, data collection may occur at specific points (e.g., point-intercept cover data), or in quadrats or plots of specific size and shape located at specific points (e.g., density per square foot, every 5 feet along the transect).

TREND - The direction of change in an attribute as observed over time.

TRIGGER - Within-season guide for livestock managers to make changes or move livestock to ensure grazing management meets end-point indicators. Generally, does not work well if codified into hard and fast requirements.

UTILIZATION - The proportion of the current year's growth consumed or trampled through grazing or browsing during the growth period (i.e., before seed ripe). Usually expressed as a percent used. See the photo guides below (from McKinney 1997. Rangelands 19(3):4-7). For utilization data to have optimum value, it has to be related to plant growth stage for when grazing occurred.



VIGOR - The relative robustness of a plant in comparison to other individuals of the same species. The size of a plant and its parts in relation to its age and the environment in which it is growing are factors used to assess vigor.

LITERATURE CITED *

Dickard, M., M. Gonzalez, W. Elmore, S. Leonard, D. Smith, S. Smith, J. Staats, P. Summers, D. Weixelman, S. Wyman. 2015. Riparian area management: Proper functioning condition assessment for lotic areas. Technical Reference 1737-15. U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO. Available at: http://www.remarkableriparian.org/pdfs/pubs/TR_1737-15.pdf

Pellant, M., P. Shaver, D.A. Pyke, and J.E. Herrick. 2005. Interpreting indicators of rangeland health, version 4. Technical Reference 1734-6. U.S. Department of the Interior, Bureau of Land Management, National Science and Technology Center, Denver, CO. BLM/WO/ST-00/001+1734/REV05. Available at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1043944.pdf

McKinney. E. 1997. It May be Utilization, but is it Management. Rangelands. 19(3):4-7.

Perryman, B.L., L.B. Bruce, P.T. Tueller, and S.R. Swanson. 2006. Ranchers Monitoring Guide. University of Nevada Cooperative Extension Educational Bulletin EB 06-04. 34 p plus Forms.

Stiver, S.J., E.T. Rinkes, D.E. Naugle, P.D. Makela, D.A. Nance, and J.W. Karl, eds. 2015. Sage-Grouse Habitat Assessment Framework: A Multiscale Assessment Tool. Technical Reference 6710-1. Bureau of Land Management and Western Association of Fish and Wildlife Agencies, Denver, Colorado. Available at: https://www.fs.fed.us/sites/default/files/sage-grouse-habitat-assessment-framework.pdf

Swanson, S., B. Schultz, and 13 others. 2018. Nevada Rangeland Monitoring Handbook – In Pursuit of Better Rangeland Management. Third Edition. University of Nevada Cooperative Extension Special Publication. SP-18-03. 121 p.

* **Most of the references that support methods in this Guide occur in its companion publication, the Nevada Rangeland Monitoring Handbook (Swanson et al. 2018).**

INFORMATION SOURCES

USDA Forest Service
Intermountain Region
324 25th St.
Ogden, Utah 84401
801-625-5306
https://www.fs.usda.gov/r4

Bureau of Land Management
1340 Financial Blvd.
P.O. Box 12000
Reno, Nevada 89520-0006
775-861-6400
https://www.blm.gov/office/nevada-state-office

Natural Resources Conservation Service
1365 Corporate Blvd.
Reno, Nevada 89502-7102
775-857-8500
https://www.nrcs.usda.gov/wps/portal/nrcs/site/nv/home/

Nevada Section of the Society for Range Management
NVsectionwebmaster@gmail.com

Nevada Department of Agriculture, Main Office
405 S. 21st St.
Sparks, Nevada 89431
775-688-1180 or 775-688-1182
http://agri.nv.gov/

College of Agriculture Biotechnology & Natural Resources
University of Nevada, Reno
Mail Stop 222
1660 N. Virginia St.
Reno, Nevada 89557-0107
775-784-1660
https://www.unr.edu/cabnr

University of Nevada, Reno Extension
University of Nevada, Reno
Mail Stop 404
Reno, Nevada 89557-0106
775-784-7070
https://extension.unr.edu/

FORMS

SITE INFORMATION FORM

Complete this form when conducting any of the study methods in this booklet to provide an important summary of site information. If no study methods are conducted, completing this form alone will still provide a record of valuable information. All fields are required unless otherwise indicated with an "opt." Complete the blanks to the best of your knowledge.

Initial:		Annual:	

General and Site Location Information

Unit Name:		**Pasture:**			
Study Site (# or Name):		**Date:**		**Observer:**	
Monitoring Method(s):		**Date Study Established:**			
Study Located:	☐ N ☐ S ☐ E ☐ W				
1/4 of:		**1/4 of Section:**			
Township:		**Range:**			
Access:					
Ownership (opt.):					
GPS Coordinates:	**Latitude:**		**Longitude:**		

Site Characteristics

Landform:					
Elevation:		**% Slope:**		**Avg Annual Precipitation:**	
Note:					

Range Site		Current Growing Conditions		Exposure (opt.)				Soil (opt.)	
Upland (U)	☐	Above Average (1)	☐	N	☐	S	☐	Sand (1)	☐
Riparian (R)	☐	Average (2)	☐	NE	☐	SW	☐	Silt (2)	☐
		Below Average (3)	☐	E	☐	W	☐	Clay (3)	☐
				SE	☐	NW	☐	Loam (4)	☐

Other Climatic Information (opt. snow depth/persistence, temperatures, storms, flooding, etc.):

Unit/Pasture Use Information

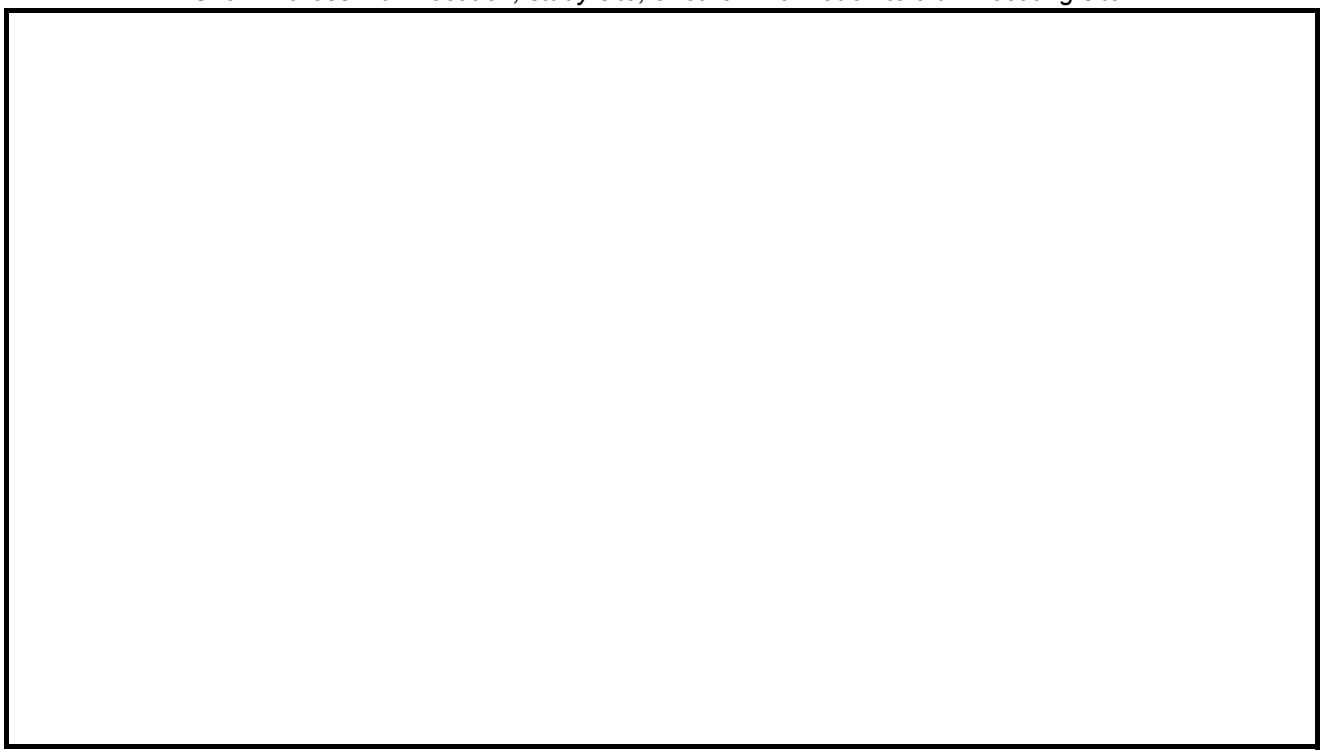
Animal (Kind & Class):		**Season of Use:**	**to**
Number:		**Grazing System:**	
Current Year Grazing Management:			

Other Notes (optional e.g., growth stage of plants at time of use):

SITE LOCATION FORM

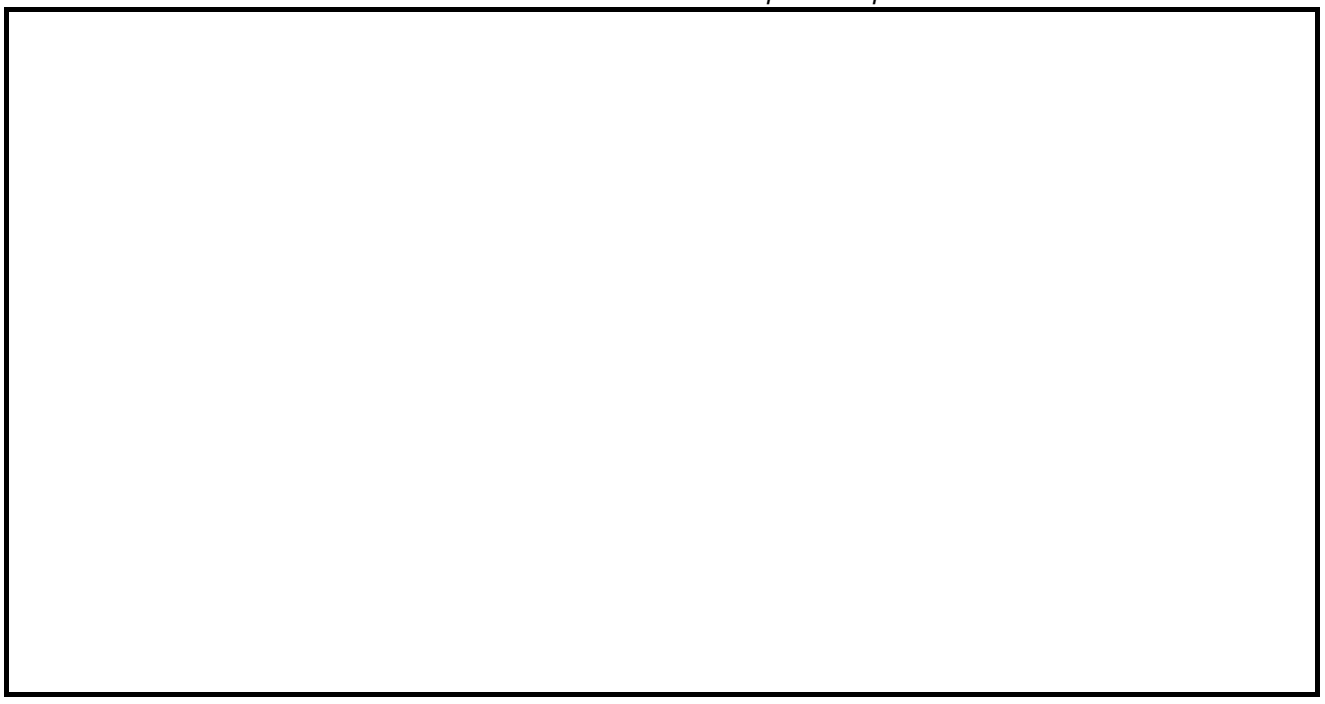
Site Location Map

Show witness mark location, study site, or other information to aid in locating site.



Site Location Photograph

Show Photo Information Sheet in all photos if possible.



VEGETATION

Dominant Plants:	

Primary Forage/Indicator ("Key") Species:	

VEGETATION USES

	Degree of Use			Optional Comments
	High	Moderate	Low	
Livestock				
Big Game				
Rodent				
Insects				
Recreation				
Motorized				
Horse				
Dispersed Camping				
Other (e.g., Fishing)				
Other				
Other				
Other				

Notes (use additional pages as needed):	

PHOTO INFORMATION SHEET

UNIT NAME:	

PASTURE NAME:	

STUDY SITE:	

OBSERVER:	

DATE:	

LANDSCAPE APPEARANCE METHOD (HERBACEOUS)

Unit Name:		Pasture Name:	

Transect ID:		Date:		Observer:	

Animal Kind/Class:		Season of Use:		Sample Interval:	

Class (Midpoint)	Dot Tally	(#) Count	# x Midpoint	Description of Landscape Appearance
0-5% (2.5%)				The rangeland shows evidence of no grazing, or of negligible use.
6-20% (13.0%)				The rangeland has the appearance of very light grazing. The herbaceous forage plants may be topped or slightly used. Few current seedstalks and young plants are grazed.
21-40% (30.0%)				The rangeland may be topped, skimmed, or grazed in patches. The low value herbaceous plants are ungrazed and 60-80% of the number of current seed stalks of herbaceous plants remain intact. Fewer than 50% of the young plants are grazed.
41-60% (50.0%)				The rangeland appears entirely covered as uniformly as natural features and facilities will allow. 15-25% of the number of current seed stalks of herbaceous species remain intact. No more than 10% of the number of low value herbaceous forage plants have been untilized.
61-80% (70.0%)				The rangeland has the appearance of complete search. Herbaceous species are almost completely utilized, with less than 10% of the current seed stalks remaining. Shoots of rhizomatous grasses are missing. More than 10% of the number of low-value herbaceous forage plants have been utilized.
81-94% (88.0%)				The rangeland has a mown appearance and there are indications of repeated coverage. There is no evidence of reproduction or current seedstalks of herbaceous species. Herbaceous forage species are completely utilized. The remaining stubble of preferred grasses is grazed to the soil surface.
95-100% (97.5%)				The rangeland appear to have been completely utilized. More than 50% of the low-value herbaceous plants have been utilized.
	Total	**A**	**B**	
Average Utilization = B/A				

LANDSCAPE APPEARANCE METHOD (BROWSE)

Unit Name:		Pasture Name:	

Transect ID:		Date:		Observer:	

Animal Kind/Class:		Season of Use:		Sample Interval:	

Class (Midpoint)	Dot Tally	(#) Count	# x Midpoint	Description of Landscape Appearance
0-5% (2.5%)				Browse plants show no evidence of use; or browse plants have the appearance of negligible use.
6-20% (13.0%)				The available leaders of palatable browse plants have the appearance of very light use.
21-40% (30.0%)				There is obvious evidence of leader use. The available leaders appear cropped or browsed in patches and 60-80% of the available leader growth of the palatable browse plants remain intact.
41-60% (50.0%)				Browse plants appear rather uniformly utilized and 40-60% of the available leader plants remain intact.
61-80% (70.0%)				The use of the browse gives the appearance of complete search. The preferred browse plants are hedged and some plant clumps may be slightly broken. Nearly all available leaders are used and few terminal buds remain on palatable browse plants. Between 20-40% of the available leader growth of the palatable browse plants remain intact.
81-94% (88.0%)				There are indications of repeated coverage. There is no evidence of terminal buds and usually less than 20% of available leader growth on the palatable browse plants remain intact. Some patches of 2nd and 3rd year's growth may be utilized. Hedging is readily apparent and the browse plants are more frequently broken. Repeated use at this level will produce a definitely hedged or armored growth form.
95-100% (97.5%)				Less than 5% of the available leader growth on browsed plants remain intact. Some, and often much, of the more accessible 2nd and 3rd year's growth of the browse plants has been utilized. All browse plants have major portions broken.
	Total	**A**	**B**	
Average Utilization = B/A				

RANGE UTILIZATION - KEY FORAGE PLANT METHOD

Unit Name:		Pasture Name:	

Transect ID:		Date:		Observer:	

Animal Kind/Class:		Season of Use:		Vegetation Type:	

	Key Species		Key Species		Description of Use Classes
Midpoint (x)	Frequency (f)	f * x	Frequency (f)	f * x	
					No Use (0%): The rangeland shows no evidence of use by grazing animals.
					Slight (1-20%): The rangeland has the appearance of very light grazing. The key herbaceous forage plants may be topped or slightly used. Current seed stalks and young plants of key herbaceous species are little disturbed. The available leaders of key browse plants are little disturbed.
					Light (21-40%): the rangeland may be topped, skimmed, or grazed in patches. The low value herbaceous plants are ungrazed, and 60-80% of the number of current seed stalks of key herbaceous plants remain intact. Most young plants of key species are undamaged. The available leaders appear cropped or browsed in patches, and 21-40% of the available leader growth of the key browse plants has been removed.
					Moderate (41-60%): The rangeland appears entirely covered as uniformly as natural features and facilities will allow. 15-25% of the number of current seed stalks of key herbaceous species remain intact. No more than 10% of the number of low value herbaceous forage plants are utilized. Browse plants appear rather uniformly utilized, and 41-60% of available leader growth of key browse plants has been removed.
					Heavy (61-80%): The rangeland has the appearance of complete search. Key herbaceous species are almost completely utilized with less than 10% of the current seed stalks remaining. More than 10% of the number of low value herbaceous forage plants has been utilized. Approximately 61-80% of the available leader growth of the key browse plants has been removed.
					Severe (81-100%): The rangeland has a mown appearance, and there are indications of repeated coverage. There is no evidence of reproduction of current seed stalks of key herbaceous species. There is no evidence of terminal buds, and 81-100% of available leader growth on the key browse plants has been removed. Some, and often much, of the 2nd and 3rd previous years' growth on the browse plants has been utilized.
Totals					**Remarks:**
Σfx/Σf					

STUBBLE HEIGHT

Unit Name:		**Pasture Name:**	

Transect ID:		**Date:**		**Observer:**	

Animal Kind/Class:		**Season of Use:**		**Sample Interval:**	

Record at least 36 stubble heights for each species or species group. More readings can be taken if desired.

Species (Group):			
	Column A		***Column B***
Sub			
Grand Total			
#			
Avg. Height " (Tot/#)			

Species (Group):			
	Column A		***Column B***
Sub			
Grand Total			
#			
Avg. Height (Tot/#)			

Species (Group):			
	Column A		***Column B***
Sub			
Grand Total			
#			
Avg. Height (Tot/#)			

COVER BY LIFEFORM TRANSECT

Unit Name:		Pasture Name:	

Transect ID:		Date:		Observer:	

Notes:

***Litter:** includes everything but rock soil, moss/lichen, or live plants.*

***Other** categories below may be used for specific species or groupings of interest.*

You may record dot counts optionally for separate species (e.g., perennial vs. annual species, desirable vs. undesirable species, or noxious weeds vs. native forbs) if doing so will help meet objectives.

	Grasses	Forbs	Shrubs		*Litter	Moss/ Lichen	Rock	Bare Ground
Perennial								
Annual								
Noxious								
Other:								
Other:								
Other:								
Total (=100%)				+				

PLANT DENSITY

Unit Name:		Pasture Name:	

Transect ID:		Date:		Observer:	

Animal Kind/Class:		Season of Use:		Vegetation Type:	

Quadrant Sample Size (check):			
	1	3' x100'	
	10	3' x 5'	
	25	2' x 5'	
			Other

KEY SPECIES	TRANSECT 1 Numbers	TRANSECT 2 Numbers	TRANSECT 3 Numbers	AVERAGE Per Quadrant
Total				
Avg				
Total				
Avg				
Total				
Average				
Total				
Avg				

Note: *Check the appropriate quadrant sample size; use a dot-count procedure to record the plant numbers.*

Remarks:	

STREAMSIDE STABILITY

Unit Name:		Pasture Name:	

Transect ID:		Date:		Observer:	

Existing Community Type	Value	Dot Tally	Count	Rating (Val x Count)
Anchored rock/logs	10			
Trees (coniferous & deciduous)	7			
Willows	8			
Other shrubs (e.g., sagebrush, cinquefoil, etc.)	5			
Wet sedges & rushes	9			
Other sedges	4			
Wet grasses (e.g., hairgrass, canarygrass, reedgrass, cordgrass)	8			
Other grasses (e.g., bluegrass, redtop, bentgrass, barley, muhly)	3			
Sandbars, loose rock, bare soil (unvegetated areas)	1			
		Total		
		Numerical Rating*		

***Note:** To determine the **rating**, multiply the value for each community type by the number of tally points **(count).** To determine the **numerical rating**, sum all the **ratings** and divide by the **total count** (number of places).To determine the overall **stability rating** for the riparian/stream reach sampled, use the table below.*

Numerical Rating	Stability Rating
9-10	Excellent (very high)
7-8	Good (high)
5-6	Moderate
3-4	Poor (low)
0-2	Very Poor (very low)

GRAZING RESPONSE INDEX

Use this method to evaluate each pasture, or several sites within a pasture. Each row represents one GRI rating. ***To determine the GRI, add all three values (frequency, intensity, and opportunity) and record the sum in the total column.*** *Several sites within a pasture can be averaged to obtain an overall rating for the entire pasture. Complete the* ***Site Information Form*** *for each site or pasture.*

Unit Name:		**Pasture Name:**	

Transect ID:		**Date:**		**Observer:**	

Grazing System:		**Season of Use:**		**to**	

Frequency		**Intensity**		
1	+1	Light	<40%	+1
2	0	Moderate	40-55%	0
3 or more	-1	Heavy	>55%	-1

Opportunity	
Opportunity to Grow or Regrow	**Value**
Full Season	+2
Most of Season	+1
Some Chance	0
Little Chance	-1
No Chance	-2

Pasture Name	Site ID	Frequency	Intensity	Opportunity	GRI (Total)
Total					

Remarks:	

PERMANENT PHOTO-POINT TRANSECT

Date:	
Unit Name:	
Pasture:	
Study Site (# or Name):	
Observer:	
Grazing System:	
Season of Use:	to
Study Located:	☐ N ☐ S ☐ E ☐ W
of:	
1/4 of:	
1/4 of Section:	
Township:	
Range:	
Photo Direction:	
Photo Subject:	
Photo Purpose:	
Camera:	
Lense(s):	
Film Speed:	

Remarks:	

ACTUAL USE RECORD FOR LIVESTOCK OPERATORS

Note: *this form keeps the records that many ranchers note in their pocket herd book. It may apply to a whole pasture or to a use area within a pasture if livestock are moved into or away from the use area and kept away during non-use periods so plants can grow or regrow. Scoring a pasture by use areas will add to the GRI score assuming managers move animals within large pastures.*

If this form is used for several pastures, write the name(s) on the first line for that section.

Pasture:		**Observer:**	

	Number of Livestock			
Move Date	**Put In**	**Taken Out**	**Kind and Class**	**Remarks[1]**

Salting/Supplementation Date(s)	**Product**	**Locations**

Waters[2]	**On Date**	**Off Date**	**Effects on Grazing Use**

Riding/Herding Date	**Effects of Grazing Use**

Use by Other Herbivores/Recreationist	**Season, Duration, Intensity and Effects**

[1] "Remarks" may address death losses, grazing problems involving water or livestock distribution, forage conditions, or other important matters that influenced grazing user such as fire, gates left open, etc. continue on the back of the form if necessary.

[2] "Waters" include sources that can be turned on or off such as a trough or intermittent waters that are occasionally or seasonally dry.