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Chapter 1  NRI Grazing Land On-Site Data Collection - Introduction

1.1 Overview

The National Resources Inventory (NRI) Grazing Land On-Site Data Collection began in 2003 on non-Federal rangelands and continues to be a vital component of the continuous inventory process. Following several years of pilot studies on non-Federal pastureland, NRI began conducting on-site data collection on both rangeland and pastureland in 2013. Most data collection protocols use the same techniques for rangeland and pastureland.

The NRI on-site framework has been extended to lands managed by the Department of Interior Bureau of Land Management (BLM) beginning in 2011. BLM has partnered with NRCS in implementing a national approach to monitoring rangeland resources by expanding NRI on-site data collection to BLM managed lands. NRCS leadership on grazing lands will be enhanced through this adoption of NRI protocols on BLM managed landscapes.

The NRI Grazing Land On-Site Data Collection is conducted cooperatively with the Iowa State University Center for Survey Statistics and Methodology (CSSM). The NRI is a statistically based sample of land use, natural resource conditions and trends on U.S. non-Federal lands. It is the most comprehensive database of its kind ever attempted anywhere in the world.

The Natural Resources Conservation Service (NRCS) is mandated (through the Rural Development Act of 1972, the Soil and Water Resources Conservation Act of 1977, and other supporting legislation) to assess the status, condition, and trends of soil, water, and related resources on the Nation’s non-Federal lands. Resources inventory legislative authorities, NRCS policy, and responsibilities for conducting the NRI are contained in NRCS General Manual 290, Part 400.

The NRI program serves as the Federal Government’s principle source of information on natural resources in the United States. The NRI provides a nationally consistent database that allows for resources assessment. Analyses of the NRI database are useful for public policy considerations because the database:

- has a high degree of reliability,
- looks at the natural resources over a period of time, and
- permits analyses at national, regional, and sub-regional levels.

1.2 Background - NRI On-Site Data Collection Program

The NRI plays a key role in development of conservation policy and programs for the Nation. It serves to educate the public regarding natural resource issues and provides a comprehensive, nationally consistent source of data for researchers in many fields. Informed and valid decisions are best made when based upon scientifically derived data. The NRI has been developed to supply this type of information. The NRI database is powerful, credible, and scientifically designed. NRI grazing land on-site data gathering has introduced new protocols to the NRI. Types of data collected about grazing land include:
1.3 Trending and Monitoring - Integrity of the NRI

In 2012 NRI began collecting data for rangeland segments previously inventoried to further strengthen the database and support the continuous inventory process. Collected data will be used to address grazing lands programmatic issues having to do with water quality and carbon sequestration. On-site data will be used to evaluate trends in natural resources over time.

1.4 Survey Overview

Inventory methodology is evolving as part of an ongoing effort to better assess soil conservation, natural resource health, and other environmental issues. The continuous inventory, with some data collected every year, makes the NRI a flexible instrument for monitoring the status of natural resources on a continuous basis. The purpose of the Continuous Resource Inventory Process is to provide up-to-date and relevant data. Current initiatives of the Continuous Resource Inventory Process include:

- Collecting data using photo interpretation for an annually observed core sample (42,000 segments) and a rotating sample (31,000 segments) each year.
- Collecting data using onsite protocols for a sample of approximately 3400 segments annually.
- Incorporating new resource assessment tools utilizing digital materials and further developing geospatial inventory techniques, monitoring tools, and data collection procedures.

1.5 Grazing Land Sample Data Collection

Grazing land data are collected for up to 2 points for each sample segment. For the range or pasture samples, grazing land data are collected at points 1 and 2 whenever the Land Cover/Use (LCU) is classified as grassland (LCU = 2001 Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range) and land ownership is classified as non-Federal (ownership code NF-Non-Federal). For the BLM sample, grazing land data are collected at points 1 and 2 whenever the LCU is classified as grassland defined as range (LCU = 2001 Grassland defined as range) or scrub shrub defined as range (LCU = 2201 Scrub Shrub defined as range) and land ownership is Federal - BLM managed (ownership code BLM-Federal BLM managed). If either point 1 or 2 does not meet these criteria, then grazing land data are collected from point 3 when the LCU and ownership conditions for the sample type are met.

Specific methodology for identifying, documenting, measuring, and recording grazing land resource conditions is presented in chapters 4 to 22 of these instructions.
Chapter 2 Guidelines for Grazing Land On-Site Data Collection

2.1 Data Quality

Quality assurance is an integral part of the NRI process. Quality is the first responsibility of each state resource inventory coordinator, state grassland/range management specialist, and data gatherer. State NRI leaders and state grassland/range management specialists must develop and implement a plan for on-site data collection to track progress and provide support to data gatherers.

All personnel involved with the NRI Grazing Land On-Site Data Collection are responsible for promoting the scientific integrity and ensuring the quality of grazing land on-site data. All data gatherers must thoroughly and consistently follow protocols established for data collection. These protocols are established and described in this NRI Handbook of Instructions for Grazing Land On-Site Data Collection.

Key components of the quality assurance process include:

- Workload planning
- Training and Calibration
- Using the Computer Assisted Survey Instrument (CASI) data gathering software
- Assuring that all data gatherers have data collection instructions and know how to get assistance when needed with interpretation of instructions
- Maintaining an open communication network between leaders and data gatherers and the NRI support structure including the NRI Help Desk
- Spot checking data gatherer’s work throughout data collection

2.2 Confidentiality

The National Resources Inventory program is based upon scientific and rigorous sample survey protocols. These protocols include maintaining and protecting the integrity and confidentiality of the data gathering sites. USDA and NRCS policy states that: The geographic locations of data gathering sites used for USDA’s National Resources Inventory are not public information and are to be used only for purposes of official NRI data gathering activities or for such purposes approved by the Secretary.

All NRI leaders, range leaders, and data gatherers (NRCS and contract) are required to sign a Confidentiality Statement prior to starting data collection. NRI data that identify owners, operators, data collection sites, or unreleased data are not to be released to the public.

2.3 Access to Private Lands to Gather Grazing Land Data

NRCS policy and a part of our agreement with Conservation Districts require obtaining landowner/operator permission before going on private property. Access to private lands is an issue in many areas. State NRI and range leaders are to work with local on-site office personnel to obtain ownership information for sample sites and to establish procedures for obtaining permission to visit sample sites to collect grazing land data. The documents in Appendix C were developed to aid in obtaining and documenting landowner permission for data collection.
following documents are available from the NRI Help Desk and may be modified to address local conditions and customs:

- Landowner Contact Guide
- NRI Grazing Land On-Site Data Collection Access Record
- Sample letter to Landowner/Operator/Land User and FAQs

While collecting grazing land data on private lands, data gatherers are to:

- Work with local on-site office personnel to assure permission is granted before going on private land to collect data.
- Show proper conduct regarding access to private property.
- Take special care to not disrupt soils, vegetation, and animals.
- Minimize activities that could lead to special treatment of a site resulting from owners/operators knowing that the site is part of an inventory.

2.4 Training

Every grazing lands onsite data collection must be conducted by an authorized technical leader, accompanied by one or more crew members. Each of the collectors must be authorized annually before collecting data. Authorization is based on the combination of training and experience as indicated.

2.4.1 Crew Members

A crew member for a grazing lands onsite collection must attend one of the following the same year as the collection:

- Grazing lands onsite training conducted by the National Employee Development Center (NEDC)
- Grazing lands onsite training conducted locally by a national grazing lands trainer
- Grazing lands onsite training conducted by an authorized technical leader

The current year training may be waived if the crew member was also a crew member the previous year and conducted data collections at five or more points.

2.4.2 Technical Leader

The technical leader for any grazing lands onsite collection must:

- Have been previously qualified as a crew member and acted as a crew member for data collections at five or more points, led by an authorized technical leader.
- Have attended the NEDC grazing lands onsite training for the year conducting collection as a technical leader.

The current year training may be waived if the technical leader was also a technical leader the previous year and acted as technical leader for data collections at five or more points.

2.4.3 Training Records

The State resource inventory coordinator or equivalent leader of the State onsite collections must maintain training and collection experience records for all NRI grazing lands onsite collection
personnel. Those training records will be audited periodically by the NRI Program onsite
collection national leader and also used annually to plan for the NEDC national training.

2.5 Grazing land On-Site Data Collection Materials

Data collection will be done by teams of at least two gatherers who will go onsite to observe,
measure, and record information about the sample point and the surrounding area. The following
tools, equipment, and references are required for each data gathering team to collect NRI grazing
land data:

Tools and equipment:

Field PC with current version of the NRI Grazing Land survey software installed (See NRI
Grazing Land website for more information on field PCs and the NRI Grazing Land survey
software: https://grazingland.cssm.iastate.edu).

- Pen, pencil, and clipboard for a writing surface
- Camera for macro plot shots
- Dry-erase board or blackboard & markers or chalk to use to identify macroplot in photos
- Steel pins, two 150-foot tapes with 0.1 - foot gradations, and a compass to mark and
  orient the two transects, NW-SE and NE-SW.
- Clinometer (or Abney level) for slope reading
- Compass for slope aspect orientation
- Soil auger or sharp shooter shovel for confirming the soil map unit component at
  macroplot point.
- Wire flag for doing the point intercept method
- Pasture stick, survey rod, or clinometer for height measurements
- Quadrat frames (1.92, 4.8 or 9.6 sq ft) for clipping forage yield samples and doing the
  dry-weight-rank (DWR) method of estimating species composition
- Grass shears, clippers, and loppers
- Paper sacks or cotton bags for species composition by weight and standing biomass
  protocols
- Penetrometer or steel rod for soil compaction detection (pasture condition)
- 50- and 300-gram field scales with pinch clip (to grasp forage sample) graduated in gram
  increments
- 10X magnifying lens for plant identification
- Vegetative grass key, and weed key.
- 5 to 6 survey stakes to temporarily secure tapes onsite
- Soil stability test kit (see Chapter 11)
- Deionized water (any noncarbonated bottled water except mineral water (1 quart per test)
- Stopwatch or chronograph watch (CASI also provides timer)
- Small spray bottle (atomizer or equivalent with very fine mist)
- Data recording instrument
- Computer Assisted Survey Instrument (CASI) or electronic questionnaire (see appendix
  A)
- 2 stretch tapes (25 ft) or 11.75 foot length of string for woody plots
- Small bottle of 1N or 1M HCl for testing effervescence class (see Chapter 7)
- Metal diameter tape (metric) with millimeter graduations
Other suggested items for emergencies:

- Extra batteries
- Cell phone

References and documents:

- NRI Handbook of Instructions for Grazing Land On-Site Data Collection
- Maps of segment sample site
- Plant guides and appropriate floras
- Information about the segment sample site including:
  - Segment and point site map on aerial imagery background
  - County highway map with plotted sample locations
  - Quadrangle compilation map
  - Soil survey atlas sheet, on-site sheet, or equivalent soil survey map information
  - Ecological site description

2.6 Technical Assistance and Help

Technical assistance and help are available to data gatherers from instructions, Web sites, e-mail, telephone, and voice mail. Selection of the appropriate avenue depends upon the kind and urgency of assistance required.

The first point of help is written instructions for grazing land data collection. NRI leaders are to provide all data gatherers with the complete NRI Handbook of Instructions for Grazing Land On-Site Data Collection. Instructions are posted at:

https://grazingland.cssm.iastate.edu

If the question is not resolved, contact the state grazing land/range management specialist or state resource inventory coordinator. This procedure is meant to ensure that State NRI and grazing land/range leaders are the first source of information for data gatherer questions. Leaders will resolve the problem or contact the NRI Help Desk to get assistance.

The NRI Help Desk will consult with appropriate technical staff to obtain answers to questions and provide responses to state specialists and data gatherers. If the data gatherer needs immediate assistance and their leader cannot be reached, they may contact:

NRI Grazing Land Help Desk: (nri-graze-help@iastate.edu) for protocol/CASI issues and questions.

2.7 State Leaders and Data Gatherers Responsibilities

State NRI and grazing land management specialists are responsible for:

- Ensuring that all data gatherers are trained and understand all concepts and instructions in this handbook and those data gatherers can demonstrate proper application of these instructions when collecting grazing land data.
- Providing each data gatherer with instructions, ancillary materials, and references needed to locate segment sample sites and collect data.
• Providing data gatherers equipment to collect or measure grazing land resource conditions.
• Using the materials and services available from the NRI Help Desk to support training and data collection needs.

Individual data gatherers are responsible for mastering and using skills required to collect grazing land data. Each data gatherer must possess the following skills, knowledge, and abilities to collect data:

• Understanding and applying the NRI survey protocols and instructions.
• Using aerial photography, maps, segment ancillary materials to locate sample sites.
• Operating the field computer with CASI to record and communicate grazing land data.
• Using the tools listed above to measure and obtain grazing land data according to survey protocols.
• Communicating with state leaders to provide information and ask questions when needed.
Chapter 3  Point Location and Plot/Transect Layout

3.1 Overview
This chapter covers data elements relating to:

- Locating the sample point field location and capturing the sample point field position
- Establishing the sample plot and transects

The CASI screen also includes data entry cells for Data Gatherer, Ownership, and Land Cover/Use.

3.2 What’s New
- Update of section 3.4.1 Conditions for Data Collection to reflect updates to land cover/use codes in Chapter 6.
- Update of section 3.7 Procedure for Taking On-Site Photographs to clarify procedure.

3.3 Critical Points to Remember
On-site data will be collected at the certified NRI point location. Certified locations are the geographic coordinate system descriptions of NRI sample points and segments that accurately describe the location of each point and segment in prior photo-interpreted NRI data collection. The certified location is unique for each point and segment. The site map representation of the certified point locations should be considered the definitive source. GPS locations should closely match this map representation. In instances where the GPS accuracy is poor or the GPS location contradicts the site map, move to the certified location as shown on the segment and point site map. Always review the point location carefully before beginning data collection.

3.4 Preliminary Steps

3.4.1 Conditions for Data Collection
Point location data are documented for all sample points.

Plot layout with transects, GPS location recording, and on-site photographs are conducted for points when the following conditions are met:

- For the non-Federal range sample, plot layout with transects, GPS location recording, and on-site photographs are documented for non-Federal points with land cover/use of grassland (LCU = 2001 Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).
- For the non-Federal pasture sample, plot layout with transects, GPS location recording, and on-site photographs are documented for non-Federal points with land cover/use of grassland (LCU = 2001 Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).
• For the BLM range sample, plot layout with transects, GPS location recording, and on-site photographs are documented for BLM-managed Federal points with land cover/use of grassland defined as range (LCU = 2001 Grassland defined as range) or scrub shrub defined as range (LCU = 2201 Scrub Shrub defined as range).

3.4.2 Ancillary Resources

In addition to the basic data collection materials noted in chapter 2, the following ancillary resources are required:

• Appendix A - CASI Operation, Section A.3 Navigation and capturing position data
• Appendix B - The Garmin GPS Map 76 Receiver, Features, Functions, Setup and Quality of Position.

3.5 Data Collection Procedure for Capturing the Sample Point Field Position

3.5.1 Definitions

Segment and point site map. A verified spatial representation of the segment boundaries and point locations on an ortho photo base. The official NRI spatial data base containing certified locations is the source for this map. [NRI-2012]

Sample point target position. This refers to the pair of coordinates in a global coordinate system derived from the official NRI spatial data base containing certified locations for the sample point. [NRI-12-Range]

Certified locations. The geographic coordinate system descriptions of NRI sample points and segments that accurately describe the location of each point and segment in prior photo-interpreted NRI data collection. The certified location is unique for each point and segment. [NRI-2012]

Sample point field position. The location of the sample point in terms of a pair of coordinates in a global coordinate system. In the NRI Grazing Land Onsite Data Collection Instructions, the term position is reserved for the information or reading obtained in the field by the GPS instrument. These coordinates should match the certified point locations. [NRI-12-Range]

3.5.2 Procedure

Review the provided point location support information for each segment. This includes:

• Site map, the segment and point site map (point locations marked on the provided photo for each segment)
• A county level map showing the general location of the segment boundary (aids in planning navigation to the segment).

3.5.2.1 Field Visit

After ownership is entered, the data collector will be asked if the sample point was visited in the field. Both the Ownership field and Field visit fields may be populated in the office. Both are
based on preparations for data collection (i.e., determining the landowner, contacting the landowner for permission to access the site, determination from site map that the land cover/use is CLEARLY ineligible). It is important to note that the land cover/use of most points can only be determined in the field. NAIP imagery used for the background of the site maps may be up to 3 years old. Actual land cover/use of the site may have changed since the NAIP image was flown. For example, cropland may be in rotation with pasture. A point that is shown as cropland on the NAIP image may now be pastureland. Always confirm land cover/use in the field when there is a possibility of land cover/use change to rangeland or pastureland.

If the answer is No, a choice list of reasons is presented:

- **No contact with land owner/manager** - Use this when the land owner/manager could not be contacted for permission to access the site.
- **Denied access by land owner/manager** - Use this when the land owner/manager was contacted, but they refused to grant permission to access the site.
- **Not eligible land cover/use or ownership** - This identifies sites that are not eligible for data collection because the land cover/use is not rangeland or pastureland or the ownership is incorrect for the survey. Always confirm land cover/use in the field when there is a possibility of land cover/use change to rangeland or pastureland. No note is required for this field selection.
- **No access to site** - An example is refusal by a private landowner/manager to cross their land on the way to a point located on BLM managed land.
- **No attempt for other reason** - Choose this selection when none of the above four reasons apply. Choosing this answer requires the data collector to document an explanation of the situation in a note.

Record the **Field Visit** information.

### 3.5.2.2 Field Position

Use the **Field Position** field when navigating to the sample point location. For purposes of this instruction, navigation refers to the process of interpreting information to travel to the location of the NRI sample point.

General navigation considerations:

- It is unnecessary to physically navigate to the point if it is obvious the point is not eligible for data collection. This may result from a change in ownership to an ineligible...
ownership or an obvious conversion to an ineligible cover type. These situations require a negative response to the Field visit field in step 1.

- In other cases, the point may be eligible for data collection and a site visit is attempted, but other conditions prevent data collection. Select one of the reasons (listed in the CASI) and record a note to provide more detail of the situation:
  - Access denied/locked gates
  - Topography dangerous/impassible
  - Flora/fauna dangerous/impassible
  - Other reason

- The CASI expects to obtain complete field collected data for two points per segment whenever possible.
- For BLM sample segments, points 1 and 2 will initially be available for the on-site inventory protocols. If points 1 or 2 are not eligible for data collection, point 3 will become available for data collection in the CASI.
- For the non-Federal sample, data may be collected for up to two points per segment based on past on-site data collection history.

The navigation process can be done in two ways described as option 1 and 2 below.

**Option 1 (Navigation with GPS):** Use the CASI and integrated GPS technology to navigate to the Sample Point Field Position. This uses the Point Location displayed at the top of the screen as target coordinates. This option should work well for most sample points in this survey and should normally be the preferred option to locate the sample point location.

The CASI navigation process can now be accomplished via one of two protocols listed below:

- **Protocol 1 (Garmin GPSmap 76):** This protocol uses the Garmin GPS Map 76 and proprietary Garmin program language to communicate between the Garmin and the Trimble Recon. This is the navigation method used in all previous versions of the CASI and is designed specifically for the Trimble Recon and the Garmin GPS Map 76 combination. With this method, the Garmin Map 76 screen and key controls are used for navigation.

- **Protocol 2 (NMEA GPS):** This is a new protocol (as of 2010) and uses the National Marine Electronics Association (NMEA) communication language to communicate NEMA GPS strings to the Field PC. The CASI has been customized to work with the built-in GPS devices included with the Trimble Geo XT and the 3D Pro XYZ with minimal required setup. With this method, the Field PC screen is used to display maps and control the navigation process.

This protocol can also be used to configure other NMEA compatible GPS devices to work with a field PC. To do this, communication port, baud rate and certain NMEA
strings must be specified between the Field PC and GPS unit. For assistance with specific units, please contact the NRI Help Desk.

**Option 2 (Navigation by map):** In the event of heavy canopy cover or other technical difficulties that result in poor GPS performance, data gatherers may use the segment point and site map(s) in association with visible landmarks and other distinct features on the land to navigate to the sample point location in the field. In this case, select **No GPS capture (reached site)** from the displayed CASI choice list. Data collection can proceed in this instance.

### 3.5.2.3 Navigation via GPS/CASI Interface

**Protocol 1: For Garmin GPS Map 76 and Trimble Recon Users**

The Garmin GPS Map 76 cannot be completely setup by the CASI. It is imperative the Garmin76 be set to the correct datum -- **NAD83** and that communication (**Interface**) is set to Garmin.

Follow these steps to review/change the settings on the Garmin prior to hooking up to the Recon device.

Table 3-1. Special instructions for Garmin GPS Map 76

<table>
<thead>
<tr>
<th>To set datum type: NAD83</th>
<th>To set the Garmin Interface: Garmin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Press the menu button to move to the main menu.</td>
<td>1. Press the menu button and select setup.</td>
</tr>
<tr>
<td>2. Use the rocker button to highlight setup.</td>
<td>2. Use the rocker button to highlight setup.</td>
</tr>
<tr>
<td>3. Press the enter button. A series of different tabs will be displayed at the top of the screen.</td>
<td>3. Press the enter button. A series of different tabs will be displayed at the top of the Garmin76 screen.</td>
</tr>
<tr>
<td>4. Use the rocker button to move to the location tab.</td>
<td>4. Use the rocker button to move to the interface tab.</td>
</tr>
<tr>
<td>5. Use the rocker button to move down to map datum (usually set to WGS84).</td>
<td>5. Use the rocker button to move to the serial data format.</td>
</tr>
<tr>
<td>6. Press the enter button and highlight NAD83 from the pop up list of datum types.</td>
<td>6. Press enter and select Garmin.</td>
</tr>
<tr>
<td>7. Press the enter button again to select NAD83.</td>
<td>7. Press the menu button several times to return to navigation mode.</td>
</tr>
<tr>
<td>8. Press the menu button several times to return to the navigation mode.</td>
<td></td>
</tr>
</tbody>
</table>
1. To use the Garmin GPS Map 76 to navigate to the sample point, follow these steps:
   - Check the Garmin GPS Map 76 to make sure the interface and datum setting are correct (see Table 3-1)
   - Connect the Garmin GPS Map 76 and Recon using the supplied Garmin cable. The nine pin serial cable attaches to the bottom of the Recon unit.
   - Tap the field position element and select Navigate (Garmin GPSmap 76) from the pop-up menu (Figure 3-4).
   - Tap on open connection to create a communication session with the Garmin.
   - Tap transfer target to move the point target coordinates to the Garmin as a way point. They will be labeled as point 1, point 2 or point 3.
   - Use the Garmin GPS Map 76 to navigate to the downloaded way point as near as possible. Refer to appendix B for more information on operating the Garmin unit.

2. Evaluate the location. The site map representation of the sample point location should be considered the definitive source. GPS locations should closely match this map representation. In instances where the GPS accuracy is poor or the GPS location contradicts the site map, move to the certified location as shown on the segment and point site map.

3. Capture the sample point field position by tapping the capture location button in the CASI navigation window. The coordinates will be returned to CASI and appear in the longitude and latitude data entry cells. Note: The capture is instantaneous as there is no averaging.

4. Mark the sample point location with a flag or other suitable marker.

For more information on using the CASI/Garmin to navigate and capture position information, refer to Appendix B, The Garmin GPS Map 76 Receiver. Features, Functions, Setup and Quality of Position.

**Protocol 2: NMEA GPS- For Trimble Geo XT and 3DPro XYZ Configurations**

The NEMA GPS protocol uses the following NEMA sentences to communicate location/navigation information to the Field PC.
• GPGGA: Provides latitude, longitude, elevation, HDOP and fix type
• GPRMC: Provides date and status
• GPGSA (optional): Provides PDOP and VDOP

1. To use the CASI with the Trimble GEO XT, 3DPRO XYZ Field PC/GPS combination units to navigate to the sample point, follow these steps:
   • Tap the field position element and select **Navigate (NEMA GPS)** from the pop-up menu (Figure 3-4).
   • The CASI navigation window will be displayed (figure 3-6). To set up for the first time:
     • Tap on settings (lower left hand corner) and select the GPS type menu option to specify the type of GPS you are using.
     • Tap on orientation to change the navigation map orientation from ‘North Up’ to ‘Course Up’.
     • Upon completion of setup, tap **ok** and the navigation window will re-appear and the GPS will begin the navigation process.
     • Note: It may take a few minutes for the GPS to determine a valid starting location. Once a valid position has been established, the navigation window will display the distance and direction to the target coordinates.
     • The Navigation window includes a number of features which assist in the navigation process which are detailed in figure 3-8.
     • Use the navigation screen to navigate as near to the target coordinates as possible.

2. Evaluate the location. The site map representation of the sample point location should be considered the definitive source. GPS locations should closely match this map representation. In instances where the GPS accuracy is poor or the GPS location contradicts the site map, move to the certified location as shown on the segment and point site map.

3. Capture the sample point field position by tapping the capture option (lower right hand portion of the screen) in the CASI navigation window. The coordinates will be returned to CASI and appear in the longitude and latitude data entry cells. **Note:** The capture is instantaneous as there is no averaging.

4. Mark the sample point location with a flag or other suitable marker.
Figure 3-8. When using a NEMA GPS, the field PC provides the map and controls for navigation.

Possible Messages
- Stopped: Indicates no communication taking place with GPS
- Running: Indicates communication with GPS
- Invalid: GPS position not valid for navigation
- Good: GPS position adequate for navigation

Course: While navigating, indicates the course in degrees you are traveling

Speed: Indicates your speed while navigating

Turn: Indicates suggested turn needed to stay on course in degrees (-180 to 180)

Text description: Text message displayed to assist in navigation.

Radio Button Choices
- Dop (dilution of precision): GPS signal quality information
- L/L: Displays latitude and longitude of target and current position
- Msg: Displays status of NEMA string retrieval to navigation process

Figure 3-9. Tapping on capture, pulls up a summary of the captured coordinate information.

Date and Time 2010/03/22 14:29
Latitude 41.99819
Longitude 93.63719
Elevation 957
HDOP 1.8
Type of fix 5

OK
3.6 Procedure for Establishing/Documenting the Sample Plot and Transects

3.6.1 Definitions

On-site plot. A circular area 150 feet in diameter centered around the NRI sample point. The plot includes two transects 150 feet in length that intersect at the NRI sample point. Transect bearings are set on a diagonal. [NRI-03-Range] A labeled plot diagram is shown in figure 3-8.

Transect. A cross-section of an area used as a sample for recording, mapping, or studying vegetation and its use; may be a series of plots, a belt or strip, or merely a line. In the grazing land on-site data collection, two 150-foot transect lines intersect at the NRI sample point. Measurements are taken at predetermined marks along the transect line. The transect arms are oriented 45 degrees in both directions from magnetic north. Transect distances are recorded from the NW to SE and NE to SW from a tape stretched along the ground. [NRI-03-Range].

The following protocols utilize the transect line during sampling:

- Line Point Transects for Cover Composition
- Line Intercept Transects: Basal and Canopy Gaps
- Soil Stability Test
- Plant Height
- Species Composition by Weight
- Dry Weight Rank
- Standing Biomass
- Sagebrush Shape

3.6.2 Procedure

1. Place all equipment outside the 0.4-acre plot area. Minimize foot traffic as much as possible in the sample area, especially at the segment point (75-ft intersection on tape).

2. Lay out the two 150-foot transects through the sample point. The middle of each transect intersects at the sample point (see fig. 3-10).

   - Transect 1 - From the NRI sample point, use the compass to locate the NE starting (0 on the tape) point of transect 1 by extending tape at 45 degrees. When the tape is extended 75 feet, secure NE point with a surveyor stake. Locate the SW end point of transect 1 by extending tape at 225 degrees to a total length of 150 feet. Secure the SW transect 1 end with a survey stake.

   - Transect 2 - From the NRI sample point, use the compass to locate the NW starting (0 on the tape) point of transect 2 by extending tape at 315 degrees. When the tape is extended 75 feet, secure NW point with a surveyor stake. Locate the SE end point of transect 2 by extending tape at 135 degrees.
degrees to a total length of 150 feet. Secure the SE transect 2 end with a survey stake.

3. Place a marking flag at the transect beginning (0.0 ft), middle (segment point, 75 ft), and end (150 ft), respectively.

**Considerations in stretching tapes and reading data**

- In areas with shrubs, the tape should pass below the shrub canopies so that it rests on or close to the ground.
- If needed, use additional surveyor stakes at various intervals to secure the tape close to the ground, especially where wind is a consideration.
- Read data from one side of tape and always walk on the other side.
- Do not estimate values from a distance as this can lead to errors due to parallax. Be careful not to disturb vegetation in the production plots.
- An imaginary circle serves as a plot border and forms four quadrants (north, south, east, and west) (see fig. 1) which make up the macroplot.

### 3.7 Procedure for Taking On-Site Photographs

#### 3.7.1 Definitions

None

#### 3.7.2 Procedure

Use a high resolution digital camera (at least 5 megapixel capacity) with 50 mm equivalent lens to photograph the plot according to the following procedures. Both CLOSE-UP and DISTANT photos are framed identically. Do not zoom in. Begin photographs at the 150-ft mark (south end) of transect 1. Prepare a legible photo identification card (clipboard size or equivalent). The photo identification card must have the following information:

- State, County codes
- Segment number
- Segment point number (1, 2, or 3)
- Transect Number and direction (e.g., 1-SW to NE; 2-SE to NW; 2-NW to SE; 1-NE to SW)
- Date
- Any point of interest photo: e.g. Juniper invasion (JUVI), noxious weed (CIAR4), gully, disturbance, aesthetic photo, prescribed burning, etc.

If additional photos are taken for Ecological Site or Forage Suitability Group development, leave out all the NRI related codes. List on photo identification card: Ecological Site or Forage Suitability Group number and site name.

1. Place the photo identification card one to two feet to the right or left of the 150.0 ft mark (Transect 1, SW-NE), stand outside of the macroplot, in line with the tape, 10 ft from the 150.0-ft mark. **Signal data collection crew to exit the macroplot completely.** Compose photo from a height of 1.5 m. The close-up photo is digitally focused at the 150-foot mark (nearest end of the tape), then tilt the camera upward to include the horizon within the frame without losing the close-up focus and photo identification card at the near end of the tape.
Keep shutter button partially depressed till the horizon is framed, then completely depress the shutter button and take the photo. Review the digital photo for readability of the photo identification card. Note: the photo identification card information is for later tagging the photos in NRI images application and will be masked.

2. From the same location, the distant photo is digitally focused on the horizon or the 0-foot mark (at the far end of the tape). While holding the shutter button partially depressed, tilt the frame lower so that both the horizon and near end of tape and photo identification card are included within the frame. Depress shutter button and take the photo. Repeat at each transect end/beginning. Be sure to label the photo file correctly.

3. Now move to 150-ft mk Transect 2, SE-NW(south end). Change photo identification card information. Stand back 10 ft from edge of macroplot, focus on 150-ft mk and card. Take photo. Focus on 75-ft mk. Take photo.

4. **Signal data collection crew to enter the plot and begin data collection.** Begin walking up Transect 2 toward the NW. Take optional photos of special site characteristics or anomalies as observed. Label photo identification card if topic will not be obvious later when labeling photograph file.

5. If the 75 ft mark is obscured from view at either of the 150.0-ft marks, label the photo identification card mk =75 ft and other appropriate identifying information. Take photo.

6. The third set of 2 photos will be taken from the 0 ft mark at the end of transect 2 (NW to SE) using the same procedure. Label photo identification card. Data collection crew may remain in the plot since clean site photos were achieved with the first 2 sets taken from the south.

7. Repeat procedure for the fourth set of 2 photos taken from the 0-ft mk of Transect 1 (NE to SW).

8. Note that an additional photo is required to document the soil profile (see Chapter 7).
Optional Photos: point of interest designator: Ecological Site/Forage Suitability Group boundary change, noxious weed, burn, brush control, aesthetics, gully, rills, water and wind erosion, plant disease, production plot close-ups, invasive species, conservation practices, seeding, water developments, fence line contrasts, etc). Any optional photographs should include a photo identification card and a short written explanation of what is on the photo.

3.8 Procedure for Submitting Digital On-Site Photographs

3.8.1 Definitions

None

3.8.2 Procedure

1. Copy digital photos to your desktop computer.
2. Open the web-based NRI Grazing Land Images application (found on the Grazing Land website or at https://www.nrisurvey.org/grazinglandImages) and enter your username and password.
3. Select the Upload Images link and enter the NRI Point ID and survey year for the images you want to upload. When you have filled in all required values, an upload interface will appear. Click "Select Files," choose the image files you would like to upload, and click "Upload." The images files will be uploaded to a temporary location on the server, from which you can tag them and submit them to the Grazing Lands Image Database.
4. Select the Tag Images link and select the directory for the images that you uploaded.
5. Complete information for all boxes shown in red as incomplete. These fields include:
   - Transect end ("NE", "NW", "SE", "SW", or "OT" for other)
   - View ("CU" for close-up, "TV" for teleview, or "OT" for other)
   - Photo Year
   - Month photo was taken (2-digit month (01-12))
   - Day photo was taken (2-digit day of month (01-31))
6. Use the tool to mask out any identifying labels (e.g., white board information, any segment and point information burned into the digital image).
7. Enter any notes to describe features of interest on the photo.
8. Submit the photo to the Grazing Lands Image Database by clicking the “Submit” button.
9. Select the View Tagged Images link to view or edit submitted photos.
Chapter 4  Data Gatherers

4.1 Overview
This chapter covers the collection of information relating to:

- Data gatherer(s) for the segment

Data gatherer(s) shares the CASI screen with Point Location, Ownership, and Land Cover/Use.

Information on segment ID and segment point are pre-populated for all segments and are non-editable.

4.2 What’s New
No changes have occurred in data collection procedures for this chapter.

4.3 Critical Points to Remember
Data gatherers must have received training in the collection of grazing land information, CASI operation, and GPS navigation prior to data collection. All data gatherers must also sign the NRI confidentiality agreement.

4.4 Preliminary Steps

4.4.1 Conditions for Data Collection
Data gatherer information is collected for all segments.

4.4.2 Ancillary Resources
No specific materials are needed to complete data collector information.

4.5 Procedures for Identifying Data Gatherer Information

4.5.1 Definitions
Data gatherer. The person responsible for interpreting data for a segment and entering data into the Computer Assisted Survey Instrument (CASI). [NRI-2001]

4.5.2 Procedure
1. Identify the Primary gatherer and Other gatherer(s) information for the segment.
   - The Primary gatherer is the person leading the on-site collection team, and Other gatherer(s) are those that assist with collection and recording of data.
   - Data gatherers must have received training in rangeland data collection, CASI operation, and GPS navigation.

2. Enter Primary gatherer and Other gatherer(s) information.
• Select the **Primary gatherer** screen and enter the team leader’s name, first name first followed by last name (i.e., James Johnson). Once a name is entered in the CASI, it will be displayed and may be selected for subsequent segment data entry.
• Enter other gatherer(s) that assist with data collection and data entry in the same manner as above.
Chapter 5 Ownership

5.1 Overview
This chapter covers data elements relating to:

- Ownership

The CASI screen also includes data entry cells for Point Location and Land Cover/Use.

5.2 What’s New
No changes in this protocol.

5.3 Critical Points to Remember
Ownership information is always collected at the certified point location. Certified locations are the geographic coordinate system descriptions of NRI sample points and segments that accurately describe the location of each point and segment in prior photo-interpreted NRI data collection. The certified location is unique for each point and segment. The site map representation of the certified point locations should be considered the definitive source.

5.4 Preliminary Steps

5.4.1 Conditions for Data Collection
Ownership will be determined for every sample point.

5.4.2 Ancillary Resources
In addition to the basic data collection materials, the following materials may be useful in collecting data for this chapter:

- Local tax and land office records.
- Maps published by Federal and State agencies.
- Commercial maps and county plat books.
- NRCS and FSA office records.
- Topographic quadrangle maps or Digital Raster Graphics (DRG).
- Geospatial data layers containing ownership information.

5.5 Data Collection Procedures for Ownership

5.5.1 Definitions

Certified locations. The geographic coordinate system descriptions of NRI sample points and segments that accurately describe the location of each point and segment in prior NRI data collection. The certified location is unique for each point and segment. [NRI-2012]

Ownership. For the non-Federal range and pasture samples, the two ownership categories are:

- **NF - Non-Federal** - Non-Federal ownership includes land owned privately, or by municipal, county, state, or Indian tribal and trust lands.
- **Fed - Federal** - A land ownership category designating land that is owned by the Federal Government. It does not include, for example, trust lands administered by the Bureau of Indian Affairs (BIA) or the Tennessee Valley authority (TVA). [NRI-92]

For the BLM sample, the two ownership categories are:

- **BLM - Federal BLM managed** - A Federal land ownership subcategory designating land that is administered by the Department of Interior Bureau of Land Management (BLM).
- **Oth - Other** - A land ownership category designating land that is not administered by the Department of Interior Bureau of Land Management (BLM).

5.5.2 Procedure

1. Determine correct sample point location for data collection.
   - The correct location is the certified point location. On-site data collection information will be gathered at the certified point location.

2. Determine ownership for the sample point location.
   - The onsite determination of ownership must be accurate and should be supplemented by current, authoritative, and applicable sources.
   - For the non-Federal range and pasture samples, the two ownership categories are:
     - **NF - Non-Federal** - Non-Federal ownership includes land owned privately, or by municipal, county, state, or Indian tribal and trust lands.
     - **Fed - Federal** - A land ownership category designating land that is owned by the Federal Government. It does not include, for example, trust lands administered by the Bureau of Indian Affairs (BIA) or the Tennessee Valley authority (TVA).
[NRI-92]
  
  **Note:** If there is a change in or out of Federal ownership, a note is always required.
  
  - For the BLM sample, the two ownership categories are:
    - **BLM - Federal BLM managed** - A Federal land ownership subcategory designating land that is administered by the Department of Interior Bureau of Land Management (BLM).
    - **Oth - Other** - A land ownership category designating land that is not administered by the Department of Interior Bureau of Land Management (BLM).
    - **Note:** If there is a change in or out of Federal ownership, a note is always required.

3. Enter the **Ownership** category under current survey year for the sample point.
Chapter 6  Land Cover/Use

6.1 Overview
This chapter covers data elements relating to:

- Land cover/use

Land cover/use shares the CASI screen with Point Location, Data Gatherer, and Ownership.

6.2 What’s New
Land cover/use codes are updated to be consistent with the larger NRI. The former 250 Rangeland code is equivalent to 2001 Grassland defined as range or 2201 Scrub Shrub defined as range. The former 211 - 213 Pasture and Native Pasture codes are equivalent to 2000 Grassland not defined as range or 2200 Scrub Shrub not defined as range. Selection of the new land cover/use codes within the CASI will enable data collection for the corresponding range or pasture protocols. Other codes are listed in section 6.5.2 Table 1.

<table>
<thead>
<tr>
<th>Old Codes</th>
<th>New Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 Rangeland</td>
<td>2001- Grassland defined as range</td>
</tr>
<tr>
<td></td>
<td>2201- Scrub Shrub defined as range</td>
</tr>
<tr>
<td>211 - 213 Pastureland</td>
<td>2000 - Grassland not defined as range</td>
</tr>
<tr>
<td></td>
<td>2200 - Scrub Shrub not defined as range</td>
</tr>
</tbody>
</table>

6.3 Critical Points to Remember
Grazing Land On-site Data Collection information shall always be gathered at as the certified point location. Certified locations are the geographic coordinate system descriptions of NRI sample points and segments that accurately describe the location of each point and segment in prior photo-interpreted NRI data collection. The certified location is unique for each point and segment. The site map representation of the certified point locations should be considered the definitive source.

6.4 Preliminary Steps

6.4.1 Conditions for Data Collection
- Enter the land cover/use for each point.

6.4.2 Ancillary Resources
In addition to the basic data collection materials noted in chapter 2, the following materials may
be useful in collecting data for this chapter:

- Site maps
- NRCS and FSA office records
- Digital Orthophoto Quads (DOQ)
- Digital Raster Graphics (DRG)

6.5 Data Collection Procedures for Land Cover/Use

6.5.1 Definitions

**Certified locations.** The geographic coordinate system descriptions of NRI sample points and segments that accurately describe the location of each point and segment in prior NRI data collection. The certified location is unique for each point and segment. [NRI 2012]

**Land Cover/use.** A term that includes categories of land cover and categories of land use. Land cover is the vegetation or other kind of material that covers the land surface. Land use is the purpose of human activity on the land; it is usually, but not always, related to land cover. The NRI uses the term "land cover/use" to identify the categories that account for all the surface area in the United States [BS-1982, NRI-92]

**Grassland.** An area that has at least 50% aerial coverage of grasses, grass-like plants and/or forbs. When viewed from a vertical direction there must be less than 30% canopy cover of woody plants that grow to a height of less than 4 meters at maturity and less than 25% canopy cover of leaves and branches of trees that grow to a height of 4 meters or taller at maturity. The total area coverage of shrubs and trees must be less than 50%. **The minimum area for classification of grassland is 1 acre, and the area must be at least 100 feet wide.** [NRI-2005]

Grassland is further classified as either “rangeland” or “not rangeland.”

**Grassland defined as Rangeland.** A land cover/use category on which the vegetation is predominately grasses, grass-like plants, and/or forbs and defined as rangeland. Includes lands re-vegetated naturally or artificially when routine management of that vegetation is accomplished mainly through manipulation of grazing. [NRI-2005]

**Grassland not defined as Rangeland.** A land cover/use category on which the vegetation is dominated by grasses, grass-like plants, and/or forbs not defined as rangeland used primarily for the production of introduced or domesticated native forage plants for livestock grazing, erosion control, wildlife habitat, or recreation areas. Cultural practices may include periodic tillage, fertilization, mowing weed control and irrigation. This category does not include intensely managed turfgrass areas around homes and businesses. [NRI-2005]

**Scrub shrub classification criteria.** Scrub shrub: Scrub shrub areas must have at least 30% canopy cover of woody plants that grow to a height of less than 4 meters at maturity and less than 25% canopy cover of trees that grow to a height of more than 4 meters at maturity. **The minimum area for classification of scrub shrub land rangeland is 1 acre, and the area must be at least 100 feet wide.** [NRI-2005]

Scrub shrub is further classified as either “rangeland” or “not rangeland.”
Scrub shrub, defined as Rangeland. A land cover/use category with significant numbers of woody plants that grow to a height of less than 4 meters at maturity defined as rangeland. [NRI-2005]

Scrub shrub not defined as Rangeland. A land cover/use category with significant numbers of woody plants that grow to a height of less than 4 meters at maturity not defined as rangeland and used for livestock grazing, erosion control, wildlife habitat, or recreation areas. This category may include abandoned cropland. [NRI-2005]

Rangeland. A land cover/use category that includes land on which the climax or potential plant cover is composed principally of native grasses, grass-like plants, forbs or shrubs suitable for grazing and browsing, and introduced forage species that are managed like rangeland. This would include areas where introduced hardy and persistent grasses, such as crested wheatgrass, are planted and practices, such as deferred grazing, burning, chaining, and rotational grazing, are used with little or no chemicals or fertilizer being applied. Grassland, savannas, many wetlands, some deserts, and tundra are considered to be rangeland. Certain low forb and shrub communities, such as mesquite, chaparral, mountain shrub, and pinyon-juniper, are also included as rangeland. [NRI-97]

Pastureland. The land cover/use category of land managed primarily for the production of introduced forage plants for livestock grazing. Pastureland cover may consist of a single species in a pure stand, a grass mixture, or a grass-legume mixture. Management usually consists of cultural treatments: fertilization, weed control, reseeding, or renovation, and control of grazing. For the NRI, pastureland includes land that has a vegetative cover of grasses, legumes, and/or forbs, regardless of whether it is being grazed by livestock. [NRI-92]

Note: Definitions for land cover/use categories and specific land cover/use types are in an abridged glossary of "NRI Land Cover/Use Terms" in Section 6.6, Support Materials, of this chapter.

6.5.2 Procedure
1. Identify the land cover/use for the area where the sample point is located.
   - LCU determinations are made for the area in which the sample point is located. At a minimum, the area must be an acre in size and greater than 100’ wide.
   - Grazing land On-Site Data Collection LCU information will always be gathered at the certified point location.

2. Enter LCU information in the CASI for the current survey year.
   - Definitions for most LCU categories are in the abridged glossary of NRI Land Cover/Use Terms in Section 6.6 - Support Materials.

3. Enter the LCU source:
   - Field - Direct field observation - Select this choice if you were able to observe the land cover/use in the field. Included are situations where you were able to directly observe the land cover/use, even if you could not access the site. For example, a land owner/manager may not have provided access to the site, but you close enough to see the sample location, where the location was verified by comparison to the site map, and you were able to observe the land cover/use of that location.
• **Site map** - There are situations where the site map with a NAIP image background may be used to determine land cover/use of points within the sample segment. These include cases where:
  • No field visit can be made (e.g., the land owner/manager denies access)
  • Prescreening of site maps is used to determine the land cover/use definitely not eligible for data collection (e.g., a sample point is located in a waterbody)
• **Other map / image** - Use this selection to provide details about the map (other than the site map) or image was used to determine land cover/use when no site visit could be made.
<table>
<thead>
<tr>
<th>Land Cover/Use</th>
<th>Description</th>
<th>Land Cover/Use</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hort: Fruit</td>
<td>410</td>
<td>Other farmland: CRP land</td>
</tr>
<tr>
<td>2</td>
<td>Hort: Nut</td>
<td>611</td>
<td>Barren Land: Salt flats</td>
</tr>
<tr>
<td>3</td>
<td>Hort: Vineyard</td>
<td>612</td>
<td>Barren Land: Bare exposed rock</td>
</tr>
<tr>
<td>4</td>
<td>Hort: Brush fruit</td>
<td>613</td>
<td>Barren Land: Strip mines, gravel pits, borrow pits</td>
</tr>
<tr>
<td>5</td>
<td>Hort: Berries</td>
<td>614</td>
<td>Barren Land: Beaches</td>
</tr>
<tr>
<td>6</td>
<td>Hort: Other</td>
<td>615</td>
<td>Barren Land: Sand dunes</td>
</tr>
<tr>
<td>7</td>
<td>Nurseries</td>
<td>616</td>
<td>Barren Land: Mixed barren lands</td>
</tr>
<tr>
<td>11</td>
<td>Row Crop: Corn</td>
<td>617</td>
<td>Barren Land: Mud flats, salt evaporator ponds</td>
</tr>
<tr>
<td>12</td>
<td>Row Crop: Sorghum</td>
<td>618</td>
<td>Barren Land: River wash</td>
</tr>
<tr>
<td>13</td>
<td>Row Crop: Soybeans</td>
<td>619</td>
<td>Barren Land: Oil wasteland</td>
</tr>
<tr>
<td>14</td>
<td>Row Crop: Cotton</td>
<td>620</td>
<td>Barren Land: Other barren land</td>
</tr>
<tr>
<td>15</td>
<td>Row Crop: Peanuts</td>
<td>630</td>
<td>Other rural land: Permanent snow-ice</td>
</tr>
<tr>
<td>16</td>
<td>Row Crop: Tobacco</td>
<td>640</td>
<td>Other rural land: Marshland</td>
</tr>
<tr>
<td>17</td>
<td>Row Crop: Sugar beets</td>
<td>641</td>
<td>Wet herbaceous Tundra</td>
</tr>
<tr>
<td>18</td>
<td>Row Crop: Potatoes</td>
<td>650</td>
<td>All other land</td>
</tr>
<tr>
<td>19</td>
<td>Row Crop: Other veg/truck crops</td>
<td>652</td>
<td>Not vegetated construction site</td>
</tr>
<tr>
<td>20</td>
<td>Row Crop: All other row crops</td>
<td>710</td>
<td>Eligible Area</td>
</tr>
<tr>
<td>21</td>
<td>Row Crop: Sunflower</td>
<td>745</td>
<td>Residences and related structures and features</td>
</tr>
<tr>
<td>111</td>
<td>Close Grown: Wheat</td>
<td>746</td>
<td>Agricultural related structures and features</td>
</tr>
<tr>
<td>112</td>
<td>Close Grown: Oats</td>
<td>815</td>
<td>Transportation: Public roads, 4 lanes or greater</td>
</tr>
<tr>
<td>113</td>
<td>Close Grown: Rice</td>
<td>825</td>
<td>Transportation: All other public paved roads</td>
</tr>
<tr>
<td>114</td>
<td>Close Grown: Barley</td>
<td>845</td>
<td>Transportation: All other public non-paved roads</td>
</tr>
<tr>
<td>116</td>
<td>Close Grown: All other close grown</td>
<td>860</td>
<td>Transportation: Railroad</td>
</tr>
<tr>
<td>144</td>
<td>Hayland</td>
<td>870</td>
<td>Transportation: Other roads</td>
</tr>
<tr>
<td>170</td>
<td>Other Cropland: Summer fallow</td>
<td>901</td>
<td>Waterbody 2-40 acres</td>
</tr>
<tr>
<td>171</td>
<td>Other Cropland: Aquaculture</td>
<td>902</td>
<td>Waterbody less than 2 acres</td>
</tr>
<tr>
<td>180</td>
<td>Other Cropland: Other-set aside etc.</td>
<td>913</td>
<td>Perennial Stream ≥ 1/8 mile wide (660 ft)</td>
</tr>
<tr>
<td>2001</td>
<td>Grassland defined as rangeland</td>
<td>914</td>
<td>Glacial bar &amp; river complex ≥1/8 mi wide (660 ft)</td>
</tr>
<tr>
<td>2000</td>
<td>Grassland not defined as rangeland</td>
<td>915</td>
<td>Perennial stream less than 1/8 mile wide (660 ft)</td>
</tr>
<tr>
<td>2201</td>
<td>Scrub shrub defined as rangeland</td>
<td>916</td>
<td>Glacial bar &amp; river complex less than 1/8 mi wide</td>
</tr>
<tr>
<td>2200</td>
<td>Scrub shrub not defined as rangeland</td>
<td>921</td>
<td>Waterbody: ≥40 ac Lake</td>
</tr>
<tr>
<td>340</td>
<td>Forestland</td>
<td>922</td>
<td>Waterbody: ≥40 ac Reservoir</td>
</tr>
<tr>
<td>402</td>
<td>Comm. feedlots and feeding facilities</td>
<td>923</td>
<td>Waterbody: ≥40 ac Bay or gulf</td>
</tr>
<tr>
<td>404</td>
<td>Xmas trees, agro-forestry</td>
<td>924</td>
<td>Waterbody: ≥40 ac Estuary</td>
</tr>
<tr>
<td>405</td>
<td>Miscellaneous other farmland</td>
<td>937</td>
<td>Open Ocean</td>
</tr>
</tbody>
</table>
6.6 Supporting Materials

NRI Land Cover/Use Terms - Abridged Glossary Definitions

**All other land.** A cover/use category used to classify rural land that does not meet the specifications for any of the other specific cover/use categories. [NRI-92]

**Aquaculture in a crop rotation.** A land cover/use category that includes aquaculture in rotation with crop production. Includes rotations such as crayfish farming after rice production, soybeans rotated after catfish (planted in drained catfish ponds). [NRI-92]

**Barren land.** A land cover/use category used to classify lands with limited capacity to support life and having less than 5 percent vegetative cover. Vegetation, if present, is widely spaced. [NRI-87]

- Typically, the surface of barren land is sand, rock, exposed subsoil, or salt-affected soils. Subcategories include salt flats; sand dunes; mud flats; beaches; bare exposed rock; quarries, strip mines, gravel pits, and borrow pits; river wash; oil wasteland; mixed barren lands; and other barren land. [NRI-92]

**Bay.** A recess in the shore or an inlet of a sea between two capes or headlands, not so large as a gulf, but larger than a cove. [USACE-1984]

**Beach.** A barren land category. Includes the area adjacent to the shore of an ocean, sea, large river, or lake that is washed by the tide or waves. [NRI-92]

**Berries.** A land cover/use category under horticultural cropland. Includes cranberries (grown in bogs) and strawberries. [NRI-92]

**Borrow pit.** A use category under the land cover category of barren. [NRI-92]

**Bush fruit.** A use category under the land cover category horticultural cropland. [NRI-92]

**Certified locations.** The geographic coordinate system descriptions of NRI sample points and segments that accurately describe the location of each point and segment in prior NRI data collection. The certified location is unique for each point and segment. [NRI 2012]

**Close grown crops.** Crops that are generally drill-seeded or broadcast, such as wheat, oats, rice, barley, and flax. [BS-1982]

**Conservation Reserve Program Land (CRP).** A land cover/use category that includes land under a CRP contract. [NRI-97]

**Cropland.** A land cover/use category that includes areas used for the production of adapted crops for harvest. Two subcategories of cropland are recognized: cultivated and noncultivated. Cultivated land comprises land in row crops or close-grown crops and also other cultivated cropland, for example, hayland or pastureland that is in a rotation with row or close-grown crops. Noncultivated cropland includes permanent hayland and horticultural cropland. [NRI-97]

**Dams, spillways and levees.** Dams, spillways, and levees that are hard-surfaced (not earthen) are considered eligible areas. However, some earthen structures are considered eligible areas too.
Include all earthen dams associated with large waterbodies (40 acres or greater) and large streams (660 feet or greater in width) as eligible areas. Also include other dams greater than 300 feet in length as eligible areas. However, never include earthen dams as eligible areas when the waterbody is less than 40 acres. That part of an earthen levee that borders an eligible area is considered part of the eligible area. Earthen levees, not classified as eligible areas, covered by public roads are classified as transportation. All other levees that are earthen are given land cover/use of the vegetation covering the levee. [NRI-07]

**Eligible areas.** Areas that include airports; apartment buildings, row houses, and adjacent parking areas; cemeteries; dams, spillways, and levees (for further direction on earthen levees see “dams, spillways, and levees”); gas stations; golf courses; institutional sites; industrial/commercial sites; parking facilities; playground areas and parks; public administration sites; sanitary landfills; and sewage treatment plants. [NRI-05]

**Estuary.** A perennial tidally influenced body of water existing where a river meets the sea. Ocean water is at least occasionally diluted by freshwater. [NRI-97]

**Fallow.** Cropland which has been left idle, either tilled or untilled, during the whole or greater portion of the growing season. [SCSA]

**Forest land.** A land cover/use category that is at least 10 percent stocked by single-stemmed woody species of any size that will be at least 4 meters (13 feet) tall at maturity. Also included is land bearing evidence of natural regeneration of tree cover (cutover forest or abandoned farmland) and not currently developed for non-forest use. Ten percent stocked, when viewed from a vertical direction is a canopy cover of leaves and branches of 25 percent or greater. The minimum area for classification of forest land is 1 acre, and the area must be at least 100 feet wide. [NRI-92]

![Crown Density Scale](image)

Figure 15: Subdivision of a region into equal size cells for forest cover estimation. Kleinman C. 2003. Estimating metrics of forest spatial pattern from large area forest inventory cluster samples. Forest Science 46(4):546-557.

**Grassland.** An area that has at least 50% aerial coverage of grasses, grass-like plants and/or
forbs. When viewed from a vertical direction there must be less than 30% canopy cover of woody plants that grow to a height of less than 4 meters at maturity and less than 25% canopy cover of leaves and branches of trees that grow to a height of 4 meters or taller at maturity. The total area coverage of shrubs and trees must be less than 50%. The minimum area for classification of grassland is 1 acre, and the area must be at least 100 feet wide. [NRI-2005]

Grassland is further classified as either “rangeland” or “not rangeland.”

**Grassland Defined as Rangeland.** A land cover/use category on which the vegetation is predominately grasses, grass-like plants, and/or forbs and defined as rangeland. Includes lands re-vegetated naturally or artificially when routine management of that vegetation is accomplished mainly through manipulation of grazing. [NRI-2005]

**Grassland Not Defined as Rangeland.** A land cover/use category on which the vegetation is dominated by grasses, grass-like plants, and/or forbs not defined as rangeland used primarily for the production of introduced or domesticated native forage plants for livestock grazing, erosion control, wildlife habitat, or recreation areas. Cultural practices may include periodic tillage, fertilization, mowing weed control, and irrigation. This category does not include intensely managed turfgrass areas around homes and businesses. [NRI-2005]

**Gravel pit.** A barren land - land cover/use category. An area from which gravel is extracted. [NRI-92]

**Gulf.** A relatively large portion of sea, partially enclosed by land. [ASCE-Nomenclature of Hydraulics]

**Hayland.** A subcategory of cropland managed for the production of forage crops that are machine harvested. These crops may be grasses, legumes, or a combination. Hayland also includes land in set-aside or other short-term agricultural programs. [NRI-92]

**Horticultural cropland.** A subcategory of cropland used for growing fruit, nut, berry, vineyard, and other bush fruit and similar crops. Commercial flower operations including bulb and seed production, ornamental cutting, and sales are included. [NRI-92]

**Lake.** A natural inland body of water, fresh or salt, of 40 acres or larger occupying a basin or hollow on the Earth’s surface, and which may or may not have a current or single direction of flow. [NRI-97]

**Legume-grass.** A land cover/use category under hayland, and is composed of a mixture of legumes and grasses. [NRI-92]

**Marshland.** A subcategory of the land cover/use Other Rural Land described as a non-forested area of land partially or intermittently covered with water characterized by the presence of monocotyledons, such as sedges and rushes. These areas are usually in a wetland class and are not placed in another NRI land cover/use category, such as rangeland or pastureland. [NRI-92]

**Mud flat.** A land/cover use subcategory under barren land. A mud area with less than 5 percent vegetative cover. [NRI-92]

**Nurseries.** 007 Nursery production areas
Nut. A category under the land cover/use data element of cropland, horticultural crops. [NRI-92]

Oil wasteland. A category under the land cover category of barren land. [NRI-92]

Other cropland not planted. A category under the land cover category of Other land. It may include cropland in USDA set-aside or similar short-term programs. [NRI-92]

Other land in farms. A land cover/use category that includes land used for field windbreaks, commercial feedlots, greenhouses, nurseries, poultry facilities, and airplane landing strips that are not associated with farmsteads. These areas are not classified as part of cropland, pastureland, rangeland, forest land, barren land, farmsteads and ranch headquarters, or rural transportation. [NRI-92]

Other rural land. A land cover/use heading under which are the categories of permanent snow and ice fields, and marshland. [NRI-92]

Pastureland. The land cover/use category of land managed primarily for the production of introduced forage plants for livestock grazing. Pastureland cover may consist of a single species in a pure stand, a grass mixture, or a grass-legume mixture. Management usually consists of cultural treatments: fertilization, weed control, reseeding, or renovation, and control of grazing. For the NRI, pastureland includes land that has a vegetative cover of grasses, legumes, and/or forbs, regardless of whether it is being grazed by livestock. [NRI-92]

Perennial stream. A stream or reach of a stream that normally flows continuously throughout the year. [NSSH-96] A natural or artificial watercourse, which continuously contains water and normally flows. [NRI-97]

Rangeland. A land cover/use category that includes land on which the climax or potential plant cover is composed principally of native grasses, grass-like plants, forbs or shrubs suitable for grazing and browsing, and introduced forage species that are managed like rangeland. This would include areas where introduced hardy and persistent grasses, such as crested wheatgrass, are planted and practices, such as deferred grazing, burning, chaining, and rotational grazing, are used with little or no chemicals or fertilizer being applied. Grassland, savannas, many wetlands, some deserts, and tundra are considered to be rangeland. Certain low forb and shrub communities, such as mesquite, chaparral, mountain shrub, and pinyon-juniper, are also included as rangeland. [NRI-97]

Reservoir. A pond, lake, basin, or other space, created in whole or in part by the building of engineering structures, that is used for the storage, regulation, and control of water. [NRI-97]

River wash. A land cover/use subcategory under barren land. Barren alluvial area, usually course-textured, exposed along streams at low water and subject to shifting during normal high water. [NRI-2000]

Row crops. A subset of the land cover/use category Cropland (subcategory, cultivated) comprising land in row crops, such as corn, soybeans, peanuts, potatoes, sorghum, sugar beets, sunflowers, tobacco, vegetables, and cotton. [NRI-97]

Rural transportation land. A land cover/use category which consists of all highways, roads, railroads, and associated rights-of-way outside urban and built-up areas. Also includes private
roads to farm or ranch headquarters, logging roads, and other private roads (field lanes are not included). [NRI-92]

**Sand dunes.** A land/cover use subcategory under barren land. A sand area with less than 5 percent vegetative cover. An accumulation of loose sand heaped by the wind, commonly found along low-lying seashores above high-tide level, more rarely on the border of large lakes or river valleys, as well as in various desert regions, where there is abundant dry surface sand during some part of the year. (Glossary of Geology, American Geological Institute). [NRI-92]

**Scrub shrub classification criteria.** Scrub shrub: Scrub shrub areas must have at least 30% canopy cover of woody plants that grow to a height of less than 4 meters at maturity and less than 25% canopy cover of trees that grow to a height of more than 4 meters at maturity. The minimum area for classification of scrub shrub land rangeland is 1 acre, and the area must be at least 100 feet wide. [NRI-2005]

Scrub shrub is further classified as either “rangeland” or “not rangeland.”

**Scrub shrub, defined as Rangeland.** A land cover/use category with significant numbers of woody plants that grow to a height of less than 4 meters at maturity defined as rangeland. [NRI-2005]

**Scrub shrub not defined as Rangeland.** A land cover/use category with significant numbers of woody plants that grow to a height of less than 4 meters at maturity not defined as rangeland and used for livestock grazing, erosion control, wildlife habitat, or recreation areas. This category may include abandoned cropland. [NRI-2005]

**Urban and built-up areas.** A land cover/use category consisting of residential, industrial, commercial, and institutional land; construction sites; public administrative sites; railroad yards; cemeteries; airports; golf courses; sanitary landfills; sewage treatment plants; water control structures and spillways; other land used for such purposes; small parks (less than 10 acres) within urban and built-up areas; and highways, railroads, and other transportation facilities if they are surrounded by urban areas. Also included are tracts of less than 10 acres that do not meet the above definition, but are completely surrounded by urban and built-up land. Two size categories are recognized in the NRI: areas 0.25 to 10 acres, and areas of at least 10 acres. [NRI-92]

**Water areas.** A land cover/use category that comprising waterbodies and streams that are permanent open water. [NRI-97]

**Waterbody.** A type of (permanent open) water area that includes ponds, lakes, reservoirs, bays, gulfs, and estuaries. There are three size categories: less than 2 acres, 2 to 40 acres, and at least 40 acres. [NRI-1997]
Chapter 7  Landscape and Soils

7.1 Overview
This chapter covers data elements relating to:

- Date of Field Visit
- NASIS SSAID
- NASIS MUSYM
- Soil component name and soil component ID
- Vertical Slope Shape
- Horizontal Slope Shape
- Slope percent
- Slope length
- Slope aspect

7.2 What’s New

- Update of section 7.4.1 Conditions for Data Collection to reflect updates to land cover/use codes in Chapter 6.

7.3 Critical Points to Remember

On-site data collection information will be gathered at the certified point location. Certified locations are the geographic coordinate system descriptions of NRI sample points and segments that accurately describe the location of each point and segment in prior photo-interpreted NRI data collection. The certified location is unique for each point and segment. The site map representation of the certified point locations should be considered the definitive source.

It is important that the correct and actual soil map unit and soil component names and ID’s be identified at the point. If designations have changed, updated, or are different from past determinations (i.e., on site identification or soil survey reports), make an entry into the notes section of the CASI.
7.4 Preliminary Steps

7.4.1 Conditions for Data Collection

- For the non-Federal range sample, landscape and soil data are documented for non-Federal points with land cover/use of grassland (LCU = 2001 Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).
- For the non-Federal pasture sample, landscape and soil data are documented for non-Federal points with land cover/use of grassland (LCU = 2001 Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).
- For the BLM range sample landscape and soil data are documented for BLM-managed Federal points with land cover/use of grassland defined as range (LCU = 2001 Grassland defined as range) or scrub shrub defined as range (LCU = 2201 Scrub Shrub defined as range).

7.4.2 Ancillary Resources

In addition to the basic data collection materials noted in chapter 2, the following ancillary materials are required:

- The Official Copy of the latest published soil survey report or set of maps generated from digital data with appropriate attribute data referenced in Section II, Field Office Technical Guide.
- Official map unit legend in NASIS

7.5 Data Collection Procedure for Date of Field Visit

7.5.1 Definitions

None

7.5.2 Procedure

1. Enter the date the point was visited in the field. This information will be used to determine climatic conditions for the date of the field visit.

   - If the data logger system date is set correctly, the correct date will be displayed in the calendar pull-down window.
   - If the data logger system date is not set correctly, adjust the date to reflect the current date using the calendar adjustments.
   - To adjust the system date on the data logger, go to Start/Settings/System/Clock

7.6 Data Collection Procedures for Soil Component Name and Soil Component ID #

7.6.1 Definitions

Certified locations. The geographic coordinate system descriptions of NRI sample points and segments that accurately describe the location of each point and segment in prior NRI data
The certified location is unique for each point and segment. [NRI-2012]

**Soil survey.** The systematic examination, description, classification, and mapping of soils in an area. The USDA-NRCS Soil Survey Program produces Soil Survey Reports, which generally consist of four principal parts: (1) maps, (2) a map legend, (3) a description of soils in the survey area, and (4) a use and management report. The survey area commonly is a single county but may comprise parts of counties, physiographic regions, or other management areas. [NRI-97]

**National Soil Information System (NASIS).** The National Soil Information System integrates soil survey information, operations, and management. It divides soil survey data into four major categories: 1) map unit records, 2) geographic area records, 3) point characteristics, and 4) standards, criteria, and guidelines. The system also includes ancillary tools, functions, and records to assure the security, integrity, and utility of the soil survey data. [NSSH]

**Soil Survey Area ID (SSAID).** A concatenation of State alpha FIPS code and the Soil Survey Area ID (SSAID) number. Example: CO017 [NASIS]

**Map unit symbol (MUSYM).** The symbol used to uniquely identify the soil map unit in the soil survey. [NASIS].

**Soil map unit.** A collection of soil areas or miscellaneous areas delineated in a soil survey (combined individual delineations that are identified by a unique symbol in a survey area represent one soil map unit). [NSSH]

**Soil component name.** Separate individual soils with individual properties grouped together for simplicity’s sake when characterizing the map unit. [NSSH]

**Soil component ID #.** A unique identification number that links a soil component to its NASIS interpretation data. [NRI-03-Range]

### 7.6.2 Procedure

The CASI will display the SSAID (soil survey area symbol) and map unit symbol (MUSYM) as non-editable fields. These symbols will come from the SSURGO GIS link where available, not from the historic NRI entries. Most SSAIDs are established even if the MUSYM is not. If one or both of these are missing, the field(s) will be shown as blank in the CASI.

Any soils component ID and name recorded during an earlier NRI grazing land on-site survey will be displayed in the CASI Historical Soil Component Name and ID field for verification purposes.

Determine/verify the soil component near the point where the two transects intersect (75-ft **mrk**).

1. For each sample point, dig a small hole (1-2 shovel widths in diameter) to a depth of at least 20 inches unless the soil is shallow (then dig to soil depth). Cut a clean face on one side, being careful to avoid disturbing the soil surface at the top of this one side of the pit. Do not step even a single time on that preserved side of the pit. If disturbed, simply shave off the face of the profile back to the point of no disturbance.
2. Position a tape measure along the profile depth, with the zero-mark of the tape at the top of the profile (i.e., the soil surface). Take a vertical photograph of the profile face (Figure 7-1). Hold the camera as low as possible in order to capture all of one side of the pit, in focus from surface to bottom. Ideally, the entire face is completely in the sun or shade, and the entire face is captured in one photo. If necessary, take two photos, one with and without flash. If you are unable to get a clear picture of the soil pit or if you take a soil core, lay the soil horizons out in order and take a photo. (See Chapter 3 for additional required on-site photos.)

3. Conduct soil evaluation (hand soil texture, and other soil and topographic (e.g. slope) properties).

4. Select the soil component name and ID. The CASI will provide a drop-down choice list.
   - The choice list is based on soil components associated with the SSAID and MUSYM.
   - If the soil component identified at the site is not in the CASI choice list, select “Other”.

5. For all sample points, record for each mineral soil horizon to at least 20 inches:
   - Depth in inches from the soil surface
   - Texture, as determined by hand (Figures 7-3 and 7-4, Table 7-1)
   - Soil texture modifier or the estimated % rock fragment content by volume (Table 7-2)
   - Effervescence class using 1N or 1M HCl (Table 7-3)
   - Any unusual features, such as redoximorphic features (mottles), CaCO₃ (caliche) nodules, concretions, etc.

6. Based on the data collection team knowledge of the local soils, select a confidence rating for the soil component determination from the provided choice list.
Figure 7-3. Guide\textsuperscript{1} to determining soil texture by feel.

\textsuperscript{1}Modified from S.J. Thien. 1979. A flow diagram for teaching texture by feel analysis. Journal of Agronomic Education. 8:54-55.
Figure 7-4. Texture triangle showing the proportion of sand, silt, and clay.

Table 7-1. Soil Texture Codes based on texture class (record the Code in the CASI).

<table>
<thead>
<tr>
<th>Texture Class or Subclass</th>
<th>Code</th>
<th>Texture Class or Subclass</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse sand</td>
<td>cos</td>
<td>Very Fine Sandy Loam</td>
<td>vfs</td>
</tr>
<tr>
<td>Sand</td>
<td>s</td>
<td>Loam</td>
<td>l</td>
</tr>
<tr>
<td>Fine Sand</td>
<td>fs</td>
<td>Silt Loam</td>
<td>sil</td>
</tr>
<tr>
<td>Very Fine Sand</td>
<td>vfs</td>
<td>Silt</td>
<td>sil</td>
</tr>
<tr>
<td>Loamy Coarse Sand</td>
<td>lcos</td>
<td>Sandy Clay Loam</td>
<td>scl</td>
</tr>
<tr>
<td>Loamy Sand</td>
<td>ls</td>
<td>Clay Loam</td>
<td>cl</td>
</tr>
<tr>
<td>Loamy Fine Sand</td>
<td>lfs</td>
<td>Silty Clay Loam</td>
<td>scl</td>
</tr>
<tr>
<td>Loamy Very Fine Sand</td>
<td>lvfs</td>
<td>Sandy Clay</td>
<td>sc</td>
</tr>
<tr>
<td>Coarse Sandy Loam</td>
<td>cosl</td>
<td>Silty Clay</td>
<td>sic</td>
</tr>
<tr>
<td>Sandy Loam</td>
<td>sl</td>
<td>Clay</td>
<td>c</td>
</tr>
<tr>
<td>Fine Sandy Loam</td>
<td>fsl</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 7-2. Texture Modifier Codes (record the Code, not the rock fragment name, in the CASI).

<table>
<thead>
<tr>
<th>ROCK FRAGMENTS: Size &amp; Quantity</th>
<th>Code</th>
<th>Criteria: Percent (By Volume) of Total Rock Fragments and Dominated By</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ROCK FRAGMENTS (&gt; 2 mm; ≥ Strongly Cemented)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gravelly</td>
<td>GR</td>
<td>≥ 15% but &lt; 35% gravel</td>
</tr>
<tr>
<td>Fine Gravelly</td>
<td>GRF</td>
<td>≥15% but &lt; 35% fine gravel</td>
</tr>
<tr>
<td>Medium Gravelly</td>
<td>GRM</td>
<td>≥15% but &lt; 35% med. gravel</td>
</tr>
<tr>
<td>Coarse Gravelly</td>
<td>GRC</td>
<td>≥ 15% but &lt; 35% coarse gravel</td>
</tr>
<tr>
<td>Very Gravelly</td>
<td>GRV</td>
<td>≥ 35% but &lt; 60% gravel</td>
</tr>
<tr>
<td>Extremely Gravelly</td>
<td>GRX</td>
<td>≥ 60% but &lt; 90% gravel</td>
</tr>
<tr>
<td>Cobbly</td>
<td>CB</td>
<td>≥ 15% but &lt; 35% cobbles</td>
</tr>
<tr>
<td>Very Cobbly</td>
<td>CBV</td>
<td>≥ 35% but &lt; 60% cobbles</td>
</tr>
<tr>
<td>Extremely Cobbly</td>
<td>CBX</td>
<td>≥ 60% but &lt; 90% cobbles</td>
</tr>
<tr>
<td>Stony</td>
<td>ST</td>
<td>≥ 15% but &lt; 35% stones</td>
</tr>
<tr>
<td>Very Stony</td>
<td>STV</td>
<td>≥ 35% but &lt; 60% stones</td>
</tr>
<tr>
<td>Extremely Stony</td>
<td>STX</td>
<td>≥ 60% but &lt; 90% stones</td>
</tr>
<tr>
<td>Bouldery</td>
<td>BY</td>
<td>≥ 15% but &lt; 35% boulders</td>
</tr>
<tr>
<td>Very Bouldery</td>
<td>BYV</td>
<td>≥ 35% but &lt; 60% boulders</td>
</tr>
<tr>
<td>Extremely Bouldery</td>
<td>BYX</td>
<td>≥ 60% but &lt; 90% boulders</td>
</tr>
<tr>
<td>Channery</td>
<td>CN</td>
<td>≥ 15% but &lt; 35% channers</td>
</tr>
<tr>
<td>Very Channery</td>
<td>CNV</td>
<td>≥ 35% but &lt; 60% channers</td>
</tr>
<tr>
<td>Extremely Channery</td>
<td>CNX</td>
<td>≥ 60% but &lt; 90% channers</td>
</tr>
<tr>
<td>Flaggy</td>
<td>FL</td>
<td>≥ 15% but &lt; 35% flagstones</td>
</tr>
<tr>
<td>Very Flaggy</td>
<td>FLV</td>
<td>≥ 35% but &lt; 60% flagstones</td>
</tr>
<tr>
<td>Extremely Flaggy</td>
<td>FLX</td>
<td>≥ 60% but &lt; 90% flagstones</td>
</tr>
<tr>
<td><strong>PARAROCK FRAGMENTS (&gt; 2 mm; &lt; Strongly Cemented)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parabouldery</td>
<td>PBY</td>
<td>(same criteria as bouldery)</td>
</tr>
<tr>
<td>Very Parabouldery</td>
<td>PBYV</td>
<td>(same criteria as very bouldery)</td>
</tr>
<tr>
<td>Extr. Parabouldery</td>
<td>PBYX</td>
<td>(same criteria as ext. bouldery)</td>
</tr>
<tr>
<td>etc.</td>
<td>etc.</td>
<td>(same criteria as non-para)</td>
</tr>
</tbody>
</table>

1 The “Quantity” modifier (e.g., very) is based on the total rock fragment content. The “Size” modifier (e.g., cobbly) is independently based on the largest, dominant fragment size. For a mixture of sizes (e.g., gravel and stones), a smaller size-class is named only if its quantity (%) sufficiently exceeds that of a larger size-class. For field texture determination, a smaller size-class must exceed 2 times the quantity (vol. %) of a larger size class before it is named (e.g., 30% gravel and 14% stones = very gravelly, but 20% gravel and 14% stones = stony). For more explicit naming criteria see NSSH-Part 618, Exhibit 618.11(Soil Survey Staff, 2001b).
2 Use “Para” prefix if the rock fragments are soft (i.e., meet criteria for “para”). [Rupture Resistance - Cementation Class is < Strongly Cemented, and do not slake (slake test: ≈3cm (1 inch) diam. block, air dried, then submerged in water for ≥ 1 hour; collapse / disaggregation = “slaking”).]
3 For “Para” codes, add “P” to “Size” and “Quantity” code terms. Precedes noun codes and follows quantity adjectives, e.g., paragravelly = PGR; very paragravelly = VPGR.
**Table 7-3.** Effervescence classes\(^1\) used to describe the entire soil matrix using 1 M HCl.

*Add 1 to 2 drops of 1 M HCl to soil, observe the initial reaction, and wait about 2 minutes before assessing the final extent of effervescence and assigning the appropriate effervescence class.*

<table>
<thead>
<tr>
<th>Code</th>
<th>Effervescence Class</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE</td>
<td>Noneffervescent</td>
<td>No bubbles detected</td>
</tr>
<tr>
<td>VS</td>
<td>Very slightly effervescent</td>
<td>Few bubbles seen</td>
</tr>
<tr>
<td>SL</td>
<td>Slightly effervescent</td>
<td>Bubbles readily seen</td>
</tr>
<tr>
<td>ST</td>
<td>Strongly effervescent</td>
<td>Bubbles form low foam</td>
</tr>
<tr>
<td>VE</td>
<td>Violently effervescent</td>
<td>Thick foam forms quickly</td>
</tr>
</tbody>
</table>

\(^1\)Soil Survey Technical Note 5, Assessing Carbonates in the Field with a Dilute Hydrochloric Acid (HCl) Solution ([https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_053572](https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_053572)).

Note: This technical reference also describes the process for preparing 1 M HCl.

### 7.7 Data Collection Procedures for Vertical Slope Shape

#### 7.7.1 Definitions

**Vertical slope shape.** Shape of the slope perpendicular to the contour. [FBD&SS]

#### 7.7.2 Procedure

1. Determine vertical slope shape of a line that runs through the point. Categories are:
   - concave
   - convex
   - linear

2. Enter vertical slope shape in the CASI for the current survey year.

### 7.8 Data Collection Procedures for Horizontal Slope Shape

#### 7.8.1 Definitions

**Horizontal slope shape.** Shape of the slope along the horizontal contour. [FBD&SS]

#### 7.8.2 Procedure

1. Determine horizontal slope shape of a line that runs through the point. Categories are:
   - concave
   - convex
   - linear

2. Enter horizontal slope shape in the CASI for the current survey year.
7.9 Data Collection Procedures for Slope Percent

7.9.1 Definitions

Slope gradient. The angle of the ground surface (in percent) through the site and in the direction that overland water would flow. [FBD&SS]

7.9.2 Procedure

1. Determine the slope percent in the direction that overland water would flow through the sample point. The gradient measurement is observed within the slope shape that flows through the point and includes all intensities of slope within that shape.
   - Slope is recorded to the nearest whole number for slopes of 1 percent or greater.
   - Slopes less than 1 percent are recorded to the nearest 0.1 percent.
   - A zero is not recorded unless the slope is laser leveled to less than 0.05 percent.

2. Enter Slope percent in the CASI from the provided choice list.

7.10 Data Collection Procedures for Slope Length

Soil loss and erosion generally increases as slope length increases. As the slope length increases, there is more accumulation of surface runoff, which results in increased soil detachment and transport.

Slope length should be determined in the field by measuring the distance in feet. Slope length can be somewhat subjective and difficult to determine where vegetation obscures the view, and where topography may be uneven with numerous hummocks or mounds. Surface runoff will generally concentrate in distances less than 500 ft, although greater slope lengths are possible, but less common. Topographic maps should not be used to determine slope length because most maps do not have enough detail and the distance will not be accurate.

7.10.1 Definitions

Slope Length. The distance from the point of origin of overland flow to the point where either the slope gradient decreases enough that soil deposition begins or the runoff water enters a well-defined channel that may be part of a drainage network or constructed channel. For NRI, length of the slope is taken through the sample point.

7.10.2 Procedure

1. Determine the slope length.
   - Slope length is measured in feet through the sample point (the 75 ft center mark of the macro plot).
   - The starting and ending points for measuring slope length may be in an adjoining field or outside the PSU boundary.

2. Enter the slope length to the nearest foot.
Length of Slope Determination Example

Macroplot = 150 ft length.

<table>
<thead>
<tr>
<th>Transect</th>
<th>Slope Length (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>370</td>
</tr>
<tr>
<td>2</td>
<td>204</td>
</tr>
<tr>
<td>3</td>
<td>231</td>
</tr>
<tr>
<td>4</td>
<td>289</td>
</tr>
</tbody>
</table>

Note: The macroplot circles are placed in the diagram for example purposes. The close proximity of the macroplots in this example would not occur in reality.

7.11 Data Collection Procedures for Slope Aspect

7.11.1 Definitions
Slope aspect. The direction toward which a slope faces with respect to the compass.

7.11.2 Procedure
1. Determine the slope aspect as a direction toward which the predominant slope
2. Enter Slope aspect (cardinal direction) from the CASI choice list shown below:
   - N
   - NE
   - E
   - SE
   - S
   - SW
- W
- NW
- NA - Not applicable - flat

**7.12 Supporting Materials**

None Identified
Chapter 8  Ecological Site/Forage Suitability Transect Information and Use

8.1 Overview

This chapter covers data elements relating to:

- Historic Major Land Resource Area (MLRA)
- 1992 Ecological Site (displayed if rangeland historically)
- Ecological Site (ES) or Forage Suitability Group (FSG) Identification
- Apparent Rangeland Trend (rangeland only)
- Use Questions
  - Grazing
  - Haying

8.2 What’s New

- Update of section 8.4.1 Conditions for Data Collection to reflect updates to land cover/use codes in Chapter 6.

8.3 Critical Points to Remember

- This protocol shall be used to characterize ecological sites for rangeland and forage suitability groups for pastureland. The naming convention and other background information on ESD/FSG’s are discussed in detail in the NRCS National Range and Pasture Handbook.
- The apparent rangeland trend question applies only to rangeland points; it will be grayed out if the point is not classified as rangeland.
- Rangeland and pastureland on-site data must always be gathered at the certified point locations as depicted on the site maps.
- Ecological site/forage suitability group information is determined for the sample area where the sample point falls, regardless of the presence of other ecological sites/Forage Suitability groups in the plot area.
- If the area represented by the point has value for documenting an ecological site or forage suitability group the **Use plot for ESD/FSG option** should be used for data collection.
- For rangeland, if more than one ecological site is identified along a transect, use the ecological site at the point for rangeland health and similarity index calculations.
- For pastureland, if more than one forage suitability group is identified along a transect, use the forage suitability group at the point for pasture condition score ratings.

8.4 Preliminary Steps

8.4.1 Conditions for Data Collection

- For the non-Federal range sample, ecological site or forage suitability data are documented for non-Federal points with land cover/use of grassland (LCU = 2001
Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).

- For the non-Federal pasture sample, ecological site or forage suitability data are documented for non-Federal points with land cover/use of grassland (LCU = 2001 Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).
- For the BLM range sample, ecological site or forage suitability data are documented for BLM-managed Federal points with land cover/use of grassland defined as range (LCU = 2001 Grassland defined as range) or scrub shrub defined as range (LCU = 2201 Scrub Shrub defined as range).

8.4.2 Ancillary Resources

In addition to the basic data collection materials noted in chapter 2, the following materials may be useful in collecting data for this chapter:

- National Range and Pasture Handbook
- Respective State List of Ecological Sites/forage suitability groups and Numbers

8.5 Data Collection Procedures for 1992 Ecological Site and Historical Major Land Resource Area (MLRA)

8.5.1 Definitions

**Ecological site.** A kind of land with specific physical characteristics which differs from other kinds of land in its ability to produce distinctive kinds and amounts of vegetation in response to management. [SRM]

**Forage suitability group.** Soils with similar species adaptation, production potential, and management needs. A planning tool for species selection, practice selection, management options, forage production levels, and recommended initial stocking rates.

8.5.2 Procedure

The 1992 ecological site name and MLRA will appear as the segment/point is loaded and will appear at top of the screen. These values are provided for information purposes and are not editable.

Note: The historical information may not agree with the current inventory determination for MLRA and ecological site number identified in Section 8.6 below.

8.6 Data Collection Procedures for Ecological Site/Forage Suitability Group Coverage, Number and Name

8.6.1 Definitions

**Ecological site/forage suitability group number.** A 10-character number identifying the ecological site/forage suitability group. [NRI-03-Range]

**Ecological site/forage suitability group coverage.** The distance in feet along each transect that can be identified as a distinct ecological site/forage suitability group. If necessary, the two
transects can be subdivided into a total of 6 unique zones and labeled accordingly.

**Major Land Resource Areas (MLRA).** Geographically associated land resource units. Land resource units are geographic areas, usually several thousand acres in extent, and are characterized by a particular pattern of soils, climate, water resource, and land uses. [NSSH]

### 8.6.2 Procedure

1. Enter transect ID and coverage of ESD/FSGs along each transect for the plot.
   - If the same ESD/FSG exists for all portions of both transects enter ‘all’ for coverage. No additional coverage data are required.
   - If more than one ESD/FSG is evident along either transect, enter the transect ID (NE/SW or NW/SE) and the coverage in feet covered by each specific ESD/FSG. A total of 6 different segments can be identified (3 on screen I and 3 on screen II). Use the screen II button to create additional columns as needed to characterize the plot.
   - **Note:** When more than one ESD/FSG is identified on either transect, the coverage in feet for each ecological site must be entered for each transect (NE/SW and NW/SE). Refer to Figure 8-1.

2. Ineligible cover types may intersect the transect lines. If this occurs, use the coverage feature to disqualify portions of the transect from certain data collection protocols. The ‘state’ drop down menu includes the following additional categories:
   - Water (XW)
   - Road (XR)
   - Inaccessible (physical barrier to data collection exist) (XI)
   - Not Eligible -wrong cover (XN)

3. In some cases, an appropriate ESD/FSG may not have been developed or documented. If this occurs, select ‘No Eco Site/FSG established (XE) from the State coverage menu.

4. Enter the ES/FSGs number in the CASI for each identified transect extent.
   - Select the appropriate State, MLRA, and LRU.
   - Enter ecological site number. Site number is:
     - 2 digit state code; e.g., NM
     - MLRA - 3 digits plus letter code; e.g., 0488
     - Land resource unit letter plus 3 digits; e.g., Y001
   - If the site ID is not on the choice list, enter a new code and name by selecting ‘enter new code’ from the pull down menu.

5. The Ecological site name appears as the ecological site number is selected.

**Special note for Forage Suitability Group ID and name:** No FSG site IDs or names are

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January 2019 Grazing Land On-Site Data Collection Handbook of Instructions
included in the CASI as part of a choice list. These will be added as they become available.

8.7 Use of Data Question, NRI or Ecological Site Description (ESD)/Forage Suitability Group (FSG))

8.7.1 Definitions
None

8.7.2 Procedure
1. Determine if the plot is suitable for use in developing or further documenting state ecological site descriptions/Forage Suitability Groups.

Note: State Rangeland Management/Grassland specialists should provide general guidelines on answering this question.

- Enter a ‘Y, Yes’ to use the plot for documenting ESD/FSG descriptions and NRI.
- Enter a “N, No” to use the plot for only NRI.

This question controls the number of sub plots for the following protocols:

- Soil Stability
- Line Intercept Transects for Basal and Canopy Cover
- Plant Height
- Species Composition By Weight

8.8 Data Collection Procedures for Apparent Rangeland Trend

8.8.1 Definitions

Rangeland trend. The direction of change in an existing plant community relative to the historic climax plant community for the ecological site. [National Range and Pasture Handbook Glossary, September 1997]

Apparent rangeland trend. A point in time determination of the direction of change in an existing plant community relative to the historic climax plant community. [NRPH]

8.8.2 Procedure
1. Apparent Rangeland Trend is only applicable on rangelands that have ecological site descriptions identifying the historic climax plant community.
2. Determine the apparent rangeland trend of the area surrounding the sample point.
3. Enter information in the CASI for the current survey year. Categories are:
   - Toward - Toward Historic Climax Plant Community (HCPC)
   - Notapp - Trend not apparent
   - Away - Away from HCPC
   - NA - Annual rangeland/no ESD

8.9 Data Collection Procedures for Presence or Absence of
grazing/haying activity

8.9.1 Definitions

Macroplot. A circular area 150 feet in diameter centered around the NRI sample point. The plot includes two transects 150 feet in length that intersect at the NRI sample point. Transect bearings are set on a diagonal from northeast (NE) to southwest (SW) and northwest (NW) to southeast (SE). A labeled plot diagram is shown in Figure 10-1.

Conservation management unit (CMU): For purposes of this protocol, the CMU shall be considered equivalent to the field (fenced or delineated by other means) where the NRI point resides. If no field boundary exists, use a distance of 1,000 ft as a boundary. Do not cross public roads, railroads, or obvious ownership boundaries within the 1,000 ft distance.

8.9.2 Procedure

1. For each of the listed use characteristics, rate for degree of presence or absence at conservation management unit level
   - Use characteristics and rating descriptions are included in Table 8-1.
   - Codes and short rating statements are listed in the CASI choice list for each rated characteristic

2. Enter the appropriate response in the CASI for the CMU.

8.10 Supporting Materials

None identified.
Table 8-1. Site characteristic rating factors for grazing use.

<table>
<thead>
<tr>
<th>Code</th>
<th>Category Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Currently Grazed Light (&lt;30% harvest)</td>
<td>Some evidence of light grazing by domestic livestock. The field is fenced, vegetation and existing stocking rate are light. Areas of uneaten forage is common. Grazing and utilization of plants may be patchy. Height of all principle forage plants exceed minimum grazing heights.</td>
</tr>
<tr>
<td>2</td>
<td>Currently Grazed Moderate (30-50% harvest)</td>
<td>Minimum grazing stubble heights are being observed by the grazing manager and livestock moved to another pasture, or grazing is allowed to occur at will but there remain areas of grass that is only partially eaten or avoided altogether intermixed with areas grazed frequently and at low stubble heights. Areas of uneaten or little used tall grass cover less than 50 percent of the pasture area.</td>
</tr>
<tr>
<td>3</td>
<td>Currently Grazed Heavy (greater than 50% harvest)</td>
<td>Grazing of all but the most unpalatable species has occurred to lowest stubble height possible for the livestock type. Some rejection of urine or dung patch areas. May be some rejection of heavily manured areas around water troughs, shade trees, or hay feeding areas.</td>
</tr>
<tr>
<td>4</td>
<td>No evidence of current growing season grazing -Conservation program limitation</td>
<td>Conservation program does not allow grazing by domestic livestock.</td>
</tr>
<tr>
<td>5</td>
<td>No evidence of current growing season grazing -No/poor fence</td>
<td>There is no fence or the condition of the fence will not contain domestic livestock.</td>
</tr>
<tr>
<td>6</td>
<td>No evidence of current growing season grazing -Urban/odd area</td>
<td>The area is either urban/built-up or not an odd area that is not suitable for grazing domestic livestock.</td>
</tr>
<tr>
<td>7</td>
<td>No evidence of current growing season grazing -Physical/environmental constraints</td>
<td>Physical or environmental constraints prevent grazing by domestic livestock.</td>
</tr>
<tr>
<td>8</td>
<td>No evidence of current growing season grazing -Pollution effects</td>
<td>Pollution effects prevent this area from being grazed by domestic livestock.</td>
</tr>
<tr>
<td>9</td>
<td>No evidence of current growing season grazing -Could be grazed</td>
<td>The area is suitable for grazing, but has not been grazed in the past year.</td>
</tr>
</tbody>
</table>

**HAYED**

<table>
<thead>
<tr>
<th>Code</th>
<th>Category Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>No</td>
<td>There is no evidence of haying during the last year</td>
</tr>
<tr>
<td>Y</td>
<td>Yes</td>
<td>Yes, hay has been harvested during the last year</td>
</tr>
</tbody>
</table>
Chapter 9  

Line Point Intercept Transect for Foliar Cover Composition

9.1 Overview

This chapter covers data elements relating to:

- Foliar canopy and basal cover

9.2 What’s New

- Update of section 9.4.1 Conditions for Data Collection to reflect updates to land cover/use codes in Chapter 6.

9.3 Critical Points to Remember

- This protocol measures plant foliar canopy cover using the point intercept method. The pin will be vertically placed perpendicular to the transect tape at 3-foot intervals.
- Use a wire surveying flag to determine the point location for vegetation of low stature.
- Use a surveying pole or other suitable rod for taller vegetation, such as shrubs and trees.
- This protocol allows entry of up to six canopy and one basal cover layers. At least one entry must be made for each of these two data categories at each designated Mrk (3-ft intervals) along the transect. An optional bedrock/water (BR/W) layer is used to distinguish non-soil conditions.
- This protocol requires entering data onto a very small screen row. Some practice with the stylus is recommended.

9.4 Preliminary Steps

9.4.1 Condition for Data Collection

- For the non-Federal range sample, line point intercept data are documented for non-Federal points with land cover/use of grassland (LCU = 2001 Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU =2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).
- For the non-Federal pasture sample, line point intercept data are documented for non-Federal points with land cover/use of grassland (LCU = 2001 Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).
- For the BLM range sample, line point intercept data are documented for BLM-managed Federal points with land cover/use of grassland defined as range (LCU = 2001 Grassland defined as range) or scrub shrub defined as range (LCU = 2201 Scrub Shrub defined as range).

9.4.2 Ancillary Resources

In addition to the basic data collection materials noted in chapter 2, the following ancillary
resources are required:

- Forage Suitability Groups/Ecological Site Descriptions
- Plant identification references (floras) for your state or region.

9.5 Data Collection Procedure for Line Point Transect measurement of Canopy and Basal Cover

9.5.1 Definitions

**Transect.** A cross-section of an area used as a sample for recording, mapping or studying vegetation and its use; may be a series of plots, a belt or strip, or merely a line. In the rangeland field data collection, two 150 foot transect lines intersect at the NRI sample point. Measurements are taken at pre-determined **marks** along the transect line. The transect arms are oriented 45 degrees in both directions from magnetic north. Transect distances are recorded from the NE to SW and NW to SE from a tape stretched along the ground. [NRI-03-Range]

- Line point transects are useful for measuring plant foliar canopy and basal cover. Data from point transects can be used to calculate plant species composition and determine changes in total vegetation cover (aerial and basal).

**Basal cover.** The cross sectional area of the stem or stems (see figure 1) of a plant or of all plants in a stand. Herbaceous and woody plants are measured at the ground level. [NRI-03-Range]

**Canopy (NRI):** Living or dead plant material (herbaceous or woody) attached to a rooted plant.

**Plant Litter (NRI):** Plant material (herbaceous or woody) that is not attached to a rooted plant.

**Herbaceous Litter (NRI):** Herbaceous litter is defined as detached stems, roots, leaves, hay bales, and dung.

**Woody Litter (NRI):** Woody litter is defined as detached woody or succulent litter that is greater than ¼ inch in diameter.

**Non-Vegetative Litter (NRI):** Non-vegetative litter is litter that is not plant-based litter (e.g., plastic, metal, decomposing animal matter).

**Canopy cover (NRI).** The percentage of ground covered by a vertical projection of the foliar canopy. [NRI-03-Range]

9.5.2 Procedure

Use the following criteria for identifying plant species:

- **Option I.** Identify plant genus and species. If the genus and species of the plant cannot be determined, it is recommended that the plant be collected and identified later or by another plant specialist.

- **Option II.** Identify genus—only if efforts to determine the species cannot be made
because of lack of maturity, damage to the plant, or immature phenological stage. If you can, try to reconstruct the identity of the species by every available means.

- **Option III.** If Genus/Species or Genus cannot be determined, open the Point Intercept screen or the Names screen. Touch the Unknown button near the top. Select Create N… button. Pick an accurate functional group and enter a description. The list of unknown plants automatically refreshes for each new point.

1. Start at the zero (0.0) end of the NE-SW transect (transect 1). The CASI will default to this transect at **Mrk 0**.
   - The line should be straight, taut and placed as close to the ground as possible. Slide tape under plant branches to avoid disturbing the structure. For additional information on the plot and transect, refer to Chapter 3, Section 3.6, Procedure for Establishing/Documenting the Sample Plot and Transects.
   - Always stand on the south side of the transects to avoid disturbing the measurement area.

2. The wire pin flag is the standard tool for training, calibration, and performing the line point intercept protocol. Determine the plant species (canopy cover) intercepted by a vertical line at **Mrk 0.0** (thereafter every 3.0 ft; 0.0, 3.0, 6.0, ..., 150.0) up to 6 canopy species may be identified for each **Mrk** to accommodate multiple layers of vegetation.
   - Use a survey rod or other suitable device to determine all over-the-head canopy cover transect interception. For most herbaceous vegetation, a survey flag works to determine plant species intercepts. Two people are required to accurately and safely use laser devises.
   - The survey flag or rod should always be placed 90 degrees vertical when determining canopy intercepts.
   - Do not record multiple canopy hits of the same species. Record only the uppermost hit in the CASI. (A species code can be recorded twice for a point only if it occurs as both a canopy and basal intercept.)

3. Record in column 1 the plant species code of living or dead rooted canopy intercepted by the pin. If no leaf or stem canopy is intercepted, record **None** and Basal **None**. **Refer to table 9-1 for more information on data entry choices by column in the CASI.**
   - The plant selection window (lower part of the screen) accesses the CASI plant database and enters the accepted plant symbol for the selected species. For additional information on use of this database, refer to Appendix A, Section A.4, Using the Plant Database.
   - Canopy layers 2-6 can also be litter (herbaceous, woody, artificial or organic (dung). Herbaceous litter or woody litter are nonrooted plants or detached plant parts.

4. Record the basal cover intercept in the **Basal** column. Basal hits may include:
   - Plant symbol = any plant species (living or dead)
   - LC = lichen crust on the soil (lichen crust on rock is recorded as RF)
   - M = moss
   - RF = rock fragments (must be greater than ¼ inch in diameter, if smaller classify as soil).
   - None = soil that is visibly unprotected by any of the above

5. The **BR/W** column (rightmost column in the CASI data entry screen) is an optional column used to distinguish the basal hit from soil. Use this column to further characterize a condition
at the Mrk as:
- BR = bedrock
- W = water

6. Repeat the procedure for each of the 50 Mrks along transect 1 (NE-SW) and for the 50 Mrks along transect 2 (NW-SE)

### Table 9-1
A list of columns that can be populated as part of this protocol along with a list of legal choices presented for each column.

<table>
<thead>
<tr>
<th>CASI column ID</th>
<th>Legal choices</th>
<th>Source/choice</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>None (no canopy)</td>
<td>-</td>
<td>Indicates no canopy</td>
</tr>
<tr>
<td></td>
<td>Plant symbol</td>
<td>From plant data base</td>
<td>Plant canopy</td>
</tr>
<tr>
<td></td>
<td>Unknown plant</td>
<td>Assign code by user</td>
<td></td>
</tr>
<tr>
<td>2-6*</td>
<td>Plant Symbol</td>
<td>From plant data base</td>
<td>Plant canopy</td>
</tr>
<tr>
<td></td>
<td>Unknown Plant</td>
<td>Assign code by user</td>
<td></td>
</tr>
<tr>
<td>Litter</td>
<td>HL - Herbaceous litter</td>
<td></td>
<td>Litter cannot be entered above the first plant canopy, this will produce an error in the CASI.</td>
</tr>
<tr>
<td></td>
<td>WL - Woody litter</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NL - Non-vegetative litter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basal</td>
<td>None</td>
<td>-</td>
<td>Indicates bare soil</td>
</tr>
<tr>
<td></td>
<td>Plant Symbol</td>
<td>From plant data base</td>
<td>Indicates pin hits a plant base</td>
</tr>
<tr>
<td></td>
<td>Unknown Plant</td>
<td>Assign code by user</td>
<td></td>
</tr>
<tr>
<td>Lichen/Moss/Rock</td>
<td>LC - Lichen crust</td>
<td></td>
<td>Record if over soil, but not if on bedrock</td>
</tr>
<tr>
<td></td>
<td>M - Moss</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RF - Rock Fragment &gt; ¼ inch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BR/W*</td>
<td>BR - Bedrock</td>
<td>-</td>
<td>Lithomorphic</td>
</tr>
<tr>
<td></td>
<td>W - Water</td>
<td>-</td>
<td>Permanent water</td>
</tr>
</tbody>
</table>
9.6 Supporting Materials

9.6.1 Example 1

At transect distance 0.0 (Mk 0), field blackberry (*Rubus arvensis*; RUAR5) was intercepted by the vertical pin twice (see fig.9-3). Multiple canopy hits of field blackberry are considered as one canopy hit. Kentucky bluegrass (*Poa pratensis*; POPR) was identified as both canopy and basal hits. Because canopy has no minimum height, record a canopy hit above any plant basal hit even when no apparent pin contact is made with a leaf or stem.

**Figure 9-2.** Data entry screen example for the line point intercept protocol. Explanation for primary screen button and menus are included and highlighted in red dashed lines.

**Figure 9-3.** Simulated view of canopy at Mk 0
9.6.2 Example 2

At transect distance 0 feet (Mk 0), Field blackberry is entered in column 1. Kentucky bluegrass is entered in both canopy (column 2) and the basal column (Example 1, fig.9-3).

At transect distance 3 feet (Mk 3), Field blackberry (Rubus arvensis; RUAR5) was intercepted twice by the vertical pin, annual ragweed (Ambrosia artemisiifolia;L) was intercepted twice, and lichen crust on the soil surface was intercepted at the soil surface. The lichen crust is in contact with mineral soil, not rock or exposed consolidated bedrock (fig. 9-4).

At transect distance 6 feet (Mk 6), no plant canopy was hit but herbaceous litter was touched before hitting soil (no figure shown).

9.7 References

Chapter 10  Gap Intercept: Basal and Canopy Gaps

10.1 Overview

This chapter covers data elements relating to:

- Basal gaps (collected only for ESD/FSG documentation)
- All foliar and perennial canopy gaps

Canopy gap entry for perennial canopy gaps information is entered first. If there are all-foliar canopy gaps and they are different than the perennial canopy gaps, the data collector selects Y-yes to the two questions and records those gaps. The CASI screen allows for entry of basal gap data if the ESD/FSG option is selected.

10.2 What’s New

- Clarify that all plant species should be considered when recording all foliar gaps.
- Clarify that biennials should be treated as perennials when recording perennial gaps.
- Update of section 10.4.1 Conditions for Data Collection to reflect updates to land cover/use codes in Chapter 6.

10.3 Critical Points to Remember

- This protocol measures canopy and basal gaps (ESD/FSG option only) 1.0 foot or larger in length.
- Treat biennials as perennials when recording perennial gaps.
- Consider all plant species when recording all foliar gaps.
Always use a pin or flag and look straight down to determine where a gap begins or ends.
Do not consider gaps or vegetation that occur off the tape measurement edge. Assume there is a wall at the ends of the tape.
Always stand on the south side of the transect to avoid disturbing the measurement area.

10.4 Preliminary Steps

10.4.1 Conditions for Data Collection

- For the non-Federal range sample, gap intercept data are documented for non-Federal points with land cover/use of grassland (LCU = 2001 Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).
- For the non-Federal pasture sample, gap intercept data are documented for non-Federal points with land cover/use of grassland (LCU = 2001 Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).
- For the BLM range sample, gap intercept data are documented for BLM-managed Federal points with land cover/use of grassland defined as range (LCU = 200-1 Grassland defined as range) or scrub shrub defined as range (LCU = 220-1 Scrub Shrub defined as range).

10.4.2 Ancillary Resources

No ancillary resources other than those listed in chapter 2 are needed for this chapter.

10.5 Data Collection Procedure for Basal Gaps with Line Intercept (ESD/FSG Option Only)

10.5.1 Definitions

**Plant base.** Any plant stem or crown (living or dead, perennial or annual) emerging from the soil surface along the edge of the transect line (minimum diameter = 1mm). [NRI-03-Range]

**Basal gap.** For purposes of this protocol, an area greater than or equal to 1.0 foot in length that is absent of any plant bases. [NRI-03-Range]

10.5.2 Basal Gap Procedure

1. Examine transect 1 (NE-SW) carefully for basal gaps (gaps along the transect edge greater than 1.0 foot).
2. If there are no gaps, answer the CASI question "Are there any basal gaps?" **No.** If there are gaps, answer **Yes** and move on to step 3.
3. Start at the zero (0.0) end of the NE-SW transect (transect 1) and record the beginning and end of each gap greater than 1.0 foot. Walk on the south side of the transect and record the gaps intersecting the north side of the tape.
   - Plant bases may be live or dead.
   - Do not consider gaps that occur off the edge of the tape or beyond the tape ends.
4. Record values in the CASI to the nearest 0.1 foot.
• Gaps less than 1.0 foot (see definitions) should be ignored. If entered they will be considered a warning (yellow color) by the CASI, but need not be deleted.

5. Repeat this procedure for transect 2 (NW-SE).

10.6 Data Collection Procedure for Canopy Gaps with Line Intercept

10.6.1 Definitions

Canopy. For purposes of this method, canopy occurs any time 50 percent of any 0.1 ft tape edge intercepts live or dead perennial or annual plant material based on a vertical projection from canopy to ground. [NRI-03-Range]

Canopy gap. For purposes of this protocol, an area 1.0 foot or greater in width absent of any plant canopy along the tape edge. [NRI-03-Range]

10.6.2 Perennial Gap Procedure

1. Examine transect 1 (NE-SW) carefully for perennial canopy gaps (gaps in canopy of biennial and perennial species along the transect edge greater than 1.0 foot).

2. If there are no gaps, answer the CASI question "Are there any perennial canopy gaps?" No. If there are gaps, answer Yes and move on to step 3.

3. Start at the zero (0.0) end of the NE-SW transect (transect 1) and record the beginning and end of each canopy gap greater than 1.0 foot.
   • Plant material may be living or attached dead.
   • Do not consider gaps that occur off the edge of the tape or beyond the tape ends.
   • Exclude all annuals as a gap disrupter.
   • Treat biennials as perennials when recording perennial gaps.

4. Record values in the CASI to the nearest 0.1 foot.
   • Gaps less than 1.0 foot (see definitions) should be ignored. If entered they will be considered a warning (yellow color) by the CASI, but need not be deleted.

5. Repeat this procedure for transect 2 (NW-SE).

10.6.3 All-Foliar Gap Procedure

1. Examine transect 1 (NE-SW) carefully for all-foliar gaps (gaps in canopy of all plant species along the transect edge greater than 1.0 foot).

2. If there are no all-foliar canopy gaps, answer the CASI question "Are there any canopy gaps?" No. If there are gaps, answer Yes and move on to step 3.

3. If the all-foliar canopy gaps are the same as the perennial gaps, answer the question “Are the all-foliar canopy gaps different than the perennial canopy gaps?” No. If at least one all-foliar canopy gap is different than the perennial canopy gaps, answer Yes and move on to step 4.

4. Start at the zero (0.0) end of the NE-SW transect (transect 1) and record the beginning and end of each all-foliar canopy gap greater than 1.0 foot.
   • Plant material may be living or attached dead.
• Do not consider gaps that occur off the edge of the tape or beyond the tape ends.
• Include any plant species as a gap disrupter.
• Use the arrow next to perennial gaps of the same size as the all-foliar gaps to copy them to the all-foliar gap column.

5. Record values in the CASI to the nearest 0.1 foot.
6. Gaps less than 1.0 foot (see definitions) should be ignored. If entered they will be considered a warning (yellow color) by the CASI, but need not be deleted.
7. Repeat this procedure for transect 2 (NW-SE).

10.7 Supporting Materials

10.7.1 Basal gap example

A partial transect is depicted in figure 10-1. In this 4.0-foot transect segment, the measurement (right edge) of the tape encounters a number of gaps. The dark areas labeled with letters symbolize the plant base areas.

Data entry for this partial transect segment is shown in figure 10-2. Two basal gaps (labeled in the figure) are greater than 1.0 foot in length. Plants A, C, D, and F are all considered basal hits. Plants B and E are outside the transect line and should not be counted. All other gaps are less than 1.0 foot in length and should not be counted.

10.7.2 Canopy gap example

Figure 10-1. Overhead view of a transect segment illustrating only plant bases.

Figure 10-2. Data entry for transect 1 (NE–SW). Two basal gaps were greater than 1.0 foot. Data entered to the nearest 0.1 foot.
A partial transect is depicted in figure 10-3. In this example, the plant base (dark area) is depicted with the aerial plant canopy (circle around dark area). Several gaps are apparent. Observations are made on the right edge of the tape.

Data entry for this partial transect segment is shown in figure 10-4. Two canopy gaps are detected, but only one is larger than 1.0 foot in length and entered in the CASI. The canopy of plants A, D, and F all impact the edge of the transect. The plant canopy for plants B, C, and E are outside of the area of consideration and should be ignored. The right hand portion of the CASI screen illustrates the entry of data for this canopy gap.

![Figure 10-3. Overhead view of a transect segment illustrating plant bases and associated perennial plant canopy.](image)

![Figure 10-4. Initial entry for this perennial plant canopy gap.](image)
Chapter 11  Soil Stability Test

11.1 Overview
This chapter covers data elements relating to

- Soil Surface Stability

11.2 What’s New

- Update of section 11.4.1 Conditions for Data Collection to reflect updates to land cover/use codes in Chapter 6.

11.3 Critical Points to Remember

- This procedure will require some practice to become proficient.
- Walk on the south side of the transect line to avoid disturbing vegetation and soil particles.
- Acquire surface soil samples at least two inches away from the transect line to avoid disturbing data collection points.
- Canopy cover for soil aggregate stability to exclude annual plants and include only biennial plants, perennial plants, shrubs and trees.
11.4 Preliminary Steps

11.4.1 Conditions for Data Collection

- For the non-Federal range sample, soil aggregate stability data are documented for non-Federal points with land cover/use 2001 Grassland defined as range or 2201 Scrub Shrub defined as range; and optionally for 2000 Grassland not defined as range or 2200 Scrub Shrub not defined as range.
- For the non-Federal pasture sample, soil aggregate stability data are documented for non-Federal points with land cover/use 2001 Grassland defined as range or 2201 Scrub Shrub defined as range; and optionally for 2000 Grassland not defined as range or 2200 Scrub Shrub not defined as range.
- For the BLM range sample, soil aggregate stability data are documented for BLM-managed Federal points with land cover/use 2001 Grassland defined as range or 2201 Scrub Shrub defined as range.

11.4.2 Ancillary Resources

The following resources may be useful in collecting data for this chapter:


11.5 Data Collection Procedure for Soil Stability

11.5.1 Equipment

- Soil stability test kit (provided)
- Deionized water (any noncarbonated bottled water except mineral water (1 quart per test)
- Stopwatch or chronograph watch (CASI also provides timer)
- Small spray bottle (atomizer or equivalent with very fine mist)

11.5.2 Definitions

**Soil aggregate stability.** Soils vary in the degree to which they are vulnerable to externally imposed destructive forces. Aggregate stability is a measure of this vulnerability. For example, soil structure may begin to deteriorate visibly and rapidly as the soil surface is subjected to destructive forces such as repeated traffic, machinery, cultivation, hoof impact, and water and wind erosion. [NRI-03-Range]

**Soil Stability Test.** This test provides information about the integrity of soil aggregates, soil structural development, and erosion resistance. The test measures the stability of the soil when exposed to rapid wetting. Soil aggregate stability is affected by texture (soil particle size) and biotic and mineral constituents that may be present. [NRI-03-Range]
11.5.3 Procedure

1. Start at the zero (0.0) end of the NE-SW transect (transect 1). Select small surface samples from the selected transect marks. The number of samples will vary depending upon whether you selected the NRI or ecological site data collection option.

   **Note:** If the point can be used for ESD documentation, the CASI will provide 18 sub-plots for soil stability at transect marks 15, 30, 45, 60, 75, 90, 105, 120, and 135 on each transect. If the NRI data collection option is selected (see Chapter 8 for more information), only 9 subplots (5 from the NE/SW transect and 4 from the NW/SE transect) will be sampled.

   - Always sample at least 2 inches from any vegetation measurement line.
   - As a rule of thumb, obtain samples one stability box length away from the transect line.
   - If a surface root mat, moss, duff or water (on the soil surface) is present, the procedure need not be completed. Select root mat with or without canopy from the CASI choice list and move to the next mark.
   - Always walk on the south side of the transect tape and obtain sample from the undisturbed area along the transect line.

2. Record the presence or absence of canopy for the sample in the CASI screen in the corresponding entry cell.

   - Canopy is recorded as present if there is at least 50 percent canopy over the sample.
   - Canopy cover for soil aggregate stability to exclude annual plants and include only biennial plants, perennial plants, shrubs and trees.

3. Excavate a small trench 1/2 inch deep in front of the area to be sampled (fig. 11-1).

4. Use the spatula to lift a surface fragment (soil ped) from the trench (fig. 11-2). The size should be 1/4 inch (6-8 mm) in diameter and no more than 1/8 inch (2-3 mm) thick. Do not shatter the soil fragment during sampling. It may work best to lift out a larger fragment and carefully break it down to the desired size.

   - If the sample mark was disturbed by previous measurements or is covered by rock (>1/4 inch diameter), water, or embedded litter (i.e., removal of litter disturbs soil surface and/or leaves an indentation in the soil’s surface), randomly select another point by moving 1/2
foot down the line. Repeat until you reach an appropriate sampling point. All samples must be at least 5 ft apart.

Special circumstances:

- **Lichen on soil:** sample and test the lichen (it is often a stability class 6).
- **Moss on soil:** Code as a root mat in the CASI, move to the next soil stability mrk.
- **Duff on soil:** Code as a root mat in the CASI. Duff is the layer just below litter. It consists of decomposing leaves and other organic material. There should be NO recognizable plant parts. The duff layer is usually dark decomposed organic matter. The bottom of the duff layer is the point where mineral soil (A horizon) begins.
- **Plant base:** remove a sample from inside the plant base or as close as possible to the edge of the plant base.
- **Water:** As part of a wetland site, code as a root mat in the CASI.

**Note:** If the sample is too weakly structured (falls through sieve), mist it lightly with water using an atomizer or equivalent, and then take the sample. If this procedure fails to produce an adequate sample, rate the sample a 1 (see step 9 - ratings).

5. Gently place the sample in a dry sieve (fig. 11-3) and place in the dry box beginning in the top left corner.

6. Repeat this procedure for each of the selected mrks on both transects (1 and 2) placing samples top to bottom and left to right. This results in 9 samples placed in the dry box as shown in figure 11-4 (18 if used for ecological site documentation).

- The samples must be dry before proceeding with the test. If not dry, allow the samples to air dry with the lid off the collection box.
- Do not leave the lid closed on the samples for more than 1 minute on hot/sunny days. Excessive heat can significantly increase humidity in the sample box, which will affect the stability test.

7. Fill the water box with deionized or distilled water (fig. 11-5).

- Fill each compartment to the top.
- The water should be approximately the same temperature as the soil (no melted snow).
- If the sample is hydrophobic (floats on the water surface) push it under the water until it no longer floats on top.

8. Test the samples following the sequence listed below:

- Lower the first sieve into the upper left cell (other box, same cell as it came from)
- It should take 1 second from the time the screen touches the water until it rests on the bottom.
• Start the stopwatch or CASI timer when the first sample touches the water. 
• Follow the sequence of immersions, adding one sample every 15 seconds, top to bottom, left to right (see fig. 11-4). 
• Observe the samples for 5 minutes (300 seconds). 
• Stability rating codes 0-3 are reserved for samples that show loss of structural integrity prior to 300 seconds (see rating description). 
• After exactly 5 minutes, raise the basket completely out of the water and then lower it nearly to the bottom (do not allow it to bump the bottom). Repeat this immersion five times. Carefully note the condition of the soil samples and use the table below to rate them. **Do this even if you already rated the sample 1, 2, or 3. (You are allowed to change your rating based on the sieving.)** It should take about 1 second for the basket to clear the surface of the water and 1 second to lower it to the bottom (total 10 seconds to sieve).

9. Record the soil stability rating information in the CASI entry screen.

• The test kit is set up with three rows of six columns (you only need to use 3 columns if point is not for ecological site documentation). Care should be taken to enter the ratings in the right order.
• Rate the sample based on the amount of soil remaining and call out stability class to the individual recording data in the CASI. Do not include sand and gravel particles that cannot pass through the sieve.

**CASI screen choices:**

1 = 50% of structural integrity lost, (melts) within 5 seconds of immersion in water OR soil too unstable to sample (falls through the sieve) **AND** less than 10% remains after 5 dipping cycles

2 = 50% of structural integrity lost, (melts) 5-30 seconds after immersion **AND** less than 10% remains after 5 dipping cycles

3 = 50% of structural integrity lost, (melts) 30-300 seconds after immersion **OR** < 10% remains on the sieve after 5 dipping cycles.

4 = 10-25% of original soil material remains on the sieve after 5 dipping cycles

5 = 25-75% of original soil material remains on the sieve after 5 dipping cycles

6 = 75-100% of original soil material remains on the sieve after 5 dipping cycles
11.6 Supporting Materials

The following example photos illustrating stability class ratings show the key steps of testing soil samples for four stability ratings. Some of the fragments shown in these samples may appear large. They are for illustration only. Be sure to follow the fragment size guidelines (1/4 inch diameter and no more than 1/8 inch thick).

**Sequence for stability class = 1**

![Sequence for stability class = 1](image1)

**Sequence for stability class = 4**

![Sequence for stability class = 4](image2)

**Sequence for stability class = 5**

![Sequence for stability class = 5](image3)

**Sequence for stability class = 6**

![Sequence for stability class = 6](image4)
Chapter 12  Plant Height

12.1 Overview
This chapter covers data elements relating to:

- Plant height

12.2 What’s New

- Update of section 12.4.1 Conditions for Data Collection to reflect updates to land cover/use codes in Chapter 6.

12.3 Critical Points to Remember
On-site data collection information will be gathered at the certified point locations. Certified locations are the geographic coordinate system descriptions of NRI sample points and segments that accurately describe the location of each point and segment in prior NRI data collection. The certified location is unique for each point and segment.

Identify plant species; enter plant species code into CASI, then measure height according to height criteria.

- Data entry is only required when plants are present at one of the 14 locations designated in the “Procedures” section.
- Changing transects can be slow on this screen, be patient.

12.4 Preliminary Steps

12.4.1 Conditions for Data Collection

- For the non-Federal range sample, plant height data are documented for non-Federal points with land cover/use grassland (LCU = 2001 Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).
- For the non-Federal pasture sample, plant height data are documented for non-Federal points with land cover/use of grassland (LCU = 2001 Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).
- For the BLM range sample, plant height data are documented for BLM-managed Federal points with land cover/use of grassland defined as range (LCU = 2001 Grassland defined as range) or scrub shrub defined as range (LCU = 2201 Scrub Shrub defined as range).

12.4.2 Ancillary Resources
None required.

12.5 Data Collection Procedure for Plant Height

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12.5.1 Equipment
- Survey rod or other suitable pasture height measuring stick with graduations in 0.5 inches and feet.
- Clinometer

12.5.2 Definitions

Transect. A cross-section of an area used as a sample for recording, mapping, or studying vegetation and its use; may be a series of plots, a belt or strip, or merely a line. In the rangeland field study, two 150-foot transect lines intersect at the NRI sample point (fig. 12-2). Measurements are taken at predetermined marks along the transect line. The transect arms are oriented 45 degrees in both directions from magnetic north. Transect distances are recorded from the NE to SW and NW to SE from a tape stretched along the ground. [NRI-03-Range]

Plant Height: For this protocol, the height of the tallest living or dead plant part (including seed heads) intersecting a 12 inch diameter vertical cylinder tangent to the designated transect mark. Do not stretch the plant while making the measurement.

12.4.3 Procedure

1. Start at the zero (0.0) end of the NE-SW transect (transect 1).
   - The CASI will default data entry to the first plant height location at mark 15.
   - Subsequent observations are made every 10 feet at marks 25, 35, 45, 55, 65, 75, 85, 95, 105, 115, 125, 135 and 145

2. At each designated mark, separately determine for herbaceous and woody species the tallest living or dead plant within a projected 12-inch diameter vertical cylinder. The cylinder is tangent to the mark and on the north side of the tape.

3. Record the plant species and height from the CASI choice lists for herbaceous and woody plants.
   - The plant species choice list is the same one used in the line point intercept protocol, plant census protocol and dry weight rank protocol.
   - Record the height where the plant intersects the 6-inch radius of the transect mark, not the total height of the plant.
   - Do not stretch the plant while making the measurement.
   - Record plant height by category:
     o Record the height of plants 0-6 feet tall to the nearest inch.
     o Record the height of plants that exceed 6 feet in height to the nearest foot.
     o Plants greater than 60 feet should be recorded as “61+ ft” tall.
   - For more information on managing and using plant species choice lists refer to the Appendix A of the Handbook of Instructions.
4. For shrubs and trees, use a clinometer to measure the height the tallest living or dead tree or shrub part within a projected 12-inch diameter vertical cylinder. Standing at a fixed distance (not less than the height of the tree part being measured) from the base of the tree, sight to the tallest part of tree intercepting the projected 12-inch diameter vertical cylinder, noting the angle expressed as a percent. Then measure to the bottom of the tree, again using percent. Subtract the percent slope to the bottom of the tree from the slope to the highest part of the tree intercepting the projected 12-inch diameter vertical cylinder. Note that when the ground slopes downwards, you record a negative slope to the base of the tree. When this is subtracted from the slope to the top of the tree, it is actually being added. These numbers are then divided by 100, and multiplied by the distance from the tree. There is still some error in this number, because the distance is measured along the ground, and is not the actual horizontal distance. By standing at the base of the tree, you mark your eye level. Then stand back, and find the slope expressed as a degree to the mark. This is the slope of the ground. By taking the cosine of that number, and multiplying it with the previous number, you calculate the height of the tree part intercepting the projected 12-inch diameter vertical cylinder.

5. Repeat for transect 2 (NW-SE).

12.5 Supporting Materials

N/A
Chapter 13  Dry Weight Rank (DWR) Method (Optional)

13.1 Overview
This chapter covers data elements relating to:

- Dry weight ranking by plant species using the Dry Weight Rank Method

13.2 What’s New
- Update of section 13.4.1 Conditions for Data Collection to reflect updates to land cover/use codes in Chapter 6.

13.3 Critical Points to Remember
- Dry weight quadrats are evaluated at regular intervals beginning at the 12.5 ft mrk; thereafter, every 12.5 ft.
- 10 quadrats are sampled on each transect making a total of 20 quadrats per point
- Use a 1.92 sq. ft plot quadrat where vegetation is relatively homogeneous and of short stature. Stands with greater heterogeneity, use a 4.8 sq. ft. quadrat.

13.4 Preliminary Steps

13.4.1 Conditions for Data Collection
This is an optional protocol for both pastureland and rangeland.

- For the non-Federal range sample, dry weight rank data can be documented for non-Federal points with land cover/use of grassland (LCU = 2001 Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).
- For the non-Federal pasture sample, dry weight rank data can be documented for non-Federal points with land cover/use of grassland (LCU = 2001 Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).
- For the BLM range sample, dry weight rank data can be documented for BLM-managed Federal points with land cover/use of grassland defined as range (LCU = 2001 Grassland defined as range) or scrub shrub defined as range (LCU = 2201 Scrub Shrub defined as range).

13.4.2 Ancillary Resources
In addition to the basic data collection materials noted in chapter 2, the following ancillary resources are required:

- Plant identification aids
13.5 Data Collection Procedure for Field Weight by Species

13.5.1 Definitions

Herbaceous Plant. A term used to reference vegetative plants with little or no woody component, usually graminoids and forbs. [NRPH]

Woody plant. A term used in reference to trees, shrubs, or browse that characteristically contain persistent ligneous material. [NRPH]

DWR quadrat (plot). A plot or quadrat established along the transect at predetermined intervals to provide areas for determining dry weight percent composition by species.

13.5.2 Procedure

1. Start at the zero (0.0) end of the NE-SW transect (transect 1).
   - For additional information on the plot and transect, refer to Chapter 3, Section 3.6, Procedure for Establishing/Documenting the Sample Plot and Transects.
   - Always stand on the south side of the transect to avoid disturbing the measurement area.
   - The line should be taut and placed as close to the ground as possible.

2. Determine the proper size frame by doing preliminary sampling on the site with different size frames. Select a frame size on the premise that most frame quadrats along each transect will contain three or more species.
   - A large frame size will require scanning so care must be taken to avoid errors of double counting or skipping an area of assessment. Generally, a 2.4 sq. ft. frame is the largest frame that can be viewed without having to scan the ground.
   - For homogeneous sod-forming pastures, with low stature, the 1.92 square foot quadrat works well. A square quadrat whose inside dimensions are 16 5/8” X 16 5/8”, or a rectangular quadrat whose inside dimensions are quadrat 1’ X 1’ 11 1/16”.
   - For vegetative stands with greater heterogeneity and taller stature, increase quadrat to 4.8 sq. ft. to accommodate at least 2 or more complete plant crowns.

3. For each quadrat (plot), place the sampling frame at the predetermined transect mrk. DWR quadrat transect mrks are located at 12.5, 25, 37.5, 50, 62.5, 87.5, 100, 112.5, 125 adn137.5-foot intervals on both transects. DWR plots overlap with quadrats sampled in standing biomass/production protocols. Access to quadrant mrk data entry cells can be adjusted by selecting the displayed radio buttons at the top of the CASI screen.
   - For rectangular and square quadrats, place the lower right hand corner of the quadrant frame at the predetermined transect mrk.
   - For circular quadrats, center the bottom of the frame or cable at the predetermined quadrat mrk. If using a cable or loop, arrange it to be as close to a full circle as possible.

4. Shift any vegetation lying underneath the frame to the side of the frame it is rooted on.

5. Determine the order of dry weight production of the top three plant species in the quadrant regardless of the forage value of the species. Rank the three dominant plant species (usually) in the frame according to the criteria in Table 13-1.
• In some cases there will be less than 3 species in a quadrat. Follow the instructions in table 13-2 when entering ranking information in the CASI.

• **Each quadrat must have at least one species with a ranking of 1.** If rankings 2 and 3 are excluded, they will be automatically credited to the plant ranked 1. Refer to section 13.6 for specific examples.

6. Record species from the CASI choice list and rank according to weight rank as described in step 5.

• This protocol also uses the line point intercept and plant census plant choice list. Searching for plants also works the same here as in other protocols where plant name are used. Refer to Appendix A for more information on using plant names in the CASI.

• Each DWR CASI screen can hold up to 7 plants, additional screens can be created by

### Table 13-1. Ranking criteria for the Dry Weight Protocol

<table>
<thead>
<tr>
<th>Rank</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Plant species with the highest weight in quadrat, most or very dominant</td>
</tr>
<tr>
<td>2</td>
<td>Plant species with 2(^{nd}) highest weight in quadrat, not as dominant as 1 but not the least productive in the quadrat</td>
</tr>
<tr>
<td>3</td>
<td>Plant species with 3(^{rd}) highest weight in quadrat, least productive but still dominant in the quadrat</td>
</tr>
</tbody>
</table>

### Table 13-2. Species composition and Rank Category Options

<table>
<thead>
<tr>
<th>Species composition in frame by species number</th>
<th>Rank Category Options in CASI</th>
<th>Production Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only one species in the frame</td>
<td>Rank 1 (No rank 2 or 3 given.)</td>
<td>100% to species 1</td>
</tr>
<tr>
<td>Only two species in the frame</td>
<td>Option 1: Rank one species as 1 and the other species as 2. (No rank 3 given).</td>
<td>70% to species 1 30% to species 2</td>
</tr>
<tr>
<td></td>
<td>Option 2: Rank one species as 1 and the other species as 3. (No rank 2 given).</td>
<td>90% to species 1 10% to species 2</td>
</tr>
<tr>
<td>Three species or more in the frame</td>
<td>Rank top three species as 1, 2, and 3 according to visual percent composition.</td>
<td>70% to species 1 20% to species 2 10% to species 3</td>
</tr>
<tr>
<td>Ties</td>
<td>Favor the species with the lower annual biomass production (see table 13-1) with the higher rank. Ties are not allowed.</td>
<td></td>
</tr>
</tbody>
</table>
tapping the **add** button to create additional screens as needed to accommodate more plant species.

- Key out any plant species if in doubt. Record weedy species as well as forage species if they have enough dry matter to rank in the top 3 in a quadrat. Plant keys that use vegetative characteristics are the best to use since seed heads or flowers are not often present in grazed fields.

7. Adjust the relative quadrat yield as necessary. Refer to section 13.6.3 for specific guidance. A full stand quadrant relative yield rating is assumed to be 5. This value is displayed at the top of each quadrat column. Adjust the relative yield down if:

   - A quadrat contains primarily lower yielding species (e.g. common white clover, annual bluegrass, dandelion, or carpetgrass) while the other quadrats are mostly higher yielding species.
   - A quadrat falls on areas with a noticeably thinner stand of grass or forbs (unvegetated gaps present) than the densest quadrats within the macroplot.

8. Repeat this for the remaining 19 quadrats entering new plants in the CASI list as encountered. Complete the quadrat column for applicable species by individual quadrat. Some previously entered species will be skipped depending upon the composition in a particular quadrat.

9. A summary of Dry Weight Ranking for the point can be displayed by tapping the **summary button**.

### 13.6 Supporting Materials

#### 13.6.1 Overview

The Dry Weight Rank method is a non-destructive visual estimation procedure to measure botanical composition by weight. Dry Weight Rank has been tested against actual clipping and weighing of separate species on a variety of pasture and range types in a variety of climates. Potential biases are adjusted for by combining Dry Weight Rank with Relative Yield and Cumulative Ranking. The method produces an estimate of percent composition by weight for the PSU plot as accurate as other methods but is faster and repeatable for long-term monitoring.

#### 13.6.2 Ranking Procedure

The observer assigns ranks of one, two, and three based on the individual species relative contribution to the total dry weight contained within the frame at the time of viewing. View the frame from above. When estimating weight remember that a high proportion of the yield is in the lower layers. It is essential to gauge the density of material in these lower layers and it may be helpful to handle the pasture mass. Points to consider are:

- the amount of plant material
- the area of bare ground between plants
- height

Figure 13-1. Tap on the summary radio button to display a summary of entered DWR information by % composition.
It is faster to rank plant species than to assign direct percentage composition. However, a coarse visual percentage of composition by weight is used to rank the species.

Ranking has standardized values. A rank of 1 corresponds to 70% composition, rank 2 to 20%, and rank 3 to 10%. The 70/20/10 split will seldom match the coarse visual percentage distribution within a frame. That is OK. The total of all frames along the transects is how the percent composition by weight is determined. This method of calculation has been tested for accuracy and repeatability.

13.6.2.1 Cumulative Ranking

There will occasionally be some frames with less than three species. The procedure is to assign more than one rank to a species. This is termed Cumulative Ranking.

- When only one species is found in a frame it should be given rank 1. This species will then be credited with 100% of the plot production.
- When two species are found: the first species may be given ranks 1 and the second species given ranks 2 or 3 depending upon the relative amounts of the two species in the plot. Refer to table 13-2 for ranking options for two species plots

Do not use Cumulative Ranking when three or more species occur in the frame unless the coarse visual percent composition by weight of the dominant species exceeds 85 percent.

Do not use Cumulative Ranking when pastures have a species that is consistently dominant and at least two more species are within the frames. This is to recognize minor species that may be key to management either desirable or undesirable.

13.6.2.2 Ties

Ties of dry weight estimates, and therefore ranking, seldom occur though there are many close calls. If the tie cannot be quickly broken by close examination of the two competing species, the favor goes to the species of generally lower annual biomass production capability (see Tables 13-3 and 13-4 for Relative Yield Values for Mixed Grass Stands).
Pastureland NRI comparative yield method eliminates biases caused by the potential treatments applied and seasonal effects that will be encountered on the randomly selected pasture points.

Comparative Yield Method compares relative total standing biomass for each frame on the dry weight rank protocol transects. Rather than estimating the weight directly within each frame.
relative ranks are recorded. The present standing biomass in a frame is compared to reference frames 1, 2, 3, 4, and 5. The best fit reference frame is recorded. The five reference frames represent 20% breaks in standing biomass with five being the highest. The reference frames represent the range in dry weight of standing crop that will be commonly found along the transect and not the extreme.

Once a set of reference frames are established (see Comparative Yield Training Protocol) the transect quadrate frames will be compared and rated back to these reference frames.

It is best if the same observer reads each frame throughout the transect to ensure accuracy.

**Comparative Yield Training Protocol to be conducted prior to field data collection:**

1. Five reference frames are subjectively located. References 1 and 5 are located first.
   - The first frame (reference 1) is placed in a low-yielding area which represents the low-yielding situations commonly encountered on the site (avoid bare or nearly bare frames).
   - Reference 5 is determined by placing a frame on a high-yielding area, excluding unusually dense patches of vegetation which would have a rare chance of being sampled.

2. The examiner should make a mental note of the amount of production in each of the reference frames. These references are then clipped and weighed.
   - If the clipped weight in reference 5 is more than five times the weight found in reference 1, then two new sites should be selected as references 1 and 5.
   - **Note:** In establishing the initial reference frames, the weight in reference 5 is usually too high and the weight in reference 1 is too low. Make sure reference 5 does not represent a rare situation.

3. Once references 1 and 5 have been selected, reference 3 is located by placing a frame in an area considered to have a yield halfway between references 1 and 5. References 2 and 4 are located the same way by selecting the midpoint yield between references 1 and 3 and references 3 and 5, respectively.

4. All five reference frames are clipped and weighed to compare the reference frames to a linear distribution of frame weights. This process is repeated by clipping additional frames until the weights of the five reference frames are approximately linear and observers are confident in their ability to rank frames relative to one of the five references.
   - If the rankings are not linear, the precision of the method will be reduced.
   - If more than five percent of the frames have no production, then a larger frame should be used.

**13.6.4 Examples**

1. Only one species in the quadrat
   - One species occurs in plot 1: tall fescue. If only one species is found in the quadrat, rank as 1. It will be credited with all the production.

2. Two species in the quadrat
   - Two species occur in plot 2: tall fescue and white clover. Tall fescue is very dominant,
rank tall fescue as 1. White clover is subdominant, rank as 3. (Tall fescue will get the unranked 2 portion here.)

- Two species occur in plot 3: tall fescue and white clover. Tall fescue is dominant; however, white clover is also dominant but not quite equal to tall fescue. Rank tall fescue = 1 and white clover = 2.
- Two species occur in plot 4: tall fescue and white clover. Each species is equal in production and tied for dominance. Refer to tables 13-3 and 13-4 for relative yield levels. Since white clover has a lower relative yield value, it receives a higher rank. Rank white clover = 1 and tall fescue = 2.

3. Three species in the quadrat

- Three species occur in plot 5: tall fescue, white clover, and dandelion. Tall fescue is clearly very dominant, white clover is subdominant, and dandelion is minor. Rank tall fescue = 1, while clover = 2, and dandelion = 3.
- Three species occur in plot 6: tall fescue, white clover, and perennial rye. Tall fescue is dominant, however white clover and perennial rye are tied for 2nd. Rank tall fescue = 1, white clover = 2, and perennial rye = 3 (based on relative yields in table 13-3).
- Three species occur in plot 7: tall fescue, white clover, and dandelion. Tall fescue and white cover are tied, and dandelion is minor. Rank white clover = 1, tall fescue = 2, and dandelion = 3 (based on relative yields in table 13-3).

13.7 References

Chapter 14   Species Composition by Weight (Non-Federal Rangeland Only)

14.1 Overview

This chapter covers data elements relating to:

- Field weight entry by species
- Reconstruction of total production by species
- Similarity index calculation

Two CASI entry screens are used in this protocol. The field weight screen is displayed first. The reconstructed weight and similarity index entry screen (Recon) can be accessed by the adjacent Recon buttons.

14.2 What’s New

- Update of section 14.4.1 Conditions for Data Collection to reflect updates to land cover/use codes in Chapter 6.

14.3 Critical Points to Remember

- The CASI is set up to record actual field weight in grams for each plant species inventoried in each production quadrat.
- Quadrat field weights can be determined by clipping the entire quadrat or through the double sampling method. If double sampling method is used, all supplementary
calculations must be made outside the CASI on a field sheet.

- The CASI will determine total annual production based on entered correction factors.
- Include only plant canopy produced by stems and roots growing inside the production quadrat. Conversely, all plants rooted outside the quadrat with overhanging vegetation in the quadrat are considered "outside the quadrat: and not recorded.
- Entry of the reconstruction factors and similarity index data entry may be done in the office as a final step before sending the segment back to the server. Care should be taken to assure a complete inventory of all plant species is performed in the field.
- The number of herbaceous and woody production quadrats (subplots) varies for the NRI data collection and ESD option. A summary of quadrat locations for both data collection options is shown in Table 14-1 below.
- If more than one ecological site is identified along the transect, use the ecological site at the point for all similarity index calculation.
- States will specify the herbaceous quadrat size (1.92, 4.8, or 9.6 square feet) based on vegetation communities in their state.
- For all quadrats (rectangular, square, or circular), center the bottom of the frame at the predetermined quadrat \textit{mrk} on the north side of the tape.

**Table 14-1.** Production quadrat mrks for herbaceous and woody quadrats by transect and data collection type.

<table>
<thead>
<tr>
<th></th>
<th>NE/SW Transect</th>
<th>NW/SE Transect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Herbaceous</td>
<td>Woody</td>
</tr>
<tr>
<td>NRI Data Collection Option</td>
<td>37.5, 62.5, 112.5</td>
<td>37.5, 112.5</td>
</tr>
<tr>
<td>Ecological Site Data Collection Option</td>
<td>12.5, 37.5, 62.5, 112.5, 137.5</td>
<td>37.5, 112.5</td>
</tr>
</tbody>
</table>

### 14.4 Preliminary Steps

#### 14.4.1 Conditions for Data Collection

Production data are not gathered on BLM managed land.

- For the non-Federal range sample, production data are documented for non-Federal points with land cover/use of grassland defined as range (LCU = 2001 Grassland defined as range) or scrub shrub defined as range (LCU = 2201 Scrub Shrub defined as range).
- For the non-Federal pasture sample, production data are documented for non-Federal points with land cover/use of grassland defined as range (LCU = 2001 Grassland defined as range) or scrub shrub defined as range (LCU = 2201 Scrub Shrub defined as range).

#### 14.4.2 Ancillary Resources

In addition to the basic data collection materials noted in chapter 2, the following ancillary resources are required:
14.5 Data Collection Procedure for Field Weight by Species

14.5.1 Definitions

**Herbaceous Plant.** A term used to reference vegetative plants with little or no woody component, usually graminoids and forbs. [NRPH]

**Woody plant.** A term used in reference to trees, shrubs, or browse that characteristically contain persistent ligneous material. [NRPH]

**Production quadrat (subplot).** A subplot or quadrat established along the transects at predetermined intervals to provide areas for determining production by species. [NRI-03-Range]

Quadrat size and frequency vary between herbaceous and woody plants as follows:

- Herbaceous production quadrats are centered on transect mrks at 12.5, 37.5, 62.5, 112.5, and 137.5 feet on the NE/SW and NW/SE transects for the ESD option. For the NRI data collection option, herbaceous production quadrats are centered on mrks at 12.5 and 137.5 feet on the NW/SE transect and 37.5, 62.5 and 112.5 feet on the NE/SW transect. Quadrat size can be 1.92, 4.8, or 9.6 square feet. Each state will specify the herbaceous quadrat size based on vegetation communities in their state. Correction factors (grams to lb/ac) are defaulted when quadrat size is chosen in the CASI. Note: correction factors are calculated as follows: \( \frac{96}{\text{ft}^2} \) in quadrat = quadrat correction factor gm to lb/ac.

- Woody production quadrats are centered on each transect at mrks 37.5 and 112.5 feet for the ecosite data collection option. For the NRI data collection option, woody production quadrats are centered at mrks 37.5 and 112.5 feet in the NE/SW transect only. Quadrat size is 435.6 square feet (0.01 acre, 11.75 ft. radius, 23.5 ft diameter circle or 20.9 ft. square).

Production quadrats are established as shown in the plot design (fig. 14-1). Herbaceous quadrats are represented by the small circles and woody quadrats by the larger circles.

14.5.2 Procedure

1. Tap the **parameters** button and enter the herbaceous quadrat size and total annual production (fig. 14-2).
Total average annual production is the total average dry weight biomass produced during the entire growing season. Use the average value given in the ecological (range) site description. Climate adjustments are made with the climate factor (%Clim).

Similarity index is calculated and displayed here by the CASI after all production and correction factors have been entered. No data entry is required for this item.

2. For each quadrat (subplot), center the sampling frame at the predetermined transect mrk tangent to the north side of the tape.

   - **Note:** The CASI will adjust which mrks are selected based on the ESD or NRI data collection option selected in the Ecological site screen.
   - Herbaceous quadrats are centered on transect mrks located at 12.5, 37.5, 62.5, 112.5, and 137.5 feet (selection will vary depending upon the ecosite or NRI data collection option).
   - Woody quadrats are centered on transect mrks located at 37.5 and 112.5 feet (selection will vary depending upon the ecosite or NRI data collection option).
   - For all quadrats (rectangular, square, or circular), center the bottom of the frame at the predetermined quadrat mrk tangent to the north side of the tape.

3. Determine the total quadrat field weight for each identified plant species and the combined SDH_BIO category (not separated by species).

   - Quadrat field weights can be determined by estimating by weight unit, estimating and harvesting (double sampling), harvesting all quadrats, or a combination of these methods. If the double sampling method is used, all supplementary calculations must be made outside the CASI on a Range 417 or equivalent field sheet. Refer to the USDA-NRCS National Range and Pasture Handbook (1997) for more information and detailed procedures.
   - For each identified plant species, include only current year's production (canopy both inside and outside the quadrant) produced by stems and roots growing inside the production quadrant. Conversely, all plants rooted outside the quadrant with overhanging vegetation in the quadrant are considered "outside the quadrant" and not recorded.
   - Retain any standing dead herbaceous biomass and include in the SDH_BIO category auto created for each quadrat.

4. Enter the plant names found in each quadrat from the CASI choice list.

   - The choice list uses the same set of plant names established in the point line transect protocol. Many of the plants identified in the quadrant will already be on the list. If a new plant is found, use the search functions to access the plant database to add the new plant to the choice list. Refer to appendix A, section A.4 for detailed instructions.
   - In the event a woody plant is present at the predetermined woody quadrat, check the box in the w (woody plant) column adjacent to the woody plant symbol.
• The plant list is cumulative; it continues to build when new plants are found in a different quadrat. The CASI will enter ‘0’ for production for species added to the list but not found in previous production quadrats.

5. For each quadrat, enter the total field weight for each species/SDH_BIO to the nearest gram (fig. 14-3).

• The displayed list represents all plants found in all quadrats. Enter 0 for yield if a listed plant is not found in a subsequent quadrant. **Do not delete the plant from the list.** This will remove the plant from all quadrats.
• Enter trace (Tr) from the number key pad if plant production is less than 0.5 gram.

6. Repeat this procedure for transect 2 (NW-SE).

### 14.6 Reconstructing the Present Plant Community from the Measured Data

#### 14.6.1 Definitions

**Air-dry weight.** The weight of a substance, usually vegetation, after it has been allowed to dry to equilibrium with the atmosphere, usually without artificial heat. [NRPH]

**Reconstruction factor.** A factor used to convert plant field weight at the time of observation to total normal annual air dry production. The factor considers physical, physiological, and climatological variables that affect the amount of biomass measured for a species at a specific point in time. The present plant community is reconstructed by multiplying the measured weight of each species by this factor. [NRI-03-Range] The reconstruction formula is

\[
ReFctr = \frac{\%Dwt}{(\%UnGr)(\%Grth)(\%Clim)}
\]

where

• \(ReFctr\) is the calculated reconstruction factor,
• \(\%Dwt\) is the percent air dry weight for each plant species,
• \(\%UnGr\) is the estimated percent of the current plant growth that has not been removed by grazing or harvest,
• \(\%Grth\) is the percent of the current year's growth for each species that should normally have occurred at the time of sampling,
• \(\%Clim\) is the climate adjustment: percent of the current year’s plant growth in comparison to a normal average year. Example: 0.9 means the current year’s production is 90% of normal or is 10% below normal. A value of 1.1 is 110% of normal or 10% above normal.

**Similarity index.** A similarity index is the percentage of a specific vegetation state plant community that is presently on the site. [NRPH]
14.6.2 Procedure

1. Determine the reconstruction factor for each plant species identified in the production quadrats (plots).

2. Tap the Recon button to access the CASI entry screen for entry of necessary reconstruction factors (fig. 14-4).
   - Each plant species (plant symbol) previously inventoried in a production quadrat will be displayed here.

3. For each plant species enter the following:
   - %Dry Weight: Air dry weight percentage (enter from choice list).
     - Use dry weight tables for your area. Be sure to adjust dry weight values by date of sampling.
     - If dry weight tables are not available or you wish to check dry weight values, clip and weigh the plant species (record field green weight and bag weight on paper bag), air dry plant in bag, and weigh when dry. Calculate dry weight percentage:

\[
\text{Air dry weight percentage} = \frac{\text{Air dry weight of plant weight}}{\text{Green weight of plant}} \times 100
\]

   - % Ungrazed: Percent of plant biomass of each species that has not been removed (enter from the choice list).
   - % Growth: Percent of growth of each species that should normally have occurred at the date of sampling (enter from the choice list).
   - % Climate: Percent of growth of each species that has occurred relative to normal growing conditions (enter from choice list).

4. The following information will now be calculated and displayed:
   - Reconstruction Factor: Factor determined for each species and used by the CASI to determine similarity index for the site.
   - Total Weight (grams): The total unadjusted weight of all production quadrats in grams. This value will be adjusted by the reconstruction factor calculated in the previous procedure.
   - Reconstructed Weight (1lbs/ac): The reconstructed weight in pounds per acre.

5. Determine the percent of allowable production (% Allowable Production) for each listed plant species.
   - Use the Ecological Site Description to determine this factor for each species.
   - Assume an average year when making this decision.
• Enter values to the nearest percent.

6. The CASI will now calculate and display:
   • Potential Allowable Production: This value is equal to the average annual production (entered in parameters) x % Allowable Production (entered in step 5).
   • Allowable production: The CASI determines this value by evaluation of the Potential Allowable Production and the Reconstructed Weight values. If the Reconstructed Weight is less than or equal to the Potential Allowable Production, then the Reconstructed Weight is used for the similarity index calculation. If the Reconstructed Weight is greater than the Potential Allowable Production), then the Potential Allowable Production is used in the similarity index calculation.

7. Complete this process for each listed plant species.
   • The similarity index will be displayed in the parameters screen for review and information (see fig. 14-2).

14.7 Supporting Materials

14.7.1 Example

The following species and field weights were recorded for each quadrat. The sample point represents an ESD from Jornada Site No. O42XB012NM (Sandy Range Site (SD-2)).

The example illustrates the number of quadrants samples for the ecosite data collection option. The NRI sampling option requires 5 herbaceous and 2 woody or expanded quadrants.

1. To begin, enter the following information in parameters (fig. 14-5):
   • Plot size (square feet)
     o 1.92
     o 4.8
     o 9.6
   • Total annual production-average value from the ESD

2. Inventory and enter yield data for each plant species in the transect quadrats (fig. 14-6 and 14-7).

3. Determine and enter in the CASI (fig. 14-8) reconstruction factor information for each plant species where:
   • %Dwt = (% Air dry weight) (enter from choice list)
   • %UnGr = (% Ungrazed), percent of plant biomass of each species that has not been removed (enter from the choice list).
   • %Grth = (% Growth), percent of growth of each species that should normally have occurred at the date of sampling (enter from the choice list).
   • %Clim = (% Climate), Percent of growth of each species that has occurred relative to
normal growing conditions (enter from choice list).

- \( \% \text{AP} = (\% \text{Allowable Production}) \), percent of allowable production from the Ecological Site Description (ESD)

4. Review the reconstructed yield levels which are automatically calculated.

- **Total Weight (g)**: Total unadjusted weight of all 10 production quadrats in grams. This value will be adjusted by the reconstruction factor calculated in the previous procedure.
- **Reconstructed weight (lbs/ac)**: Reconstructed weight in pounds of air dry forage per acre.

5. Upon completion of all data entry, the similarity index will be displayed in the parameters screen. It is a good idea to review this value to verify that no data entry errors were made.

<table>
<thead>
<tr>
<th>Transect 1 (NE-SW) Grams/Quadrat @ Mark</th>
<th>Species W 12.5 38 63 113 138</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOER4 black grama</td>
<td>20 40 0 40 0</td>
</tr>
<tr>
<td>SPCR sand dropseed</td>
<td>0 0 30 0 40</td>
</tr>
<tr>
<td>GUSA2 broom snakeweed</td>
<td>0 0 0 0 40</td>
</tr>
<tr>
<td>ERLO5 longleaf buckwheat</td>
<td>0 0 4 0 0</td>
</tr>
<tr>
<td>CRTE4 Texas croton</td>
<td>0 20 10 20 20</td>
</tr>
<tr>
<td>CHCH5 bristlecup sandmat</td>
<td>0 0 0 0 0</td>
</tr>
<tr>
<td>ACNA2 dwarf desert peony</td>
<td>0 0 0 0 0</td>
</tr>
<tr>
<td>ERLE Leymans lovegrass</td>
<td>0 0 0 0 0</td>
</tr>
<tr>
<td>YUEL soaptree yucca</td>
<td>X 80 85</td>
</tr>
<tr>
<td>OPPO Plains prickleypear</td>
<td>X 225 225</td>
</tr>
</tbody>
</table>

**Figure 14-6.** Field weight data entry for transect 1 (NE-SW), mrk 12.5 (ecosite option). Use the radio buttons adjacent to transect mrks to select another quadrat.
Species Composition by Weight (Non-Federal Rangeland Only) | 14-9

Figure 14-7. Field weight data for transect 2 (NW/SE). Use the ‘Add’ button to add more species than can be displayed on one page. To move from page to page, use the page pull down menu.

<table>
<thead>
<tr>
<th>Transect 2 (NW-SE)</th>
<th>Grams/Quadrat @Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species</td>
<td>W</td>
</tr>
<tr>
<td>BOER4 black grama</td>
<td>10</td>
</tr>
<tr>
<td>SPCR sand dropseed</td>
<td>0</td>
</tr>
<tr>
<td>GUSA2 broom snakeweed</td>
<td>10</td>
</tr>
<tr>
<td>ERLO5 longleaf buckwheat</td>
<td>0</td>
</tr>
<tr>
<td>CRTE4 Texas croton</td>
<td>0</td>
</tr>
<tr>
<td>CHCH5 bristlecup sandmat</td>
<td>0</td>
</tr>
<tr>
<td>ACNA2 dwarf desert peony</td>
<td>0</td>
</tr>
<tr>
<td>ERLE Leymans lovegrass</td>
<td>30</td>
</tr>
<tr>
<td>YUEL soaptree yucca</td>
<td>X</td>
</tr>
<tr>
<td>OPPO Plains prickleypear</td>
<td>X</td>
</tr>
</tbody>
</table>

Figure 14-8. Complete required reconstruction data entry for each plant species. The reconstruction factor, total weight, reconstructed weight and potential and allowable production will be automatically calculated.

<table>
<thead>
<tr>
<th>Species</th>
<th>%Dwt</th>
<th>%UnGr</th>
<th>%Grth</th>
<th>%Clim</th>
<th>%AP</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOER4</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>95</td>
<td>30</td>
</tr>
<tr>
<td>SPCR</td>
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<td>90</td>
<td>90</td>
<td>95</td>
<td>20</td>
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<td>100</td>
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<tr>
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<td>100</td>
<td>100</td>
<td>95</td>
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</tr>
<tr>
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<td>95</td>
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<td>95</td>
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<td>85</td>
<td>100</td>
<td>100</td>
<td>95</td>
<td>10</td>
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<td>100</td>
<td>100</td>
<td>95</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Chapter 15    Standing Biomass (Pastureland only)

15.1 Overview

This chapter covers data elements relating to:

- Field weight by quadrat (subplot)

15.2 What’s New

- Clarification in instructions that woody vines should be classified as low, medium, or high shrubs based on basal diameter.
- Update of section 15.4.1 Conditions for Data Collection to reflect updates to land cover/use codes in Chapter 6.

15.3 Critical Points to Remember

- Dry weight for herbaceous species may be determined by sub sample or total weight. This can be adjusted in the Params screen. Dry weight determinations should be done for each biomass subplot as species composition changes from along the transect.
- Enter weights for herbaceous plant in grams (g)
- Microwave or air dry sample or total to obtain dry weight
- States will specify the herbaceous quadrat frame size (1.92, 4.8, or 9.6 square feet) based on vegetation communities in their state.
- Dry weight for woody species is determined with the equation method by recording the species group, diameter, and number of stems or trees.
- Include plant biomass from stems and plant bases rooted from inside the frame area at each biomass subplot location (canopy both inside and outside the subplot). Conversely, all plants rooted outside the quadrant with overhanging vegetation in the subplot are considered "outside the subplot and not recorded.
- Include both living and dead plant material considered plant canopy (do not include ground litter in the biomass sample)
- There are a total of 5 herbaceous subplots and 2 two expanded woody subplots.
- All subplot frames are centered at the predetermined transect mrks tangent to the north side of the tape.
- The center of woody plants must be at least 50% within the expanded subplot’s edge to be included.

15.4 Preliminary Steps

15.4.1 Conditions for Data Collection

- For the non-Federal pasture or range samples, standing biomass data are documented for non-Federal points with land cover/use 2000 Grassland not managed as range or 2200 Scrub Shrub not managed as range.

15.4.2 Ancillary Resources
In addition to the basic data collection materials noted in chapter 2, the following ancillary resources are required:

- Plant identification aids
- Forage Suitability Groups

15.5 Data Collection Procedure for Standing Biomass

15.5.1 Definitions

**Herbaceous Plant.** A term used to reference vegetative plants with little or no woody component, usually graminoids and forbs. [NRPH]

**Woody plant.** A term used in reference to trees, shrubs, or browse that characteristically contain a persistent ligneous material. [NRPH]

**Biomass subplot (quadrat).** A subplot or quadrat established along the transect at predetermined intervals to provide areas for determining biomass by species.

- Herbaceous biomass subplots are centered on mrks at 12.5 and 137.5 feet in the NW/SE transect and 37.5, 62.5 and 112.5 in the NE/SW transect. Quadrat size can be 1.92, 4.8, or 9.6 square feet. Each state will specify the herbaceous quadrat size based on vegetation communities in their state. Correction factors (grams to lbs/acre) are defaulted based when subplot size is chosen in the CASI.

- Woody biomass subplots are centered on mrks at 37.5 and 112.5 feet along the NE/SW transect only. The subplot size is 435.6 square feet (0.01 acre).

Subplots (quadrats) are established as shown in the subplot design (figure 15.1). Herbaceous subplots are represented by the small circles and woody subplots by the larger circles.

15.5.2 Procedure

15.5.2.1 Herbaceous Biomass Subplots

1. Tap the parameters button and enter the herbaceous subplot size. States will specify the herbaceous subplot size/sampling frame (1.92, 4.8 or 9.6 square feet) that will consistently represent production.

   - For sod-forming pastures, the 1.92 ft² sampling frame is recommended.
   - For bunchgrass pastures, the sampling frame size may need to be increased to 4.8 ft² or 9.6 ft² to accommodate several plant crowns.
• **Note:** The expanded woody subplots at 37.5 and 112.5 ft marks on the NE/SW transect defaults to 0.01 acre size (23.5 ft diameter circle or 20.9 ft. square).

• Refer to the National Range and Pasture Handbook Chapter 4, section 600.0401c and exhibits 4.1, 4.2 and 4.4 for additional information and reference.

2. From the parameters screen, enter the dry weight determination method for mechanical harvest of herbaceous plant material. Dry weight can be determined in the CASI using one of two methods listed below.

   • **Sub sample:** Total green weight in grams is entered in the CASI and a sample of the material is obtained to determine air dry weight. Sample green weight and sample dry weight are also entered and the CASI makes a final calculation to determine total subplot dry weight.

   • **Total:** Total green weight in grams is entered in the CASI and the entire sample is maintained for dry weight determination which is then entered in CASI.

3. Start at the zero (0.0) end of the NE-SW transect (transect 1).

   • For additional information on the subplot and transect, refer to Chapter 3, Section 3.6, Procedure for Establishing/Documenting the Sample Plot and Transects.

   • Always stand on the south side of the transect to avoid disturbing the measurement area.

   • The line should be taut and placed as close to the ground as possible.

4. For each subplot, center the sampling frame tangent to the north side of the tape at the predetermined transect mrk. Transect mrks are shown in figure 15-1. There are a total of 5 herbaceous subplots and two expanded woody subplots.

5. Clip and weigh the total subplot green field weight and enter as total green weight in the CASI.

   • Include both living and dead plant material (canopy both inside and outside the quadrat) produced by stems and plant bases growing inside the biomass subplot.

   • Conversely, all plants rooted outside the subplot with overhanging vegetation in the subplot are considered "outside the subplot" and not recorded.

   • When clipping herbaceous vegetation, harvest to ground level.

6. Data entry requirements for dry weight determination vary by which method was selected under the parameters screen.

   • For the **sub sample** protocol:
     - Take well mixed sample of material from the total green weight harvest. Record the green weight of this sample in grams in the sub-sample weight data entry cell.
     - Air dry this sample and then record the sub sample dry weight in the CASI. The CASI will then compute the total dry weight for the biomass subplot.

---

**Figure 15-2.** Access the parameters screen before data entry. This screen is used to set plot size and harvest methods.
• For the total protocol:
  o Air dry the entire biomass subplot harvest and enter this value as total dry weight in the CASI.

7. Repeat steps 4-6 for each designated subplot on both transects.

The CASI will display the total dry weight production per acre in the parameters screen based on the entered subplot size and a full set of harvested subplots.

15.5.2.2 Woody Biomass Subplots (Equation based)

Species: Woody plant species or plant type groups that can be estimated using the equation based woody biomass method.

Tree Diameter at Breast Height (dbh): Tree dbh is outside bark diameter at breast height. Breast height is defined as 4.5 feet (1.37m) above the forest floor on the uphill side of the tree. Trees with multiple stems from the base will count each stem as a separate tree. Figure 15-3 shows standard points of measurements for DBH.

Shrub Diameter at Base: Diameter of shrub stem as determined at the base of the plant.

1. Expanded woody subplots are located at t 37.5 and 112.5 ft marks on the NE/SW transect. 2.
   • If any woody plants are present, layout an expanded woody subplot 0.01 acre in size (23.5 ft diameter circle or 20.9 ft. square).

2. Review the expanded subplot carefully and classify the any rooted woody material (live or dead) into plant species/size groups.

3. Select the plant species/group from the CASI choice list.
   • The same species/group may be entered more than once if there is a significant difference in size of the plant diameter.

4. Enter stem diameter for the identified species groups (table 15-2).
   • For trees, enter the dbh for the species group in centimeters.
   • For shrubs, enter the stem diameter at the base of the plant in centimeters.

5. Enter the number of plants (e.g., number of trees or stems) for each species/group.

6. Repeat this procedure for any other woody species/group identified as part of the woody subplot.
Fig. 15.3. Standards for measuring dbh for various situations in the field: (a) level ground; (b) sloping ground; (c) uneven ground; (d) leaning trees; (e) crook near breast height; (f) defects and trees with swellings, bumps, depressions, and branches at DBH, measure diameter immediately above the irregularity at the place it ceases to affect normal stem form; (g) trees forked at or above 4.5 feet. Trees forked at or above 4.5 feet are counted as one single tree). If a fork occurs at or immediately above 4.5 feet, measure diameter below the fork just beneath any swelling that would inflate DBH; (h) trees forked between 1.0 foot and 4.5 feet. Trees forked between 1.0 foot and 4.5 feet are measured as separate trees; (i) buttressed tree, trees with butt-swell or bottleneck: Measure these trees 1.5 feet above the end of the swell or bottleneck if the swell or bottleneck extends 3.0 feet or more above the ground.
Table 15-2. A choice list is provided to categorize woody plants into species groups.

<table>
<thead>
<tr>
<th>Species Group/Growth habit</th>
<th>Additional classification information - maximum diameter limits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enter dbh in cm (trees)</strong></td>
<td></td>
</tr>
<tr>
<td>Aspen, Alder, Cottonwood</td>
<td>70 cm</td>
</tr>
<tr>
<td>Soft maple, Birch</td>
<td>66 cm</td>
</tr>
<tr>
<td>Mixed hardwoods</td>
<td>56 cm</td>
</tr>
<tr>
<td>Hard maple, Oak, Hickory, Beech</td>
<td>73 cm</td>
</tr>
<tr>
<td>Cedar, Larch</td>
<td>250 cm</td>
</tr>
<tr>
<td>Douglas fir</td>
<td>210 cm</td>
</tr>
<tr>
<td>True fir, Hemlock</td>
<td>230 cm</td>
</tr>
<tr>
<td>Pine</td>
<td>180 cm</td>
</tr>
<tr>
<td>Spruce</td>
<td>250 cm</td>
</tr>
<tr>
<td>Juniper, Scrub oaks, mesquite</td>
<td>78 cm</td>
</tr>
<tr>
<td><strong>Enter basal diameter in cm (shrubs)</strong></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>(≈ 0.1 to 2.5 ft) and 0.1 to 1.7 cm basal diameter)</td>
</tr>
<tr>
<td>Medium Shrub</td>
<td>(2.5 to 8 ft) and 0.3 to 7.0 cm basal diameter)</td>
</tr>
<tr>
<td>High Shrub</td>
<td>(&gt; 8.0 ft) and 0.4 to 7 cm basal diameter)</td>
</tr>
</tbody>
</table>

*Woody vines should be classified as low, medium, or high shrubs based on basal diameter.

15.6 References

Chapter 16  Plant Census

16.1 Overview
This chapter covers data elements relating to:

- Vegetation composition
- All plants, including invasive plants
- Plants not encountered in other protocols

16.2 What’s New
- Update of section 16.4.1 Conditions for Data Collection to reflect updates to land cover/use codes in Chapter 6.

16.3 Critical Points to Remember
- This should be one of the last protocols completed as plants identified in other protocols can be automatically imported into the census list.
- Care should be taken to not trample the plot as this could impact the identification of some plant species.
- Identify all plants in macroplot by genus and species
- Include all plants not imported into the census from other protocols, including those that are rare or occur infrequently.
- Timed search for 15 minutes.
- Plant species richness will be determined from this protocol
- If plant >= to 3.0% cover, and species is unknown; identify at least to genus.

16.4 Preliminary Steps
16.4.1 Conditions for Data Collection
- For the non-Federal range sample, plant census data are documented for non-Federal points with land cover/use of grassland (LCU = 2001 Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).
- For the non-Federal pasture sample, plant census data are documented for non-Federal points with land cover/use of grassland (LCU = 2001 Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).
- For the BLM range sample, plant census data are documented for BLM-managed Federal points with land cover/use of grassland defined as range (LCU = 2001 Grassland defined as range) or scrub shrub defined as range (LCU = 2201 Scrub Shrub defined as range).

16.4.2 Ancillary Resources
None required.
16.5 Data Collection Procedure for Plant Census

16.5.1 Equipment

- Plant identification keys, books, or other aids.

16.5.2 Definitions

Macroplot. A circular area 150 feet in diameter centered on the NRI sample point. The plot is defined by the outermost points of two transects 150 feet in length that intersect at the NRI sample point. Transect bearings are set on a diagonal from northeast (NE) to southwest (SW) and northwest (NW) to southeast (SE). A labeled plot diagram is shown in figure 16-1.

16.5.3 Procedure

1. This protocol should be done after plant height and line point intercept protocols are complete. Plant species identified in either of these protocols can be automatically imported into the plant census protocol.

2. Tap the **Import** button to bring all previously identified plants into the protocol plant list.
   - To aid in viewing the list, a sort function is also included with this protocol. Tap the **Sort** button to sort alphabetically by plant symbol designation.

3. Begin a timed search (15 minutes) for any additional plant species.
   - A timer is included on this protocol screen. Tap it to begin the 15 minute timed ID session.
   - If at least 1 new species is encountered in last 2 minutes of search, continue searching in 2 minute intervals until no new species are encountered within the ultimate 2 minute interval.
   - This protocol uses the same USDA-Plants plant choice lists and techniques as plant height and the line point intercept protocols.
   - Do not use the 15 minute time frame to identify unknown plants. Place them aside and work on ID at a later time.
   - If the species represents at least 3% of the plot plant cover, identify at least to genus.
   - Whenever possible, provide plant ID to the genus and species. Sub species, varieties and cultivars are not included as part of this survey and not included in the CASI plants data base.

4. Upon completion of the timed search, estimate a tally for each plant and place it in one of the following categories:
   - 1: 1 to 10 plants
   - 2: 11 to 100 plants
   - 3: 101 to 500 plants
   - 4: 501 to 1000 plants
   - 5: > 1000 plants

---

Figure 16-1. Transect layout and macroplot diagram.
Chapter 17  Resource Concerns

17.1 Overview

This chapter covers data elements relating to:

- Resource Concerns
  - Soil
  - Water
  - Air
  - Plants
  - Animals

Data entry screens for Resource Concerns:

17.2 What’s New

- Update of section 17.3.1 Conditions for Data Collection to reflect updates to land cover/use codes in Chapter 6.

17.3 Preliminary Steps

17.3.1 Conditions for Data Collection

- For the non-Federal range sample, resource concern data are documented for non-Federal points with land cover/use of grassland (LCU = 2001 Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).
- For the non-Federal pasture sample, resource concern data are documented for non-Federal points with land cover/use of grassland (LCU = 2001 Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).
- For the BLM range sample, resource concern data are documented for BLM-managed...
Federal points with land cover/use of grassland defined as range (LCU = 2001 Grassland defined as range) or scrub shrub defined as range (LCU = 2201 Scrub Shrub defined as range).

17.3.2 Ancillary Resources

In addition to the basic data collection materials, the following materials may be useful in collecting data for this chapter:

- Engineering Field Manual
- State Drainage Manual
- Section 3 of Field Office Technical Guide (FOTG)
- National Handbook of Conservation Practices (NHCP)
- National Range and Pasture Handbook (NRPH)

17.4 Data Collection Procedures for Resource Concerns

17.4.1 Definitions

**Resource Concerns.** An identified conservation problem used to set quality criteria and treatment needs for a resource management system. NRCS has historically divided major resource concerns into the general categories of Soil, Water, Air, Plant, and Animal (SWAPA). [NRI-2000]

**Conservation Management Unit (CMU).** The CMU shall be considered equivalent to the field (fenced or delineated by other means) where the NRI point resides. If no field boundary exists, use a distance of 1,000 ft as a boundary. Do not cross public roads, railroads, or obvious ownership boundaries within the 1,000 ft distance. [NRI-2008 Pasture Pilot On-Site Study]

17.4.2 Procedure

1. Determine correct sample point location for data collection. The correct location is the certified point location as depicted on the site map. Certified locations are the geographic coordinate system descriptions of NRI sample points and segments that accurately describe the location of each point and segment in prior NRI data collection. The certified location is unique for each point and segment.

2. Identify the CMU (the area considered for conservation planning) where the sample point falls.

3. Identify any conditions that are associated with the 22 resource concerns at the sample point and CMU.

- A list of 20 concerns organized by SWAPA categories along with definitions is available in Section 17.5, Supporting Materials.
- If multiple sample points occur within the same field or treatment unit, resource concern information must be entered for each sample point.

4. Enter (Y) for any identified resource concern from the list of displayed potential concerns.

17.5 Supporting Materials

17.5.1 Soil Concern Definitions

17.5.1.1 Soil Erosion

**Sheet & Rill** - Detachment and transport of soil particles caused by rainfall splash and runoff degrade soil quality.

**Wind** - Detachment and transport of soil particles caused by wind degrade soil quality and/or damage plants.

**Classic Gully** - Deep, permanent channels caused by the convergence of surface runoff degrade soil quality. They enlarge progressively by headcutting and lateral widening.

**Streambank** - Accelerated loss of streambank soils restricts land and water use and management.

**Shoreline** - Soil is eroded along shorelines by wind and wave action, causing physical damage to vegetation, limiting land use, or creating a safety hazard.

**Mass Movement** - Soil slippage, landslides, or slope failure, normally on hillsides, result in large volumes of soil movement.

17.5.1.2 Soil Condition

**Organic Matter Depletion** - Soil organic matter has or will diminish to a level that degrades soil quality.

**Compaction** - Compressed soil particles and aggregates caused by grazing and/or mechanical compaction. Compaction effects adversely affect hydrology and soil moisture relationships.

**Damage From Soil Deposition** - Sediment deposition damages or restricts land use/management or adversely affects ecological processes.

17.5.2 Water Concern Definitions

17.5.2.1 Water Quantity

**Excessive Runoff, Flooding, or Ponding** - Water from runoff, flooding, or ponding having an adverse effect on land use and management.

**Reduced Storage of Water-bodies by Sediment Accumulation** - Sediment deposits in waterbodies reduce the desired volume capacity.

**Insufficient Flows in Water Courses** - Water flows are not consistently available in sufficient quantities to support ecological processes and land use and management.

17.5.2.2 Water Quality

**Excessive Nutrients and Organics in Surface Water** - Pollution from natural or human induced nutrients, such as N, P, and organics (including animal and other wastes), degrades surface water quality.
**Excessive Suspended Sediment and Turbidity in Surface Water** - Pollution from mineral or organic particles degrades surface water quality.

### 17.5.3 Plant Concern Definitions

17.5.3.1 Plant Condition

**Plant Not Adapted or Suited** - Plants are not adapted and/or suited to site conditions.

**Productivity, Health and Vigor** - Plants do not produce the yields, quality, and soil cover to protect the resource.

**Noxious and Invasive Plants** - The site has noxious or invasive plants present.

**Forage Quality and Palatability** - Plants do not have adequate nutritive value or palatability for the intended use.

**Wildfire Hazard** - The kinds and amounts of fuel loadings (plant biomass, dry litter) pose a wildfire risk to human safety, structures, and land resources.

### 17.5.4 Animals Concern Definitions

17.5.4.1 Domestic Animal

**Inadequate Stock Water** - The quantity, quality, and distribution of drinking water are insufficient to meet the production goals for the kinds and classes of livestock.
18.1 Overview
This chapter covers data elements relating to:

- Conservation Practices

Data entry screens for Conservation Practices:

18.2 What’s New

- Update of section 18.4.1 Conditions for Data Collection to reflect updates to land cover/use codes in Chapter 6.
- Practice 575 now correctly labeled as “Trails and Walkways” instead of “Animal Trails and Walkways.”

18.3 Critical Points to Remember

- Conservation practice application and needs are determined for the conservation management unit (CMU). The point need not fall directly on the practice to be considered applied/needed for the point. The area of consideration for determining conservation application/need may extend beyond the segment boundary, but must be in the conservation management unit where the sample point falls.
- Conservation practices should be recorded if visually apparent for any NRI year in which they are applied, maintained, and functioning according to the State practice standard. They are not just reported the year they are first established. For example, the practice Pond [Practice = 378] should be reported when the pond is initially established and thereafter as long as it is maintained and functioning according to the practice standard.
18.4 Preliminary Steps

18.4.1 Conditions for Data Collection

- For the non-Federal range sample, conservation practice data are documented for non-Federal points with land cover/use of grassland (LCU = 2001 Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).
- For the non-Federal pasture sample, conservation practice data are documented for non-Federal points with land cover/use of grassland (LCU = 2001 Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).
- For the BLM range sample, conservation practice data are documented for BLM-managed Federal points with land cover/use of 2001 Grassland defined as range or 2201 Scrub Shrub defined as range.

18.4.2 Ancillary Resources

In addition to the basic data collection materials noted in chapter 2, the following ancillary resource is required:

- Field Office Technical Guide Section IV (See appropriate state.)

Materials useful in collecting data for this chapter include:

- National Handbook of Conservation Practices
- Frequently Asked Questions (FAQs) for Conservation Practices
- Glossary
- Ancillary information provided by field office staff

18.5 Data Collection Procedure for Conservation Practices

18.5.1 Definitions

**Conservation practice.** A specific treatment, such as a structural or vegetative measure, or management technique commonly used to meet specific needs in planning and implementing conservation for which standards and specifications have been developed. Conservation practices are in the Natural Resources Conservation Service’s Field Office Technical Guide, Section IV, which is based on the National Handbook of Conservation Practices [NPPH-98]. The practices recorded for NRI have been applied to the area of land in which the NRI point falls or the portion of the field that would be used in conservation planning (CMU). The point need not fall on a specific practice. [NRI-97]

Each state determines which national practice standards will be adapted for use in their state and issues them as state conservation practice standards in Section IV of the Field Office Technical Guide. The state adds technical details and minimum standards for practice application. This guide should be referenced for state-specific practice information. Practices reported as applied for the point must meet the minimum standards established in the published state practice standards.

**Conservation Management Unit (CMU).** For purposes of the NRI, a defined area for
consideration of a protocol. For conservation practices, the CMU shall be considered equivalent to the field (fenced or delineated by other means) where the NRI point resides. If no field boundary exists, use a distance of 1,000 ft as a boundary. Do not cross public roads, railroads, or obvious ownership boundaries within the 1,000 ft distance. [NRI-2008 Pastureland On-Site Study].

**18.5.2 Procedure**

1. Identify the CMU in which the point falls for the current survey year.

2. Identify any conservation practices that are applied in the specified area associated with the point.
   - A detailed definition of each NRI conservation practice and the appropriate land cover/use category are included in Section 18.6, Supporting Materials.
   - To be considered applied, a conservation practice must:
     - be visually apparent on the site,
     - meet the national standard definition and the minimum state standard, and
     - be functioning and maintained according to the intended purpose.
   - If multiple sample points occur within the same field or treatment unit, conservation practice information must be entered for each point.

3. Enter the applied practice information in the CASI.
   - Check the **Yes (Y)** box for any applied practices for the current survey year.
   - Check the **No (N)** box if the practice is not present.
   - A Yes (Y) or No (N) must be checked for each practice on all CASI screens (Set I and Set II).

4. If a ‘no’ is entered for a practice, determine if the practice is needed to treat a resource concern or facilitate other conservation practices in a resource management system.
   - Check the **Yes (Y)** box if the practice is needed.
   - Check the **No (N)** box if the practice is not needed.
   - A Yes (Y) or No (N) must be checked for each practice shown as not applied.

**Note:** Depending on initial land classification (pasture or rangeland), some practices will be grayed out so they cannot be answered.
18.6 Supporting Materials

Table 18-1. Summary of practice codes, names, and definitions (source: National Handbook of Conservation Practices)

<table>
<thead>
<tr>
<th>Practice Number</th>
<th>Practice Name</th>
<th>Practice Description</th>
<th>Range only</th>
<th>Pasture only</th>
</tr>
</thead>
<tbody>
<tr>
<td>314</td>
<td>Brush Management</td>
<td>Removal, reduction, or manipulation of nonherbaceous plants.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>338</td>
<td>Prescribed Burning</td>
<td>Applying controlled fire to a predetermined area.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>378</td>
<td>Pond</td>
<td>A water impoundment made by constructing an embankment or by excavating a pit or dugout.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>380</td>
<td>Windbreak/Shelterbelt Establishment</td>
<td>Linear plantings of single or multiple rows of trees or shrubs or sets of linear plantings.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>382</td>
<td>Fence</td>
<td>A constructed barrier to livestock, wildlife, or people.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>390</td>
<td>Riparian Herbaceous Cover</td>
<td>Grasses, grass-like plants and forbs that are tolerant of intermittent flooding or saturated soils and that are established or managed in the transitional zone between terrestrial and aquatic habitats.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>393</td>
<td>Filter Strip</td>
<td>A strip or area of herbaceous vegetation that removes contaminants from overland flow.</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>449</td>
<td>Irrigation Water Management</td>
<td>The process of determining and controlling the volume, frequency and application rate of irrigation water in a planned, efficient manner.</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>512</td>
<td>Forage and Biomass Planting</td>
<td>Establishing native or introduced forage species.</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>516</td>
<td>Pipeline</td>
<td>Pipeline having an inside diameter of 8 inches or less.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>528</td>
<td>Prescribed Grazing</td>
<td>Managing the controlled harvest of vegetation with grazing animals.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>548</td>
<td>Grazing Land Mechanical Treatment</td>
<td>Modifying physical soil and/or plant conditions with mechanical tools by treatments, such as pitting, contour furrowing, and ripping or subsoiling.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practice Number</td>
<td>Practice Name</td>
<td>Practice Description</td>
<td>Range only</td>
<td>Pasture only</td>
</tr>
<tr>
<td>-----------------</td>
<td>----------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------</td>
<td>--------------</td>
</tr>
<tr>
<td>550</td>
<td>Range Planting</td>
<td>Establishment of adapted perennial vegetation, such as grasses, forbs, legumes, shrubs, and trees.</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>574</td>
<td>Spring Development</td>
<td>Utilizing springs and seeps to provide water for a conservation need.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>575</td>
<td>Trails and Walkways</td>
<td>A trail is a constructed path with a vegetated or earthen surface. A walkway is a constructed path with an artificial surface. A trail/walkway is used to facilitate the movement of animals, people, or off-road vehicles.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>614</td>
<td>Watering Facility</td>
<td>A device (tank, trough, or other watertight container) for providing animal access to water.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>642</td>
<td>Water Well</td>
<td>A hole drilled, dug, driven, bored, jetted, or otherwise constructed to an aquifer.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>666</td>
<td>Forest Stand Improvement</td>
<td>The manipulation of species composition, stand structure and stocking by cutting or killing selected trees and understory vegetation.</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>
Chapter 19  Disturbance Indicators

19.1 Overview

This chapter covers data elements relating to:

- Past and present disturbance of the listed indicators

Screen shots of screen 1 and 2 disturbances. Five other screens are used for recording disturbances.

19.2 What’s New

- Changed layout from five screens to seven screens in order to make buttons easier to toggle without a stylus.
- Update of section 19.4.1 Conditions for Data Collection to reflect updates to land cover/use codes in Chapter 6.

19.3 Critical Points to Remember

- Conduct at the macro plot and conservation management unit level (CMU)
- Both past and present disturbances will be evaluated for the 0.40 acre (150-foot diameter circular) sample area and the (CMU).
- Thirty-five indicators of disturbance will be assessed for each sample site.

19.4 Preliminary Steps

19.4.1 Conditions for Data Collection

- For the non-Federal range sample, disturbance indicator data are documented for non-Federal points with land cover/use of grassland (LCU = 2001 Grassland defined as range
or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).

• For the non-Federal pasture sample, disturbance indicator data are documented for non-Federal points with land cover/use of grassland (LCU = 2001 Grassland defined as range or 2000 Grassland not defined as range) or scrub shrub (LCU = 2201 Scrub Shrub defined as range or 2200 Scrub Shrub not defined as range).

• For the BLM range sample disturbance indicator data are documented for BLM-defined Federal points with land cover/use of grassland defined as range (LCU = 2001 Grassland defined as range) or scrub shrub defined as range (LCU = 2201 Scrub Shrub defined as range).

19.4.2 Ancillary Resources
No specific materials or tools are needed to complete this information.

19.5 Data Collection Procedures

19.5.1 Definitions

Disturbance indicators. Displacement or dislocation of the natural state of a sample site resulting from human induced, natural events, or other occurrences. Thirty-five visually observable features are rated for the degree of disturbance evident within the 0.40-acre (150-foot diameter circular) sample area and the expanded conservation management unit plot.

Conservation Management Unit (CMU). For purposes of this protocol, the CMU shall be considered equivalent to the field (fenced or delineated by other means) where the NRI point resides. If no field boundary exists, use a distance of 1,000 ft as a boundary. Do not cross public roads, railroads, or obvious ownership boundaries within the 1,000 ft distance.

For purposes of this protocol present is defined as occurring within the last year, past as over one year.

19.5.2 Procedure
For each disturbance indicator:

• Determine if Past evidence of disturbance exists (over 1 year ago)
• Determine if Present evidence of disturbance exists (within a year’s time)

1. Examine the entire macro plot area and determine if any of the 35 causes of disturbance are evident. Identify disturbances that are easily and readily observed for the sample area for each of the following categories:

• Cultivation (plowing, disking, cultivator, chisel plow etc.)
• Mowing (clipping)
• Hay removal
• Heavy machinery (soil disturbance from)
• Seedbed preparation (tillage implements, drill)
• Livestock tanks, spring development
• Livestock heavy use area
• Livestock grazing
2. Enter **Disturbance** information in the data collection worksheet for the macro plot column.

   - Indicate the absence (N) or presence (Y) of **Past** disturbance for the 35 categories on **Dist 1** and **2** screens.

3. Repeat the disturbance assessment for the CMU-expanded area.

**19.6 Supporting Materials**

N/A
Chapter 20  Rangeland Health (Rangeland only)

20.1 Overview

This chapter covers data elements relating to Rangeland Health:

- Rills
- Waterflow patterns
- Pedestals and/or Terracettes
- Bare Ground
- Gullies
- Wind-Scoured Areas
- Litter Movement
- Soil Surface Resistance to Erosion
- Soil Surface Loss or Degradation
- Infiltration and Runoff
- Compaction Layer
- Functional/Structural Groups
- Plant Mortality/Decadence
- Litter Amount
- Annual Production
- Invasive Plants
- Reproductive Capability of Perennial Plants

Rangeland Health CASI data entry screens:
Describing Indicators of Rangeland Health (DIRH) CASI data entry screens:

20.2 What’s New

- Update of section 20.4.1 Conditions for Data Collection to reflect updates to land cover/use codes in Chapter 6.

20.3 Critical Points to Remember

- The rangeland health protocol is a qualitative assessment that provides an early warning of resource problems at the ecological site level related to:
  - soil/site stability
  - hydrologic function
  - integrity of the biotic community
- When more than one ecological site is determined to be part of the 150 foot circular plot, use the ecological site at the point for all assessment comparisons.
- This protocol is not appropriate or available for any points classified as pastureland. Pasture condition score (Chapter 20) is used to evaluate pastureland.

20.4 Preliminary Steps

20.4.1 Condition for Data Collection

- For the non-Federal range sample, rangeland health data are documented for non-Federal points with land cover/use of grassland defined as range (LCU = 2001 Grassland defined as range) or scrub shrub defined as range (LCU = 2201 Scrub Shrub defined as range).
- For the non-Federal pasture sample, rangeland health data are documented for non-Federal points with land cover/use of grassland defined as range (LCU = 2001 Grassland defined as range) or scrub shrub defined as range (LCU = 2201 Scrub Shrub defined as range).
- For the BLM range sample, rangeland health data are documented for BLM-managed Federal points with land cover/use of grassland defined as range (LCU = 2001 Grassland defined as range).
defined as range) or scrub shrub defined as range (LCU = 2201 Scrub Shrub defined as range).

20.4.2 Ancillary Resources

In addition to the basic data collection materials noted in chapter 2, the following materials may be useful in collecting data for this chapter:


20.5 Data Collection Procedures for Rangeland Health and Describing Indicators of Rangeland Health (DIRH)

20.5.1 Definitions

**Rangeland health.** The degree to which the integrity of the soil, vegetation, water, and air, as well as the ecological processes of the rangeland ecosystem, are balanced and sustained. Integrity is defined as maintenance of the structure and function attributes characteristic of a locale, including normal variability. [SRM]

**Indicator.** Components of a system whose characteristics (e.g., presence or absence, quantity, distribution) are used as an index of an attribute (e.g., rangeland health) that are too difficult, inconvenient or expensive to measure. [TR 1734-6 2005]

**Ecological site description (ESD).** A description of the soils, uses, and potential of a kind of land with specific physical characteristics to produce distinctive kinds and amounts of vegetation. [TR 1734-6 2005]

**Attributes of Rangeland Health (ecological processes).**

- **Soil/site stability.** The capacity of a site to limit redistribution and loss of soil resources (including nutrients and organic matter) by wind and water. [TR 1734-6 2005]
- **Integrity of the Biotic Community.** Capacity of a site to support characteristic functional and structural communities in the context of normal variability, to resist loss of this function and structure due to a disturbance, and to recover following such disturbance. [TR 1734-6 2005]
- **Hydrologic function.** The capacity of the site to capture, store, and safely release water from rainfall, run-on, and snowmelt, to resist a reduction in this capacity, and to recover this capacity following degradation. [TR 1734-6 2005]

20.5.2 Procedure

Use the information provided in Table 20-1 to determine which “Soil Survey/ESD Status Class” (“status class”) best describes the plot. The table uses a combination of soil survey and ESD availability and detail to aid in the determination of the status class.

- For plots that are in status class 1 or 2, use the Rangeland Health procedure (section 20.5.2.1).
- For plots that are in status class 3, follow instructions to complete the DIRH procedure (section 20.5.2.2).
20.5.2.1 Procedure for Rangeland Health

1. Identify the degree of departure from ecological site description for each of the 17 rangeland health indicators.
   - Ecological processes (water cycle, energy flow, and nutrient cycle) functioning within a normal range of variation will support specific plant and animal communities. Biological and physical attributes are often used as indicators of the functional status of ecological processes and site integrity.
   - The area of consideration for determining the rangeland health indicators is the 150-foot diameter sample area around the PSU point.
   - Select the degree of departure from the ESD for each indicator. The five degrees of departure are:
     - Extreme to total
     - Moderate to extreme
     - Moderate
     - Slight to moderate
     - None to slight
   - Use the Rangeland Health Indicator Evaluation Matrix (Table 2) to determine the degree of departure from the ESD for each of the 17 indicators.
   - Use the Ecological Reference Worksheet and the example to describe the potential for the site.
   - Use the Evaluation Sheet Example and Evaluation Sheet to assign and document indicator ratings.

2. Enter rangeland health information for each indicator in the CASI.
   - Rangeland health indicators are listed on two CASI screens: Set I, with 10 indicators and Set II with the remaining 7 indicators.
   - When all 17 rangeland health indicators have been completed, the CASI will tally the data in and produce Indicator Summary for each of the three ecological processes.


4. Enter rangeland health information for each attribute in the CASI.

20.5.2.2 Procedure for Describing Indicators of Rangeland Health (DIRH)

1. The DIRH matrix is found in Table 3, and is to be used on all NRI plots that fall into Status Class 3 (refer to Table 1). Select the Class which best-fits the current conditions in the NRI evaluation area.
   - Where there are multiple criteria, choose the class with the best match. As a last resort, select the ‘median’ class for all of the criteria. For example, #2-Water Flow Patterns, includes three criteria: length, density, and intensity of water flow patterns. A site with long, common, occasionally connected water flow patterns would fall into Class 3.
   - Take photos of indicators where they may help a future evaluator make an evaluation based on a future reference sheet and the information in Table 2.
2. In the CASI, on the “Eco Site/FSG” screen, select XE (no ESD available) in the “State” drop-down box.

3. The DIRH form will appear when the ‘Rangeland Health’ screen is selected.

4. Complete the DIRH form based on Table 3 in Section C of these instructions.
   - For each indicator that is not grayed-out, check the description that best fits the conditions on the site.
   - Indicators that are grayed-out will be generated later from the Line-Point Intercept (LPI) data, except for annual production, which must be entered in the notes for plots on BLM-managed lands.

5. Enter pertinent, descriptive notes in the CASI for the following:
   - Total production. Record this as an “Ecological” note from the Tools menu on the CASI.
   - Other information (optional). Record as an “Ecological” note from the Tools menu on the CASI.

6. Take supplementary photos to illustrate key indicators in the DIRH matrix. Describe the DIRH indicator in the notes section of the NRI Grazing Land Images application (https://www.nrisurvey.org/grazinglandImages).

20.6 Supporting Materials
Table 20-1. Determination of Soil Survey/ESD Status Class.

<table>
<thead>
<tr>
<th>Soil Survey / ESD Status Class</th>
<th>Soil survey status</th>
<th>ESD status</th>
<th>ID Soil Map Unit Component?</th>
<th>ID Ecological Site?</th>
<th>Complete IIRH? (version 4 or later)²</th>
<th>Complete all other methods?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Soil survey exists</td>
<td>ESD exists¹</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>No soil survey, but soils comparable to soil described in another soil survey within the MLRA.</td>
<td>Ecological sites described for MLRA, including precip zone for NRI point.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>No relevant soil info</td>
<td>Ecological sites not described for MLRA³</td>
<td>No. Follow DIRH instructions.</td>
<td>No</td>
<td>No. Follow DIRH instructions.</td>
<td>Yes</td>
</tr>
</tbody>
</table>

¹ If a soil survey exists, it should at least have range sites identified.
² Develop a reference sheet if one does not exist.
³ No ESD within the MLRA has been completed, and the ESD for the NRI point does not exist.
Table 20-2. Rangeland Health Indicator Evaluation Matrix expressing degree of departure from Ecological Site Description.

<table>
<thead>
<tr>
<th>RH Indicator</th>
<th>Degree of Departure Extreme to Total</th>
<th>Degree of Departure Moderate to Extreme</th>
<th>Degree of Departure Moderate</th>
<th>Degree of Departure Slight to Moderate</th>
<th>Degree of Departure None to Slight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rills</td>
<td>Rill formation is severe and well defined throughout most of the area.</td>
<td>Rill formation is moderately active and well defined throughout most of the area.</td>
<td>Active rill formation is slight at infrequent intervals, mostly in exposed areas.</td>
<td>No recent formation of rills; old rills have blunted or muted features.</td>
<td>Current or past formation or rills as expected for the site.</td>
</tr>
<tr>
<td>2. Waterflow patterns</td>
<td>Extensive and numerous; unstable with active erosion; usually connected.</td>
<td>More numerous than expected; deposition and cut areas common; occasionally connected.</td>
<td>Nearly matches what is expected for the site; erosion is minor with some instability and deposition.</td>
<td>Matches what is expected for the site; some evidence of minor erosion. Flow patterns are stable and short.</td>
<td>Matches what is expected for the site; minimal evidence of past or current soil deposition or erosion.</td>
</tr>
<tr>
<td>3. Pedestals and/or terracettes</td>
<td>Abundant active pedestalling and numerous terracettes. Many rocks and plants are pedestalled; exposed plant roots are common.</td>
<td>Moderate active pedestalling; terracettes common. Some rocks and plants are pedestalled with occasional exposed roots.</td>
<td>Slight active pedestalling; most pedestals are in flow paths and interspaces and/or on exposed slopes. Occasional terracettes present.</td>
<td>Active pedestalling or terracette formation is rare; some evidence of past pedestal formation, especially in water-flow patterns and/or on exposed slopes.</td>
<td>Current or past evidence of pedestalled plants or rocks as expected for the site. Terracettes absent or uncommon.</td>
</tr>
<tr>
<td>4. Bare Ground</td>
<td>Much higher than expected for the site. Bare areas are large and generally connected.</td>
<td>Moderately to much higher than expected for the site. Bare areas are large and occasionally connected.</td>
<td>Moderately higher than expected for the site. Bare areas are of moderate size and sporadically connected.</td>
<td>Slightly to moderately higher than expected for the site. Bare areas are small and rarely connected.</td>
<td>Amount and size of bare areas nearly totally match that expected for the site.</td>
</tr>
<tr>
<td>RH Indicator</td>
<td>Degree of Departure Extreme to Total</td>
<td>Degree of Departure Moderate to Extreme</td>
<td>Degree of Departure Moderate</td>
<td>Degree of Departure Slight to Moderate</td>
<td>Degree of Departure None to Slight</td>
</tr>
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</tr>
<tr>
<td>5. Gullies</td>
<td>Common with indications of active erosion and down-cutting; vegetation is infrequent on slopes and/or bed. Nickpoints and headcuts are numerous and active.</td>
<td>Moderate to common with indications of active erosion; vegetation is intermittent on slopes and/or bed. Headcuts are active; down-cutting is not apparent.</td>
<td>Moderate in number with indications of active erosion; vegetation is intermittent on slopes and/or bed. Occasional headcuts may be present.</td>
<td>Uncommon with vegetation stabilizing the bed and slopes; no signs of active headcuts, nickpoints, or bed erosion.</td>
<td>Drainages are represented as natural stable channels; no signs of erosion with vegetation common.</td>
</tr>
<tr>
<td>6. Wind-scoured blowouts, and/or deposition areas</td>
<td>Extensive.</td>
<td>Common.</td>
<td>Occasionally present.</td>
<td>Infrequent and few.</td>
<td>Matches what is expected for the site.</td>
</tr>
<tr>
<td>7. Litter movement (wind or water)</td>
<td>Extreme; concentrated around obstructions. Most size classes of litter have been displaced.</td>
<td>Moderate to extreme; loosely concentrated near obstructions.</td>
<td>Moderate to small size classes of litter have been displaced. Moderate movement of smaller size classes in scattered concentrations around obstructions and in depressions.</td>
<td>Slightly to moderately more than expected for the site with only small size classes of litter being displaced.</td>
<td>Matches that expected for the site with a fairly uniform distribution of litter.</td>
</tr>
<tr>
<td>8. Soil surface Resistance to Erosion</td>
<td>Extremely reduced throughout the site. Biological stabilization agents including organic matter and biological crusts virtually absent.</td>
<td>Significantly reduced in most plant canopy interspaces and moderately reduced beneath plant canopies. Stabilizing agents present only in isolated patches.</td>
<td>Significantly reduced in at least half of the plant canopy interspaces, or moderately reduced throughout the site.</td>
<td>Some reduction in soil surface stability in plant interspaces or slight reduction throughout the site. Stabilizing agents reduced below expected.</td>
<td>Matches that expected for the site. Surface soil is stabilized by organic matter decomposition products and/or a biological crust.</td>
</tr>
<tr>
<td>RH Indicator</td>
<td>Degree of Departure Extreme to Total</td>
<td>Degree of Departure Moderate to Extreme</td>
<td>Degree of Departure Moderate</td>
<td>Degree of Departure Slight to Moderate</td>
<td>Degree of Departure None to Slight</td>
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</tr>
<tr>
<td>9. Soil surface loss or degradation</td>
<td>Soil surface horizon absent. Soil structure near surface is similar to or more degraded than that in subsurface horizons. No distinguishable difference in subsurface organic matter content.</td>
<td>Soil loss or degradation severe throughout site. Minimal differences in soil organic matter content and structure of surface and subsurface layers.</td>
<td>Moderate soil loss or degradation in plant interspaces with some degradation beneath plant canopies. Soil structure is degraded and soil organic matter content is significantly reduced.</td>
<td>Some soil loss has occurred and/or soil structure shows signs of degradation, especially in plant interspaces.</td>
<td>Soil surface horizon intact. Soil structure and organic matter content match that expected for the site.</td>
</tr>
<tr>
<td>10. Plant community composition and distribution relative to infiltration and runoff</td>
<td>Infiltration is severely decreased due to adverse changes in plant community composition and/or distribution. Adverse plant cover changes have occurred.</td>
<td>Infiltration is greatly decreased due to adverse changes in plant community composition and/or distribution. Detrimental plant cover changes have occurred.</td>
<td>Infiltration is moderately reduced due to adverse changes in plant community composition and/or distribution. Plant cover changes negatively affect infiltration.</td>
<td>Infiltration is slightly to moderately affected by minor changes in plant community composition and/or distribution. Plant cover changes have only a minor effect on infiltration.</td>
<td>Infiltration and runoff are equal to that expected for the site. Plant cover (distribution and amount) adequate for site protection.</td>
</tr>
<tr>
<td>11. Compaction layer (below soil surface)</td>
<td>Extensive; severely restricts water movement and root penetration.</td>
<td>Widespread; greatly restricts water movement and root penetration.</td>
<td>Moderately widespread; moderately restricts water movement and root penetration.</td>
<td>Rarely present or is thin and weakly restrictive to water movement and root penetration.</td>
<td>None to minimal; not restrictive to water movement and root penetration.</td>
</tr>
<tr>
<td>RH Indicator</td>
<td>Degree of Departure Extreme to Total</td>
<td>Degree of Departure Moderate to Extreme</td>
<td>Degree of Departure Moderate</td>
<td>Degree of Departure Slight to Moderate</td>
<td>Degree of Departure None to Slight</td>
</tr>
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<td>-----------------------------------</td>
</tr>
<tr>
<td>12. Functional/structural groups (F/S groups)</td>
<td>Number of F/S groups greatly reduced; and/or relative dominance of F/S groups has been dramatically altered; and/or number of species within F/S groups dramatically reduced.</td>
<td>Number of F/S groups moderately reduced; and/or one dominant group and/or one or more sub-dominant groups replaced by F/S groups not expected for the site; and/or number of species within F/S groups significantly reduced.</td>
<td>Number of F/S groups slightly reduced; and/or relative dominance of F/S groups slightly reduced; and/or one or more sub-dominant F/S groups replaced by F/S groups not expected for the site; and/or number of species within F/S groups moderately reduced.</td>
<td>F/S groups and number of species in each group closely match that expected for the site.</td>
<td></td>
</tr>
<tr>
<td>13. Plant mortality/decadence</td>
<td>Dead and/or decadent plants are common.</td>
<td>Dead and/or decadent plants are somewhat common.</td>
<td>Some dead and/or decadent plants are present.</td>
<td>Slight plant mortality and/ or decadence.</td>
<td>Plant mortality and decadence matches that expected for the site.</td>
</tr>
<tr>
<td>14. Litter amount</td>
<td>Largely absent or dominant relative to site potential and weather.</td>
<td>Greatly reduced or increased relative to site potential and weather.</td>
<td>Moderately more or less relative to site potential and weather.</td>
<td>Slightly more or less relative to site potential and weather.</td>
<td>Amount is what is expected for the site potential and weather.</td>
</tr>
<tr>
<td>15. Annual production</td>
<td>Less than 20% of potential production.</td>
<td>20-40% of potential production.</td>
<td>40-60% of potential production.</td>
<td>60-80% of potential production.</td>
<td>Exceeds 80% of potential production.</td>
</tr>
<tr>
<td>16. Invasive plants</td>
<td>Dominate the site.</td>
<td>Common through-out the site.</td>
<td>Scattered through-out the site.</td>
<td>Present primarily on disturbed sites.</td>
<td>Rarely present on the site.</td>
</tr>
<tr>
<td>17. Reproductive capability of perennial plants (native or seeded)</td>
<td>Capability to produce seed or vegetative tillers is severely reduced relative to recent climatic conditions.</td>
<td>Capability to produce seed or vegetative tillers is greatly reduced relative to recent climatic conditions.</td>
<td>Capability to produce seed or vegetative tillers is somewhat limited relative to recent climatic conditions.</td>
<td>Capability to produce seed or vegetative tillers is only slightly limited relative to recent climatic conditions.</td>
<td>Capability to produce seed or vegetative tillers is not limited relative to recent climatic conditions.</td>
</tr>
<tr>
<td>DIRH Indicator</td>
<td>Class 5</td>
<td>Class 4</td>
<td>Class 3</td>
<td>Class 2</td>
<td>Class 1</td>
</tr>
<tr>
<td>----------------</td>
<td>---------</td>
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<td>---------</td>
</tr>
<tr>
<td><strong>1. Rills.</strong> Small, intermittent watercourses with steep sides. Rills are generally linear.</td>
<td>Widespread (&gt;10) AND long (&gt;2’).</td>
<td>Common (&gt;5) AND long (&gt;2’).</td>
<td>Common (&gt;5) OR long (&gt;2’).</td>
<td>Very few (&lt;5) AND short (&lt;2’).</td>
<td>Not present.</td>
</tr>
<tr>
<td><strong>2. Water Flow Patterns.</strong> Soil surface patterns caused by runoff. Indicated by litter, soil, gravel redistribution. Steep cuts may occur on one side (see #1).</td>
<td>Very long (50’) numerous; unstable with active erosion; almost always connected.</td>
<td>Long (20-50’), very common, and usually connected. Erosion and deposition areas very common.</td>
<td>Moderately long (5-20’), common and often connected. Erosion and deposition areas common.</td>
<td>Very short, (&lt;5’), rare and occasionally connected. Erosion and deposition areas rare.</td>
<td>None.</td>
</tr>
<tr>
<td><strong>4. Bare Ground.</strong> Percent soil surface not covered by vegetation, rock, plant litter, mosses, lichens or dark algal crusts. Percent will be generated from LPI. Use classes to describe connectivity. Connectivity is broken by plants rooted on the site, whether annual or perennial.</td>
<td>Nearly always connected.</td>
<td>Generally connected.</td>
<td>Occasionally connected.</td>
<td>Rarely connected.</td>
<td>Not connected.</td>
</tr>
<tr>
<td><strong>5. Gullies.</strong> Large, intermittent watercourses with steep sides. Stable gullies have less steep sides with plants and no active erosion at the headcut (top) or top of sides.</td>
<td>Active headcut, whether or not in evaluation area, unstable sides.</td>
<td>Active headcut, whether or not in evaluation area, partially stable sides.</td>
<td>Active headcut, whether or not in evaluation area, stable sides with a few nickpoints.</td>
<td>Inactive. Stable throughout.</td>
<td>None.</td>
</tr>
<tr>
<td>DIRH Indicator</td>
<td>Class 5</td>
<td>Class 4</td>
<td>Class 3</td>
<td>Class 2</td>
<td>Class 1</td>
</tr>
<tr>
<td>------------------------------------------------------------------------------</td>
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<td>------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>6. <strong>Wind Scoured</strong>, Blowout and/or Depositional Areas</td>
<td>Widespread throughout area (&gt;50% area affected).</td>
<td>Many (25-50% of area affected).</td>
<td>Common.(10-25% of area affected) .</td>
<td>Few.</td>
<td>None.</td>
</tr>
<tr>
<td>7. <strong>Litter Movement (wind or water)</strong>. Distance moved by different sizes of plant litter (needles, leaves, bark, branches). Indicated by litter accumulation in low, flat (water) or protect (wind) areas.</td>
<td>Fine litter moved very long distances (&gt;20’). Large litter moved moderate distances(&lt;10’).</td>
<td>Fine litter moved long distances (&lt;20’). Large litter moved short distances(&lt;5’).</td>
<td>Fine litter moved moderate distances (&lt;10’) Large litter moved very short distances(&lt;2’).</td>
<td>Fine litter moved short distances (&lt;5’).</td>
<td>Fine litter moved very short distances (&lt;2’).</td>
</tr>
<tr>
<td>8. <strong>Soil Surface Resistance to Erosion.</strong> (FROM SOIL STABILITY KIT)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. <strong>Soil Surface Loss and Degradation</strong>. Take at least 1 photo of the top 30cm under a typical plant or patch of plant, and in an interspace.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. <strong>Cover of plants that help increase water infiltration and reduce runoff.</strong> (FROM LPI + CANOPY GAP).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. <strong>Compaction Layer (below soil surface)</strong>. Dense soil layers with horizontal (platy) structure at least 2’’ (can be up to 8-10’’) below the soil surface which affect or reduce root penetration (e.g. grow horizontally.)</td>
<td>Extensive; severely restricts water movement and root penetration.</td>
<td>Common. Greatly restricts water movement and root penetration.</td>
<td>Moderately widespread, moderately restricts water movement and root penetration.</td>
<td>Rarely present or thin and weakly restrictive to infiltration and root penetration.</td>
<td>None.</td>
</tr>
<tr>
<td>DIRH Indicator</td>
<td>Class 5</td>
<td>Class 4</td>
<td>Class 3</td>
<td>Class 2</td>
<td>Class 1</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>12. Plant F/S Groups.</strong> (FROM LPI)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em><em>13. Plant Mortality Decadence</em>.</em>* Proportion of aboveground biomass that is dead or decadent.</td>
<td>&gt;50</td>
<td>25-50</td>
<td>10-25</td>
<td>2-10</td>
<td>&lt;2</td>
</tr>
<tr>
<td><strong>14. Litter Amount.</strong> From LPI.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>15. Annual Production.</strong> Record (IN NOTES) best estimate of total annual production (all species present in NRI plot) in #/acre. Record as number followed by #/a.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>16. Invasive Plants.</strong> (FROM LPI)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>17. Reproductive capability of perennial plants.</strong> Reflected in ability of PERENNIAL plants, but not invasive plants, to produce seeds or tillers, and to recover following grazing, drought or other disturbance.</td>
<td>At least 10% of the individuals of &lt;50% of the species capable of reproduction, including &lt;50% of the species that are dominant or sub-dominant.</td>
<td>At least 10% of the individuals of 50% of the species capable of reproduction, including 50% of the species that are dominant or sub-dominant.</td>
<td>At least 10% of the individuals of 75% of the species capable of reproduction, including 75% of the species that are dominant or sub-dominant.</td>
<td>At least 10% of the individuals of 90% of the species capable of reproduction, including 90% of the species that are dominant or sub-dominant.</td>
<td>Nearly all perennial species capable of reproduction, including all that are currently dominant or sub-dominant.</td>
</tr>
</tbody>
</table>
Chapter 21  Pasture Condition Score (Pasture only)

21.1 Overview

This chapter covers data elements relating to:

- Evaluating indicators in the pasture condition scoring methodology for NRI

21.2 What’s New?

- Update of section 21.4.1 Conditions for Data Collection to reflect updates to land cover/use codes in Chapter 6.

21.3 Critical Points to Remember

- The Pasture Condition Score Sheet contains both qualitative and quantitative variables that can be used within a single growing season or for the same pasture over a number of years. It is designed to be a “quick assessment tool”.
- In this NRI protocol, the score is calculated based on the indicators included.
- This protocol is conducted within the macro plot.
- This protocol records the effects of management, climate, diseases, and insects on the pasture resource - the soil and the plant community.
- Use the National Pasture Condition Score Sheet (Cosgrove et al. 2001) to provide a common benchmark for this methodology.
- Do not use locally adapted Pasture Condition Score Sheet Methodologies. Use the terminology and score descriptions in (Cosgrove et al. 2001).
- If available, use Forage Suitability Group Descriptions to assist with determining indicator scores.
• The following indicators are not included in the CASI as part of PCS:
  o Soil fertility (P & K status)
  o Soil fertility (N status)
  o Soil pH

21.4 Preliminary Steps

• Have a list of desirable forage species available to refer to as needed. One should have been developed for the correlated Forage Suitability Group Description (FSGD) or state agronomy guide forage species recommendations in Field Office Technical Guide.
• Determine indicator score 1 through 5 for each indicator on the CASI.

21.4.1 Condition for Data Collection

• For the non-Federal range sample, pasture condition score data are documented for non-Federal points with land cover/use of grassland not defined as range (LCU = 2000 Grassland not defined as range) or scrub shrub not defined as range (LCU = 2200 Scrub Shrub not defined as range).
• For the non-Federal pasture sample, pasture condition score data are documented for non-Federal points with land cover/use of grassland not defined as range (LCU = 2000 Grassland not defined as range) or scrub shrub not defined as range (LCU = 2200 Scrub Shrub not defined as range).

21.4.2 Ancillary Resources

In addition to the basic data collection materials noted in chapter 2, the following ancillary resources are required:

• “Guide to Pasture Condition Scoring”,
• Plant identification references (floras) for your state or region. Use weed ID references for non-leguminous forbs for your state or region to identify unfamiliar forbs and/or retrieve scientific name.

21.5 Data Collection Procedure for Pasture Condition Scoring

21.5.1 Definitions

Definitions are presented in the order that they appear in the Procedure.

Indicators. They are detectable symptoms that can be easily estimated or measured in a pasture. They indicate how much one or more causative factors are affecting the plant community and soil resource of that pasture. Both management and environmental conditions play a role in determining what the condition of a pasture is at any moment.

Causative factors. The underlying reasons why the indicators look or act the way they do when being observed and measured during the pasture condition scoring process. Some causative factors can be easily adjusted, such as severity of use; while others cannot, such as episodic climatic events. The latter ones must be reacted to by management to lessen their impact.

Desirable species. Forage species that are adapted to the climate and soils they grow in, readily
consumed, persistent, and provide high tonnage and quality for a significant part of the growing season.

**Intermediate species.** Forage species that are eaten but provide low tonnage, or lose quality fast, or have a short-lived grazing use period. They also may be eaten secondarily to the most desirable species so they may not be preferred species if left to choice.

**Undesirable species.** Plant species that are generally refused or only partially eaten when little else is available. This includes woody invaders, noxious weeds, and toxic or thorny plants.

**Canopy cover (NRI).** The percentage of ground covered by a vertical projection of the canopy.

**Litter.** Detached plant residue and dung that lies on the ground surface and provides ground cover.

**Standing dead.** This is a combination of dead leaves and stems not lying on the soil surface that is left behind when pastures are selectively grazed. This dead tissue is intermixed with standing green leaves and stems. It interferes with grazing activity when choices are available and reduces forage quality if ingested when animals are forced to or inadvertently eat it.

**Forage Suitability Group Descriptions.** Forage suitability group descriptions (FSGDs) are interpretive reports providing the soil and plant science basis for conservation planning on livestock operations where forage crops are grown. FSGDs are developed to organize information for a group of soil map unit components that have similar potentials and limitations for forage production. They identify adapted forage species, yearly forage production estimates, and distribution of production during the growing season. Information from the forage suitability group description is utilized during the conservation planning process to select appropriate forage species for pasture and hay planting and to develop livestock forage balance reports. Forage Suitability Groups (FSGs) are composed of one or more individual soil map unit components having similar potentials and limitations for forage production. Soils within a FSG are sufficiently uniform to:

- Support the same adapted forage plants under the same management conditions.
- Require similar conservation treatment and management to produce the forages selected in the quality and quantity desired.
- Have comparable potential productivity.

**Functional groups.** Functional groups for pasture can be expressed rather simply and broadly as effect types. Effect plant functional types are groups of plant species that affect ecosystem processes such as productivity, nutrient cycling, and trophic transfer similarly. For pastures, they are cool season grasses and grass-likes, warm season grasses, legumes (forb or shrub), and other forbs. A fifth one, woody species, is to be avoided unless the pasture is a silvopasture where trees are intentionally grown along with the forage resource in a way that nurtures forage growth and/or shelters livestock.

**Percent legume.** Percent of standing forage as air-dry weight that is legume.

**Uniformity of use.** A grazing pattern formed by differences in grazing use across a pasture. It is a result of livestock responding to how the forage is presented to them. The more they have to
choose from, both in quantity as well as number of species, the less uniform the grazing will be. The less used areas are where the standing dead residue appears.

**Management unit.** A field containing a specific land use and treated with the same set of management practices. When a pasture, it is usually fenced in some fashion. Grazing management, the grazing schedule as practiced, stocking densities, species composition, and other applied practices from one area to the next within the unit are not different.

**Soil compaction.** When a load is applied to a soil while it is moist enough to be molded or displaced, the soil compresses to an increased density. In a pasture setting, the loads primarily being applied are from the hooves of the grazing animals.

**Livestock concentration areas.** These are bare earth heavy use areas in pastures where the livestock traffic is so high that the vegetation has been treaded out. The soils are densely compacted at the surface on these sites. Commonly they occur under shade trees and at gate openings, water troughs, hay bunks, and other areas where livestock congregate repeatedly for prolonged periods of time to lounge or satisfy their hunger or thirst.

**Streambank and shoreline erosion.** Bank undercutting is the root cause of both forms of erosion. Water currents flowing against the toe slope of the bank cause streambank undercutting. Shoreline undercutting occurs when waves strike against the shore bank of a pond or lake. Both of these forms of erosion can and do occur without livestock traffic. Streambank and shoreline erosion are worsened by livestock where they access the banks to graze, drink, cross over to graze another part of the pasture, or cool off in water. Since the banks are unstable due to the undercutting, they are often very steep and on the verge of collapse. The sharpness and pressure load of livestock hooves cause the banks to shear and slough into the water. This sloughed-off soil is eroded away by water currents or wave action, creating a moving front of repetitive events of undercutting and sloughing.

21.5.2 Procedure

1. **Pasture condition score protocol is the last assessed protocol on the macroplot.**
2. Rate each of the listed indicators by scoring them based on the criteria that best fits or describes what is being observed in the macro plot.
   
   
   - **Percent desirable Plants** - total up the percentage of species composition that is desirable plants recorded for the macro plot. Use the state list of desirable forage plants. Using the total percentage that are desirable forage species, compare with score sheet ranges for each of the 5 condition score values and select the appropriate score (1-5) for the percent plant cover by weight that is desirable forage found within the macro plot. **If noxious weeds or other undesirable species were found** inside the macro plot when doing the plant census, refer to the narrative descriptions of each score value and adjust to the score that best describes the amount of undesirable plants. Note that if some woody species (invading ones) are present and well established, the score drops to a 3. If the woody plants are still young and infrequent to rare, a score of 4 is appropriate. They would be lumped in with any other undesirable species.
   
   - **Plant cover** - Visually estimate the total cover of all desirable and intermediate species. Assign a value based on either green leaf canopy or live vegetative basal area cover.
percentage.

- **Plant diversity** - Plant diversity ratings are based on forage species and functional groups.
- **Plant residue** - Rate ground cover and standing dead forage separately and average score.
- **Plant vigor** - Plant recovery is often an issue for some people using the score sheet. Base this on your impression of the growing conditions at the time of visit. If the weather has been abnormally dry, plant growth has slowed. Make a score selection based on your best judgment. For grass species that telescope out of their leaf sheaths, it is easier to tell how much new growth they have put on by measuring how much new growth has telescoped out since the last known time the grass was grazed. Legume growth slows and plants tend to dwarf and set flower when under stress. Growth from their axillary buds at nodes or from crown buds can be measured. Look at the other narrative criteria, especially the greenness of the plants and correlate what you see with the most appropriate score’s narrative. Lack of soil fertility will only make plant recovery even slower if weather or repeated grazing events are not conducive to fast regrowth. Also look for evidence of wilting and for any insect or disease damage.
- **Percent Legume** - rate the macro plot for this indicator. Select the score
- **Uniformity of use** - rate the macro plot is in for this indicator. Select the score whose narrative best fits what is seen.
- **Livestock concentration areas** - rate the macro plot for this indicator. Select the score whose narrative best fits what is seen.
- **Soil compaction** - Use a steel probe or soil penetrometer to feel the amount of resistance the soil gives to being penetrated by either instrument when standing in the macro plot. Do several measurements to get an average resistance within the macro plot, a few probes in each quadrant is best. Then, check soil resistance to penetration at the nearest fenceline where the animals cannot step on the soil and compare the ease of the probe entering the soil there compared to it entering the soil at the macro plot. Push the probe at least 8 inches into the ground where resistance is not so great that damage to the equipment or an injury to you is probable. Soil texture and moistness at the fence should be similar to the macro plot. Select the score whose narrative best fits what is felt and observed at the macro plot compared to the resistance (or lack thereof) at the fence.
- **Erosion** - rate the macro plot. Always rate sheet and rill erosion. Rate wind, streambank or shoreline, and gully erosion only if present. If present, state type of erosion and the score it received. Select the score whose narrative best fits the description of the severity of the erosion type observed. Streambank and shoreline erosion should be rated based on animal activity that has initiated the erosion or has worsened a pre-existing condition that will not stop entirely, if at all, after the livestock are excluded. Areas of drink and wading are ones initiated by livestock. Bank sloughing from undercutting may be worsened by livestock walking on them, but the condition is related more to bank heights, natural rock armor, stream morphology, and wind fetch and direction on open water of ponds and lakes.

3. If plant vigor is rated below, 4, rate each of the following causative factors by scoring them based on the criteria that best fits or describes what is being observed in the macro plot.

- **Severity of use** - rate the macro plot. Judge within the macro plot (depending on which paddock it landed in) if residual grazing stubble heights were at or above those recommended in Table 5-3 of the NRPH, page 5.2-12. There is also the possibility of the plants being regrazed before they have had a chance to fully recover. The literature is less
clear on this matter so rely on your professional judgment whether the livestock are returning too soon. For continuously grazed pastures, it is likely they are returning too soon by regrazing short grass areas and avoiding older, taller areas (spot grazing), or everything is grazed down except for inedible plants with no rejection occurring even at most urine and dung spots. **This factor is only available for rating when plant vigor is rated less than 4.**

- **Site Adaptation of Desired Species** - observe the macro plot. Select the score whose narrative best describes the presence/absence and overall proportion of desired species at the site. Site adaptation of desired species requires knowledge of what was originally planted on the field. In most instances this information is unavailable to an NRI data collector. This causative factor is useful for recently renovated pastures to check to see if the planted species were adapted to the site or not based on management received, the soils, and the climate.

- **Climatic stresses** - observe at the macro plot. Select the score whose narrative best fits the description of the climatic stress, if any, being exhibited by the plants. **This factor is only available for rating when plant vigor is rated less than 4.**

- **Insect and/or Disease pressure** - observe at the macro plot. Check plant leaves for lesions, yellowing, stunting, or browning caused by rust, molds, viruses, or fungi. There is no need to key out specific disease. Also check for insect feeding of leaves or spittle at the axils of legumes. Select the score that whose narrative best fits the description of the effect insects and/or diseases are having on the plants within the macro plot. Scores 2 and 3 narratives refer to economic thresholds. For NRI and to keep the sampling protocols simple, we will not be collecting data to ascertain whether or not the economic threshold has been reached. Instead, observe damage and based on the relative amount of leaf damage assign a reasoned score that seems to capture the amount of damage observed. At level 1, mortality of plants is occurring. At 2, the plants would be at a point that if not treated, they would soon be dying off or the current forage crop would be lost for grazing or haying use. At 3, the plants’ forage quality is suffering enough that although it could be graze or hayed, its quality is much lower than that of unaffected plants. **This factor is only available for rating when plant vigor is rated less than 4.**

### 21.6 References

- USDA, NRCS. 2003. National Range and Pasture Handbook. Chapter 5, Section 2, page 5.2-12, Table 5-3. Fort Worth, TX
## Table 21-1. Pasture Condition Score Evaluation Matrix

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Score 1</th>
<th>Score 2</th>
<th>Score 3</th>
<th>Score 4</th>
<th>Score 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent desirable plants</td>
<td>Desirable species</td>
<td>Desirable species 20-40% of stand. Mostly weedy annuals and/or woody species present and expanding. Shade a factor.</td>
<td>40-60% desirable forage species. Undesirable broad-leaf weeds and annual weedy grasses invading. Some woodies.</td>
<td>60-80% of plant community are desirable species. Remainder mostly intermediates and a few undesirables present.</td>
<td>Desirable species exceed 80% of plant community. Scattered intermediates.</td>
</tr>
<tr>
<td>Plant cover (Live stems and green leaf cover of all desirable and intermediate species.)</td>
<td>Canopy: &lt; 50% Basal area: &lt; 15% Photosynthetic area very low. Very little plant cover to slow or stop runoff.</td>
<td>Canopy: 50-70%, Basal area: 15-25% Photosynthetic area low. Vegetal retardance to runoff low.</td>
<td>Canopy: 70-90%, Basal area: 25-35% Most forages grazed close, little leaf area to intercept sunlight. Moderate vegetal retardance.</td>
<td>Canopy: 90-95%, Basal area: &gt;50% Forages maintained in leafy condition for best photosynthetic activity. Very thick stand, slow or no runoff flows.</td>
<td></td>
</tr>
<tr>
<td>Plant diversity</td>
<td>One dominant (&gt; 75% of DM wt.) forage species. Or, over 5 forage species (all &lt;20%) from one dominant functional group, not evenly grazed - poorly distributed.</td>
<td>Two to five forage species from one dominant functional (&gt;75% of DM wt.) group. At least one avoided by livestock permitting presence of mature seed stalks. Species in patches.</td>
<td>Three forage species (each 20% of DM wt.) from one functional group. None avoided. Or, one forage species each from two functional groups, both supply 25-50% of DM wt.</td>
<td>Three to four forage species (each ≥20% of DM wt.) with at least one being a legume. Well intermixed, compatible growth habit, and comparable palatability.</td>
<td>Four to five forage species representing three functional groups (each ≥20% of DM wt.) with at least one being a legume. Intermixed well, compatible growth habit, and comparable palatability.</td>
</tr>
<tr>
<td>Indicator</td>
<td>Score 1</td>
<td>Score 2</td>
<td>Score 3</td>
<td>Score 4</td>
<td>Score 5</td>
</tr>
<tr>
<td>-----------</td>
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<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Plant residue</strong> (Rate ground cover and standing dead forage separately and average score.)</td>
<td><strong>Ground cover:</strong> No identifiable residue present on soil surface. Or, heavy thatch evident (&gt; 1 inch). <strong>Standing dead forage:</strong> &gt;25% of air dry weight.</td>
<td><strong>Ground cover:</strong> 1-10% covered with dead leaves or stems. Or, thatch 0.5 inch to 1 inch thick. <strong>Standing dead forage:</strong> 15-25% of air dry weight.</td>
<td><strong>Ground cover:</strong> 10-20% covered with dead residue. Or, slight thatch buildup but &lt; 0.5 inch. <strong>Standing dead forage:</strong> 5-15% of air dry weight.</td>
<td><strong>Ground cover:</strong> 20-30% covered with dead residue. No thatch present. <strong>Standing dead forage:</strong> some, but &lt; 5% of air dry weight.</td>
<td><strong>Ground cover:</strong> 30-70% covered with dead residue, but no thatch build-up. <strong>Standing dead forage:</strong> none available to grazing animal.</td>
</tr>
<tr>
<td><strong>Plant vigor</strong> (If plant vigor rating is less than 4, determine cause by rating 4 possible causes listed under below Plant Vigor and Causative Factors)</td>
<td>No recovery after grazing or pale yellow or brown, or permanent wilting, or plant loss due to insects or disease, exercise lot only. Or, lodged, dark green overly lush forage. Often avoided by grazers.</td>
<td>Recovery after grazing takes 2 or more weeks longer than normal, or yellowish green leaves, or major insect or disease yield loss, or plants wilted most of day. Productivity very low.</td>
<td>Recovery after grazing takes 1 week longer than normal, or urine/ dung patches dark green in contrast to rest of plants, or minor insect or disease loss or midday plant wilting. Yields regularly below site potential.</td>
<td>Recovery after grazing takes 1 to 2 days longer than normal, or light green plants among greener urine and dung patches, or minor insect or disease damage. No plant wilting. Yields near site potential.</td>
<td>Rapid recovery after grazing. Healthy green color. No signs of insect or disease damage. No leaf wilting. Yields at site potential for the species adapted to the site's soil and climate.</td>
</tr>
<tr>
<td><strong>Percent legume</strong> (Cool season stands. See footnote 1 of score sheet for warm season)</td>
<td>&lt; 10% by wt. Or, greater than 60% of bloating legumes.</td>
<td>10-19% legumes. Or, losing grass, 40-60% spreading legume.</td>
<td>20-29% legumes.</td>
<td>30-39% legumes.</td>
<td>40-60% legumes. No grass loss; grass may be increasing.</td>
</tr>
<tr>
<td><strong>Uniformity of use</strong></td>
<td>Little-grazed patches cover over 50% of the pasture. Mosaic pattern throughout or identifiable areas of pasture avoided.</td>
<td>Little-grazed patches cover 25-50% of the pasture either in a mosaic pattern or obvious portion is not frequented.</td>
<td>Little-grazed patches cover 10-25% of the pasture either in a mosaic pattern or obvious portion is not frequented.</td>
<td>Little-grazed patches minor spots where isolated forage species is rejected. Urine and dung patches avoided.</td>
<td>Rejected areas only at urine and dung patches. No forage species rejection.</td>
</tr>
<tr>
<td>Indicator</td>
<td>Score 1</td>
<td>Score 2</td>
<td>Score 3</td>
<td>Score 4</td>
<td>Score 5</td>
</tr>
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<td>-------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Livestock concentration areas</td>
<td>Cover &gt;10% of the pasture; or all convey contaminated runoff directly into water channels.</td>
<td>Livestock conc. areas and trails cover 5-10% of pasture; most close to water channels and drain into them unbuffered.</td>
<td>Isolated livestock conc. areas and trails &lt;5% of area; one close to water channel and drains into it unbuffered.</td>
<td>Some livestock trails and one or two small concentration areas. Buffer areas between them and water channels.</td>
<td>No presence of livestock concentration areas or heavy use areas sited or treated to minimize contaminated runoff.</td>
</tr>
<tr>
<td>Soil compaction</td>
<td>Infiltration capacity and surface runoff severely affected by heavy compaction. Excessive livestock traffic killing plants over wide areas. Very hard to push probe into soil without damaging the probe.</td>
<td>Infiltration capacity lowered and surface runoff increased due to large areas of bare ground and dense compaction layer at surface. Livestock trails common throughout. Off-trail hoof prints common. Hard to push probe past compacted layers.</td>
<td>Infiltration capacity lowered and surface runoff increased due to plant cover loss and soil compaction by livestock hooves. Soil resistant to soil probe entry at one or more depths within plow depth.</td>
<td>Infiltration capacity lowered and surface runoff increased due to reduced vegetal cover/retardance. Probe enters soil easily except at rocks. Scattered signs of livestock trails and hoof prints, confined to lanes or small, wet areas.</td>
<td>Infiltration capacity and surface runoff equal to that expected for an ungrazed meadow; not affected by livestock traffic.</td>
</tr>
<tr>
<td>Sheet and rill erosion</td>
<td>Sheet and rill erosion is active throughout pasture; rills 3-8 inches deep at close intervals and/or grazing terracettes are close-spaced with some slope slippage.</td>
<td>Most sheet and rill erosion confined to steepest terrain of unit; well defined rills 0.5-3 inches deep at close intervals and/or grazing terracettes present.</td>
<td>Most sheet and rill erosion confined to heavy use areas, especially in loafing areas and water sites; rills 0.5-3 inches deep. Debris fans at downslope edge.</td>
<td>No current formation of rills; some evidence of past rill formation, but are grassed. Scattered debris dams of litter present occasionally.</td>
<td>No evidence of current or past formation of sheet flow or rills.</td>
</tr>
</tbody>
</table>

1For warm season grass (C4)-legume stands, use the following criteria: 5, 30-40%; 4, 20-29%; 3, 10-19%; 2, 5-9%, and 1 <4%.
Table 21-2. Optional Pasture Condition Score Evaluation Matrix. Rate these additional erosion categories below only if present.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Score 1</th>
<th>Score 2</th>
<th>Score 3</th>
<th>Score 4</th>
<th>Score 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind erosion</td>
<td>Blowouts or dunes forming or present.</td>
<td>Soil swept from the established pasture being rated causing plant death by burial or abrasion.</td>
<td>Soil swept from adjacent fields or pasture during seedbed prep and seedling growth to cause pasture plant death by burial or abrasion.</td>
<td>Some vegetative debris windrowed. Some dust deposition from offsite source. Minor wind damage to foliage.</td>
<td>No visible signs of windblown soil or trash. No wind related leaf damage.</td>
</tr>
<tr>
<td>Streambank or shoreline erosion</td>
<td>Banks mostly bare and sloughing. No native streambank or shoreline vegetation remaining.</td>
<td>Banks are heavily grazed and trampled all over. Many are actively eroding laterally. Little native streambank or shoreline vegetation remaining. Bank sloughing common.</td>
<td>Banks are close grazed, but few are unstable. Some native streambank or shoreline vegetation remaining. Livestock enter only at specific points, but use heavy. Remote alternative water site present</td>
<td>Banks are grazed but stable. Mix of pasture plants and native water's edge species. Muddy livestock stream crossing(s) or pond entrance(s) not used heavily. Alternative water sites present.</td>
<td>Banks ungrazed or grazed infrequently. Abundant streambank or shore loving vegetation. Gravelly or constructed stable livestock stream crossing(s) or watering ramp(s). Or, alternative water sources present and close-by.</td>
</tr>
<tr>
<td>Gully</td>
<td>Mass movement of soil, rock, plants, and other debris; occurrence of landslides, debris avalanches, slumps and earthflow, creep and debris torrents. Found in mountainous or very hilly terrain.</td>
<td>Gully(s) advancing upslope cutting longer channel(s). Revegetation difficult without using constructed structures &amp; livestock exclusion; continuous gully(s) with many finger-like extensions into the hillside.</td>
<td>Gully(s) present with scattered active erosion, vegetation missing at heavy use slopes and/or on bed below overfalls. New eroding channels present and new overfalls appearing along sides and bed of main channel.</td>
<td>One or more existing stable gullies present, vegetation covers gully bottom and slopes well; no visual signs of active cutting at gully head or sides. Some soil moved in channel bottom.</td>
<td>No gullies; natural drainageways are stable grassed channels. Spring or seep fed bare channels are small and stable, often covered with overhanging vegetation.</td>
</tr>
</tbody>
</table>
Table 21-3. Plant Vigor or Causative Factors

<table>
<thead>
<tr>
<th>Plant Vigor or Causative Factors</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
<th>Factor 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severity of use</td>
<td>All desirable species grazed out. Or no grazing, resulting in thatch and/or standing dead accumulation and woody invasion.</td>
<td>All edible plants grazed to lowest level feasible by the livestock type (mown lawn look). Or, undergrazed - mostly stemmy overgrowth and much dead leaf.</td>
<td>Spot grazing common. Equal amount of close-grazed and little-grazed areas. Close grazed areas are grazed as low as livestock can graze (mown lawn look.)</td>
<td>Some spot grazing, avoided areas primarily at dung and urine spots. Closer grazed areas are not grazed below proper height needed for plant vigor.</td>
<td>Forage species grazed within height ranges that promote dense sward and near maximum production.</td>
</tr>
<tr>
<td>Site adaptation of desired species</td>
<td>Properly planted and established (desired) species are no longer present</td>
<td>Properly planted and established (desired) species are nearly gone. Volunteer unwanted species dominate.</td>
<td>One or more properly planted and established, or recruited desired species are missing. Unwanted species invading.</td>
<td>Properly planted and established, or recruited desired species still represented, but not in the desired proportions.</td>
<td>Properly planted and established, or recruited desired species are present in the desired proportions.</td>
</tr>
<tr>
<td>Climatic stresses</td>
<td>Brownout from drought. Or, frost heaved plants, most with severed roots and dying. Or, major loss due to submergence or ice sheets.</td>
<td>Wilted plants, little recovery during night. Or, some frost heaved plants, recovery slow. Some spotty stand loss due to submergence or ice sheets.</td>
<td>Wilting during heat of the day. Or, weak plants from winter damage or short-term submergence. Or, freezing damage to foliage.</td>
<td>Dry conditions, but no wilting. Or, above or below normal temperatures slowing growth. Or, slight leaf yellowing due to cold, wet conditions.</td>
<td>No climatic stress.</td>
</tr>
<tr>
<td>Insect and/or disease pressure</td>
<td>Severe insect attack, mortality high. Or, disease caused mortality high.</td>
<td>Insect or disease outbreak at economic threshold, treat now.</td>
<td>Insect or disease outbreak near economic threshold, continue watch and weigh options for treatment.</td>
<td>Some insect and/or disease present, but little impact on forage quality or quantity.</td>
<td>No visible damage.</td>
</tr>
</tbody>
</table>
### Table 5-3 (from NRPH 1997). Suggested residual grazing heights for major pasture forage species

<table>
<thead>
<tr>
<th>Pasture type</th>
<th>Continuously stocked, average height of pasture (in)</th>
<th>Rotationally stocked, minimum height at removal (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Predominately grass</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bahiagrass</td>
<td>1.5 to 3</td>
<td>2</td>
</tr>
<tr>
<td>Bahiagrass-legume</td>
<td>1 to 3</td>
<td>1</td>
</tr>
<tr>
<td>Common bermudagrass</td>
<td>1.5 to 3</td>
<td>1</td>
</tr>
<tr>
<td>Bermudagrass-white clover</td>
<td>1 to 3</td>
<td>1</td>
</tr>
<tr>
<td>Hybrid bermudagrass</td>
<td>3 to 6</td>
<td>2</td>
</tr>
<tr>
<td>Kentucky bluegrass</td>
<td>2 to 3</td>
<td>1 to 2</td>
</tr>
<tr>
<td>K. bluegrass-white clover</td>
<td>2 to 3</td>
<td>1</td>
</tr>
<tr>
<td>Bromegrass, smooth 2</td>
<td>4 to 5</td>
<td>2 to 3</td>
</tr>
<tr>
<td>Orchardgrass</td>
<td>4 to 5</td>
<td>2 to 3</td>
</tr>
<tr>
<td>Orchardgrass-Ladino clover</td>
<td>2 to 4</td>
<td>2</td>
</tr>
<tr>
<td>Reed canarygrass 2,3</td>
<td></td>
<td>2 to 3 4/</td>
</tr>
<tr>
<td>Ryegrass</td>
<td>2 to 3</td>
<td>1 to 2</td>
</tr>
<tr>
<td>Ryegrass-white or Ladino clover</td>
<td>1.5 to 3</td>
<td>1 to 2</td>
</tr>
<tr>
<td>Switchgrass 3</td>
<td></td>
<td>6 to 8 4/</td>
</tr>
<tr>
<td>Tall fescue</td>
<td>4 to 5</td>
<td>2 to 3</td>
</tr>
<tr>
<td>Tall fescue-Ladino clover</td>
<td>2.5 to 4</td>
<td>1.5</td>
</tr>
<tr>
<td>Winter small grains</td>
<td>3 to 6</td>
<td>3</td>
</tr>
<tr>
<td><strong>Predominately legume</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alfalfa 3</td>
<td></td>
<td>1 to 3 5/</td>
</tr>
<tr>
<td>Arrowleaf clover</td>
<td>2 to 4</td>
<td>2</td>
</tr>
<tr>
<td>Berseem clover 3</td>
<td></td>
<td>3 to 4</td>
</tr>
<tr>
<td>Birdsfoot trefoil, prostrate type 3</td>
<td></td>
<td>1 to 2</td>
</tr>
<tr>
<td>Birdsfoot trefoil, upright type 3</td>
<td></td>
<td>2 to 3</td>
</tr>
<tr>
<td>Crimson clover</td>
<td>2 to 4</td>
<td>2</td>
</tr>
<tr>
<td>Ladino or white clover</td>
<td>1 to 4</td>
<td>2</td>
</tr>
<tr>
<td>Lespedeza 3</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Red clover 3</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Rose clover</td>
<td>2 to 4</td>
<td>2</td>
</tr>
<tr>
<td>Subterranean clover</td>
<td>1 to 3</td>
<td>1</td>
</tr>
</tbody>
</table>

1. Heights given are those to maintain stand vigor and longevity. Greater heights may be needed to maintain proper intake for certain livestock types and classes.
2. Must be grazed before jointing occurs or allowed to mature for hay and aftermath grazed.
3. Not recommended for continuous stocked pasture use; includes grazing type alfalfa.
4. Stubble height largely dictated by stiff stems discouraging lower defoliation.
5. Stubble height of 3 inches for overwinter protection. Grazing type benefits more from residual stubble height during the growing season than does a hay type.

Chapter 22  Sagebrush Shape (Rangeland Only)

22.1 Overview
This chapter covers the collection of information relating to sagebrush shape.

22.2 What’s New
- Six new plants have been added to the list of twenty-two plants for which sagebrush shape data are collected. A table listing the twenty-eight sagebrush plants (and their associated synonyms) is provided in section 22.5.2.
- Update of section 22.4.1 Conditions for Data Collection to reflect updates to land cover/use codes in Chapter 6.

22.3 Critical Points to Remember
- Shape is determined for two categories (columnar or spreading).
- Shape is observed for each 3-ft Mrk that falls within a vertically-projected perimeter of a sagebrush’s canopy crown.
- Shape is determined only for sagebrush that have at least one living branch. Do not include dead sagebrush plants in this protocol.

22.4 Preliminary Steps
22.4.1 Conditions for Data Collection
- For the non-Federal pasture or range samples, sagebrush shape data are documented for non-Federal points with land cover/use 2001 Grassland defined as range or 2201 Scrub Shrub defined as range.
- For the BLM range sample, sagebrush shape data are documented for BLM-managed Federal points with land cover/use 2001 Grassland defined as range or 2201 Scrub Shrub defined as range.

22.4.2 Ancillary Resources
No specific materials are needed to complete data collector information.

22.5 Data Collection Procedure for Sagebrush Shape
22.5.1 Definitions
Canopy perimeter. A continuous line drawn around the edge of the sagebrush plant such that the maximum possible area is enclosed.

Sagebrush Shape: Describe the sagebrush plant as predominately columnar or spreading using...
the provided site guide as a reference:

22.5.2 Procedure

Characterization of shape will be for plants listed in Table 22-1:

1. Are there any sagebrush listed above that are growing along the transects?
   - If no, select 00 - All None under Shape in the CASI. The protocol is complete.
   - If yes, complete steps 2 and 3.

2. Start at the zero (0.0) end of the NE-SW transect (transect 1). The CASI will default to this transect at Mrk 0.
   - Always stand on the south side of the transects to avoid disturbing the measurement area.
   - The line should be taut and placed as close to the ground as possible.

3. Determine the predominant shape (columnar or spreading) of the listed sagebrush whose vertically-projected canopy perimeter is intercepted by Mrk 0 (thereafter every 3.0 ft; 0.0, 3.0, 6.0, . . ., 150.0). The shape designation for adjacent Mrks may be from the same sagebrush plant. Choose shape based on the taller plant when more than one canopy intercepts the Mrk.

4. Select the sagebrush shape from the choice list:
   - 0 - None (if no listed sagebrush canopy perimeter is intercepted by the Mrk)
   - 1 - Columnar
   - 2 - Spreading

5. Select the sagebrush species or subspecies from the choice list.

6. Repeat for the NW-SE transect (transect 2).
Table 22-1. Plants on Sagebrush Shape choice list. (Synonyms are not listed in bold font.)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Scientific Name</th>
<th>Common name</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARAR8</td>
<td><em>Artemisia arbuscula</em></td>
<td>little sagebrush</td>
</tr>
<tr>
<td>ARARA</td>
<td><em>Artemisia arbuscula ssp. arbuscula</em></td>
<td>little sagebrush</td>
</tr>
<tr>
<td>ARARA</td>
<td><em>Artemisia tridentata ssp. arbuscula</em></td>
<td>little sagebrush</td>
</tr>
<tr>
<td>ARARA</td>
<td><em>Seriphidium arbusculum</em></td>
<td></td>
</tr>
<tr>
<td>ARARL</td>
<td><em>Artemisia arbuscula ssp. longiloba</em></td>
<td>little sagebrush</td>
</tr>
<tr>
<td>ARARL</td>
<td><em>Artemisia arbuscula var. longiloba</em></td>
<td>little sagebrush</td>
</tr>
<tr>
<td>ARARL</td>
<td><em>Artemisia longiloba</em></td>
<td></td>
</tr>
<tr>
<td>ARARL</td>
<td><em>Artemisia spiciformis var. longiloba</em></td>
<td>little sagebrush</td>
</tr>
<tr>
<td>ARARL</td>
<td><em>Seriphidium arbusculum ssp. longilobum</em></td>
<td>little sagebrush</td>
</tr>
<tr>
<td>ARARL3</td>
<td><em>Artemisia arbuscula ssp. longicaulis</em></td>
<td>little sagebrush</td>
</tr>
<tr>
<td>ARART</td>
<td><em>Artemisia arbuscula ssp. thermopola</em></td>
<td>little sagebrush</td>
</tr>
<tr>
<td>ARBI3</td>
<td><em>Artemisia bigelovii</em></td>
<td>Bigelow sage</td>
</tr>
<tr>
<td>ARCA13</td>
<td><em>Artemisia cana</em></td>
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<td><em>Artemisia cana ssp. bolanderi</em></td>
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<tr>
<td>ARCA13</td>
<td><em>Artemisia bolanderi</em></td>
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<tr>
<td>ARCA13</td>
<td><em>Artemisia tridentata ssp. bolanderi</em></td>
<td>silver sagebrush</td>
</tr>
<tr>
<td>ARCA13</td>
<td><em>Artemisia tridentata var. bolanderi</em></td>
<td>silver sagebrush</td>
</tr>
<tr>
<td>ARCA13</td>
<td><em>Seriphidium canum ssp. bolanderi</em></td>
<td>silver sagebrush</td>
</tr>
<tr>
<td>ARCA13</td>
<td><em>Artemisia cana ssp. cana</em></td>
<td>silver sagebrush</td>
</tr>
<tr>
<td>ARCA13</td>
<td><em>Artemisia cana var. cana</em></td>
<td>silver sagebrush</td>
</tr>
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<td><em>Seriphidium canum</em></td>
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</tr>
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<td><em>Artemisia tridentata ssp. nova</em></td>
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</tr>
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<td>Owyhee sage</td>
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<td><em>Artemisia pedatifida</em></td>
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<td><em>Oligosporus pedatifidus</em></td>
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<tr>
<td>ARR12</td>
<td><em>Artemisia rigida</em></td>
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</tr>
<tr>
<td>Symbol</td>
<td>Scientific Name</td>
<td>Common name</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------------------------------</td>
<td>-------------------------</td>
</tr>
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