

Upland Monitoring Protocol For the Northern and Southern Colorado Plateau I&M Networks

Standard Operating Procedure (SOP) # 1

Preparations and Equipment Setup Prior to the Field Season

Version 1.0 (August 2006)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

NOTE: This SOP was adopted with modifications from Vegetation Community Monitoring Protocol For the Heartland I&M Network and Prairie Cluster Prototype Monitoring Program Standard Operating Procedure (SOP) # 1 Preparations and Equipment Setup Prior to the Field Season Version 1.0 (December 2004).

This SOP provides information to prepare for the summer field season, including a list of field equipment needed.

I. General Preparations

Prior to the field season each year, all observers should review the entire protocol, including SOPs. Polishing plant identification skills is particularly important, as is reviewing the standard sampling procedures implemented at each plot. The following list includes key points to consider in preparing for the upcoming field season.

1. A field notebook for the survey year should be prepared with pages for entry of sampling schedules, observer names, field hours and unique happenings that may influence how the data is reported. Trip reports are based on information recorded in field notebooks so it is imperative that they are clearly organized for ease of field note entry.
2. Species lists from previous years should be reviewed if available to identify any unique plants that may be encountered. Prior knowledge of species most likely to be encountered in a park will aid botanists in preparing for the sampling season. Therefore, species lists from previous community monitoring efforts in a park or sample unit should be compiled and compared to reference manuals to identify species not recorded which have a probability of being recorded. Primary sources are certified species lists from NP Species and list from vegetation mapping efforts. Copies of these combined species list should be carried into the field as quick references.
3. Monitoring will be conducted during the period coinciding with the growing season across the Colorado Plateau. Sampling dates should be scheduled and logistics organized prior to the start of each field season.

4. All equipment should be organized and made ready for the field season several weeks in advance of the field season. This allows time to make needed repairs and order equipment. The following is a list of field equipment needs for one crew. If two or more crews work simultaneously, equipment needs will change accordingly (Table 1.1).

Table 1.1. Equipment needs associated with vegetation community sampling

Activity	Equipment
Plot Establishment and Set-Up	• GPS units (2) • Clinometers (2) • Compass (2) • Data sheets for site establishment • 35mm Camera with color film • Flagging – for marking rebar and witness trees, and keeping field equipment visible • Cords for a 10 m² Sampling frames (1) • 1 m² Sampling Frame constructed of PVC • Maps • Metal detector – for finding transect ends • Rebar and hammer • Sighting poles for slope measurements • 50 meter Tapes (2) • Pliers/Leatherman • Tree Tags and Wire •
Data collection	• Data sheets • Clip boards • Pencils • Unknown Specimen Book • Unknown Specimen Forms • Write-In-Rain Paper (optional) • Species Identification Manuals and Taxonomical Books • Plant Press • Handlens
Additional equipment used when sampling wooded communities	• DBH tapes • Densiometer • Ropes and stakes • AL nails and tree tags
Required Miscellaneous Items	• Backpacks (4) • Duct Tape • First-Aid Kit • Radios • Sun Screen • Towels (2) • Water • Nourishment

II. Field Data Forms

Sufficient copies of all data forms should be generated for the full field season. Data forms used in field measures are referenced below. Actual forms are located in the various SOPs.

1. **Site Characterization** - this is filled out prior to initial establishment of a plot. It is not necessary to complete this data sheet on subsequent return visits.
2. **Site Establishment Data Sheet for Upland Monitoring** – this is filled out during the initial establishment of a sample unit. It is not necessary to complete this data sheet on subsequent return visits.
3. **Repeat Photographs** – this is filled out during every visit to a plot.
4. **Measuring Occurrence and Cover of Vegetation and Soil Surface Features, and Shrub Density** – this is filled out during every visit to a plot.
5. **Measuring Basal and Canopy Gaps Using Line-Intercept Sampling** - this is filled out during every visit to a plot.
6. **Soil Aggregate Stability** – this is filled out during every visit to a plot.
7. **Site Impact Assessment** - this is filled out during every visit to a plot.

Upland Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) # 2

Training Observers

Version 1.0 (August 2006)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP provides information to train field personnel at the start of the field season.

Procedures

Monitoring must be conducted in a reliable and repeatable manner. To this end every effort must be made to hire and retain well-qualified staff to conduct this work. Necessary skills to be acquired or honed before beginning each season's field data collect are reviewed below.

I.

I. Knowledge of the use of a GPS is essential. GPS is used to navigate to plots, and in the future, may be employed to record key site information. SOP#3 (Use of a GPS) should be thoroughly reviewed. Questions on the use of a GPS should be directed to the NCPN GIS/Cartographer. Training sessions described below will require field crew members to exercise the use of a GPS.

II. Plant identification skills are critical. Only field crew members with demonstrated plant ID skills should be hired. Even so, fine-tuning ID skills for NCPN plant species is still important. The NCPN Vegetation Ecologist or designee will provide training for all crew members. Training will consist of field-based identification of plants anticipated to be observed during the field season, with emphasis on difficult-to-ID species. Additionally, field crews will be instructed in the use of taxonomic keys and reference materials which will be available to all crew members.

III. Identifying Ecological Site types is critical during plot-establishment. Establishing new plots requires determining if the pre-selected plot corresponds to the targeted ecological site. Ecological site is an underlying strata in NCPN upland monitoring, and it is important that the computer-selected plots actually represent the intended ecological-site stratum. Ecological Site narratives and an Ecological Site dichotomous key will be provided to each crew member. The

PI or their designee will provide verbal instructions on the use of narratives and key, and will demonstrate their use in the field by visiting examples of each target ecological site.

IV. Plot Establishment and Measurement procedures will be exercised prior to operational monitoring efforts. This exercise will be conducted on non-NPS lands, such as BLM lands in the vicinity of Moab, UT. The PI or designee will provide several days of instruction covering the operational procedures of all field-based procedures. Procedures will commence with using a GPS to locate a pre-determined plot center. Each crew members will be tasked with finding plot centers using a GPS. At one or more plot centers, Site Characterization procedures will be explained and demonstrated, which includes evaluation of Ecological Site conditions. Plot Establishment, on-site measurement methods, and site-impact procedures will be explained and demonstrated. For each of these categories of activities, field crew members will be paired, and required to exercise all procedures under the critical eye of the PI or designee. All procedures will be exercised to the full extent, including actual recording of observations on data sheets.

Upland Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) # 3

Using Global Positioning System (GPS) Units

Version 1.00 (August 2006)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) explains the procedures and considerations that all observers should follow when collecting geospatial data or navigating to locations. This SOP is written for recreational-grade GPS units such as those manufactured by Garmin or Magellan. These units are far less expensive than mapping-grade units (e.g., Trimble GeoExplorer), yet they are effective for obtaining point information at a level of spatial accuracy that is required for this project. Recreational-grade GPS units do not have the capability of a data dictionary for storing attribute information with point locations.

This SOP assumes that each observer is familiar with the operation and function of the GPS unit to be used for this project. This SOP is intended to complement, not replace, the operations manual accompanying the GPS unit. Each observer should be familiar with the use of their particular GPS unit before entering the field to collect data or navigate to points.

This SOP does not require the use of a specific type or brand of GPS unit; however, the unit is required to meet the minimum standards listed below. The Northern Colorado Plateau Network (NCPN) primarily has used Garmin units, specifically, the eTrex, III Plus, and 76 models. The procedures below provide project-specific guidelines that are applicable to any recreation-grade unit. Attachment A contains detailed instructions relating to the operation of the Garmin 76 model. GPS functions other than those associated with this protocol are not explained in this document.

Procedures:**1. The minimum GPS receiver standards for navigating and mapping are:**

- Capable of storing date, time, and coordinates of features collected.
- Capable of exporting features collected to a format that can be used by GIS
- Capable of maintaining an EHE (Estimate of Horizontal Error) of less than or equal to 12 meters. Maintaining an EHE (or EPE – Estimate of Positional Error) of 12 meters or less meets the National Map Accuracy Standard.
- Capable of tracking a minimum of 4 satellites
- Capable of collecting real-time differentially-corrected positions (DGPS)

2. Required equipment

- GPS unit
- One set of extra batteries
- Operation manual
- Compass
- Rangefinder
- USGS 1:24,000-scale topographic map
- Personal computer for downloading data from the GPS unit. DNR Garmin (freeware, available at <http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions.html>) should be installed on the computer to facilitate the data download.

3. GPS Unit Setup before leaving the office (see Attachment A).

- Set GPS unit standards

Minimum GPS Receiver Settings Standards

Name	Standard
Projection (displayed coordinates)	UTM
Datum	NAD 83
WAAS	Enabled (on)

- Upload background data (MapSource)
- Upload existing waypoints to the GPS unit (if necessary)

4. Navigation to an existing location

If an existing upland monitoring plot is to be revisited, the observer can relocate that point using the GPS unit. Navigation to the point is best accomplished by using background maps that have been loaded onto the GPS unit, in addition to using hard-copy USGS 1:24,000-scale topographic maps.

- Select the waypoint you wish to navigate towards and follow the pointer displayed on the unit.
- In order to navigate, the GPS unit must be moving

5. Collecting new location data

The observation point providing the best direct line of sight to a nest must be recorded. This waypoint is documented by recording UTM and Lat/Long coordinates. Also, the bearing and distance to the nest site from this point is recorded.

- Take (or mark) a waypoint, and identify it with a unique ID that matches the location identifier recorded on the field sheet.
- Record waypoint UTM coordinates that are displayed on the GPS unit on field sheet.
- Use compass to determine bearing to nest site and record on field sheet.
- Record approximate distance from observation point to nest site. Use rangefinder, or, if out of range, determine distance using topographic map.

6. Downloading Data from GPS unit (see Attachment A)

The data from the GPS unit are downloaded to a personal computer daily, or after each field stint. Frequent, regular downloads will safeguard against any loss of data.

NCPN recommends the use of the DNR Garmin extension. This tool facilitates the communication between ArcView and Garmin Brand GPS units by allowing users to download and upload waypoints (and tracks) as text files, shapefiles and/or graphics. DNR Garmin is freeware, and is available at

<http://www.dnr.state.mn.us/mis/gis/tools/arcview/extensions.html>)

- Connect the GPS unit to the personal computer using a USB or serial cable.
- Download GPS data (.txt files) into appropriate folders (Figure 3-1). Fields required from a unit download are: ident (waypoint), lat, long, y_proj, x_proj, comment, altitude, and model.
- Review the downloaded data for accuracy and completeness.

Text files are required as part of the download. GIS shapefiles can be created at the same time. See Attachment A for additional information on shapefile creation. NCPN recommends that during the field season, downloads be limited to text files with a single set of GIS shapefiles created at the conclusion of the field season.

Downloaded GPS text files will be appended to the Integrated Upland database at the time of data entry (see SOP #18).

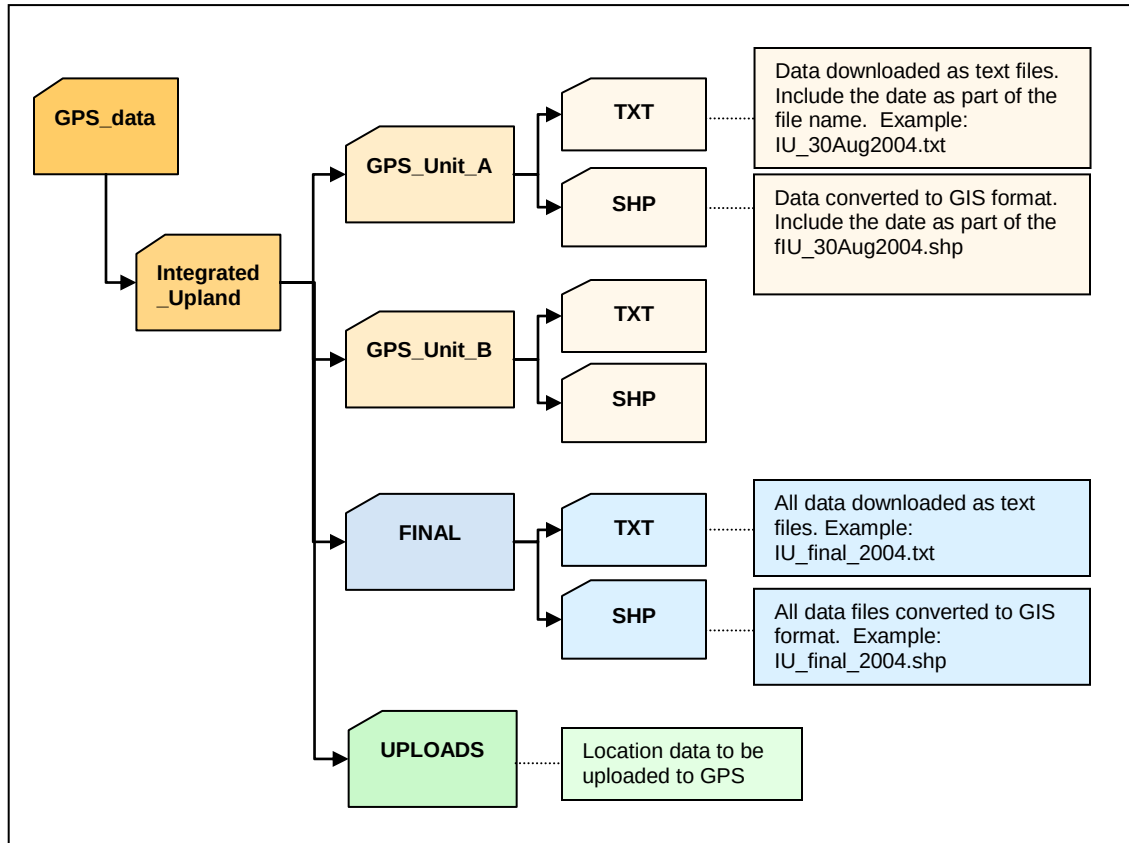
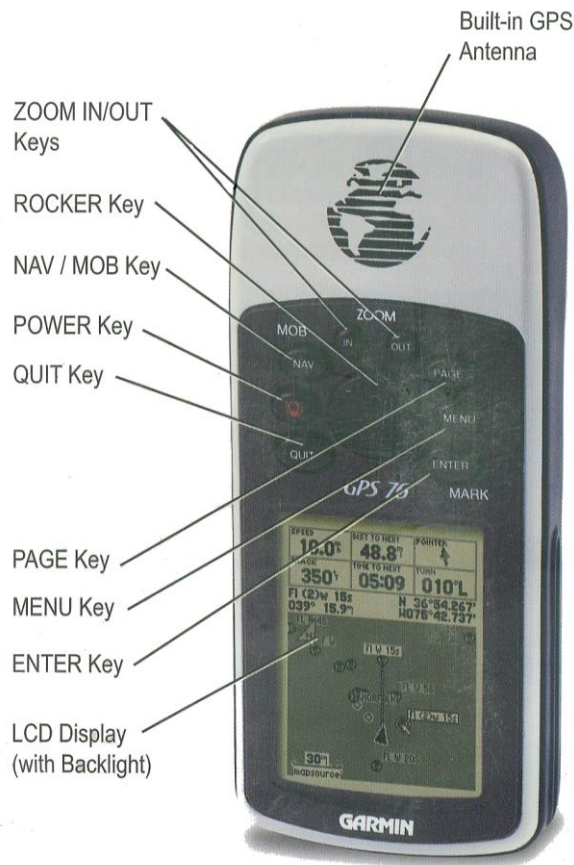


Figure 3-1. Recommended directory structure for data downloaded from GPS unit.

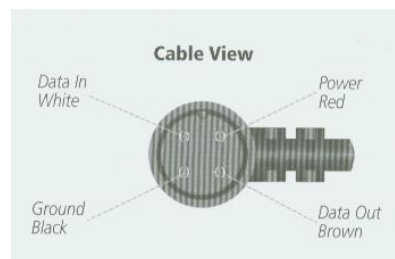
Attachment A



This graphic demonstrates the keys of a Garmin 76 GPS unit, and their functions. These keys are referred to in the following instructions.

1. To Connect GPS to Computer

- Either a serial or USB port cable will accompany the GPS unit. This is the cable that connects the GPS receiver to your workstation computer, allowing the uploading and downloading of waypoints.
- The serial or USB end of the cable attaches to your workstation computer. The other cable end (below) inserts into the Garmin GPS unit (lift bottom of black flap on the back of the GPS unit)



2. To change the displayed map projection:

- Turn on the unit by depressing the POWER key
- Set Projection
 1. Access the Main Menu (press the MENU key twice)
 2. Using the rocker key, scroll down to Setup and press the ENTER key
 3. There are several tabs listed (General, Time, Units, Location, Alarms & Interface) – using the rocker key, scroll over to the Location tab. Scroll down with the rocker key to Location Format and press the ENTER key.
 4. Scroll down the list of formats to UTM UPS, make sure this choice is highlighted, and press the ENTER key.
 5. Scroll down to Map Datum, press the ENTER key. Scroll down through the Map Datum choices, press the ENTER key when NAD 83 is highlighted.
 6. Press the PAGE key to get back to the “GPS Information” screen. (If the GPS Information screen is not showing, press the PAGE key; it will cycle through the screens). The bottom of the screen should now be displaying coordinates as UTM.

3. Set GPS to log differentially correct data

- If not already on, power up the GPS
- Enable WAAS
 1. Access the Main Menu (press the MENU key twice)
 2. Using the key, scroll down to Setup and press the ENTER key
 3. There are several tabs listed (General, Time, Units, Location, Alarms & Interface) – using the rocker key, scroll over to the Location tab. Scroll down with the rocker key to General and press the ENTER key.
 4. Scroll down to WAAS, press ENTER, highlight Enabled, and press ENTER
 5. Press the PAGE key to exit Setup

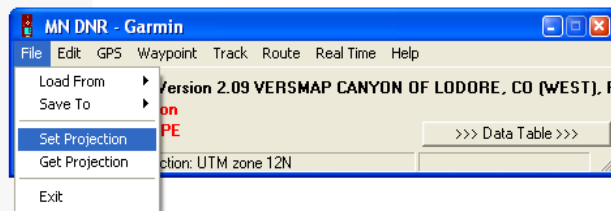
4. In the Field

- Collect (or mark) a waypoint
 1. When at the observation location, check the GPS Information page for number of satellites (4 or more needed) and accuracy (12 meters or less)
 2. Press and hold the ENTER/MARK key until the Mark Waypoint Page is displayed.
 3. Using the Rocker key, change the waypoint ID to Nest Territory number plus site letter (GPS number optional).
 4. Using the Rocker key, highlight “OK” and press ENTER
- Navigation
 1. Press the NAV key
 2. Select ‘Go To Point’ then press the ENTER key
 3. Select ‘Waypoints’ then press the ENTER key

4. Select 'your point' then press the ENTER key
5. Highlight the 'GoTo' button, press ENTER
6. As you start walking, the Pointer will point to your destination

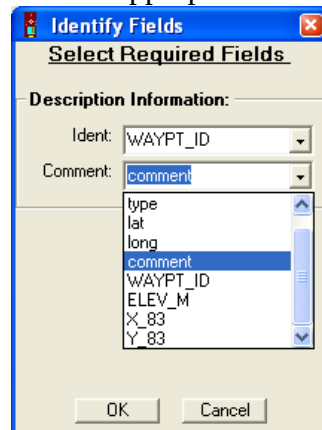
5. Upload Background Data

- Upload background maps from MapSource (proprietary software) if needed
- Upload waypoints using DNR Garmin
 1. Connect GPS to the computer
 2. Turn GPS on, then open DNR Garmin, it will connect to the computer
 3. When the MN DNR – Garmin window opens, make sure that the projection is set to UTM, NAD 83, zone 12N (unless at CURE or BLCA, which are zone 13N). Go to File, then Set Projection to



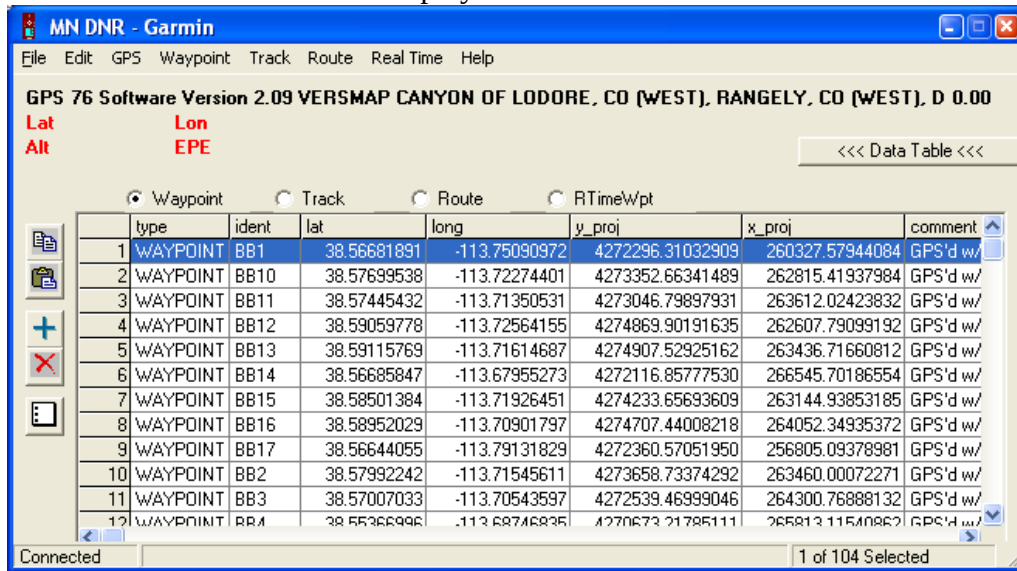
change projection.

4. Click on File, then Load From. You can upload a .txt file, .dbf file or a shapefile. Navigate to the file you wish to upload and click Open.
5. A window will open prompting you select description information. Choose appropriate fields for Ident (ID) and Comment and click OK.



6. A window will open stating "File was loaded successfully from...", click OK

7. Points will be displayed in the MN DNR – Garmin window.

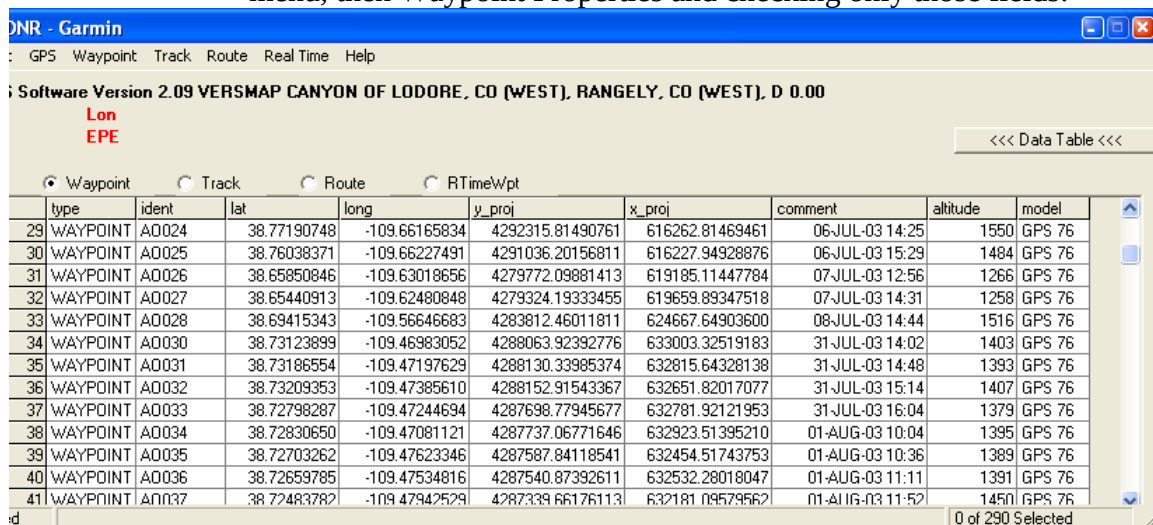


8. If the points are correct, click on WAYPOINT, then Upload

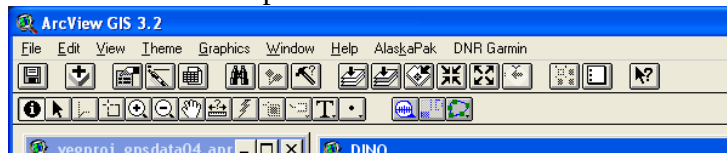
9. A window will pop up stating "Transfer Complete. # points uploaded"

6. Downloading Waypoints

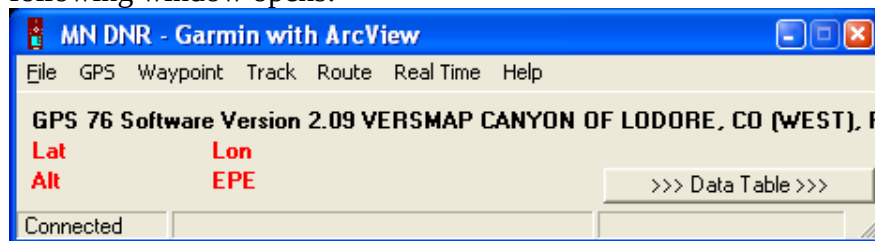
- Download waypoints using MN DNR Garmin freeware
 - Connect the GPS to the computer and turn on the GPS unit, then open the program DNR Garmin on the computer
 - From the DNR Garmin main menu, click on Waypoint, then Download. Your data will appear in the MN DNR Garmin window (see below). Elements to be included in the downloading process are: type, ident, lat, long, y_proj, x_proj, comment, altitude & model. These fields can be chosen by choosing Waypoint from the main menu, then Waypoint Properties and checking only those fields.



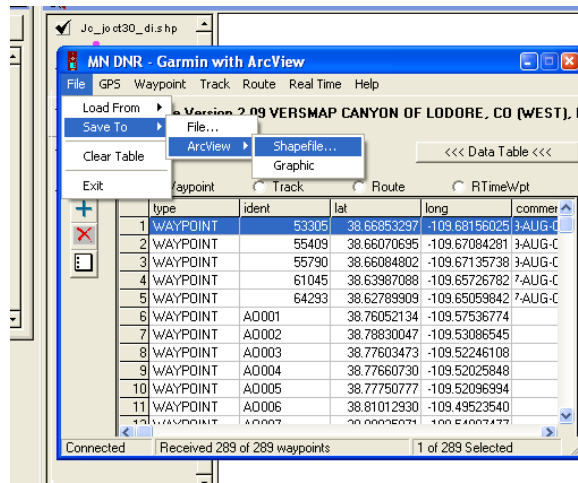
3. Click on File, and then Save To. Navigate to the proper folder on the computer (see possible directory structure, Figure 3-1)
 4. There are several file types which you can save the file as. The NCPN recommends saving the data as a Text File (Comma delimited)(* .txt) file. This is the default choice.
 5. Name the file with the date of download in the file name (example: Peregrine_June10_05.txt) and click the Save button. A window will display “File successfully written to ...”
- Download waypoints using MN DNR Garmin and ArcView 3.x
 1. Connect GPS unit to workstation
 2. Open and activate the DNR Garmin-ArcView extension in ArcView. A DNR Garmin dropdown menu will be added to ArcView.



3. From the DNR Garmin menu, choose “Set Projection”. Choose UTM NAD83, and the appropriate zone (12 for all NCPN parks except CURE and BLCA which are 13)
4. From the DNR Garmin menu, choose “Open Garmin GPS”. The following window opens:



5. From this window, click on Waypoint, then Properties. Choose (check) the following fields: type, ident, lat, long, y_proj, x_proj, comment, altitude & model. Click OK to dismiss the Properties window
6. Click on Waypoint, and then Download. All points collected will be downloaded.
7. Click on File, and then Save To, then ArcView, then Shapefile.



8. Navigate to the appropriate folder, and click Save. The newly created shapefile will appear in the active ArcView view window. Notice that X & Y coordinates have been added to the shapefile.

**Upland Monitoring Protocol
For the Northern and Southern Colorado Plateau I&M Networks**

Standard Operating Procedure (SOP) # 5

Site Characterization

Version 1.0 (August 2006)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP gives step-by-step instructions for characterizing potential field sites for long term ecological monitoring using the following three components: (1) field characterization, (2) soil collection, and (3) recommended soil analyses. This SOP describes the procedure for filling in the “Site Characterization Data Sheet.” An example of this data sheet is available in Appendix A and SOP #1.

Equipment

- GPS unit
- Compass
- Clinometer
- 2-mm soil sieve
- Trowel
- Spray bottle with water (or water in dropper bottle)
- 1M HCl in dropper bottle
- Wire flags or chain pins
- Site Characterization Data Sheets (1 per site; Appendix A)
- Ecological site tables (including soil descriptions)
- Soil maps (including soil survey map units, potential sampling locations, access to plots from the nearest road, and other useful information)
- Natural Resources Conservation Service (NRCS) definitions (Appendix B)
- Quick reference sheets (Appendix C)
- Vegetation identification keys
- Clipboard
- Pencils, extra lead, and erasers
- Portable chair
- Sharpies
- Auger or shovel

- Tarp
- Soil probe
- Bags for soil

Navigate to the plot centroid

A list of macroplot locations will be provided by the project manager. Visit the locations in the order they are listed to maintain the integrity of the sampling design. Plots will be rejected before site characterization if the actual location is determined to be outside of park boundary or if any portion of a transect is closer than the buffer distance (to be specified per park) to developments (trail, road, building, or other construction).

Use the appropriate soil map and a GPS unit (SOP #3 “Using the Global Positioning System” contains detailed instructions) to navigate to the pre-determined macroplot centroid. Mark this point with a pin flag. To avoid trampling the area sampled by the middle transect, conduct the characterization about 1-2 m down slope of the centroid/transect. If it is apparent that a significant soil/geomorphic boundary crosses the macroplot area, focus your description on the area in which the centroid itself is located.

Field Characterization

1) General Plot Info.

Fill out the information at the top of the “Site Characterization Data Sheet” including:

- **Park Name** – Use the 4-letter code for a park (e.g., ARCH, BLCA, BRCA, CANY, CARE, CEBR, COLM, CURE, DINO, FOBU, GOSP, HOVE, NABR, PISP, TICA, ZION).
- **Plot ID** – Plot IDs are unique numbers pre-assigned to upland plots within a park unit. This number is provided along with the UTM coordinates prior to field time.
- **Date** – mm/dd/yyyy.
- **Recorder** – Record the last name of the person recording data. Where necessary, include the first-name initial.
- **Soil survey area** – Determine the soil survey corresponding to the park unit and plot (multiple, non-overlapping soil surveys were conducted in some park units). This information should be condensed in a table for each park containing soil and vegetation characteristics for ecological sites of interest. Hereafter, these tables will be referred to as “ecological site tables”. See Table A1 in Appendix A for an example.
- **Soil map unit** – Using the appropriate soil map, determine the soil map unit in which the centroid lies. This should correspond with target soil map units for the ecological site of interest.
- **GPS file** – Record the name of the GPS file for the centroid coordinates (UTM), and the Datum and UTM Zone. Datum should be NAD83.
- **UTM coordinates** – Record the easting and northing (e.g. 596717 E; 4215867 N).

2) Soil and Vegetation Characterization

Use the “Site Characterization Data Sheet” to collect information that will help you decide whether the macroplot centroid is located on the target ecological site. The target soil component and ecological site for each pre-selected site location will be provided to you by the project manager. Fill out the data sheet using the guidelines below for each letter. The NRCS figures in this SOP have been condensed into two sheets that can be taken in the field for quick reference (Appendix C).

- A. Geologic setting – Characterize the geologic setting and predominant geomorphic processes evident on site. See NRCS data sheet in Field Book; pages 2-75.

- B. Landform – Use the information from the ecological site table (e.g., Table A1) to determine if you are on the correct landform. Geomorphologists have probably identified a few thousand different types of landforms, and it is NOT necessary to familiarize yourself with all of these landforms. It is important to determine whether or not you are on the expected landform for the ecological site of interest. Landforms commonly encountered on the Colorado Plateau include alluvial fans, cuestras, hillslopes, mesas, plateaus, sand sheets, and structural benches. Definitions of common landforms on the Colorado Plateau (B1) and a list of landscapes and landforms by geomorphic environment (B2) are listed in Appendix B. Additional landforms are listed in the NRCS “Field Book for Describing and Sampling Soils” (Schoeneberger et al. 2002), and definitions are provided on the NRCS website <http://soils.usda.gov/technical/handbook/contents/part629glossary1.html>. Write in the appropriate landform on the data sheet.

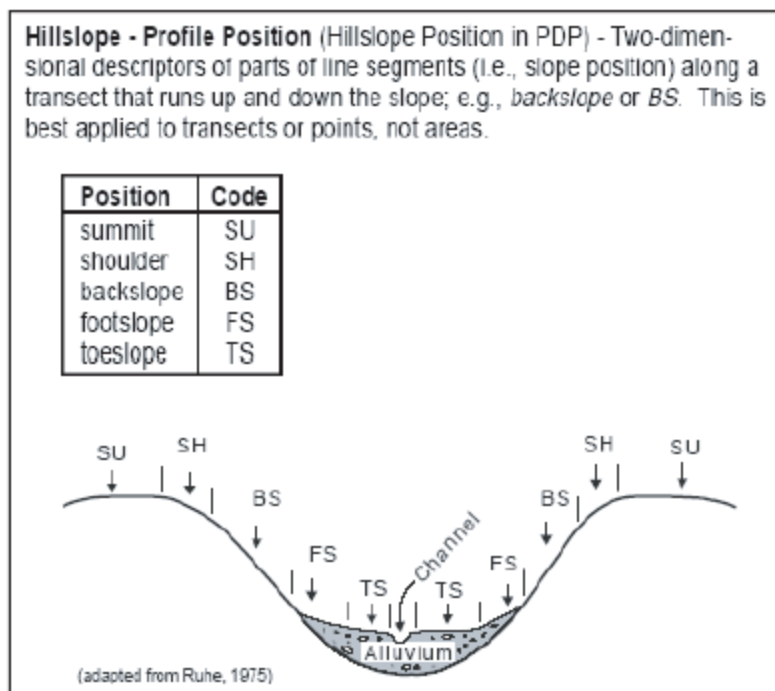


Figure 1. NRCS figure for determining hillslope position (Schoeneberger et al. 2002)

- C. Hillslope position – Use Figure 1 to select the hillslope position that describes your location. Possible hillslope positions include summit, shoulder, backslope, footslope, and toeslope. Circle the appropriate hillslope position on the data sheet. Hillslope position may not be relevant in some cases, such as for mesa tops or mountain tops. In such cases circle summit on the data sheet.
- D. Slope complexity – This refers to the relative uniformity of the ground surface leading down slope and across the macroplot. Figure 2 illustrates examples of simple vs. complex slopes. Decide which best describes your location and circle the appropriate category on the data sheet.

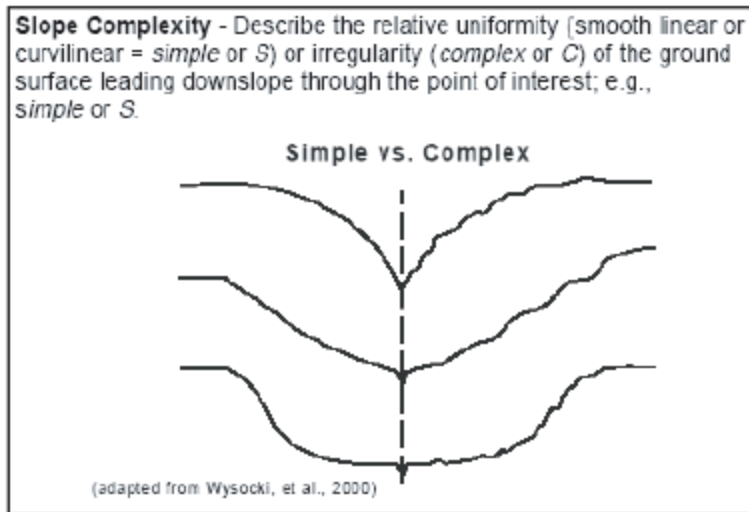


Figure 2. NRCS figure for determining hillslope complexity (Schoeneberger et al. 2002)

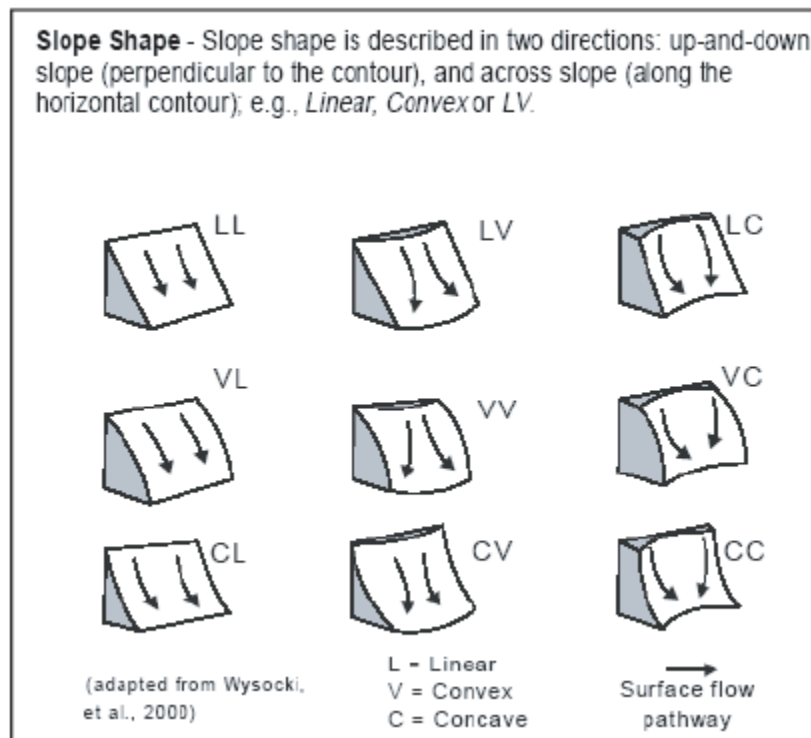
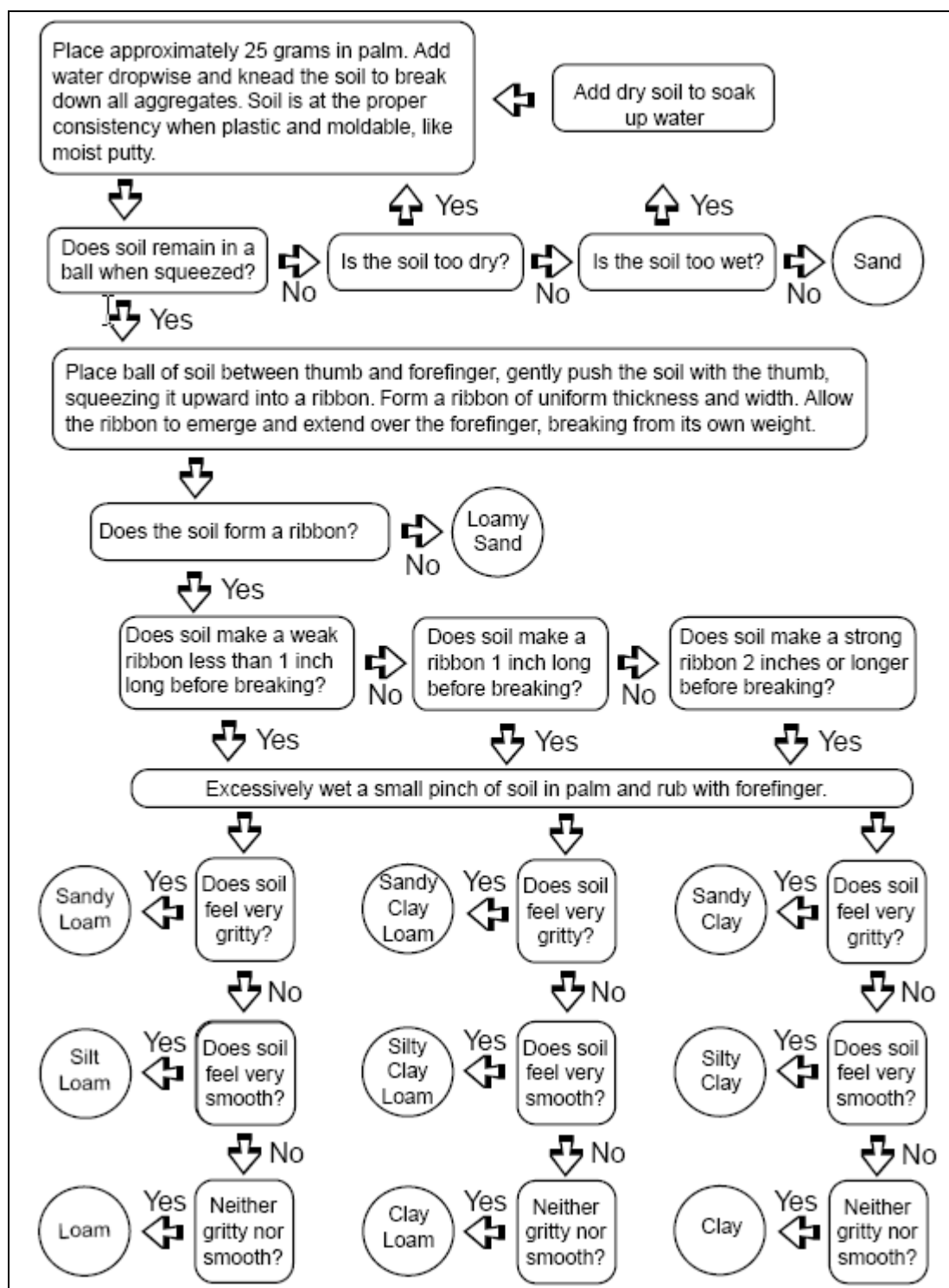


Figure 3. NRCS figure for determining slope shape (Schoeneberger et al. 2002)

Table 1. Conversion of slope angle from degrees (Deg) to percent (Pct)

Slope angle	
Deg	Pct
1	1.7
2	3.5
3	5.2
4	7.0
5	8.7
6	10.5
7	12.3
8	14.1
9	15.8
10	17.6
11	19.4
12	21.3
13	23.1
14	24.9
15	26.8
16	28.7
17	30.6
18	32.5
19	34.4
20	36.4
21	38.4
22	40.4
23	42.4
24	44.5
25	46.6
26	48.8
27	51.0
28	53.2
29	55.4
30	57.7
31	60.1
32	62.5
33	64.9
34	67.5
35	70.0
36	72.7
37	75.4
38	78.1
39	81.0
40	83.9
41	86.9
42	90.0
43	93.3
44	96.6
45	100.0

- E. Slope shape – Determine the slope curvature (linear, concave, or convex) for across slope and downslope. Figure 3 illustrates possible combinations of slope curvature. Circle the appropriate categories on the data sheet.
- F. Percent slope – Determine the percent slope using a clinometer. This is an approximate measurement used to decide if the slope at your location fits into the range of slopes for the ecological site of interest. Take a reading downslope from the centroid, sighting to the same height above the ground as your eye level. Record the reading in percent (not degrees). If your clinometer only has degrees, use Table 1 to convert to percent slope.
- G. Surface soil texture – Soil texture refers to the particle size distribution of the fine earth fraction (sand, silt, and clay particles <2 mm in diameter). Use a trowel to scoop a small amount of surface soil into the 2-mm sieve in order to separate rock fragments from the fine fraction. Collect a small amount of sieved soil in your hand and add water slowly using a spray bottle or dropper. Mix the water and soil in your hand and use the key in Figure 4 to determine the soil texture. If you have never textured soil, practice this technique with the guidance of an experienced co-worker before the beginning of the field season. The texture triangle (Fig. 5) is also helpful for understanding the relationship between different soil particle sizes in determining soil texture. Write the soil texture in the blank provided on the data sheet.



(Herrick et.al. 2005)

Figure 4. Soil texture key. Begin in the top left corner and answer the yes/no questions to determine soil texture.

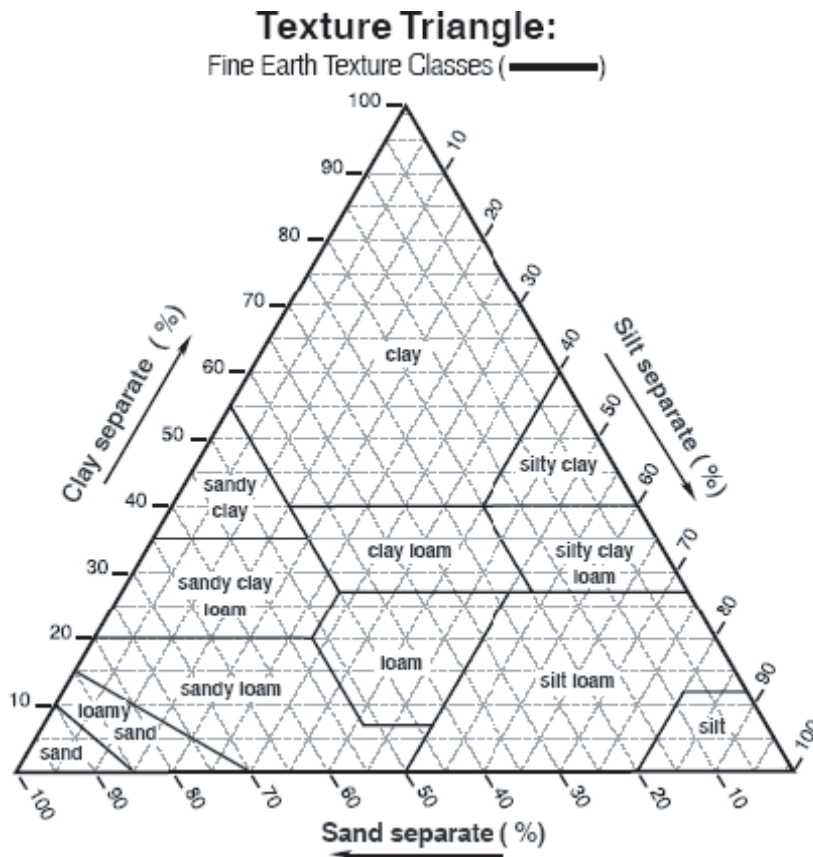


Figure 5. Soil texture triangle (Schoeneberger et al. 2002)

- H. Sand modifier – If sand is a major part of the soil texture (e.g. loamy sand or sandy loam), determine the predominant size class of sand. Use the sand particle sizes detailed in Figure 6 to choose one of two size classes: very fine/fine/medium or coarse/very coarse. The border between the two classes is 0.5 mm. Circle your choice on the data sheet. If the words “sand or “sandy” are not included in soil texture then circle “n/a”.

FINE EARTH										ROCK FRAGMENTS									
										channers			150	380	600 mm				
Clay ²		Silt				Sand				Gravel			Cob- bles	Stones	Boulders				
fine	co.	fine	co.	v. fi.	fi.	med.	co.	v. co.	fine	medium	coarse								
0.0002	.002 mm		.02	.05	.1	.25	.5	1	2 mm	5	20	76	250	600 mm					

Figure 6. Sizes of soil particles and rock fragments (Schoeneberger et al. 2002). Definitions of channers and flagstones are listed in Appendix B. (v.fi.= very fine, fi.=fine, med.= medium, co.=coarse, v.co.= very coarse, flagst.=flagstones)

- I. Rock fragment texture modifiers – Some soil types are further described by rock fragment quantity and size (e.g., very gravelly sandy loam). First, use rock fragments remaining in the soil sieve and exposed on the soil surface to determine the percent of rock fragments by volume. If there is less than 15% rock fragment by volume then no rock fragment texture modifier is necessary. Circle “n/a” for “quantity adjective” and “none” for “size”. If there is more than 15% rock fragment by volume, use the following categories to determine the appropriate rock fragment texture modifiers.

QUANTITY ADJECTIVE: Determine the approximate rock fragment content percent by volume, and refer to Table 2 for the appropriate rock fragment quantity adjective. Rock fragments 15 to <35% by volume require only fragment size (e.g. gravelly loam), therefore, circle “none” for “quantity adjective” on the data sheet. Use “very” and “extremely” to describe soils with 35 to < 60% and 60 to < 90% rock fragments respectively (e.g. very gravelly loam and extremely gravelly loam). If there is 90% or more of rock fragment then soil is described by only the rock fragment size and not by the fine earth component (e.g. gravel).

SIZE: Use the rock fragment size chart in Figure 6 to determine the largest dominant fragment. The largest dominant fragment is the largest rock fragment class present unless a smaller size-class is present in substantial quantity. A smaller fragment size-class must exceed two times the volume of a larger fragment before it is called the dominant fragment. Circle the appropriate size class on the data sheet.

Table 3 provides examples of rock fragment texture modifiers for rock fragments of different quantity and size.

Table 2. NRCS texture modifiers to describe the amount of rock fragments in soil (Schoeneberger et al. 2002).

TEXTURE MODIFIERS - Conventions for using "Rock Fragment Texture Modifiers" and for using textural adjectives that convey the "% volume" ranges for Rock Fragments - Size and Quantity .	
Fragment Content % By Volume	Rock Fragment Modifier Usage
< 15	No texture adjective is used (noun only; e.g., <i>loam</i>).
15 to < 35	Use adjective for appropriate size; e.g., <i>gravelly</i> .
35 to < 60	Use "very" with the appropriate size adjective; e.g., <i>very gravelly</i> .
60 to < 90	Use "extremely" with the appropriate size adjective; e.g., <i>extremely gravelly</i> .
≥ 90	No adjective or modifier. If ≤ 10% fine earth, use the appropriate noun for the dominant size class; e.g., <i>gravel</i> . Use Terms in Lieu of Texture .

Table 3. NRCS texture modifiers by rock quantity and size (Schoeneberger et al. 2002).

Table 3. PRCSS texture modifiers by rock quantity and size (continued).

TEXTURE MODIFIERS - (*adjectives*)

ROCK FRAGMENTS: Size & Quantity ¹	Code		Criteria: Percent (By Volume) of Total Rock Fragments and Dominated By (<i>name size</i>): ¹
	Conv.	PDP/ NASIS	
ROCK FRAGMENTS (> 2 mm; ≥ Strongly Cemented)			
Gravelly	GR	GR	≥ 15% but < 35% gravel
Fine Gravelly	FGR	GRF	≥ 15% but < 35% fine gravel
Medium Gravelly	MGR	GRM	≥ 15% but < 35% med. gravel
Coarse Gravelly	CGR	GRC	≥ 15% but < 35% coarse gravel
Very Gravelly	VGR	GRV	≥ 35% but < 60% gravel
Extremely Gravelly	XGR	GRX	≥ 60% but < 90% gravel
Cobbly	CB	CB	≥ 15% but < 35% cobbles
Very Cobbly	VCB	CBV	≥ 35% but < 60% cobbles
Extremely Cobbly	XCB	CBX	≥ 60% but < 90% cobbles
Stony	ST	ST	≥ 15% but < 35% stones
Very Stony	VST	STV	≥ 35% but < 60% stones
Extremely Stony	XST	STX	≥ 60% but < 90% stones
Bouldery	BY	BY	≥ 15% but < 35% boulders
Very Bouldery	VBY	BYV	≥ 35% but < 60% boulders
Extremely Bouldery	XBY	BYX	≥ 60% but < 90% boulders
Channery	CN	CN	≥ 15% but < 35% channers
Very Channery	VCN	CNV	≥ 35% but < 60% channers
Extremely Channery	XCN	CNX	≥ 60% but < 90% channers
Flaggy	FL	FL	≥ 15% but < 35% flagstones
Very Flaggy	VFL	FLV	≥ 35% but < 60% flagstones
Extremely Flaggy	XFL	FLX	≥ 60% but < 90% flagstones
PARAROCK FRAGMENTS (> 2 mm; < Strongly Cemented) ^{2, 3}			
Parabouldery	PBY	PBY	(same criteria as bouldery)
Very Parabouldery	VPBY	PBYV	(same criteria as very bouldery)
Extr. Parabouldery	XPBY	PBYX	(same criteria as ext. bouldery)
etc.	etc.	etc.	(same criteria as non-para)

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).

- J. *Effervescence* – The degree of effervescence relates to the quantity and surface area of carbonate compounds in the soil. Apply a few drops of 1-M HCl to the fine soil fraction, and use Table 4 to determine the effervescence class. More bubbles indicate higher amounts of carbonate compounds in the soil. Circle your choice on the data sheet.

Table 4. NRCS effervescence classes determined by dropping 1-M HCl on the fine soil fraction (Schoeneberger et al. 2002)

Effervescence Class	Code		Criteria
	PDP	NASIS	
Noneffervescent	4	NE	No bubbles form.
Very Slightly Effervescent	0	VS	Few bubbles form.
Slightly Effervescent	1	SL	Numerous bubbles form.
Strongly Effervescent	2	ST	Bubbles form a low foam.
Violently Effervescent	3	VE	Bubbles form a thick foam.

- K. *Soil Profile Characterization* - NPS compliance requires that an archeologist be present when digging any holes on NPS lands. If an archeologist is not present, you will not be able to complete this step.

Use an auger or shovel to dig a single hole to characterize the soil profile that best represents the predominant soil-geomorphic setting associated with the macroplot. Dig the hole within the macroplot to ensure that it represents the macroplot, but make sure it is not within a quadrat or in a location which may otherwise result in impacts to on-site dynamics. Dig to a depth of 1 m or until you reach bedrock or root restricting layers (e.g. argillic (clay) horizons or calcic hardpans), whichever comes first. It will be difficult to nearly impossible to dig through restrictive layers. Use a tarp to lay out 10-cm soil increments, and to allow soil to easily be gathered and returned to hole after completing characterization and sampling. Characterize each 10-cm increment of the soil profile for texture, abundance of rock fragments by size class and predominant lithology, and degree of effervescence using information from sections G through J above. Record this information on the data sheet.

- L. *Depth class* – Measure the depth to bedrock or a root restricting layer. Use Table 5 to determine the depth class, and circle your choice on the data sheet. If an archeologist is not present, you will have to do your best to assign a soil depth class based on your observations of bedrock exposures or naturally occurring profile exposures in the area.

Table 5. Depth to root restricting layer in centimeter (cm) and inches (in) for depth classes (Soil Survey Staff 1993).

Root restricting depth		
Depth class	Cm	In
Very shallow	< 25	< 10
Shallow	25 - 50	10 - 20
Moderately deep	50 - 100	20 - 40
Deep	100 - 150	40 - 60
Very deep	>= 150	> = 60

M. Potential vegetation and dynamics – Identify dominant plants species at the site and record this information on the data sheet. Use vegetation identification keys if necessary, but avoid spending too much time on this. Examine “Potential vegetation” and “Dynamics” columns on the ecological site tables. Look specifically for evidence of vegetation listed as “Potential vegetation” for the ecological site. Familiarize yourself with the range of variation in the plant community due to natural and/or anthropogenic disturbances. Think about how well the vegetation you see fits the expected vegetation for the ecological site.

3) Soil Assessment

Compare the information you collected on the data sheet with the characteristics of the target ecological site on the ecological site table to determine if observed soil and landscape characteristics reasonably match those associated with the target soil component and ecological site? Large departures in ecologically significant characteristics such as depth and texture are grounds for answering NO to this question. Large departures in profile characteristics (e.g. presence and depth of argillic or calcic horizons) also are grounds for answering NO, but these soil properties usually cannot be determined without digging a hole. Use the following examples to help you decide.

Large departures:

- If the target soil is deep, and the observed soil is very shallow or shallow.
- If the target soil is a sandy loam, and the observed soil is a channery clay loam.

Relatively minor departures:

- If the target soil is shallow and the observed soil is very shallow.
- If the target soil is a gravelly sandy loam and the observed soil is a very gravelly loamy sand.

Use the information you collected on the data sheet and the ecological site table to determine the probable soil component at the centroid. Write this on the data sheet (or write “unknown” if the soil component cannot be determined) and decide whether this matches the target soil component(s). If you suspect several soil components to be present on the macroplot but the most dominant component matches the target component, indicate a positive match by circling yes, but note the probable occurrence of other components in “Additional comments”. If the soil component does not match the target ecological site or if

non-target components are dominant, circle “no” and add narrative explaining your choice in “Additional comments”.

4) Vegetation Assessment

Does the observed vegetation reasonably match expected vegetation associated with the target ecological site? Soil, landscape, and climate characteristics are primary determinants of ecological sites. Existing vegetation *should only be used with great caution* as a clue in determining whether you are on the target ecological site. Observed vegetation may differ from expected vegetation due to effects of land use, natural disturbances such as fire, or climate. In answering this question, it is important to consider the full range of potential vegetation dynamics on a site – including natural post-disturbance successional processes, typical fluctuations in relation to climate, and possible degradational changes associated with invasive species, overgrazing, and/or major soil loss or redistribution. If observed vegetation is within this range of potential dynamics (natural and anthropogenic) for this ecological site, then the answer should be YES. However, if observed vegetation appears to be beyond the realm of potential dynamics, then the answer should be NO. Use the following examples to help you decide.

Departures within the range of potential dynamics:

- In reference condition, potential vegetation for the target ecological site is co-dominated by sagebrush and native perennial grasses, but the observed vegetation is dominated by invasive annuals (e.g. cheatgrass) or juniper with evidence of past sagebrush presence.
- Potential vegetation for the target ecological site is a mixed conifer forest but the observed vegetation is an aspen forest. The aspen forest may be a post-fire successional stage.

Departures beyond the range of potential dynamics:

- Potential vegetation for the target ecological site is a desert grassland dominated by black grama and observed vegetation is a montane shrubland dominated by gambel oak and serviceberry.

If a mixture of vegetative communities is present on the macroplot but the dominant community matches the target ecological site, then circle ‘yes’, but indicate in “Additional comments” the presence of other types. If the dominant community differs from the target ecological site, circle “no” and add narrative explaining your choice in “Additional comments”.

5) Ecological Site Assessment

The responses to the Soil and Vegetation Assessments above (nos. 4-5) determine if the site matches the target ecological site. Fill in the name of the ecological site that you characterized and provide an estimate of the macroplot area (%) comprised of this site type. For macroplots with more than one ecological site type, indicate the second-most common and the percent area. Write “unknown” if you are unable to determine the ecological site

from the information you have. Estimate the total length of transect (in meters) that falls outside the primary or target ecological site and write this on the data sheet. Remember that each macroplot has three 50-m transects separated by 25 m (Fig. 7) for a total of 150 meters of transect.

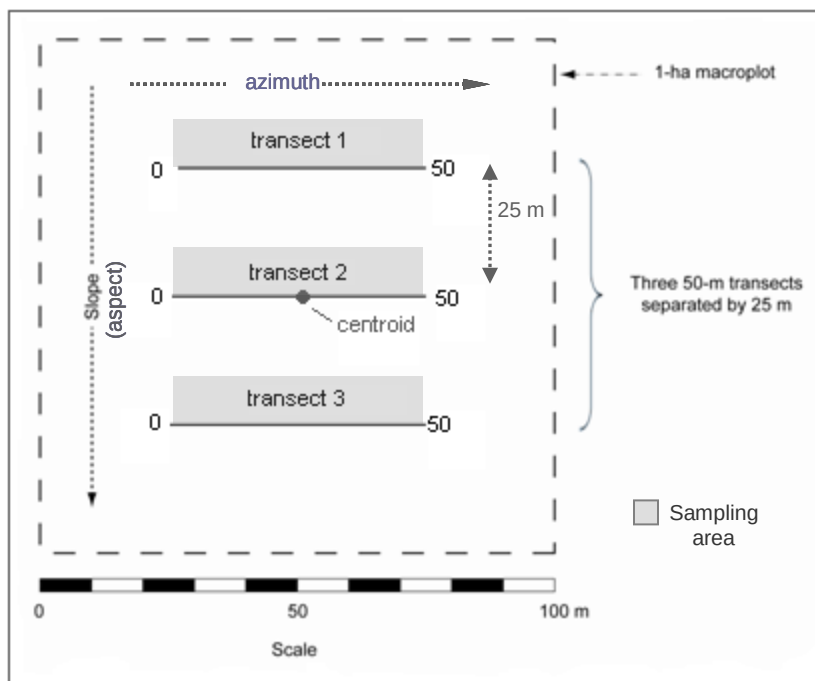


Figure 7. Standard macroplot and transect layout for upland monitoring.

6) Site Selection

Plots will be rejected if they do not match the target ecological site (wrong slope, slope position, landform, soil, soil depth, or vegetation), or if >30% of the total transect length crosses into another ecological site or an impermeable obstruction or cliff.

If both soils and vegetation are characteristic of the target ecological site, and $\leq 30\%$ of all 3 transects appear to have suitable soil and vegetation characteristics, then circle accepted on the data sheet and set up the monitoring plot (SOP #6). Using instructions from SOP #6, make sure to record the aspect, azimuth, and slope of the macroplot on the bottom of the “Site Characterization Data Sheet”.

If the vegetation or the soil do not match the expected characteristics for the ecological site, circle rejected on the data sheet and describe your rationale in the “Comments” section.

7) Soil Collection

If you accept a site, collect the following soil samples.

a) Using the hole dug for soil profile characterization, collect a soil sample from each 10-cm increment. Place ?? size sample in a soil collection bag and label it with the PlotID, date, and 10-cm increment (e.g. 10-20 cm). Note the number of 10-cm samples collected on the data sheet.

b) Next, collect composite soil samples from within the macroplot. For a 1-ha plot, the composite sample is composed of 25 subsamples collected from representative areas throughout the plot. Composite soil samples are collected for 0-2 cm and 2-10 cm depth using a probe or trowel. For each depth class, samples are placed in a bucket and mixed well before storing in soil collection bags. Place ?? amount in ?? size bag and label with the PlotID, date, and depth (e.g. 0-2 cm). Samples should be air-dried prior to storage for analysis. On the data sheet, record the number of soil samples were collected, by strata.

The following are recommended soil analyses:

For each 10-cm increment of soil profile:

- **particle size (fine fraction)**
- **percent rock fragments by size class**
- **carbonate content**
- gypsum content

For 0-2 cm and 2-10 cm composite samples:

- **particle size (fine fraction)**
- **percent rock fragments by size class**
- **carbonate content**
- **pH**
- total N, P (Na-bicarbonate extraction), and S
- exchangeable cations Ca, Mg, K, and Na
- micronutrients Zn, Mn, Fe, and Cu
- organic matter (or organic C)
- cation exchange capacity (CEC)
- electrical conductivity (saturated paste).

*Minimum set of variables in **bold**.

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- Schoeneberger, P.J., Wysocki, D.A., Benham, E.C., and Broderson, W.D. (editors), 2002. *Field Book for Describing and Sampling Soils, Version 2.0*. Natural Resource Conservation Service, National Soil Survey Center Lincoln, NE.
- Soil Survey Staff. 1993. Soil survey manual. USDA, Soil Conservation Service, Agricultural Handbook No. 18, U.S. Gov. Print. Office, Washington, D.C. 503 pp.

Appendix A.

Site Characterization Data Sheet

Site Characterization Data Sheet (p.1)

1. GENERAL PLOT INFO.

Park: _____ Plot ID: _____ Date: _____ Recorder: _____
 Soil survey area: _____
 Soil map unit: _____ GPS file name: _____
 Centroid Coordinates (UTM): _____ m E _____ m N
 Datum _____ UTM Zone _____

2. SOIL AND VEGETATION CHARACTERIZATION

A. Geologic setting: _____

B. Landform: _____

C. Hillslope position: summit - shoulder - backslope - footslope - toeslope - low level

D. Slope complexity: complex - simple

E. Slope shape - down slope: linear - concave - convex

across slope: linear - concave - convex

F. Percent slope: _____

G. Soil texture: _____

H. Sand modifier: very fine – fine - medium – coarse - very course - n/a

I. Rock fragment modifiers --- quantity adjective:

n/a (<15%) - none (15 to <35%) - very (35 to <60%) - extremely (60 to <90%) - >90%

--- size:

none - gravelly - cobbly - stony - bouldery - channery - flaggy - gravel - cobble - stone - boulder

J. Effervescence: none - very slight - slight - strong - violent

K. Soil Profile:

	Texture	Rock fragments		Effervescence
		Quantity Adj.	Size	
0-10 cm				
10-20 cm				
20-30 cm				
30-40 cm				
40-50 cm				
50-60 cm				
60-70 cm				
70-80 cm				
80-90 cm				

90-100 cm				
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Site Characterization Data Sheet (p.2)

L. Depth: very shallow - shallow - moderately deep - deep - very deep - unknown

M. Dominant vegetation: _____

3. SOIL ASSESSMENT **target match:** yes - no

Probable soil component: _____

Additional comments: _____

4. VEGETATION ASSESSMENT **target match:** yes - no

Additional comments: _____

5. ECOLOGICAL SITE ASSESSMENT

Primary Ecological site: _____ **% Area:** _____

Other Ecological site: _____ **% Area:** _____

Estimated transect length outside of target ecological site: _____ m

6. SITE SELECTION: accepted - rejected

Comments: _____

7. SOIL COLLECTION (NO. OF SAMPLES)

____ Soil profile (= 10 cm groups) ____ 0-2 cm composite ____ 2-10 cm composite

Table A1. Table of ecological sites of interest in Canyonlands National Park

Park	Survey area	Soil map unit no.	Soil map unit name	Landscape setting -- map unit	Component	Pct of map unit	Surface texture	Depth class	Parent material	Carbonates	Taxonomy
CANY	Soil Survey of Canyonlands Area, Utah, Parts of Grand and San Juan Counties (UT633)	71	Rizno, dry - Rock outcrop complex, 3-15 percent slopes	Structural benches, cuestras, and mesas	Rizno	45	Gravelly fine sandy loam	Shallow	Eolian deposits over residuum derived dominantly from sandstone and shale	Moderately calcareous	Torriorthent
					Rock outcrop	25					
					Arches	10	Fine sand	Shallow	Eolian deposits derived dominantly from sandstone	Moderately calcareous	Torripsamment
					Mido	5	Loamy fine sand	Very deep	Eolian deposits derived dominantly from sandstone		Torripsamment
					Sazi	5	Very fine sandy loam	Moderate ly deep	Eolian deposits derived dominantly from sandstone	Slightly calcareous	Calciorthid
					Begay	5	Fine sandy loam	Very deep	Eolian deposits derived dominantly from sandstone	Non-calcareous	Camborthid
					Ignacio	5	Fine sandy loam	Moderate ly deep	Eolian deposits derived dominantly from sandstone	Non-calcareous	Camborthid
		80	Sheppard fine sand, 2-8 percent slopes	Sand sheets and sand shadows on structural benches and cuestras	Sheppard	70	Fine sand	Very deep	Eolian deposits derived dominantly from sandstone	Moderately calcareous	Torrip-samment
					Arches	10	Fine sand	Shallow	Eolian deposits derived dominantly from sandstone	Moderately calcareous	Torripsamment
					Trail	10	Fine sand	Very deep	Alluvim derived dominantly from sandstone	Moderately calcareous	Torrifluvent
					Nakai	10	Fine sand	Very deep	Alluvial and eolian material derived dominantly from sandstone		Calciorthid

Appendix B.

B1. NRCS landform and rock fragment definitions

alluvial fan - A low, outspread mass of loose materials and/or rock material, commonly with gentle slopes, shaped like an open fan or a segment of a cone, deposited by a stream (best expressed in semiarid regions) at the place where it issues from a narrow mountain or upland valley; or where a tributary stream is near or at its junction with the main stream. It is steepest near its apex which points upstream and slopes gently and convexly outward (downstream) with a gradual decrease in gradient. GG

alluvial flat (a) (colloquial: western U.S.A.) A nearly level, graded, alluvial surface in bolsons and semi-bolsons which commonly does not manifest traceable channels, terraces or floodplain levels. Compare - flood-plain step, terrace, valley flat. FFP, GG, & SW. (b) (**not preferred**) A general term for a small flood plain bordering a river, on which alluvium is deposited during floods. GG

alluvial terrace - (not preferred) refer to stream terrace.

chanter - A thin, flat fragment of sandstone, shale, slate, limestone, or schist as long as 15 cm along the longest axis.

cuesta - An asymmetric, homoclinal ridge capped by resistant rock layers of slight to moderate dip (commonly less than 15 percent); produced by differential erosion of interbedded resistant and weak rocks. A cuesta has a long, gentle slope on one side (dip slope), that roughly parallels the inclined beds, and on the other side has a relatively short and steep or cliff-like slope (scarp) that cuts through the tilted rocks. Compare - hogback, mesa, dipslope, scarp slope, cuesta valley. SW & HP

flagstone - A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist as long as 15 to 38 centimeters long.

hill - A generic term for an elevated area of the land surface, rising at least 30 m (100 ft.) to as much as 300 meters (approx. 1000 ft.) above surrounding lowlands, usually with a nominal summit area relative to bounding slopes, a well-defined, rounded outline and slopes that generally exceed 15 percent. A hill can occur as a single, isolated mass or in a group. A hill can be further specified based on the magnitude of local relief: *low hill* (30 - 90 m) or *high hill* (90 - 300 m). Informal distinctions between a hill and a mountain are often arbitrary and dependent on local convention. Compare - hillock, plateau, mountain, foothills, hills. SW & HP

hillslope - A generic term for the steeper part of a hill between its summit and the drainage line, valley flat, or depression floor at the base of the hill. Compare - mountain slope. HP

landforms - discrete, natural, individual earth-surface features mappable at common survey scales.

landscapes - broad assemblages or unique groups of natural, spatially associated features.

mesa - A broad, nearly flat-topped, and usually isolated landmass bounded by steep slopes or precipitous cliff and capped by layers of resistant, nearly horizontal, rocky summit width greater than the height of bounding escarpments. (Colloquial: western USA; not preferred) Also used to designate broad structural benches and alluvial terraces that occupy intermediate levels in stepped sequences of platforms bordering canyons and valleys. Compare - butte, plateau, cuesta. HP & GG

plateau - [geomorphology] A comparatively flat area of great extent and elevation; specifically an extensive land region considerably elevated (more than 100 meters) above adjacent lower-lying terrain, and is commonly limited on at least one side by an abrupt descent, has a flat or nearly level surface. A comparatively large part of a plateau surface is near summit level. Compare - hill, foothill, mountain, mesa, plain. GG

sand dune - A low mound, ridge, bank or hill of loose, windblown, subaerially deposited granular material (generally sand), either barren and capable of movement from place to place, or covered and stabilized with vegetation, but retaining its characteristic shape. (See barchan dune, parabolic dune, parna dune, shrub-coppice dune, seif dune, transverse dune). SW & GG

sand sheet - A large, irregularly shaped, commonly thin, surficial mantle of eolian sand, lacking the discernible slip faces that are common on dunes. GG

structural bench - A platform-like, nearly level to gently inclined erosional surface developed on resistant strata in areas where valleys are cut in alternating strong and weak layers with an essentially horizontal attitude. Structural benches are bedrock controlled, and in contrast to stream terraces, have no geomorphic implication of former, partial erosion cycles and base-level controls, nor do they represent a stage of flood-plain development following an episode of valley trenching. Compare - pediment, ledge; see scarp. HP

valley - An elongate, relatively large, externally drained depression of the Earth's surface that is primarily developed by stream erosion or glacial activity. Compare - basin. HP

valley floor - A general term for the nearly level to gently sloping, lowest surface of a valley. Landforms include axial stream channels, the flood plain, flood-plain steps, and, in some areas, low terrace surfaces. Compare - flood-plain landforms, meander, braided channel, valley side.

B2. NRCS Landscapes and Landforms by Geomorphic Environment

(NASIS code follows each term; LF=landform, LS=landscape)

1. FLUVIAL - related to concentrated water flow (channel flow), including both erosional and depositional features.

Landscapes:

alluvial plain —
alluvial plain remnant —
badlands BA
bajada BJ
breaks BK
canyonlands —
delta plain —
fan piedmont FP
meander belt MP
river valley —
scabland SC

Landforms:

alluvial cone —
alluvial fan AF
alluvial flat AP
arroyo AY
axial stream (w) —
backswamp BS
bajada BJ
bar BR
basin-floor remnant BD
block stream BX
box canyon —
braided stream BZ
canyon CA
channel CC
coulee CE
cutoff CV
delta DE
delta plain (also LS) DC
drainageway DQ
draw DW

ephemeral stream —
fan apron —
fan collar —
fanhead trench FF
fan remnant —
fan skirt FI
flood plain FP
flood-plain playa FY
flood-plain splay FM
flood-plain step FO
giant ripple GC
gorge GO
gulch GT
gut (valley) GV
inset fan IF
intermittent stream —
levee [stream] LV
meander scar MS
meander scroll MG
natural levee NL
overflow stream channel —
oxbow OX
oxbow lake (ephemeral) OL
paleoterrace —
point bar PR
ravine RV
river valley (also LS) —
slot canyon —
strath terrace SU
stream terrace SX
valley border surfaces —
valley flat VF
wash WA
wind gap WG

2. EOLIAN - wind-related erosion or deposition.

Landscapes:

dune field —
sand hills SH
sand plain —

Landforms:

barchan dune BQ
blowout BY
climbing dune —
deflation basin DB
dune DU
dune lake (w) —
dune slack —
falling dune —
foredune FD

interdune ID
loess bluff LO
loess hill LQ
longitudinal dune —
paha PA
parabolic dune PB
parna dune PD
playa dune —
sand ramp —
sand sheet RX
seif dune SD
star dune —
transverse dune TD
yardang —
yardang trough —

3. VOLCANIC and HYDROTHERMAL

Landscapes:

foothills FH
hills HI
lava field (also LF) —
lava plain (also LF) —
lava plateau (also LF) —
mountains MO
volcanic field (also LF) —

Landforms:

a'a lava flow —
ash flow AS
block lava flow —
caldera CD
cinder cone CI
crater [volcanic] CR
fissure vent —
geyser —
geyser basin —
geyser cone —
hot spring —
kipuka —
lahar LA
lava field (also LS) —

lava flow unit —
lava flow LC
lava plain (also LS) LN
lava plateau (also LS) LL
lava trench —
lava tube —
louderback LV
maar —
mawae —
mud pot —
neck [volc.] —
pahoehoe lava flow —
pillow lava flow —
plug [volc.] —
plug dome PP
pressure ridge [volc.] PU
pyroclastic flow —
pyroclastic surge —
shield volcano —
step toe —
stratovolcano SV
volcanic cone VC
volcanic dome VD
volcanic field (also LS) —

4. MASS MOVEMENT (= MASS WASTING) – related to movement by gravity.

Landscapes: These generic Landscapes are not Mass Movement features per say, but are commonly modified by, and include localized areas of Mass.

Movement.

foothills FH

hills foothills FH

hills HI

mountain range —

mountains MO

Landforms:

avalanche chute AL

block glide —

block stream BX

complex landslide —

debris avalanche DA

debris fall —

debris flow DF

debris slide —

debris spread —

debris topple —

earth flow EF

earth spread —

earth topple —

fall FB

flow —

lahar LA

landslide LK

lateral spread —

main scarp (also Micro) —

mudflow MW

rock fall (also Micro) —

rockfall avalanche —

rock glacier RO

rock spread —

rock topple —

rotational debris slide —

rotational earth slide —

rotational rock slide —

rotational slide RP

sag (also Micro) —

sag pond (w; also Micro) —

sand flow RW

scree slope —

slide SJ

slump SK

slump block SN

soil fall —

talus cone —

talus slope —

topple —

translational debris slide —

translational earth slide —

translational rock slide —

translational slide TS

5. TECTONIC and STRUCTURAL - related to regional or local bedrock structures or crustal movement; recognized only if expressed at or near the land surface.

Landscapes:

batholith —
bolson BO
foothills FH
hills HI
intermontane basin IB
mountain range —
mountains MO
mountain system —
plateau PT
rift valley —
semi-bolson SB
tableland TB
valley VA

Landforms:

anticline AN
canyon bench —
cuesta CU

cuesta valley —
diapir DD
dike DK
dipslope DL
dome DO
fault-line scarp FK
fault zone —
fold FQ
graben GR
hogback HO
horst HT
louderback LU
meteorite crater —
monocline MJ
scarp slope RS
sill RT
strike valley —
structural bench SB
syncline SZ

6. SLOPE - generic terms that emphasize form rather than any particular genesis or process.

Landscapes:

badlands BA
breaks BK
canyonlands —
foothills FH
hills HI
mountain range —
mountains MO
mountain system —
piedmont PI
piedmont slope —
plateau (also LF) PT
tableland TB
upland UP

Landforms:

beveled base —
block stream BX
bluff BN
broad interstream divide —
butte BU
canyon bench —
cliff CJ
cuesta CU
dome DO
escarpment ES
faceted spur FS
fault-line scarp FK
free face FW (also Geom. Component-
Hills, Mountains)
gap GA
headwall HW
high hill —

hill (plural = LS) HI
hillslope —
hogback HO
interfluvium (also Geom. IV Component -
Hills)
knob KN
knoll KL
ledge LE
low hill —
mesa ME
mountain (plural = LS) MM
mountain slope MN
mountain valley MV
notch NO
paha PA
peak PK
pediment PE
plain (plural = LS) PN
plateau (also LS) PT
ridge RI
rim RJ
rock pediment —
scarp RY
scarp slope RS
scree slope —
spur SQ
stack [geom.] —
structural bench SB
talus cone —
talus slope —
tor TQ
valley VA
wind gap WG

7. EROSIONAL - related to water erosion, excluding perennial channel flow.

Landscapes:

badlands BA
breaks BK
canyonlands —
foothills FH
hills HI
mountain range —
mountains MO
piedmont PI
piedmont slope —
plateau (also LF) PT
tableland TB

Landforms:

ballena BL
ballon BV
basin floor remnant BD
beveled base —
canyon bench —
col CL
cuesta CU
cuesta valley —
eroded fan remnant —
eroded fan-remnant —

sideslope
erosion remnant ER
free face (also Geom. FW
Component-Hills,
Mountains)
gap GA
hogback HO
inselberg IN
monadnock MD
notch NO
paha PA
partial ballena PF
peak PK
pediment PE
plateau (also LS) PT
rock pediment —
saddle SA
scarp slope RS
stack [geom.] SR
strike valley —
structural bench SB
tor TQ
valley border surfaces —
wind gap WG

8. DEPRESSIONAL - low area or declivity features, excluding permanent water bodies.

Landscapes:

basin BS
bolson BO
semi-bolson SB
valley VA

Landforms:

alluvial flat AP
basin floor BC
basin floor remnant BD
box canyon —
canyon CA
Carolina Bay CB
closed depression —
col CL
coulee CE
cove [geom.] CO
cuesta valley —
depression DP
drainageway DQ
gap GA
gorge GO
gulch GT

gut (valley) GV
intermontane basin IB
kettle KE
mountain valley MV
open depression —
playa PL
playa floor —
playa rim —
playa slope —
playa step —
pothole PH
ravine RV
saddle SA
sag —
slot canyon —
strike valley —
swale SC
trough TR
U-shaped valley UV
valley VA
valley floor VL
V-shaped valley VV

Appendix C.

Quick Reference Sheets

Soil Texture, Depth, and Effervescence

Root restricting depth		
Depth class	Cm	In
Very shallow	< 25	< 10
Shallow	25 - 50	10 - 20
Moderately deep	50 - 100	20 - 40
Deep	100 - 150	40 - 60
Very deep	>= 150	>= 60

Effervescence Class	Code		Criteria
	PDP	NASIS	
Noneffervescent	4	NE	No bubbles form.
Very Slightly Effervescent	0	VS	Few bubbles form.
Slightly Effervescent	1	SL	Numerous bubbles form.
Strongly Effervescent	2	ST	Bubbles form a low foam.
Violently Effervescent	3	VE	Bubbles form a thick foam.

TEXTURE MODIFIERS - Conventions for using "Rock Fragment Texture Modifiers" and for using textural adjectives that convey the "% volume" ranges for **Rock Fragments - Size and Quantity**.

Fragment Content % By Volume	Rock Fragment Modifier Usage
< 15	No texture adjective is used (noun only; e.g., <i>loam</i>).
15 to < 35	Use adjective for appropriate size; e.g., <i>gravelly</i> .
35 to < 60	Use "very" with the appropriate size adjective; e.g., <i>very gravelly</i> .
60 to < 90	Use "extremely" with the appropriate size adjective; e.g., <i>extremely gravelly</i> .
≥ 90	No adjective or modifier. If ≤ 10% fine earth, use the appropriate noun for the dominant size class; e.g., <i>gravel</i> . Use Terms in Lieu of Texture .

SIMPLIFIED KEY TO SOIL TEXTURE

Add water to hand-full of soil and knead to break down aggregates. Soil is at proper consistency when plastic and moldable like moist putty.

- Soil does not remain in a ball when squeezed.....**Sand (Sa)**
- Soil remains in a ball when squeezed.....2

Squeeze ball between thumb and forefinger, attempting to make a ribbon that you push up over finger.

- Soil does not form ribbon.....**Loamy Sand (LSa)**
- Soil does form ribbon; may be very short.....3

- Ribbon extends < 1 inch before breaking.....4
- Ribbon extends > 1 inch before breaking.....5

- Add excess water to small amount of soil; soil feels very gritty.....**Sandy Loam (SaL)**, or slightly gritty.....**Loam (L)**
- Soil feels very smooth.....**Silt Loam (SiL)**

- Soil makes ribbon that breaks when 1-2 inches long; cracks if bent into ring.....6
- Soil makes ribbon > 2 inches long; doesn't crack if bent into ring.....7

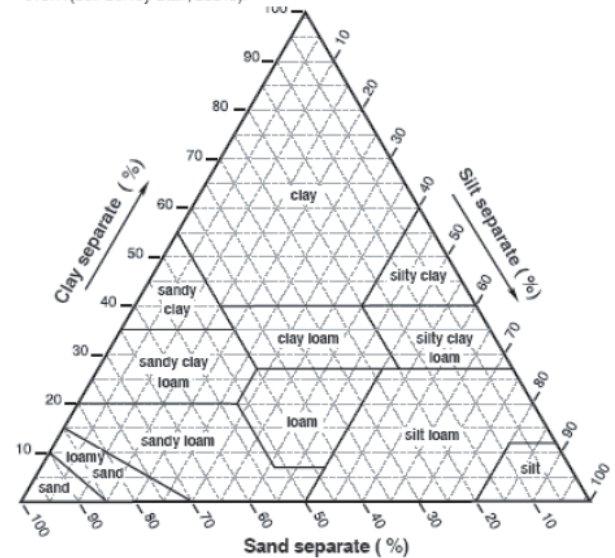
- Add excess water to small amount of soil; soil feels at least slightly gritty.....**Sandy Clay Loam (SaCL)** or **Clay Loam (CL)**
- Soil feels smooth.....**Silt (Si)** or **Silty Clay Loam (SiCL)**

- Add excess water to small amount of soil; soil feels at least slightly gritty.....**Sandy Clay (SaC)** or **Clay (C)**
- Soil feels smooth.....**Silty Clay (SiC)**

TEXTURE MODIFIERS - (adjectives)

ROCK FRAGMENTS: Size & Quantity ¹	Code		Criteria: Percent (By Volume) of Total Rock Fragments and Dominated By (name size): ¹
	Conv.	PDP/ NASIS	
ROCK FRAGMENTS (> 2 mm; ≥ Strongly Cemented)			
Gravelly	GR	GR	≥ 15% but < 35% gravel
Fine Gravelly	FGR	GRF	≥ 15% but < 35% fine gravel
Medium Gravelly	MGR	GRM	≥ 15% but < 35% med. gravel
Coarse Gravelly	CGR	GRC	≥ 15% but < 35% coarse gravel
Very Gravelly	VGR	GRV	≥ 35% but < 60% gravel
Extremely Gravelly	XGR	GRX	≥ 60% but < 90% gravel
Cobbly	CB	CB	≥ 15% but < 35% cobbles
Very Cobbly	VCB	CBV	≥ 35% but < 60% cobbles
Extremely Cobbly	XCB	CBX	≥ 60% but < 90% cobbles
Stony	ST	ST	≥ 15% but < 35% stones
Very Stony	VST	STV	≥ 35% but < 60% stones
Extremely Stony	XST	STX	≥ 60% but < 90% stones
Bouldery	BY	BY	≥ 15% but < 35% boulders
Very Bouldery	VBY	BYV	≥ 35% but < 60% boulders
Extremely Bouldery	XBY	BYX	≥ 60% but < 90% boulders
Channery	CN	CN	≥ 15% but < 35% channers
Very Channery	VCN	CNV	≥ 35% but < 60% channers
Extremely Channery	XCN	CNX	≥ 60% but < 90% channers
Flaggy	FL	FL	≥ 15% but < 35% flagstones
Very Flaggy	VFL	FLV	≥ 35% but < 60% flagstones
Extremely Flaggy	XFL	FLX	≥ 60% but < 90% flagstones
PARAROCK FRAGMENTS (> 2 mm; < Strongly Cemented) ^{2, 3}			
Parabouldery	PBY	PBY	(same criteria as bouldery)
Very Parabouldery	VPBY	PBYV	(same criteria as very bouldery)
Extr. Parabouldery	XPBY	PBYX	(same criteria as ext. bouldery)
etc.	etc.	etc.	(same criteria as non-para)

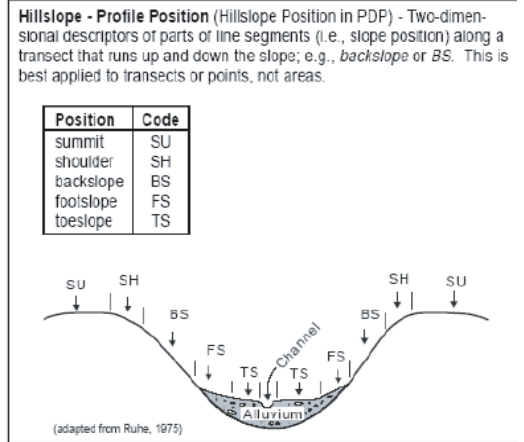
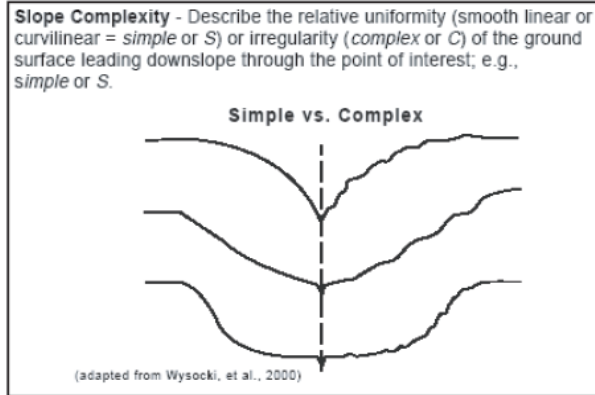
¹ The "Quantity" modifier (e.g., *very*) is based on the total rock fragment content. The "Size" modifier (e.g., *cobbly*) is independently based on the largest, dominant fragment size. For a mixture of sizes (e.g., *gravel and stones*), a smaller size-class is named only if its quantity (%) sufficiently 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).



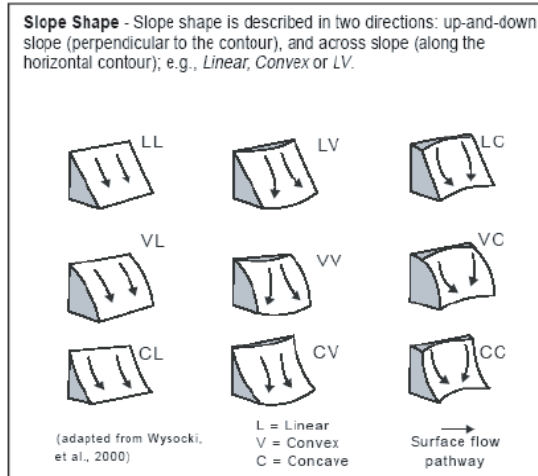
FINE EARTH										ROCK FRAGMENTS				

Hillslope Descriptors & Cover / Volume Estimation

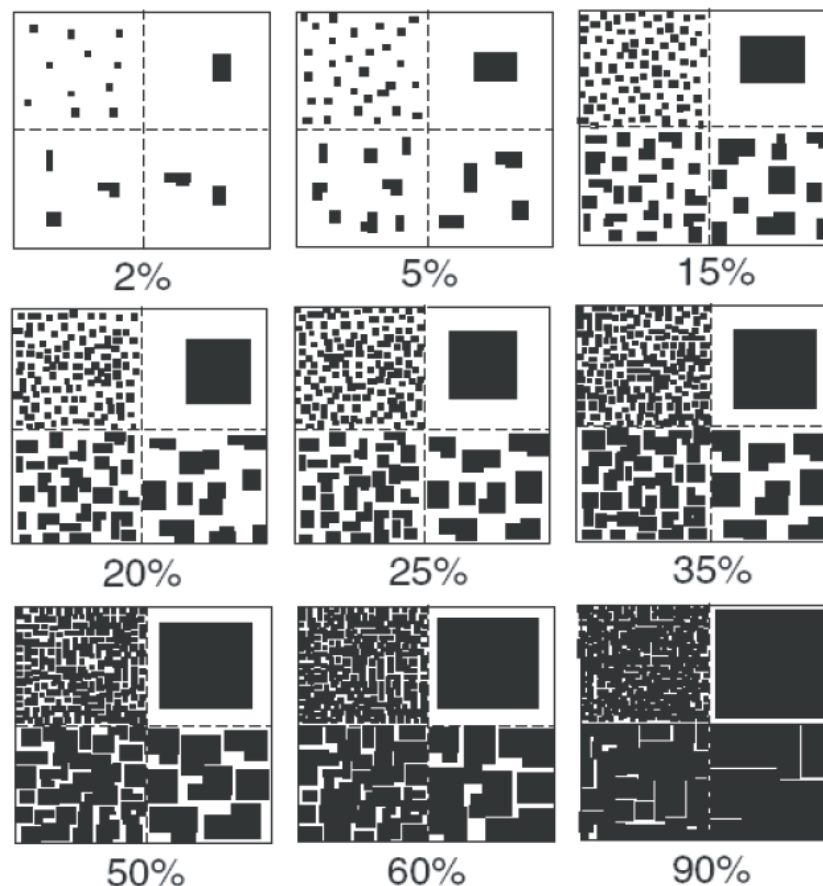
Slope angle	
Deg	Pct
1	1.7
2	3.5
3	5.2
4	7.0
5	8.7
6	10.5
7	12.3
8	14.1
9	15.8
10	17.6
11	19.4
12	21.3
13	23.1
14	24.9
15	26.8
16	28.7
17	30.6
18	32.5
19	34.4
20	36.4
21	38.4
22	40.4
23	42.4
24	44.5
25	46.6
26	48.8
27	51.0
28	53.2
29	55.4
30	57.7
31	60.1
32	62.5
33	64.9
34	67.5
35	70.0
36	72.7
37	75.4
38	78.1
39	81.0
40	83.9
41	86.9
42	90.0
43	93.3
44	96.6
45	100.0



Slope Classes	Pct. Gradient
Level.....	< 1
Nearly level.....	1-3
Gently sloping.....	4-6
Strongly sloping.....	7-10
Moderately steep.....	11-20
Steep1.....	21-45
Steep2.....	46-75
Steep3.....	76-100
Very steep.....	> 100



Foliar cover classes	
Class	Cover %
1	< 1
2	1 - 5
3	5 - 10
4	10 - 25
5	25 - 50
6	50 - 75
7	75 - 100



**Upland Monitoring Protocol
For the Northern and Southern Colorado Plateau I&M Networks**

Standard Operating Procedure (SOP) # 6

Establishing and marking permanent sample sites

Version 1.0 (August 2006)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP provides instructions for establishing the end points of the three transects comprising a permanent upland monitoring plot. This SOP is used only on the first visit to a plot, and only after ensuring that the site meets all criteria for sampling (see SOP#5 Site Characterization). This SOP was adopted with modifications from Herrick (2004) and USDI National Park Service (2003).

Equipment needed

- GPS – mapping grade
- Tape 50m (2)
- Rebar 1.2 cm x 50 cm
- Aluminum tags
- Wire
- Die set for marking tags
- Pliers
- Compass
- Hammer

Forms needed

- Plot Establishment Data Sheet

I. Plot Establishment Procedures

1. General Plot Information

Note the park, plot ID, date, and observer at the top of the Plot Establishment data sheet. If plot establishment does not immediately follow the Site Characterization (SOP#5),

then the centroid coordinates, datum, and zone fields should be filled in based on the actual plot center location used to establish a plot. Otherwise, centroid information does not need to be recorded.

2. Slope and Aspect Measurements

A general measure of slope is recorded during site characterization (SOP #5). More representative measures of both slope and aspect are required prior to actual site establishment. These measures are recorded from 5-10-m upslope from the 1st transect using a clinometer sighted on a reference or sighting pole located 5-10m downslope from the 3rd transect. A PVC pole or an unfolded 2-m engineer ruler can be used for the sighting pole. Before taking measurements, select the member who will use the clinometer. Holding the sighting pole or unfolded 2-m engineer ruler next to this crew member, use a piece of flagging to mark eye-level on the sighting pole or ruler.

If plot establishment commences immediately after site characterization (SOP #5), envision the center transect running parallel to the slope contour. Step ca. 1-2 meters downslope from this envisioned transect, and walk 30-40 meters parallel to the slope contour in order to get outside of the sampling area. The crew member with the clinometer should walk upslope 30-40 meters to locate themselves 5-10 meters upslope from the 1st transect. The second crew member should walk 30-40 meters downslope to a location about 5-10 meters downslope from the 3rd transect. Care should be taken to ensure that areas to be sampled along the three transects are not trampled. For reference, Fig. 1 illustrates the transect scheme for a macroplot.

If plot establishment occurs asynchronous with site characterization, then using a GPS estimate plot center and the 5-10m distance above and below the outer most transects of the macroplot. If a centroid marker is present on the plot, use this marker to estimate the top and bottom transects of the macroplot.

Standing ca. 5-10-m above where the 1st transect is likely to be located, record percent slope with a clinometer by sighting to the sighting pole directly down hill and located ca. 5-10-m below the 3rd transect. Slope is recorded at 0, 25, and 50-m along the 1st transect. These distances can be paced off; laying a measuring tape is not required. Aspect (direction of downhill-slope) is measured along with each slope measurement. The average of the three slope measures and of the three aspect measures is recorded on the Plot Establishment Data Sheet (Appendix A). For complex slopes, average the two most similar measures for each attribute. Record the average percent slope and aspect on the data sheet. See SOP#5 for percent-slope conversion from degrees slope, if necessary.

3. Azimuth of the Center Transect

The transect azimuth is the direction of a transect from the origin to the “finish” end. Transects are oriented parallel to the slope contour. Facing upslope, transects run from left (origin) to right (end). The azimuth of the center transect (transect #2) is based on the average aspect of the macroplot. This azimuth number should be 90° less than the average aspect. Derive this azimuth from the average macroplot aspect measure taken above, and record it on the data sheet.

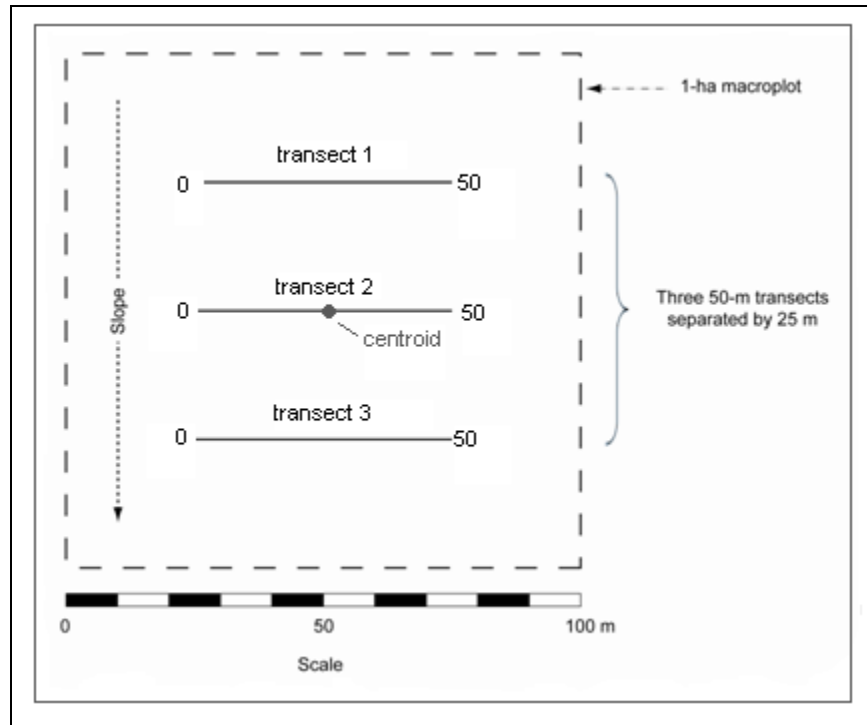


Figure 1. Standard macroplot and transect layout for upland monitoring.

4. Establish the center transect. Using the Transect Azimuth derived in #3, lay out the tape from the origin to end of the center transect (50-m). The origin is to the left when facing upslope. If on level ground arbitrarily determine the orientation of the origin.
5. Drive a 0.5" diameter rebar stake into the ground at the origin of the transect, leaving less than 30 cm exposed. If it is not possible to sink the rebar in at the origin or at the end (i.e. bedrock exposure), locate the closest possible point along the transect and drive the rebar stake in there. Always note the distance along the transect where the rebar is placed (i.e. at the origin, the distance is 0). This will clarify if the rebar stake was moved and to what distance it was moved.
6. Attach a metal tag to the rebar stake using wire. If the rebar has a hole at the top, thread a piece of wire through the hole and the tag, and securely fasten the tag. If the rebar lacks a hole, thread the tag with a piece of wire and wrap the wire securely around the top of the rebar. On one side scribe the following: NCPN, the date (e.g., Aug 06), RS29. This is required by the research permit, and identifies the study by the Research Study number. On the other side of the tag, scribe the following information. The PlotID number is always at the top of the tag. Beneath the PlotID is the transect ID. The transect ID identifies the transect and the end points of a transect. This is accomplished using the following convention: XY, where X = 1 for upper transect (i.e., uphill), 2 for the center transect, 3 for lower transect (downhill transect); Y = O for origin, C for center, E for end of the transect. The origin of a transect is to the left when facing upslope. If the plot is on level ground, arbitrarily select 'uphill' and 'downhill' and the side for the origin. For the latter situation, be consistent among transects.

7. Using the GPS, record the UTM coordinates and elevation of the rebar marking the transect origin on the Plot Establishment Data Sheet.
8. Repeat steps 2-4 for the transect center point, except UTM coordinates are not required.
9. Repeat steps 2-4 for the transect end.
10. Repeat steps 4-9 for the upper and lower transects. Note: these transects should be parallel to the center transect, even if they are no longer exactly parallel to the slope.
11. NOTE that the transect and quadrats located along the transect are further monumented during the quadrat sampling effort (SOP#21).

II. Plot Photos

1. Photographs of each of the three transects should be taken every plot visit. See SOP#7 for instructions.

III. Plot Directions

1. Complete the Plot Establishment Data Sheet by adding detailed directions to the plot.
Detailed directions are those adequate for someone unfamiliar with the site to locate it. Begin with road travel, where to park, describe (and photograph) landmarks used in navigating the origin of the center transect. Note particular obstacles or hazards to be avoided at (and en route to) this particular site.

Appendix A

Plot Establishment Data Sheet

Plot Establishment Data Sheet

Park: _____ Plot ID: _____ Date : _____ Page ____ of ____

Observer : _____

Centroid Coordinates (UTM): _____ m E _____ m N

Datum _____ UTM Zone _____

Slope (%): _____ Aspect (°): _____ Centroid Transect Azimuth (°): _____

TRANSECT LOCATION:

Transect	Rebar at transect origin		Rebar location (m)	Rebar at transect end		Rebar location (m)	Elevation m
	UTM E	UTM N		UTM E	UTM N		
1) Upper (uphill)							
2) Center							
3) Lower (downhill)							

DIRECTIONS TO PLOT: _____

**Upland Monitoring Protocol
For the Northern and Southern Colorado Plateau I&M Networks**

Standard Operating Procedure (SOP) # 7

Repeat photographs

Version 1.0 (August 2006)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

NOTE: This SOP was adopted with modifications from Herrick et al. 2005, Volume 1, pg. 6 – 9. [Herrick, J.E., J.W. Van Zee, K.M. Havstad, L.M. Burkett, and W.G. Whitford. 2004. Monitoring Manual for Grassland, Shrubland, and Savanna Ecosystems. Published as 2 volumes. Jornada Experimental Range, USDA 236 pp.]

This SOP provides information to take photographs at each upland monitoring site. One photo of each transect is required at each site visit. For more information on photo point monitoring, see the USFS Photo Point Monitoring Handbook (www.fs.fed.us/pnw/pubs/gtr526/).

Materials

35 mm or digital camera with a 50 mm equivalent lens (1:1 ratio). If a wide angle, telephoto or zoom is used, be sure to record lens and camera information.
Photo point (ID) card (Appendix B) on a clipboard
Thick marking pen

I. Photo Points

Do the following at the origin of each transect:

1. Lay the tape out on the transect.
2. Label photo point ID board (Appendix B) and lean it next to the rebar marking the origin of a transect.
3. Stand 5 meters back from the end of a transect, set the camera body on top of a 1.5-m pole

(monopod), and point the camera down the transect. The tape serves as a reference. The sign board should be at the bottom of the field of view. Take a photo. If the photo clearly shows the vegetation and site conditions along the transect, record the film information on the Photo Data Sheet (Appendix A) and record the location of the photo point as -5 m. If the view is obstructed, move the photo point along the transect and note the location in the Photo Data Sheet.

Appendix A. Photo Data Sheet.

Photo Data Sheet

Park: _____ Plot ID: _____ Date : _____

Transect #	Roll #	Frame #	Photographer	Direction	Location of photo point along transect (meters)
1 (upper)					
2 (center)					
3 (lower)					

Site:

Date:

Transect #:

Direction:

Appendix B. Photo point ID card

**Upland Monitoring Protocol
For the Northern and Southern Colorado Plateau I&M Networks**

Standard Operating Procedure (SOP) # 9

Measuring Basal and Canopy Gaps Using Line-Intercept Sampling

Version 1.0 (August 2006)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP gives step-by-step instructions for obtaining gap intercept estimates between plant canopies and between plant bases. This procedure should be conducted after quadrat sampling (SOP#21). Material for this SOP was taken from the *Monitoring manual for grassland, shrubland and savanna ecosystems, Volumes I & 2* (Herrick et al. 2005a,b) and modified where necessary.

Equipment

Transect Setup

- GPS
- Compass
- Metal detector
- Pin flags (at least 10)
- Flagging tape
- Macroplot information (Plot ID, UTM coordinates of centroid, transect aspect/azimuth)
- 50-m measuring tape
- Steel pins for anchoring tape (at least 2)

Gap Intercept Sampling

- Meter stick or other stiff stick
- Gap Intercept Data Sheets (bring at least 3/transect; Appendix A)
- Clipboard
- Pencils, extra pencil lead, and erasers
- Portable chair

Sampling teams

Gap intercept sampling requires a two-person team: one “observer” to call out gap measurements and one “recorder” to write down gap measurements.

Sampling Procedure

1. Set up the tape.

Use a GPS (SOP #3) and the coordinates of the centroid to navigate to the macroplot. Look around for rebar posts marking the ends and middle of each transects using a metal detector if necessary. Read the metal tag on the rebar to check the plot ID and to determine the transect number and the position along the transect. Use a compass, the transect azimuth/aspect, and a metal detector if necessary to locate the other ends of the 50-m transects. Each monitoring site includes three 50-m transects spaced 25 meters apart (Fig. 1). Mark the middle and ends of each transect with pin flags and/or flagging tape. Avoid trampling the sampling area along transects.

Navigate to the “origin” end of transect 1. It is absolutely crucial to begin at the “origin” end and to know which transect you are sampling. Check metal tags on the rebar to confirm plot and transect identification. Anchor the “0” end of the tape to the “origin” end of transect 1. Walk towards the other end of the transect while pulling out the tape. Walk slightly downslope of the line to avoid trampling the sampling area. Fasten the tape with a steel pin so that 50 m is aligned with the rebar at the end of the transect. The line should be taut and as close to the ground as possible to avoid curvature in the line. If the transect has quadrats permanently marked for sampling, check for proper transect alignment using the nails marking two corners of 1-m² and 10-m² quadrats. It is okay to run the tape over low shrubs, but the tape should be threaded through any shrubs taller than ~0.7 m. If it is windy, use additional steel pins to hold the tape in place at other points along the transect.

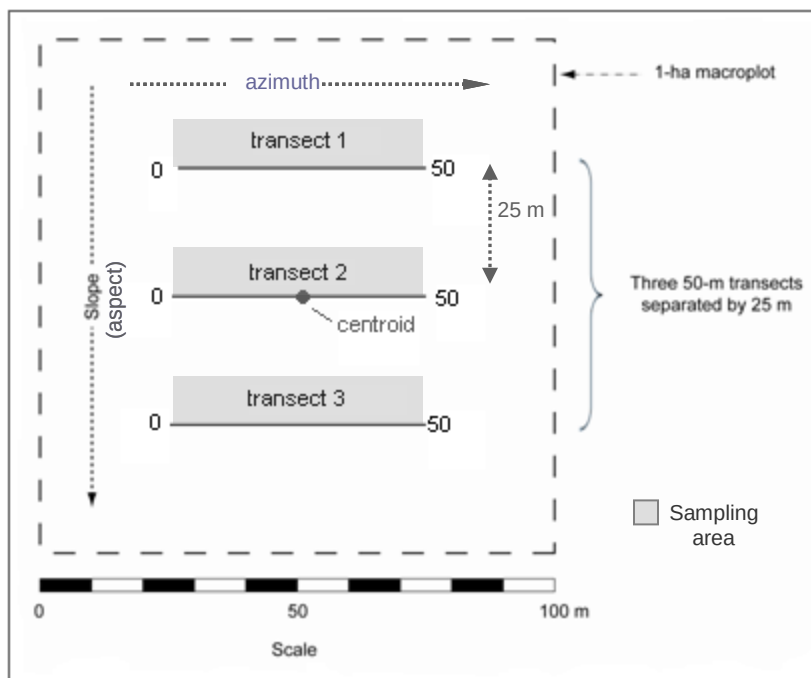


Figure 1. Standard macroplot and transect layout for terrestrial monitoring.

2. Take a photograph of the transect.

Use SOP #7 “Photopoints” to record an image of each transect before you begin sampling. If a transect is sampled by multiple procedures, you do not need to take additional photographs. Complete only one photopoint per transect per sampling date.

3. Fill out relevant information at the top of the “Gap Intercept Data Sheet” including:

- **Park Unit** - Use the 4-letter codes to indicate the park (see SOP#5).
- **PlotID** – this is the unique, pre-assigned number for the plot.
- **Transect#** - 1-3 based on slope position (1 is the upslope transect, 2 is the middle transect, and 3 is the downslope transect).
- **Date** – mm/dd/yyyy.
- **Observer** – Record the initials of the person calling out gap measurements. If initials of two or more persons are the same, include a middle initial or some other distinguishing initial.
- **Recorder** – Record the initials of the person recording data.
- **Page #** – Record the page # and the total number of data pages for each transect.

4. Sample canopy gaps.

Stand on the downhill side of the transect at the 0-m end and work from left to right towards the 50-m end. Look straight down on the tape and use a meter stick or other stiff stick to

project a line vertically to the ground on the uphill side of the tape. Record the class of canopy cover/gap and the start to the nearest centimeter. Segments along a transect fall in three distinct classes:

- **Canopy gap** – A space between canopy cover at least 20 cm in length.
- **Shrub** – Shrub canopy <2 m in height. Include all shrubs from the list provided, except dwarf-shrubs.
- **Other vegetation** – Any canopy cover not included in the shrub category. Record dwarf-shrubs in this category (i.e., cactus, yucca, snakeweed, etc.). Annual species are not included as other vegetation. Essentially, annual species are ignored when measuring canopy as well as basal gaps.

Use the abbreviations g for gap, s for shrub, v for other vegetation on the data sheet.

Follow these rules:

- A canopy gap occurs any time there is at least 20 cm of gap between plant canopies. Therefore, canopy gaps are always at least 20 cm long (Figs. 2 & 3, Tables 1 & 2).
- Canopy occurs any time 50% of any 3 cm segment of tape edge intercepts live or dead plant canopy based on a vertical projection from canopy to ground. The only exception to this rule occurs when you have a space between canopies <20 cm. When shrub canopy and other vegetation canopy occur less than 20 cm from each other along the transect, the boundary between the two canopy types is the mid-point of the intercepted space between them. When the space occurs between canopy cover in the same class, include the space within the appropriate canopy cover type (shrub or other vegetation).
- Imagine there is a brick wall at either end of the tape. If a space <20 cm between canopies occurs on either end of the transect, do not count this as a gap. At the beginning of the tape, start recording data at the first canopy cover intercept. At the end of the tape, record the endpoint to reflect the end of the last section of canopy cover intercepted. Usually the end will be 5000 cm, but it can be as low as 4981 cm if a space <20 cm occurs at the end of the transect.

5. Record the remaining information at the top of the data sheet.

Record the species which were identified as shrubs along the transect.

6. Sample basal gaps.

Immediately after you finish sampling canopy gaps, begin sampling basal gaps from the 50-m end of the tape working back towards the 0-m end of the tape. Remain on the downhill side of the transect, and use the same technique as for canopy gaps to project vertically down to the ground. Record the start and end of each gap to the nearest centimeter (Figs. 2 & 3, Tables 1 & 2). Annual species are ignored.

Follow these rules:

- A plant base is any plant stem emerging from the soil surface along the uphill edge of the tape that would force an ant walking along the line on the soil to step off the line to get around it (minimum diameter = 1 mm).
- A basal gap occurs any time there is at least 20 cm of intercept without a plant base. Therefore, there should always be at least 20 cm between basal gap starts and basal gap ends.
- A plant base can stop a gap whether live or dead.
- Plant bases must be anchored in the ground. Litter is not a plant base.
- If a space <20 cm occurs on either end of the transect, do not count this as a gap.

7. Continue sampling.

Follow steps 1 through 6 to complete gap intercept sampling on transects 2 and 3.

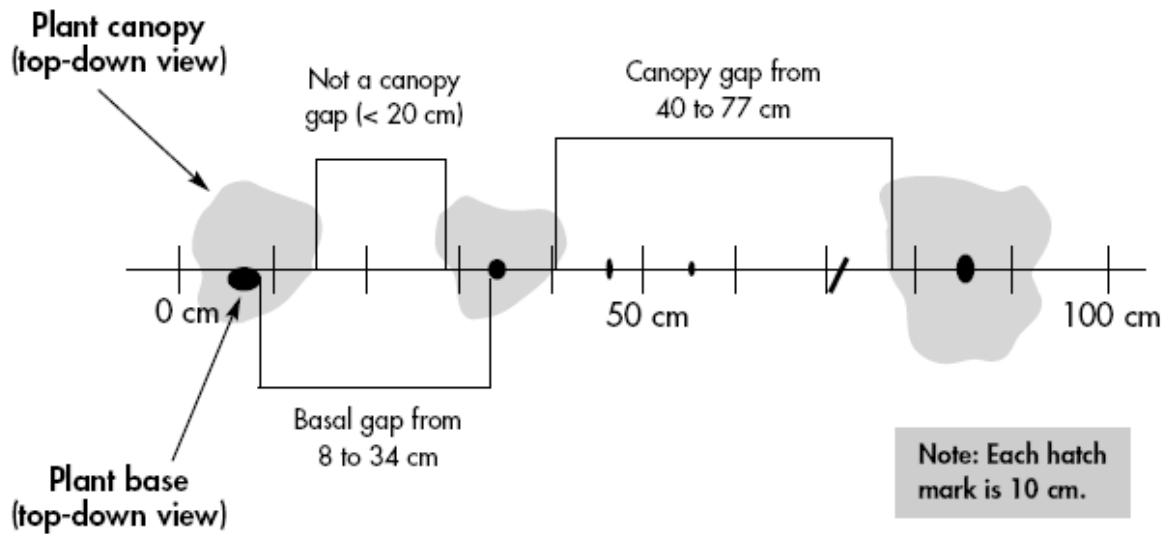


Figure 2. Example of canopy gap intercepts (above the line) and basal gap intercepts (below the line) for 1 m (100 cm) of a 50-m transect. Canopy gaps: Since the first two plants along the transect are both shrubs and the space in between is less than 20 cm, the entire segment from 0-40 cm is considered shrub canopy. There is a gap from 40 to 77 cm because the plant canopies present do not cover more than 50% of any 3-cm segment. Basal gaps: There is a basal gap between 8 and 34 cm. The three small plant bases between 34 and 86 cm are all within 20 cm of an adjacent plant base, therefore, no basal gaps exist even though there is a canopy gap. (From Herrick et al. 2005a.)

Table 1. Gap intercept data sheet example associated with Figure 2.

Canopy Gaps		Basal Gaps	
Class (s, v, g)	Start (cm)	Start (cm)	End (cm)
s	0	8	34
g	40		
s	77		

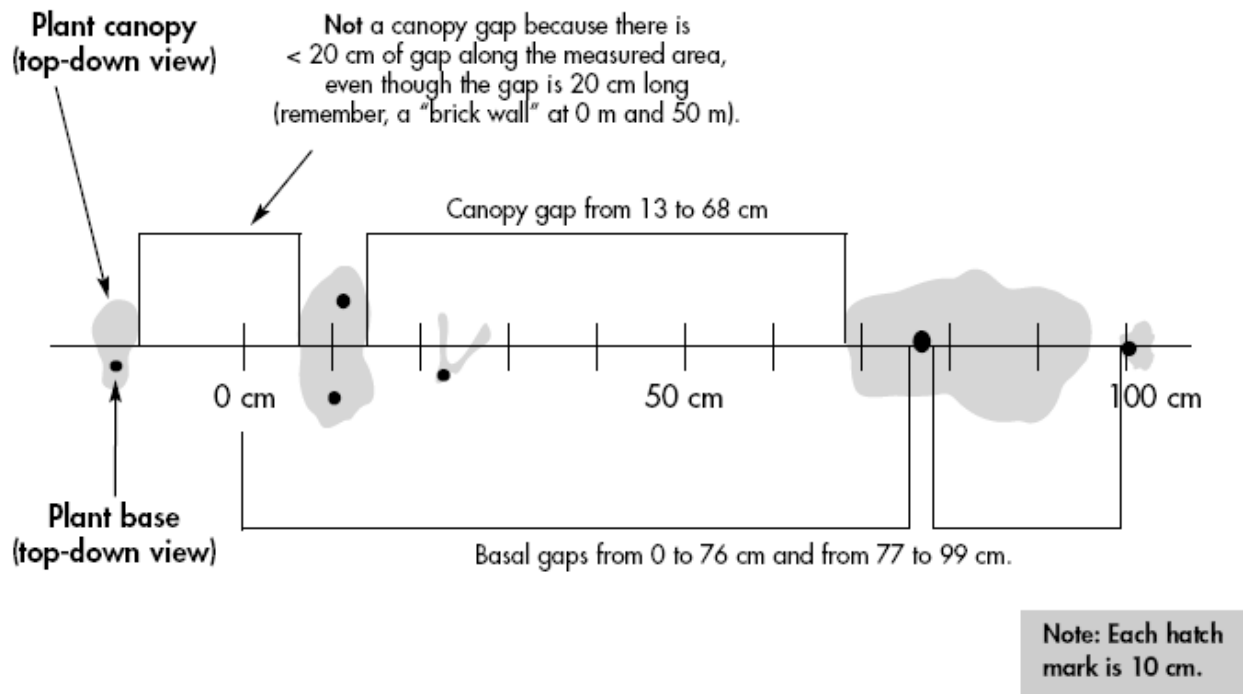


Figure 3. Example of canopy gap intercepts (above the line) and basal gap intercepts (below the line) for 1 m (100 cm) of a 50-m transect. Canopy gaps: Shrub canopy starts at 6 cm since the space from 0 to 6 cm is not large enough to be considered a canopy gap. Look at the plant canopy intercept between the 20 and 30 cm marks on the transect. Because each canopy intercept covers less than 50 percent of a 3-cm segment of the line, it does not count as canopy. Notice also that the canopy cover at 100 cm shifts from shrub canopy to other vegetation canopy with <20 cm space in between. In this case, record the midpoint of the space intercepted by the canopies, beginning other vegetation canopy at 98 cm. (From Herrick et al. 2005a.)

Table 2. Gap intercept data sheet example associated with Figure 3.

Canopy Gaps				Basal Gaps			
Class (s, v, g)	Start (cm)	Class (s, v, g)	Start (cm)	Start (cm)	End (cm)	Start (cm)	End (cm)
s	6			0	76		
g	13			77	99		
s	68						
g	98						

References:

- Herrick, J. E., J. W. Van Zee, K. M. Havstad, L. M. Burkett, and W. G. Whitford. 2005a.
Monitoring manual for grassland, shrubland and savanna ecosystems. Volume I: Quick start. USDA-ARS Jornada Experimental Range, Las Cruces, NM. 36 pp. [available online at http://usda-ars.nmsu.edu/jer/monit_assess/monitoring.htm]
- Herrick, J. E., J. W. Van Zee, K. M. Havstad, L. M. Burkett, and W. G. Whitford. 2005b.
Monitoring manual for grassland, shrubland and savanna ecosystems. Volume II: Design, supplementary methods and interpretation. USDA-ARS Jornada Experimental Range, Las Cruces, NM. 200 pp.

Appendix A.

Gap Intercept Data Sheet (p. 1)

Park: _____ Plot ID: _____ Transect#: _____ Date: _____ Page ____ of ____

Observer: _____ Recorder: _____

Shrub species on transect _____

Canopy Gaps

[illegible]

Canopy Gaps

[illegible]

Gap Intercept Data Sheet (p. 2)

Basal Gaps

[illegible]

Basal Gaps

[illegible]

**Upland Monitoring Protocol
For the Northern and Southern Colorado Plateau I&M Networks**

Standard Operating Procedure (SOP) # 11

Soil Aggregate Stability

Version 1.0 (August 2006)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP gives step-by-step instructions for using a field kit to estimate soil aggregate stability when exposed to rapid wetting. This SOP describes the procedure for filling in the “Soil Stability Test Data Form.” An example of this data sheet is available in Appendix B. Appendix C contains information on calculating and interpreting soil aggregate stability data. Material for this SOP was taken directly from the *Monitoring manual for grassland, shrubland and savanna ecosystems, Volumes I & 2* (Herrick et al. 2005a,b).

Equipment:

- Complete soil stability kits (see Appendix A for construction)
- Deionized water (1 L)
- Soil Stability Test Data Form (Appendix B)
- Clipboard
- Pencils
- Stopwatch

Sampling Procedure

With a little practice, it takes about 10-15 minutes to sample and 10 minutes to test 18 samples.

1. Fill out the information at the top of the “Soil Stability Test Data Form” including:

- **Monitoring plot** – Since this is an form from Herrick et al. (2005a), combine the Park name and PlotId by first listing the 4-letter Park unit code, followed by the pre-assigned, unique PlotID.
- **Observer** – Record the initials of the person performing the soil stability test. If initials of two or more persons are the same, include a middle initial or some other distinguishing initial.
- **Recorder** – Record the initials of the person recording data.
- **Date** – mm/dd/yyyy.
- **Page #** – Record the page # and the total number of data pages for each transect.

2. Randomly select 18 sampling points.

Use 18 randomly selected points along the transects. Record sampling locations (points) under “Pos” on the data sheet. Always sample at least 5 cm from any vegetation measurement line. Include subsurface samples if you are interested in soil erodibility after disturbance. Use one box to collect only surface samples or two boxes to collect surface and subsurface samples.

3. Determine the dominant cover class.

Determine the dominant cover class over the random point and enter this into the “Veg” column on the data sheet. The area to be classified is effectively as large as the sample area (6-8 mm in diameter). Record the dominant cover class in the “Veg” column:

NC = no perennial grass, shrub or tree canopy cover
G = perennial grass canopy and grass/shrub canopy mixture
F = perennial forb
Sh = shrub canopy
T = tree canopy

4. Collect a surface sample.

Excavate a small trench (10-15 mm deep) in front of the area to be sampled (Fig. 1). Lift out a soil fragment and trim it (if necessary) to the correct size. The soil fragment should be 2-3 mm thick and 6-8 mm in diameter (Figs. 2 and 3). This is the diameter of a wood pencil eraser. Try to fit sample in dot below (6-8 mm dia.).



Collect samples at the exact point. Move the sample point only if it has been disturbed during previous measurements or the soil surface is protected by a rock or embedded litter. Move the point a standard distance (1 m) and note this change on the data sheet. Minimize shattering by: a) slicing the soil around the sample before lifting; b) lifting out a larger sample than required, and trimming it to size in the palm of your hand; or c) misting the sample area before collection. If the soil sample is too weakly structured to sample (falls through the sieve), mist it lightly with deionized water (use an atomizer or equivalent) and then take a sample. Perfume and plastic hair spray bottles work well for this. If the sample still will not hold together, record a “1” on the data sheet. If the soil surface is covered by a lichen or cyanobacterial crust, include the crust in the sample. If the sample is covered by moss, collect the sample from under the moss. Gently place the sample in a dry sieve (Fig. 4); place sieve in the appropriate cell of a dry box.

5. Collect a subsurface sample (optional, see Step 1).

Sample directly below the surface sample. Use the flat, square (handle) end of the scoop to gently excavate the previous trench (in front of the surface sample) to a depth of 3-4 cm. Directly below the surface sample, remove soil so that a “shelf” is created with the top step 2-2.5 cm below the soil surface (Fig. 5). Use the scoop to lift out a subsurface sample from below (Fig. 6). The soil fragment should be 2-3 mm thick and 6-8 mm in diameter. If you encounter a rock, record “R” and move to the next sample. Place the sample in a dry sieve; place sieve in the dry box. Leave box lid open (Fig. 7).

6. Make sure the surface and subsurface samples are dry.

Samples must be dry before testing. If samples are not dry after collecting, allow to air dry with the lid off. Do not leave lid closed on samples for more than 1 minute on hot or sunny days. Excessive heat can artificially increase or decrease stability.



Figure 1. Excavate small trench.



Figure 2. Collect surface sample.



Figure 3. Ensure correct sample size.



Figure 4. Place sample in sieve.



Figure 5. Excavate trench for subsurface sample.



Figure 6. Collect subsurface sample.



Figure 7. Complete soil stability kit with water and samples.

7. Fill the empty (no sieves) box with deionized or distilled water (Fig. 7).

Fill each compartment to the top. The water should be approximately the same temperature as the soil.

8. Test the samples.

Lower the first sieve with the sample into the respective water-filled compartment— upper left corner of sample box to upper left corner of water box (Fig. 8). From the time the sieve screen touches the water surface to the time it rests on the bottom of the box, 1 second should elapse. Start the stopwatch when the first sample touches the water. Use Table 1 to assign samples to stability classes. After five minutes, follow the sequence of immersions on the data sheet, adding one sample every 15 seconds. Beginners may want to immerse a sample every 30 seconds. This allows nine samples to be run in 10 minutes, so it takes 20 minutes to test one box of 18 samples. Observe the fragments from the time the sample hits the water to 5 min (300 sec) and record a stability class based on Table 1. Raise the sieve completely out of the water and then lower it to the bottom without touching the bottom of the tray. Repeat this immersion a total of five times. Do this even if you have already rated the sample a 1, 2 or 3 (you are allowed to change your rating if after sieving > 10% of soil remains on sieve). It should take 1 second for each sieve to clear the water's surface and 1 second to return to near the bottom of the box. Hydrophobic samples (float in water after pushed under) are rated 6. Record the coded stability class on the data sheet under 'Rating'.



Figure 8. Place first sample in water.

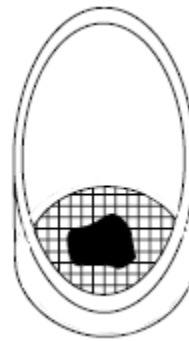


Figure 9. Sample in sieve, drawn to scale.

Table 1. Stability class ratings.

Stability class	Criteria for assignment to stability class
1	50% of structural integrity lost (melts) within 5 seconds of immersion in water, OR soil too unstable to sample (falls through sieve).
2	50% of structural integrity lost (melts) 5-30 seconds after immersion.
3	50% of structural integrity lost (melts) 30-300 seconds after immersion, OR < 10% of soil remains on the sieve after five dipping cycles.
4	10–25% of soil remains on the sieve after five dipping cycles.
5	25–75% of soil remains on the sieve after five dipping cycles.
6	75–100 % of soil remains on the sieve after five dipping cycles.

Sequence for stability class = 1.



Original sample



After 5 seconds



After 5 minutes



After 5 dips

Sequence for stability class = 4



Original sample



After 5 seconds



After 5 minutes



After 5 dips

Sequence for stability class = 5.



Original sample



After 5 seconds



After 5 minutes



After 5 dips

Sequence for stability class = 6.



Original sample



After 5 seconds



After 5 minutes



After 5 dips

Figure 10. The photos above illustrate the key steps of testing a soil sample for four different stability rankings. **Important note:** Some of the fragments shown in these samples may appear large. They are for illustration only. Be sure to follow the size guidelines (6-8 mm) in step 3 and Fig. 9.

References:

- Herrick, J. E., J. W. Van Zee, K. M. Havstad, L. M. Burkett, and W. G. Whitford. 2005a.
Monitoring manual for grassland, shrubland and savanna ecosystems. Volume I: Quick start. USDA-ARS Jornada Experimental Range, Las Cruces, NM. 36 pp. [available online at http://usda-ars.nmsu.edu/jer/monit_assess/monitoring.htm]
- Herrick, J. E., J. W. Van Zee, K. M. Havstad, L. M. Burkett, and W. G. Whitford. 2005b.
Monitoring manual for grassland, shrubland and savanna ecosystems. Volume II: Design, supplementary methods and interpretation. USDA-ARS Jornada Experimental Range, Las Cruces, NM. 200 pp.

Appendix A.

Soil stability kit (Quick Start)

Materials needed for construction of stability kits:

- Schedule 40 PVC pipe with a $\frac{3}{4}$ in inside diameter
- PVC pipe cutter and hacksaw
- Tape measure and pencil
- A section of metal window screen (mesh size approx. 1.5 mm [$\frac{1}{16}$ in])
- A bottle of water-resistant contact cement
- A plastic trash bag
- 2 plastic “parts” boxes (21 x 11.5 x 3.5 cm outside dimensions [$8\frac{1}{2}$ x $4\frac{15}{32}$ x $1\frac{5}{16}$ in]) with 18 cells, approximately 3 x 3 x 3 cm each ($1\frac{1}{4}$ x $1\frac{1}{4}$ x $1\frac{1}{4}$ in each)
- One small tube of silicone sealant
- A small piece of sheet metal, handle of an old spoon, or pocket knife

1. Stability basket construction.

- 1.1 Cut pieces of PVC pipe into 3 cm ($1\frac{1}{4}$ in) lengths.
- 1.2 Make a 2 cm deep, cross-sectional cut, 5 mm from one end (Fig. A.1).



Figure A.1. First cut on PVC.

- 1.3 Make the second cut perpendicular to the first, ending at the end of the cross-sectional cut in step 1.2 (Fig. A.2). This forms the basket handle.
- 1.4 Remove burrs from all cuts.
- 1.5 Lay out a section of window screen on top of a plastic trash bag. Make sure the screen is flat and has no creases.
- 1.6 Apply contact cement to the bottom of the cut PVC and quickly place on top of the screen (Fig. A.3). Apply glue only in areas with adequate ventilation.
- 1.7 Allow contact cement to dry overnight.
- 1.8 After 24 hours, remove the plastic trash bag from the screen. Cut out each basket from the screen (Fig. A.4).

2. Plastic box preparation.

- 2.1 If the plastic box has removable parts, be sure to glue them into place.
- 2.2 Use silicone caulk or sealant to seal all corners inside the box.

3. Stability shovel construction.

- 3.1 Using tin snips, cut out the shape of the stability shovel from a piece of thin sheet metal, tin can, aluminum weighing tin or similar material with a thickness of 1 mm ($\frac{1}{32}$ in) or less (Fig. A.5).

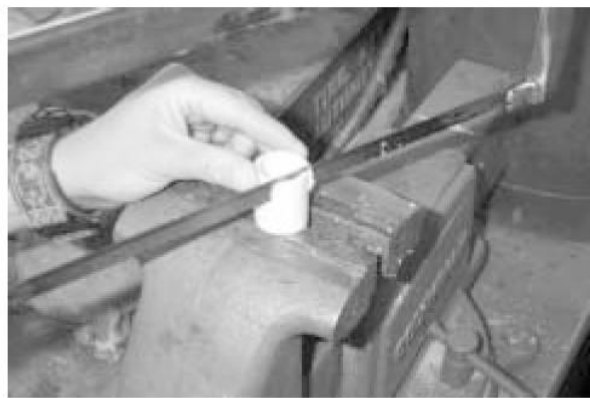


Figure A.2. Second cut on PVC.



Figure A.3. Baskets glued to screen.



Figure A.5. Cutting shovels with tin snips.



Figure A.4. Cutting out baskets from screen.

Appendix B.

Data Sheets

Soil Stability Test Data Form

Park: _____ Plot ID: _____ Observer: _____
Date: _____ Recorder: _____

Circle One: Surface sample – Subsurface sample

Pos. – location (m) of sample on transect

Veg cover= **NC** (no perennial canopy), **G** (grass or grass/shrub mix), **F** (forb), **Sh** (shrub), **T** (tree)

Rating values = 1-6. Circle values if samples are hydrophobic.

Transect 1				Transect 2				Transect 3			
Dip time	Pos.	Veg	Rating	Dip time	Pos.	Veg	Rating	Dip time	Pos.	Veg	Rating
5:00				5:15				5:30			
5:45				6:00				6:15			
6:30				6:45				7:00			
7:15				7:30				7:45			
8:00				8:15				8:30			
8:45				9:00				9:15			

Comments:

Stability class

Criteria for assignment to stability class

- | | |
|----------|--|
| 1 | 50% of structural integrity lost (melts) within 5 seconds of immersion in water, OR soil too unstable to sample (falls through sieve). |
| 2 | 50% of structural integrity lost (melts) 5-30 seconds after immersion. |
| 3 | 50% of structural integrity lost (melts) 30-300 seconds after immersion, OR < 10% of soil remains on the sieve after five dipping cycles. |
| 4 | 10-25% of soil remains on the sieve after five dipping cycles. |
| 5 | 25-75% of soil remains on the sieve after five dipping cycles. |
| 6 | 75-100 % of soil remains on the sieve after five dipping cycles. |

**Upland Monitoring Protocol
For the Northern and Southern Colorado Plateau I&M Networks**

Standard Operating Procedure (SOP) # 12

Site Impact Assessment

Version 1.0 (August 2006)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP gives step-by-step instructions for qualitatively detecting and describing on-site and off-site impacts on long term ecological monitoring plots, and for filling in the “Site Impact Assessment Data Sheet”. This assessment should proceed completed sampling a plot, and be conducted every site visit.

Equipment

- GPS unit
- Compass
- Site Impact Assessment Data Sheets (Appendix A)
- Field notebook
- Clipboard
- Pencil, extra pencil lead, and erasers

Procedure

After sampling each macroplot, use the following guidelines to record disturbances on the Site Impact Assessment data sheet (Appendix A) that could potentially impact the site.

1) Fill out the information at the top of the data sheet including:

- **Park Unit** – Standard 4-letter code.
- **Plot ID** – Pre-assigned, unique number.
- **Recorder** – Record the initials of the person(s) recording data.
- **Date** – Include month (mm)/day (dd)/year (yy).
- **Page #** – Record the page # and the total number of pages for each macroplot.

2) On-site disturbances

The purpose of this section is to document the occurrence of on-site factors which may affect ecological processes within the macroplot. Examples include land uses or natural or anthropogenic landscape alterations which alter hillslope hydrological processes or wind- or water-driven erosional processes. Such alterations may affect runoff patterns or sediment deposition within the macroplot. Common types of disturbances are listed on the bottom of the data sheet. Include any other type of disturbance that appears significant at a site.

Look for disturbances in the area sampled by transects and in the 25-m zone bordering all sides of the transects. Walk along all three transects and note any disturbances. Make sure you are walking on the downhill side of the transects and not trampling the areas sampled by quadrats and line-point intercept transects. Also walk around the perimeter of the macroplot to examine the 25 m bordering the transects on all sides. For each disturbance encountered, describe the size of the area affected in m^2 , the position of the disturbance relative to the transects, and the severity of the impact. Additionally, you may use the figure at the bottom of the data sheet to sketch the approximate size and location of the disturbance. Answer the questions on the data sheet to assess potential effects of the disturbance and provide additional information to help describe the disturbance. Each data sheet only has space to record one on-site and one off-site disturbance. Use additional data sheets as necessary.

At sites with physical and/or biological soil crusts, it is important not to impact soil stability any more than is absolutely necessary. If possible, do not create additional tracks and paths to assess on-site disturbance. Try to assess on-site disturbance from areas that have already been trampled from previous sampling.

3) Off-site disturbances

The purpose of this section is to document the occurrence of off-site (i.e. outside the macroplot) factors which may affect ecological processes within the macroplot. Concepts and examples are the same as for on-site influences.

Start about 25 m upslope of the 25-m position on transect 1 (Fig. 1). Turn on the GPS unit and make sure it is marking the waypoint for the macroplot centroid. See SOP #3 for detailed instruction on using the GPS. Begin walking upslope perpendicular to the transects looking for disturbances within 50 m of your path. Continue walking upslope until you reach a hilltop or are 500 m from the centroid, whichever happens first. Use the GPS to determine your distance from the macroplot. For each disturbance encountered, describe the type of disturbance, the size of the area affected in m^2 , the distance upslope from the macroplot, and the severity of the impact. Answer the questions on the data sheet to assess potential effects of the disturbance and provide additional information to help describe the disturbance. Use additional data sheets as necessary.

If physical and/or biological soil crusts are present, avoid creating additional upslope disturbance if possible. Find a vantage point near the macroplot, and look upslope for disturbances up to 500 m away. Record disturbances in the same way as above.

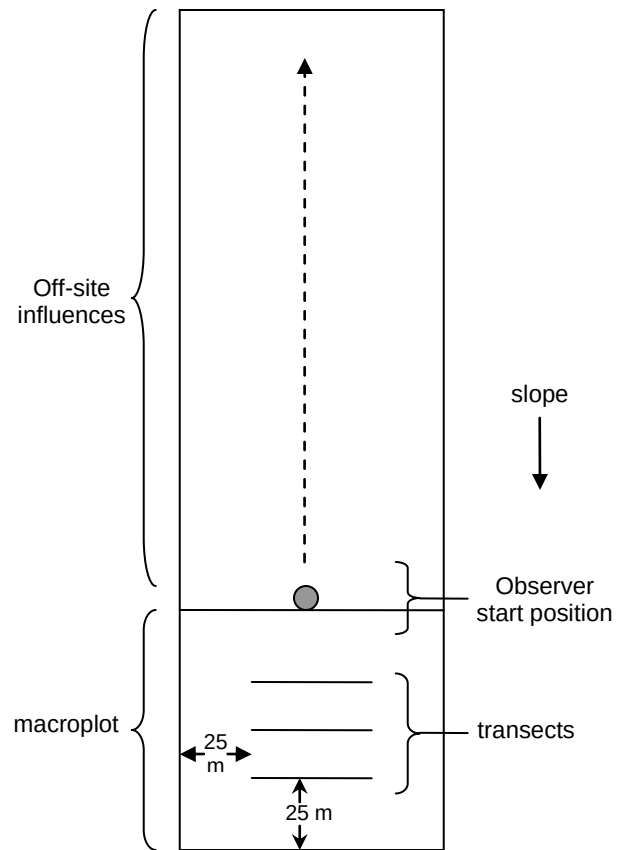


Figure 1. Diagram of area evaluated for on-site and off-site disturbances.

Appendix A

Data Sheets

Site Impact Assessment Data Sheet

Park: _____ Plot ID: _____ Recorder: _____ Date: _____ Page ___ of ___

On-site Disturbances

Disturbance type: _____

Size of area affected (m²): _____

Position of disturbance relative to transects: _____

How has this disturbance affected wind- or water-driven erosional processes on the macroplot? Describe in detail. _____

How could this disturbance alter fire behavior on the macroplot? Increased fuel loads? Fire breaks created? _____

Additional description: _____

Off-site Disturbances

Disturbance type: _____

Size of area affected (m²): _____

Distance upslope from macroplot (m): _____

How has this disturbance affected wind- or water-driven erosional processes on the macroplot? Describe in detail. _____

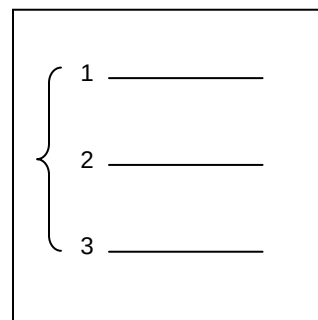
How could this disturbance alter fire behavior on the macroplot? Increased fuel loads? Fire breaks created? _____

Additional description: _____

Example disturbance types:

dirt road	fire
paved road	water
OHV activity	wind
foot/bikepath	small rodents
campsite	
livestock trailing	
livestock grazing	
livestock watering point	
other large mammal activity	

transects



slope



Upland Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) # 17

After the field season

Version 1.0 (August 2006)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP provides information to close out the field season, assuring that equipment maintenance, data management, and reporting procedures are followed.

Procedures

- I. Equipment maintenance. Make certain that all equipment is in good working order, or repair or replace if necessary.
- II. Supplies inventory. To ensure that adequate supplies are on hand for the next field season, order supplies if needed.
- III. Complete ID of unknowns. The field-crew leader is responsible to ensure complete resolution of all unknown plants. Plants are identified to species, family, or at least life form.
- IV. Data management. The field crew leader is responsible to ensure that all data sheets are completed properly, and that all 35-mm film is sent-out for processing.
- V. New Species. The crew leader is responsible to ensure that plant species not on current park list to are submitted for update to NPSpecies. This requires a voucher specimen which the crew leader is responsible to acquire.
- VI. Protocol review procedures. Prior to the departure of the field crew, the Principle Investigator will implement the annual Protocol Review procedures, which queries the field crew for problems, issues, and recommendations regarding the extant upland protocol.

Upland Monitoring Protocol for the Park Units in the Northern Colorado Plateau Network

Standard Operating Procedure (SOP) # 20

Revising the Protocol Narrative and SOPs

Version 1.0 (August 2006)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure (SOP) explains how to make and track changes to the Narrative and Standard Operating Procedures for the Northern Colorado Plateau Network (NCPN) Upland Monitoring Protocol. Individuals editing the Protocol Narrative or any one of the SOPs need to follow these procedures in order to eliminate confusion on how data are collected and analyzed. All observers conducting the monitoring should be familiar with this SOP in order to identify and use the most current methods.

Procedures:

1. Modifications must be reviewed for clarity and technical soundness. Small changes or additions to existing methods will be reviewed in-house by NCPN Inventory and Monitoring staff. An outside review is required for substantive changes in methods. Regional and national staff of the National Park Service and experts outside of the Park Service with familiarity in vegetation and soil monitoring and data analysis will be used to review major changes.
2. All changes must be documented, and updated protocol versions must be recorded in the Revision History Log that accompanies the Protocol Narrative and each SOP. Changes are recorded only in the Protocol Narrative or the SOP being modified. Version numbers increase incrementally by hundredths (e.g. version 1.01, version 1.02, etc.) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0, 4.0 ...). Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, and the reason for the changes along with the new version number.
3. Narrative and SOP updates may occur independently. That is, a change in one SOP will not necessarily invoke changes in other SOPs; a narrative update may not require SOP modifications. The NCPN tracks the narrative and SOP version numbers in a Master Version Table (MVT), which is maintained in this document (SOP #20). Any

time a narrative or an SOP version change occurs, a new Version Key number (VK#) must be created and recorded in the MVT, along with the date of the change and the versions of the narrative and SOPs in effect. The VK number increments by whole integers (e.g., 1, 2, 3, 4, 5). Updates to the MVT also must be provided to the NCPN Data Manager for inclusion in the master version table database. *The protocol narrative, SOPs, and data should not be distributed independently of this table.*

4. New versions of the protocol narrative and SOPs must be posted on the NCPN web page. Older versions of the Protocol Narrative and SOPs must be archived in the NCPN Upland Protocol Library (R:\Monitoring_Archive\Upland\Protocol).

Upland Monitoring, Northern Colorado Plateau Network Master Version Table

A dash (“-“) in a cell indicates that the narrative or SOP is not applicable during the corresponding time period.

Effective Date	Narrative	1-Preparations for the Field Season	2-Training Field Technicians	3-Using GPS Units	4-Crust-Friendly Field Procedures	5-Site Characterization	6-Establishing Plots	7-Repeat Photographs	8-Measuring Vegetation & Surface Cover	9-Measuring Canopy & Basal Gaps	10-Density, Frequency, & Richness	11-Soil Aggregate Stability	12-Site Impact Assessment	13-Measuring Overstory Trees	14-Measuring Fuels	15-Sampling Oak Plots	16-Unknown Plant Species	17-After the Field Season	18-Data Management	19-Data Analysis & Reporting	20-Revising the Protocol	21-Quadrat-Based Sampling
1/1/2006	-	1.00	1.00	1.00	-	1.00	1.00	1.00	-	1.00	-	1.00	1.00	-	-	-	-	1.00	-	-	1.00	1.00

**Upland Monitoring Protocol
For the Northern and Southern Colorado Plateau I&M Networks**

Standard Operating Procedure (SOP) # 21

**Measuring Occurrence and Cover of Vegetation and Soil Surface Features,
and Shrub Density Using 10-m² Quadrat-Based Sampling**

Version 1.0 (August 2006)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP gives step-by-step instructions for estimating nested frequency and cover of live vegetation and soil-surface features and shrub density in 10-m² quadrats. Detailed instructions are provided for locating the 10-m² nested quadrats along three transects. This SOP describes the procedure for filling in the “Frequency, Cover, and Shrub Density Data Sheet” and the “Unknown Plant Species Data Sheet”. Examples of these data sheets are available in Appendix A. This SOP was adopted with modifications from the Vegetation Community Monitoring Protocol For the Heartland Inventory and Monitoring Network and Prairie Cluster Prototype Monitoring Program SOP #5 “Measuring Frequency and Cover of Herbaceous and Shrub Species”, Version 1.0 (Debacker et al. 2004).

Equipment List

Transect Setup

- GPS
- Compass
- Metal detector
- Flagging tape
- Macroplot information (Plot ID, UTM coordinates of centroid, transect aspect/azimuth)
- 50-m measuring tape
- Steel pins for anchoring tape (at least 2)
- 30 8-12” spikes & mallet
- metal detector (if re-visiting a plot)

Quadrat Sampling

- 1-m² square quadrat (constructed with 1 inch diameter PVC tubing and delineated every 10 cm with electrical tape)
- 10-m² square quadrat (three 3.16-m cords and 4 steel pins)
- 2-m engineer ruler or meter stick
- Clipboards
- Frequency, Cover, and Shrub Density Data Sheets (at least 15/site; Appendix A)
- Unknown Plant Species Data Sheets (bring plenty of extras; Appendix A)
- Pencils, extra pencil lead, and erasers
- Plant press
- Hand lenses
- Plant species list for ecological site or park
- Unknown specimen book
- Plant identification keys
- Portable chair

Sampling Teams

Quadrat sampling requires a two-person team: one “observer” to call out frequency, cover, and density and one “recorder” to write down these data. The sampling team should keep their same roles for frequency, cover, and density on a given transect.

Sampling Procedures

1. Set up the tape.

Use a GPS (SOP #3) and the coordinates of the centroid to navigate to the macroplot. Look around for rebar posts marking the ends and middle of each transect using a metal detector if necessary. Read the metal tag on the rebar to check the plot ID and to determine the transect number and the position along the transect. See the section on plot ID below for information on the naming convention. Use a compass, the transect azimuth/aspect, and a metal detector if necessary to locate the other ends of the 50-m transects. Each monitoring site includes three 50-m transects spaced 25 meters apart (Fig. 1). Mark the middle and ends of each transect with pin flags and/or flagging tape. Avoid trampling the sampling area along transects and on the uphill side of transects.

Navigate to the “origin” end of transect 1. It is absolutely crucial to begin at the “origin” end and to know which transect you are sampling. Check metal tags on the rebar to confirm plot and transect identification. Anchor the “0” end of the tape to the “origin” end of transect 1. Walk towards the other end of the transect while pulling out the tape. Walk slightly downslope of the line to avoid trampling the sampling area. Fasten the tape with a steel pin so that 50 m is aligned with the rebar at the end of the transect. The line should be taut and as close to the ground as possible to avoid curvature in the line. It is okay to run the tape over low shrubs, but the tape should be threaded through any shrubs taller than ~0.7 m. If this is a repeat visit, check for proper transect alignment using the nails marking the two

corners of the 10-m² quadrat. A metal detector may be required for successful discovery of existing nail monuments. If it is windy, use additional steel pins to hold the tape in place at other points along the transect.

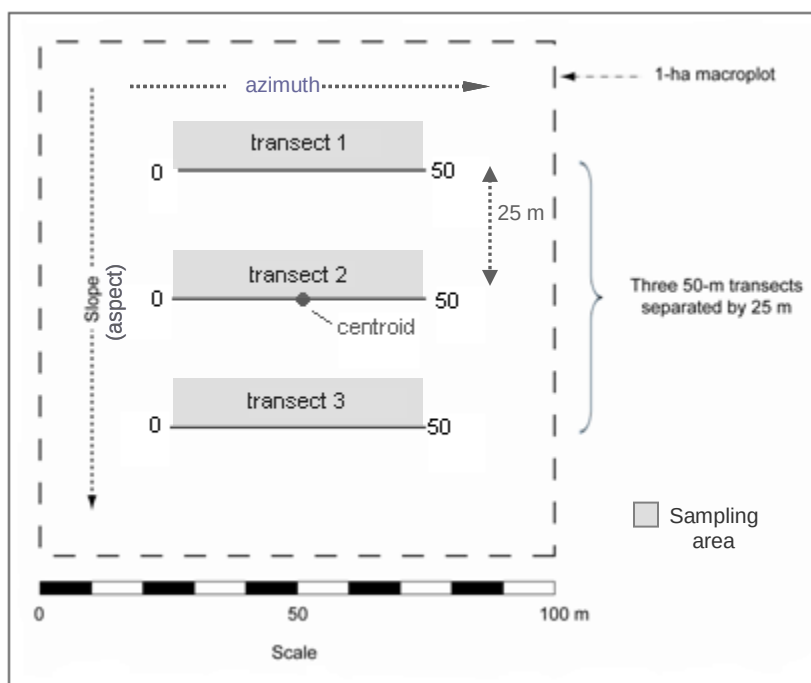


Figure 1. Standard macroplot and transect layout for terrestrial monitoring.

2. Take a photograph of the transect.

Use SOP #7 “Photopoints” to record an image of each transect before you begin sampling. If a transect is sampled by multiple procedures, you do not need to take additional photographs. Complete only one photopoint per transect per sampling date.

3. Put together the sampling frame.

Most of the time it is easier to carry the 1-m² sampling frame after it has been pulled apart into four 1-m PVC sides. In this form, the sides of the frame can easily be strapped onto a backpack and carried to the field site. When carrying the 1-m² frame this way, be sure that the elbows are firmly attached to the sides or that they are stowed safely inside a backpack. When you arrive at the field site, construct the 1-m² sampling frame by connecting the PVC sides with the elbows. Make sure the sides are correctly aligned so that the tape marks form the 0.01-m² and 0.1-m² nested quadrats on one corner of the sampling frame (Fig. 2).

4. Lay out the nested 10-m² quadrats.

Frequency, cover, and shrub density data are collected in five 10-m² rectangular quadrats located along each transect, spaced 10 meters apart (Fig. 3). Along all transects, plots begin at 0 m, 10 m, 20 m, 30 m, and 40 m on the uphill side of the tape. For the first quadrat, align

the 1-m² sampling frame so that the quadrat begins at 0 m and ends at 1 m. The 1-m² frame is marked with colored tape designating a 0.01-m² and 0.1-m² nested quadrat within (Fig. 2). Make sure that the corner of the frame with these markings is located at the “0” end of the quadrat next to the tape (Fig. 4). Next, set up the 10-m² quadrat using cords and steel pins. First, use a steel pin to set up a cord starting at 0 m and running upslope perpendicular to the tape. Second, use another steel pin to set up a cord starting at 5.0 m and running upslope perpendicular to the tape. Next, run a third cord connecting the first two on the uphill side of the transect. You do NOT need to run a fourth cord alongside the transect. At this point, you are ready to begin sampling the first quadrat. If this is the first time quadrats are being established, monument the two ends of the 10-m² quadrat that lie on the transect with 8-12” spikes. Pound the nails so that they are flush with the ground. If nails can not be inserted into the ground due to rock or other obstruction, indicate this in the comments box on the data sheet by noting the transect, quad number, and corner (i.e., transect distance from the origin; e.g., 15-m) and the reason for failure to monument. If a repeat visit, make sure the plot is square and that all four corners are properly aligned with the permanent nails marking the quadrat corners. Adjust the pins if necessary. It is important to be diligent about the placement of the plots to ensure consistent sampling from year to year.

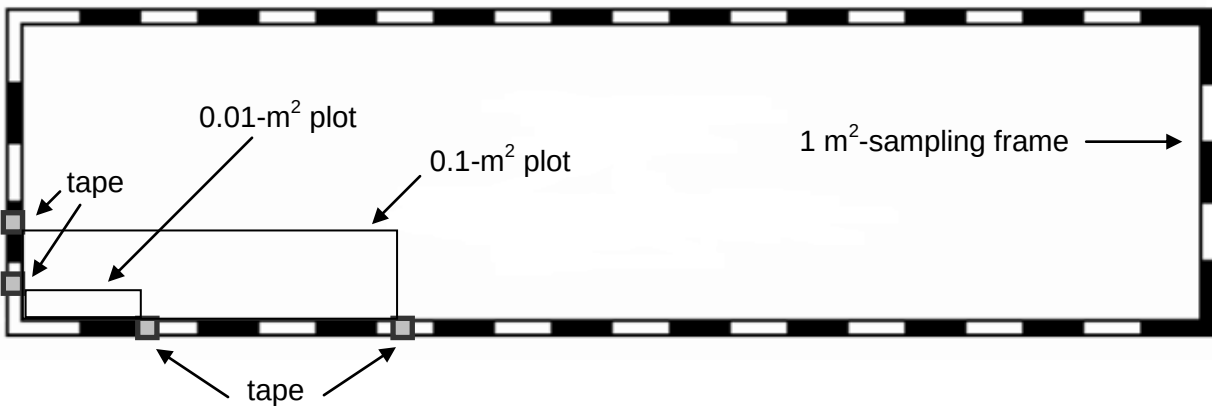


Figure 2. Alignment of nested frequency quadrats on the 1-m² sampling frame. Notice that the 0.01-m² and 0.1-m² quadrats are defined by the inside edge of the tape on the 1-m² sampling frame.

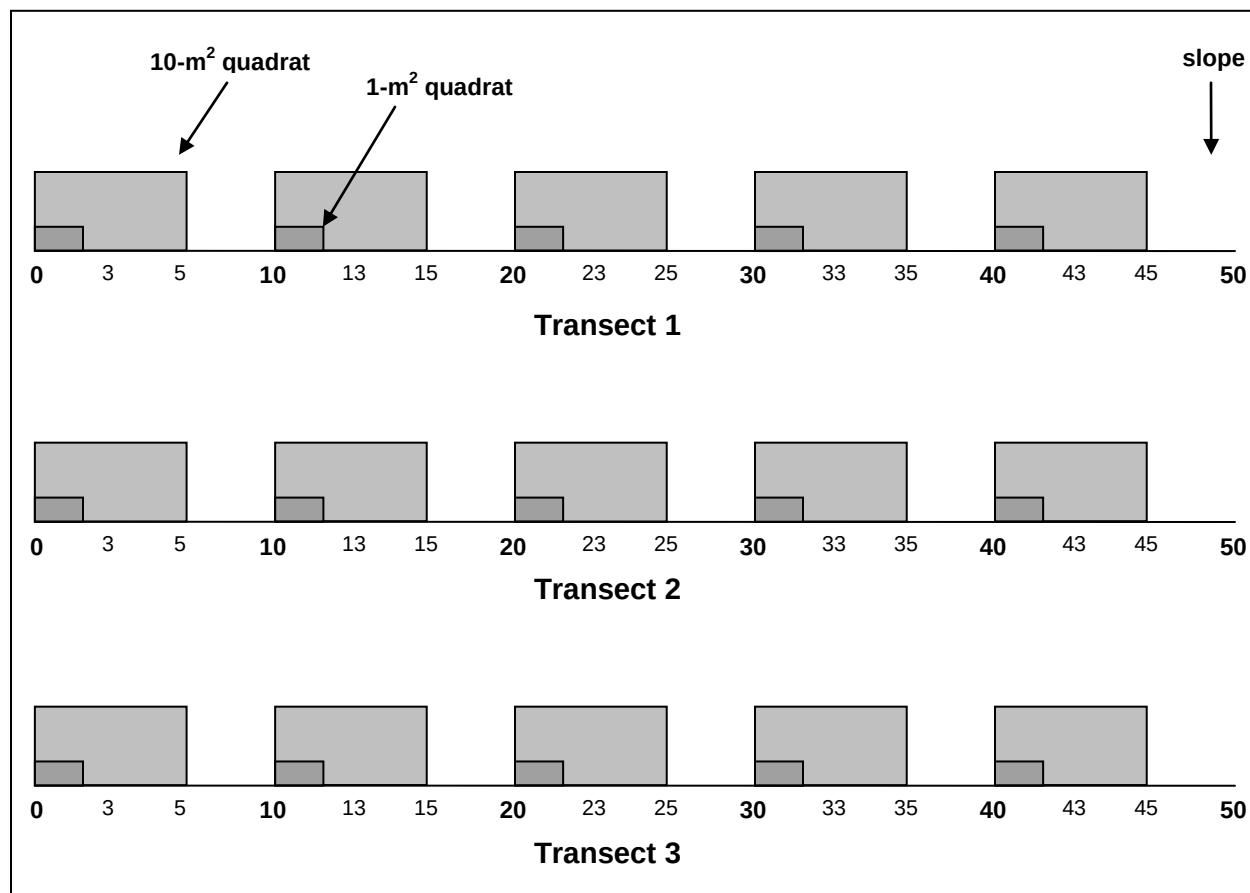


Figure 3. Quadrat placement along transects. Transects are not drawn to scale.

5. Fill out relevant information at the top of the “Frequency, Cover, and Shrub Density Data Sheet” including:

- **Park** – Use the standard 4-letter code to indicate the park unit.
- **PlotID** – A pre-assigned, unique number is provided for each plot.
- **Transect#** - 1-3 based (see Fig. 1).
- **Quadrat #** – Number the quadrats according to where they start along a transect (e.g. 0 m, 10 m, 20 m, ect.).
- **Date** – mm/dd/yyyy.
- **Observer** – Record the initials of the person calling out quadrat data. If initials of two or more persons are the same, include a middle initial or some other distinguishing initial.
- **Recorder** – Record the initials of the person recording data.
- **Page #** – Record the page # and the total number of data pages for each transect.

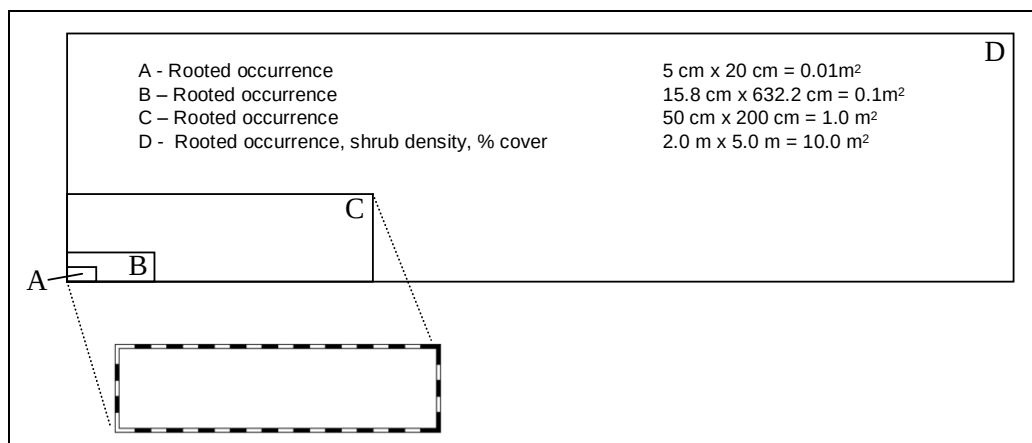


Figure 4. Nested frequency quadrat size and alignment on transect.

6. Sample nested frequency.

Nested frequency data are collected using 0.01-m², 0.1-m², 1-m², and 10-m² rectangular quadrats, one positioned inside the other, and noting the occurrence of rooted species, BSC's, soil-surface disturbances, and scat (yes scat!) within each quadrat. The small quadrats intentionally favor capturing mostly dominant species so that even small shifts in their abundance may be observed.

Data collection begins in the smallest quadrat. The corners of the 0.01-m² quadrat are marked with tape on the sides of the 1-m² sampling frame. The sides of the tape closest to the corner of the 1-m² sampling frame mark the 10-cm long sides of the 0.01-m² quadrat (Fig. 1). If necessary, use a retractable measuring tape or other straight surface to project the corners and determine whether species or other features of interest are in or out of the quadrat. If a species is rooted underneath the quadrat frame, count it. Generally, the quadrats sit on or close to the ground when sampling. However, tall or dense vegetation, rocks, or an otherwise uneven surface may prevent this. In such cases, simply estimate as well as you can whether a borderline species appears to be rooted inside or outside the quadrat. The observer identifies to species (if possible) all plants rooted within the 0.01-m² quadrat. All species with live and dead plant material rooted within the quadrat are recorded in the "Species" column of the data sheet (under live or under dead) using the full latin name or a PLANTS database species code (<http://plants.usda.gov/>), which is a four- or five-character code based on the first two letters of the genus and species and, in some cases, a number which differentiates species with the same four-letter genus and species descriptors. Mark a check in the 0.01-m² column next to each of the species found. Senesced plants that were alive earlier in the current growing season are counted as live plants for frequency. Also include the frequency of all BSC's, disturbances, and scat listed on the data sheet. BSC and disturbance categories are defined in Tables 1 and 2. The observer must take care not to trample the quadrats. This is integral to the success of any long-term monitoring project.

Once all plant species, BSC's, soil-surface disturbances, and scat have been identified within the 0.01-m² quadrat, the observer moves to the next largest quadrat (0.1-m²) and so on until the 10-m² quadrat is reached. Within each consecutively larger quadrat, only new occurrences within the larger 10-m² quadrat are recorded. When recording occurrence, a plant species and other features of interest should always be recorded in the first (smallest) quadrat in which they occur. Notice that you do NOT need to record frequency for all surface features. Bare soil, litter, woody debris, and all rock classes are excluded from frequency data.

Once the observer has completed the search of the 10 m² quadrat, the species list is consulted to look for possible mistakes in species identifications and missed species. This list provides the names, but not associated cover values, of species previously collected in a quadrat for comparison to those currently collected. If a species was previously collected but is now missing, double check the quadrat to ensure the species has not been overlooked. The species may be absent, may surface in a later sampling period, or its record in previous years reflects a change in species identification or sampling error. At this point, any lingering questions on species identification should be communicated to the project leader.

Table 1. Abbreviations and definitions of soil surface feature classes for quadrat sampling.

Soil surface type	Definition
Bare soil	Loose soil particles (0-2 mm diameter) not protected from wind erosion by any type of crust or any other soil surface feature
Crust, undifferentiated	Anything from physical crust to weak biological crust (weak cyanobacteria) but NOT including dark cyanobacteria, lichen, or moss
Cyanobacteria	Darkened cyanobacterial soil crust, typically black in color
Lichen	Lichen crust on soil (lichen on rock is recorded as the appropriate rock type)
Moss	Moss on soil (moss on rock is recorded as the appropriate rock type)
Litter	Embedded litter that is less than 2.5 cm in diameter, where removal of the litter would leave an indentation in the soil surface or would disturb the soil surface
Woody debris	Detached woody plant material that is greater than 2.5 cm in diameter and in direct contact with soil
Small rock	Rock fragments 2-20 mm in diameter
Large rock	Rock fragments >20 mm in diameter
Bedrock	Exposed bedrock
Scat, livestock	Any type of livestock scat
Scat, wildlife	Any type of wildlife scat

Table 2. Abbreviations and definitions of soil-surface disturbance classes for quadrat sampling.

Disturbance type	Definition
Ant mound	Holes and mounds created by ants
Bicycle	Disturbances caused by non-motorized bicycles
Human track/trail	Tracks or trails created by humans
Livestock track/trail	Tracks, marks, or trails created by livestock
Motor vehicle	Disturbances caused by any motorized vehicle
Wildlife excavation	Holes and mounds created by wildlife
Wildlife track	Tracks, marks, or trails created by wildlife
Other anthropogenic	Any human disturbance other than tracks and trails
Undifferentiated	Any disturbance of indeterminate origin or not classified as one of the other categories

The project leader will decide if it is necessary to fill out an “unknown” record and give the species of question an unknown number and name. See the section below entitled

“Unknown Plant Species” for detailed instructions on how to deal with unknown plant species.

After finishing frequency, you will complete cover and shrub density at 0 m before moving to the next 10-m² quadrat (Step #7).

Unknown Plant Species

Sometimes it may be difficult or impossible to determine the specific identify of individual plants encountered during sampling. When this situation occurs, search the immediate area surrounding the plot, looking for specimens of the unknown plant that are more readily identifiable (e.g., due to the presence of flowers or fruits from current or previous seasons). These may assist in correctly identifying the species in the plot. Most of these plants are not entirely “unknown.” Rather, they represent species that are known but sometimes difficult to distinguish from other similar species at the time of sampling. For example, vegetative individuals of *Sporobolus contractus* and *S. cryptandrus* generally cannot be differentiated, but both of these species can be identified with confidence when flowering.

When an unknown species is encountered, create a unique name using the following code: “unk” + 4 letter park code + number + space + genus or description (e.g. unkARCH3 cordylanthus). Record this in the appropriate column on the data sheet instead of the species code. Because there are different species lists for each park, start numbering unknowns at “1” for each park. If you know the genus of the unknown plant, use this as its description. Otherwise, create a short description (1-3 words) that will help you remember the unknown species. Before sampling, review previously collected unknown species from the ecological site and use existing unknown names whenever possible.

For each unknown species, fill out a corresponding “Unknown Plant Species Data Sheet” (Appendix A). This data sheet was adopted with modifications from Debacker et al. (2004). The more detailed description of each characteristic, the greater the possibility of future identification. Complete the following information on the data sheet:

- **Park:** A four letter code unique to a particular park (e.g. ARCH – Arches National Park)
- **Plot ID:** The pre-assigned, unique number.
- **Transect:** 1-3 (see Fig. 1).
- **Quadrat #/Position on Transect:** Number quadrats according to where they start along a transect (e.g. 0 m, 10 m, 20 m, ect.).
- **Unknown Code:** A unique code using “unk” + 4 letter park code + number + space + genus or description (e.g. unkARCH3 cordylanthus).
- **Date:** Use the format mm/dd/yyyy.
- **Plant type and General Description:** Circle the appropriate category and provide a detailed description of the overall appearance
- **Most Salient Feature:** A unique characteristic that identifies the plant from others.
- **Leaf Characteristics:** Describe the leaf type, leaf margin, leaf surface, petiole, etc.
- **Stem Characteristics:** Describe the shape, pubescence, markings, and color of the stem, as well as the bud characteristics.

- **Flower Characteristics:** Describe the floral formula, location (axillary or terminal), habit (indeterminate or determinate), pubescence, and color.
- **General and Microhabitat Characteristics:** List other species located in the general vicinity, selecting the more conservative species in the area. Describe the microhabitat in which it was found.
- **Collected:** Circle yes or no, whether a specimen was collected.
- **Best Guess:** Preliminary guess about species in field.
- **Confirmed to be:** The species determined after consultation of reference books and/or herbarium.

A sample of the unknown species is then collected and preserved in the plant press for later identification. Because of the long-term nature of monitoring, collecting outside the plot is preferred. If a specimen does not occur outside the plot, a portion of the plant from inside the plot can be collected, but at no time should the roots be dug up or the entire plant be collected from inside the plot. Collecting the roots and/or the entire above-ground portion of the plant may affect future sampling events. If a camera is available, a photograph could be taken.

7. Sample 10-m² cover by species.

For each species, surface feature, and disturbance present, an ocular estimate of cover is made within the 10-m² quadrat. This should be completed immediately after frequency is collected for each individual quadrat.

The recorder begins calling out the species recorded for frequency one at a time. For plant species, the estimate is a vertical projection of live cover, both photosynthetic and non-photosynthetic, onto the ground surface. The cover of each species is estimated to the 1% level. If cover is <1%, record as trace cover (i.e., T). Percent cover are recorded in the column titled **Percent cover in 10-m² quadrat**. All species with live foliar cover in the quadrat are included in cover estimates, whether they are fully rooted in the quadrat or not. Record the species code in the “Species” column and the cover-class code in the % cover column, but do NOT check any of the “Nested quadrats” columns. Cover of individual species cannot exceed 100 percent, but total live cover can exceed 100 percent due to canopy layering. Refer to Fig. 5 for assistance in estimating percent cover. Cover estimates for dead species are recorded separately from the live cover estimates.

8. Sample 10-m² cover by functional groups.

After completing cover for all species in the quadrat, the recorder prompts the observer for an estimate of total live-plant cover by functional groups. This is intended to provide a general measure of percent cover that is more easily comparable among plots and among ecological sites. This estimate is a vertical projection of total live cover (dead-plant cover is not included), both photosynthetic and non-photosynthetic, onto the ground surface. This accounts for overlapping species’ canopies that cannot be estimated from individual species data.

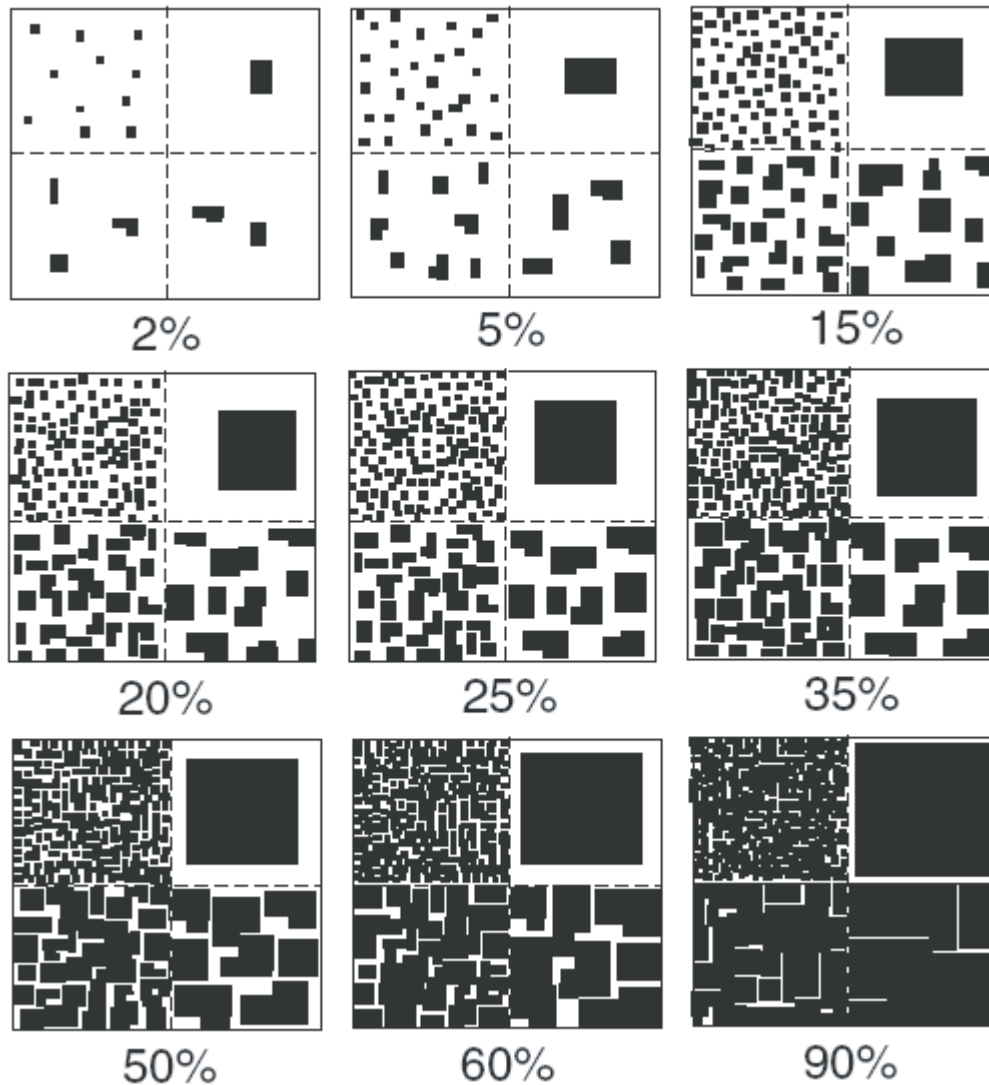


Figure 5. Guide for estimating percent of area covered (from Schoeneberger et al. 2002).

The recorder continues to call out all surface features and any disturbances present, prompting the observer for cover estimates. Estimates of Surface Features for the categories listed on the data sheet (e.g. bare soil, undifferentiated crust, cyanobacteria, lichen, moss, litter, woody debris) are recorded in the column titled **% cover 10-m²**. Combined estimates of ground-cover classes and plant basal cover (not measured) should add up to 100 percent. If a soil-surface disturbance was encountered in the quadrat, record the cover in the **% cover 10-m²** column.

9. Sample shrub density.

After you complete cover estimates at 0 m, you will count the density of live shrubs in that 10-m² quadrat. Shrubs are divided into six height classes (0-10 cm, 10-25 cm, 25-50 cm, 50-100 cm, 1-2 m, and >2 m). The recorder should transfer the names of any shrub species from frequency into the “Shrub species” column for density. Dwarf shrubs, however, are not included in density counts.

Use a 5-m retractable measuring tape (or a measuring stick with the size classes demarcated) to count the number of each shrub for each size class. Shrubs must have at least 50 percent of their base in a quadrat to be counted. The recorder is responsible for making sure that the observer collects data for all shrub species present. Here are some additional rules for shrub density:

- In cases where “individuals” are difficult to distinguish (e.g. *Coleogyne ramosissima*), the counting rule is that stems separated by 25 cm are separate counting units. For *Artemisia* species, it should be possible to trace branches down to single stem in most cases.
- At sites with high levels of shrub density, estimate density using the following categories: 100-250, 250-500, 500-1000, and >1000 individuals.

10. Complete sampling at all quadrats along the transect.

After you finish sampling the first quadrat, repeat steps 4 through 9 to set up the quadrats and sample the remaining quadrats along the transect. Sample quadrats in order as you move down the transect, making sure to sample all locations indicated in Figure 3.

11. Collect equipment and move to the next transect.

After you finish sampling all quadrats on a transect, collect your equipment. If using other sampling procedures on the transect, complete these before moving on to the next transect. Repeat steps 1 through 10 on transects 2 and 3.

12. Pack equipment and complete the site assessment.

After you finish sampling all three transects, complete the site assessment (SOP #12).

References

- DeBacker, M.D., A.N. Sasseen, C. Becker, G.A. Rowell, L.P. Thomas, J.R. Boetsch, and G.D. Willson. 2004. Vegetation Community Monitoring Protocol for the Heartland I&M Network and Prairie Cluster Prototype Monitoring Program. National Park Service, Heartland Inventory and Monitoring Network and Prairie Cluster Prototype Monitoring Program, Wilson's Creek National Battlefield, Republic, Missouri.
- Schoeneberger, P.J., Wysocki, D.A., Benham, E.C., and Broderson, W.D. (editors), 2002. *Field Book for Describing and Sampling Soils, Version 2.0*. Natural Resource Conservation Service, National Soil Survey Center Lincoln, NE.

Appendix A.

Data Sheets

Presence, Cover, and Shrub Density Data Sheet (p. 1)

Park: _____ Plot ID: _____ Observer: _____ Page ____ of ____
Transect#: _____ Quadrat #: _____ Recorder: _____ Date: _____

Check if overflow table used ☐

Presence						Percent cover in 10-m ² Quadrat	
Species name (live)	Species Code	Nested quadrats (m ²)					
		0.01	0.1	1	10	%	Check if rooted outside
Species name (dead)	Species Code						

Presence:		Nested quadrats (m ²)				% cover 10-m ²
Surface features	0.01	0.1	1	10		
crust, undifferentiated						
cyanobacteria						
lichen						
moss						
scat, livestock						
scat, wildlife						
Disturbance	-----	-----	-----	-----	-----	
ant mound						
bicycle						
human track/trail						
livestock track/trail						
motor vehicle						
wildlife excavation						
wildlife track						
other anthropogenic						
undifferentiated						

% Cover in 10 m ² quadrat	
Total live vegetation	-----
shrub & dwarf-shrub	
annual grass	
perennial grass	
forbs/herbs	
Surface features	-----
bare soil (loose)	
litter	
woody debris (>2.5cm)	
small rock (2-20mm)	
large rock (>2cm)	
bedrock	

Presence, Cover, and Shrub Density Data Sheet (p. 2)

Number of Live Shrubs Rooted in 10 m² Quadrat

[illegible]**Comments:**

Species cover overflow table

Presence						Percent cover in 10-m ² Quadrat	
Species name (live)	Species Code	Nested quadrats (m ²)				%	Check if rooted outside
		0.01	0.1	1	10		
Species name (dead)	Species Code						

Unknown Plant Species Data Sheet

Park: _____

Plot ID: _____

Transect# _____

Unknown Code: _____

Date: _____

Quadrat #/Position on Transect: _____

Plant Type & General Description: *herb shrub tree grass sedge other*_____

Most salient feature:

Leaf Characteristics:

Leaf Type: (compound/simple, arrangement, etc.)

Margin:

Other: (pubescence, sap, stipules, etc)

Stem Characteristics: (shape, pubescence, bud)

Flower Characteristics: (color, location, floral formula)

General and Microhabitat Characteristics:

Collected: *Yes* *No*

Best Guess:

Confirmed to be: