



Grassland Monitoring Protocol for the Southern Plains I&M Network and Fire Group

Standard Operating Procedures Version 1.00

Natural Resource ReportNPS/SOPN/NRR—2017/XXX.X



ON THE COVER

Blue grama grass (*Bouteloua gracilis*). Photograph by: Dawnelle Malone

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**Vegetation Monitoring Procedure for the
Southern Plains Grassland Protocol**

SOP #01: Field Preparation and Equipment List

Version 1.0
(March, 2011)

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This Standard Operating Procedure reviews tasks to be accomplished in preparation for a field season and itemizes the equipment needed to perform grassland monitoring in all parks of the Southern Plains. There are numerous tasks that must be performed to ensure a smooth and efficient field season, including generating and copying sufficient data sheets for the year, making appropriate logistical plans, and purchasing necessary equipment and supplies to provision the field effort. The equipment list can also be used at the end of field session to verify that all equipment is present and accounted for. Information contained in this SOP is augmented by procedures described in the 2003 USDI-National Park Service Fire Monitoring Handbook.

Prior to the field season each year, beginning in April or May, the field workers must review this entire protocol, including all of the SOPs. It is important that each member of the field crew is thoroughly familiar with the elements of the design and standard operating procedures for this program. These procedures are described in SOP'S # 2 through 13.

Due to the number of procedures performed as part of the vegetation monitoring field sampling effort, considerable preparations are necessary in order to effectively accomplish this suite of tasks. All materials and equipment must be brought on sampling trips with the crew. The suite of tasks involved in preparing for a field sampling bout include:

1. Preparation of Data Sheets

- Acquire a list of plots to be monitored for each park from the Project Manager. Some plots may be first-time visits, requiring establishment, while others may already exist, requiring only data collection.
- Review previous field forms for these plots and assemble copies of the existing data needed for the upcoming season. These will include UTM coordinates, general description of the plot (in terms of ecological site), travel directions (if a re-visit), and geographic data.
- Prepare appropriate data files for uploading into GPS units. *NOTE: Additional detail for this procedure will be added once we know which GPS units are being used and exactly which data can be uploaded.*
- Prepare copies of blank field forms needed to collect new data for each plot. These will include Plot Maintenance Logs, Quadrat Data forms, Point-Line Intercept forms, Biomass Collection forms, and Fuels Data forms. Additional blank forms to be copied include Shrub Transect forms, Site Impacts forms, and Unknown Plant Species forms. If the crew will be establishing new monitoring points, they will also need blank Plot Suitability forms, Transect Establishment Data forms, Plot Location Data forms, and Photo Logs.

- For each plot to be installed, generate two or three sets of random numbers, six random azimuths (0–359) (two for the plot azimuth and four for the fuel transects) ahead of time. An excellent idea is to generate all the random azimuths and distances that you will need for the entire season at once, using a spreadsheet program.
 - Prepare packets of the compiled information and forms for each park to be sampled. These packets should also contain the necessary collection permits (see below).
2. Prepare Plant Species Lists
- Certified species lists from NPSpecies available from the SOPN Data Manager and/or the Project Manager should be used to generate species lists for the field. Review species lists, identified plant species and unidentified specimen from previous monitoring efforts to identify any unique plants that may be encountered. Compile and generate a copy of comprehensive species list for each park and for each previously established plot.
 - Prior knowledge of at least the dominant species at a site will facilitate faster recognition and data collection in the field. Each member of the field crew should review the lists and use reference manuals to identify species that will likely be encountered. Copies of these combined species list should be carried into the field for quick reference.
3. Prepare Schedules and Notify Parks
- Monitoring will be conducted during the growing season across the Southern Plains. A preliminary schedule should be approved by the PI. Upon approval, resource staff of park units being visited should be notified (via an email message) of the dates the monitoring field crew will be in their parks.
 - In addition to submitting the preliminary field schedule, the project manager should also submit requests for park housing and permits (camping) any other special requests (e.g., boat transportation).
 - Collection permits have been established with the individual parks being sampled and should be carried into the field by the crew leader.
 - Just prior to the time the field crew enters a park unit the resource staff of the park is to be provided with the actual dates field-crew members will be working in the park, a list of their names, and approximate locations of monitoring activity.
4. Prepare Equipment
- All equipment (see list below) should be organized and prepared for the field season at least two months in advance of the field season. This allows time to make needed repairs and ordering/replenishing equipment.
 - Equipment needed for sampling crew should be prepared and taken to the field, even if all plots are already established, to replace any monuments removed since the last visit. However, at most, only 1-2 pieces of rebar should be carried to existing plots. This should be sufficient to cover replacement needs without undue burden to field crews

Table 1-1. Field Equipment List

Activity	Equipment
Plot establishment or re-visit	Digital Camera Photo board Compass Clinometer GPS unit Maps Daubenmire Sampling Frame (1m ²) constructed of PVC Measuring Tapes – 4 - 50meter Survey pins Rangepole for Point-Line Intercept & photos Batteries for electronics Bug spray/sulphur sock/clothes treatment
Plot Establishment	Aluminum tags Die stamps Pliers/wire cutters Rebar ½ meter long Hammer or mallet Wire for attaching tags to rebar Metal nails for 10 m marking
Data collection	Clip boards Data Sheet for all field-based procedures Hand lens Pencils/Pens/Markers Plant Press Species Identification Manuals and Taxonomy Books Species lists (previous observations, potential observations) Species Master Names and Codes list Unknown Specimen Forms
Required Miscellaneous Items	Backpacks Duct Tape First-Aid Kit Nourishment Cellular Phone or Radio for communicating Sun Screen Towels Water

Vegetation Monitoring Procedure for the Southern Plains Grassland Protocol

SOP #02: Using a GPS, Navigation & Measuring Techniques

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(November 3, 2015)

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This Standard Operating Procedure explains how to use a GPS as well as navigational and measurement techniques necessary for the specialized equipment used during grassland monitoring in the parks of the Southern Plains. As field personnel, monitors must be able to use a GPS to navigate over open terrain, determine distances traveled and plot transect locations on a map. The following sections discuss the correct use of three of the basic tools used by monitors in the field—A GPS, a compass and a clinometer—as well as some basic mapping techniques for locating and mapping transect locations in the field. Information for this SOP has been taken from the 2003 USDI-National Park Service Fire Monitoring Handbook.

Using A GPS

All GPS measurements should be set to:

- UTM coordinates
- NAD83 datum
- Meters

All crew members should be familiar with the operation of their GPS unit. Each network will supply the appropriate Users Guide for their equipment and this guide should be reviewed by all crew members and carried while on sampling events. Prior to the beginning of field season, all crew members should participate in field training in the use of their respective GPS unit.

As field personnel, monitors must be able to use a GPS to navigate to specific monitoring points and mark the beginning/ending points of a transect. This is achieved by marking waypoints. When paper data sheets are used, both the UTM coordinates and the waypoint number should also be recorded on the data sheet.

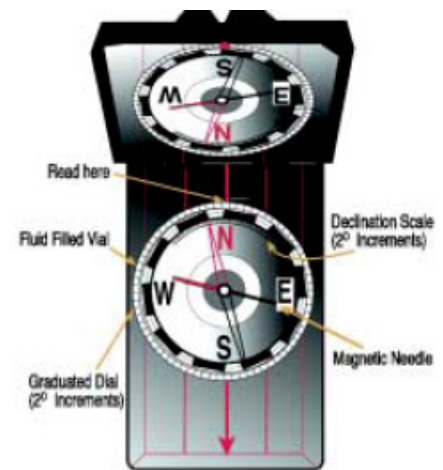


Figure 2-1. Graphic of a compass

Compass

Accurate compass bearings are essential for navigating over open terrain and for finding and mapping plot locations.

Parts of a Compass

A multitude of compass models exist with different features; however, all compasses have at minimum the following:

- **Magnetic needle**—The magnetic needle, drawn by the pull of the magnetic north pole, always points to magnetic north. The north end of the needle is usually marked by an arrow, or painted red.
- **Revolving 360° dial**—The dial is marked with the cardinal points, N, E, S, W and is graduated into degrees. Within the dial is a transparent plate with parallel orienting lines and an orienting arrow.
- **Transparent base plate**—Has a line of travel arrow and ruled edges.

Obtaining Accurate Compass Bearings

Always hold the compass level, so the magnetic needle can swing freely. Hold the compass away from magnetic objects such as rebar, watches, mechanical pencils, cameras, and belt buckles that can draw the magnetic needle off line.

Setting a Bearing

If you know the bearing in degrees from your current position to an object, turn the dial until the degree is aligned with the index point and line of travel arrow. In Figure 1, the bearing is set at 356°.

Taking a Bearing

- Aim the line of travel arrow on the compass towards the object.
- Turn the revolving dial until the magnetic needle is aligned within the orienting arrow in the compass dial.
- Read the bearing on the compass dial at the index point.

Facing a Bearing (Direction of Travel)

Hold compass with the base plate level and line of travel arrow pointing forward. Turn your body with the compass until the red north end of the magnetic needle point is aligned within the orienting arrow in the compass dial. You are now facing in the direction of the bearing.

Walking a Bearing

Look straight ahead in the direction of travel. Choose a landmark that lies in line with the direction of travel. Walk to the landmark. Continue in this manner until you reach your destination.

Using A Compass In Conjunction With A Map

You may use a compass in conjunction with a map in either of two ways:

- Determine a bearing from a map and then travel that direction in the field (map to terrain), or
- Take a bearing in the field and plot that bearing on a map (terrain to map).

Whenever combining compass (field) bearings with map (true) bearings, you must account for declination.

Declination

Declination is the degree of difference between true north and magnetic north. True north is where all lines of longitude meet on a map. Magnetic north is the location of the world's magnetic region (in the upper Hudson Bay region of Canada). Declination is east or west, depending upon where magnetic north lies in relation to your position. If magnetic north lies to the east of your position, declination is east. If magnetic north lies to the west of your position, declination is west. In North America, zero declination runs roughly from west of Hudson Bay down along Lake Michigan to the gulf in western Florida.

Declination diagrams are located in the bottom margin of USGS topographic maps. Keep in mind that declination changes slightly over time as magnetic north moves slowly west; therefore, the current declination in your area may be slightly different than the declination at the time the map was printed. Declination maps are re-mapped every five years by the USGS; the most recent declination map is for 1995 (see Figure 2). On some maps the annual rate of change may be printed and thus you can calculate the current declination. USGS also produces a Magnetic Declination Map of the United States. This map shows the rate of change throughout the US so that the current declination in any area can be calculated. You may also obtain the current declination in your area from your county surveyor.

If you need to be more precise, try using a geomagnetic calculator (e.g., NOAA 2000) that will calculate the declination for any year (1900–2005) given the latitude/ longitude or UTM coordinates.

Setting declination on your compass

Some compass models have a declination adjustment screw. The set screw key is usually attached to a nylon cord that hangs from the compass. Using the key, turn the set screw to the appropriate declination. Once you have set the proper declination you do not need to change it until you move to a different area. If you move to a new area, remember to reset the declination on your compass. Do keep in mind that declinations change over time. If you do not have a compass with a declination adjustment screw, you must add or subtract declination to determine the correct bearing. Whether you add or subtract declination depends on whether you are working from map to terrain or terrain to map.

Map to terrain

If you have determined a bearing between two positions from a map, and you are going to walk the bearing, you must convert that bearing to a magnetic bearing. The rules for converting from map to field bearings are as follows:

- For declination west, turn dial west (add number of degrees of declination)
- For declination east, turn dial east (subtract number of degrees of declination)

Terrain to map

If you have taken a field bearing and want to plot the position on a map, you must convert the bearing from a magnetic bearing to a map (true) bearing. The rules are simply the reverse of the map to terrain rules:

- For declination west, turn dial east (subtract)
- For declination east, turn dial west (add)

Clinometer

A second important field tool is a clinometer, which measures slope in degrees and/or percent. Slope is one of the most important topographic influences on fire behavior. In addition, recording the slope along the plot azimuth is another aid in defining (and thus relocating) plots.

Measuring Slope Using a Clinometer

The model of clinometer most commonly used in fire effects/grassland monitoring has both a degree scale and a percent scale. When you look through the lens, you will see the percent slope scale on the right side and the degree scale on the left (see Figure 3). Slope can be measured in degrees or as a percent. For our purposes, measurements are made in percent slope rather than in degrees. Percent slope measures the degree of incline over a horizontal distance; a +1% slope indicates the rise is very gradual over a given distance. A +60% slope indicates the rise is very rapid over a given distance.

The degree scale gives the angle of slope in degrees from the horizontal plane at eye level. The percent scale measures the height of the point of sight from the same horizontal eye level and expresses it as a percent of the horizontal distance (i.e., % slope); percent slope is used throughout this protocol.

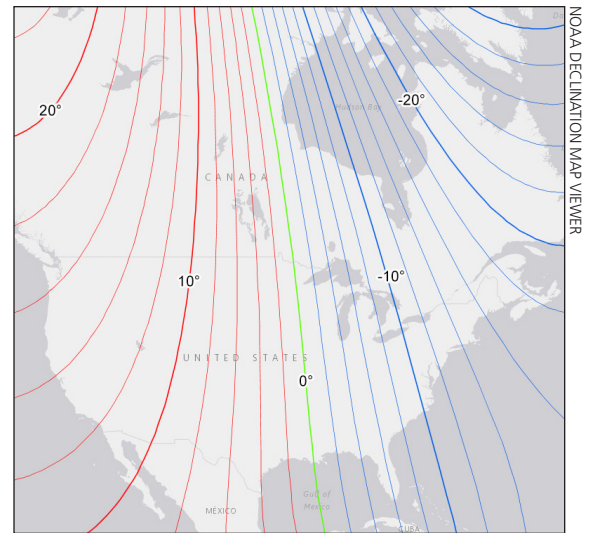


Figure 2-2. Map showing declination in North America. East of the zero line, declination is "west." West of the zero line, declination is "east."

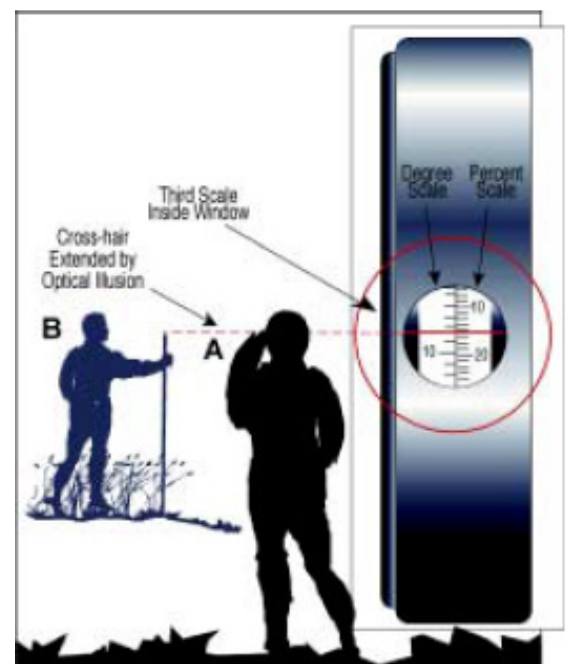


Figure 2-3. Graphic of a clinometer.

Note: The rangepole at B is the same height as the viewer's (A) eye level. Also note that you can find clinometers with percent on either the right or left side; percent being the larger number.

To use a clinometer:

- Hold the clinometer so that the round side-window faces to the left.
- Hold the clinometer up to your right eye but keep both eyes open (you can hold the instrument up to your left eye, if that is more comfortable).
- Aim the clinometer in the direction of the slope you want to measure.
- Fix the hair line of the clinometer on an object in your line of sight and at the same height as your eye level, a rangepole may be useful.
- Look into the viewing case, and read where the hair line intersects the percent scale (on the right).

Some Basic Map Techniques

Working with Scale

You will inevitably use maps with many different scales during your monitoring work. If you enlarge or reduce a map, the scale of the map will change and you must determine the new scale. Scale on a map is determined by the formula:

$$\text{Scale} = \frac{\text{Map Distance (MD)}}{\text{Ground Distance (GD)}}$$

Map distance equals the distance measured between two points on a map. Ground distance equals the distance on the ground between the same two points.

To determine the new scale of a map that was enlarged or reduced, follow these steps:

- On the original map of known scale, measure the map distance between two points that are separated horizontally and two points that are separated vertically. (The reason to measure two distances is that copy machines are not precision instruments and may skew the map.)
- Compare the distances to the original map scale to determine the four ground distances.
- On the enlarged (or reduced) map, measure the distances between the same four points. (Although the map distance has changed, the ground distances between the four points are still the same.)
- Calculate the scale of the enlarged (or reduced) map with the scale formula, using each of the four distances.
- Average all four scales, and use this for determining ground distances on the enlarged (or reduced) map.

Example:

You calculate the scale of a map from an original map at the scale of 1:24,000. On the original map, you measure two separate horizontal distances, 5.6 and 11.1 cm, and two vertical distances 4.15 and 6.5 cm. For a 1:24,000 map, 1 cm = 240 m, so the corresponding ground distances are 1,344, 2,644, 996, and 1,560 m respectively.

Using the enlarged map, now measure the same four distances. Using the first map distance-ground distance combination, we get the following scale:

$$\text{Scale} = \frac{MD}{GD} = \frac{13.2cm}{1344m} = \frac{1cm}{101.82m}$$

Continuing on for the three remaining distances, the four resulting scales would be 1:10,182; 1:10,129; 1:10,163; and 1:10,163. Taking the average of these four numbers, the scale of the enlarged map is determined to be 1 cm = 101.59 m, or 1:10,159.

Determining the Direction and Distance Between Two Map Points

You will have to determine the direction and distance between two map points when you use a map to get to your Plot Location Points (PLP).

Determining the direction between two map points

To determine the direction between two points on a map, follow these steps:

- Draw a line connecting the two points (A B).
- Place your compass with the edge of the base plate along the line.
- Orient the compass with the line of travel arrow pointing towards point B.
- Turn the revolving dial of the compass until the orienting lines within the compass dial are parallel with the north-south meridian lines on the map, and the North (N) arrow points to north on the map.

**Vegetation Monitoring Procedure for the
Southern Plains Grassland Protocol**

SOP #03: Photographing Plots

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(March, 2011)

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This Standard Operating Procedure explains the methods for photo-documentation of permanent plots and has been adopted from the 2003 USDI-National Park Service Fire Monitoring Handbook. There is a set of minimum requirements for the photo-documentation for each plot. However, each plot area is also different, and creativity is encouraged in crew members (especially the Lead Technician for this SOP) in deciding the best ways to add to these minimum requirements. Keep in mind that landscape photo-pairs repeated from identical points over time are extremely valuable tools for documenting changes through time in vegetation and landscape variables. Photo-documentation provides the following benefits to the program:

1. A graphical depiction of aspects of the vegetation mosaic and the landscape context of each plot – a snapshot in time.
2. A graphical depiction of any nearby features that might prove significant in understanding changes that could occur within a plot, such as ecotones, potential sources of disturbance, and conspicuous landmarks.
3. After the first iteration of sampling, the images are an invaluable tool for accurately setting- up plots and placing quadrats, thereby increasing the accuracy and overall repeatability of our measurements.
4. Once out of the field, plot photographs allow us a way to ‘revisit’ a plot if questions arise during data entry or analysis – that is, if something seems amiss or unusual with some aspect of the data, the photographs should allow us to assess whether this is a mistake, or that the plot truly was an “outlier” of some sort.
5. A method to actually analyze and graphically display apparent changes in the vegetation cover of a plot – sometimes a picture will capture changes that have occurred when other sampling measurements do not capture the change.

In general, one technician will be assigned the lead role for photo-documentation. Often other technicians will shoot some of the required photos, but the lead technician for this role is responsible for ensuring all required photos for the plot are taken, and any good photo opportunities to illustrate the overall grid or individual plots are utilized. As of this version (1.0), the model of the digital camera is Canon PowerShot S45, 4.0 megapixel resolution. Future models will be recorded in the revision log.

Procedures:

Responsibilities of the lead technician

1. The lead technician for the photo-documentation protocol will need to become proficient in the operation and features of the digital cameras prior to going into the field.
2. The lead technician will be skilled at the following functions of the camera: image resolution, image file size, zoom or wide-angle capabilities, the 'stitch' feature that allows multi-image panoramic photos to be stored and stitched together, and the 'macro' feature. The lead technician also makes sure that the photo-log is completely and correctly filled out, which is crucial to the photo-documentation process. All photograph notes are entered into the project database.
3. The lead technician ensures the proper gear is assembled and packed for sampling trips (see equipment list below). They also ensure that a sufficient number of charged batteries and storage cards are brought into the field each day.
4. The lead technician ensures that the equipment is well-cared for, and that the camera is stored in dry conditions during inclement weather.
5. The lead technician must be familiar with the methods, hardware and software required to download the images following a trip, and is responsible for recharging the batteries such that they will be ready for use during the subsequent field excursion.
6. The lead technician will make recommendations at the end of the field season about lessons learned and improvements to this procedure.

Shooting Photos

1. Plot photos are taken immediately after the plot is installed (SOP #3). It is essential that you take the plot photos before the measurements are made, so that images of the plot represent its most natural, undisturbed state.
2. Every photo that is taken must be recorded in the photo log. The camera automatically assigns a number to each image. Each number in the sequence for a particular grid must be recorded on the data sheet. If you delete an image, the camera will not re-assign that number to another image. Therefore, if you delete a photo for any reason, record it as a deleted image next to the associated number, so that all numbers in the sequence are accounted for.
3. Use a medium resolution format for photos. The typical file size of photos ranges between 400 KB – 1 MB. Rarely will you need to store images in the highest resolution format for routine photo-documentation.
4. A photograph identification "card" should be prepared and made visible in every photograph. The card should display, in large black letters, the plot identification code, date, subject code and any other information that may be useful, e.g., park code, unit, or burn status. Photos will be more useful if they show primarily the vegetation, and space taken up by the board and monitor is minimized. Have someone hold the board so that the codes are just visible in each photograph, but the board itself is as unobtrusive as possible. While it would make for great reminiscing, the person holding the board and the other data collectors should not be visible in the photo.
5. Once all the tapes are laid out and the ID card is ready, take a minimum of two photos at each plot, following the "Subject" sequence listed below. The 2 reference photos (#3-4) are optional:

<u>Subject</u>	<u>Code</u>
1. From 0P toward 50P	0P-50P
2. From 50P toward 0P	50P-0P
3. From 0P toward reference feature	0P-REF
4. From reference feature toward 0P	REF-0P

6. Place a rangepole or other tall marker at the midpoint of the line being photographed. The pole should be located at the same point each time the plot is re-photographed. This can provide for clearer comparisons over time.
7. If the closest stake that should be in the photo is obstructed by a shrub or tree limbs, take the photo anyway, flagging the stake and moving as little vegetation as possible. You may then take an oblique shot of the photo transect if desired, noting the exact location from which this shot was taken and that this photo should always be repeated on subsequent visits. If obtrusive vegetation prevents you from placing the camera in such a spot that you can get the closest stake in the picture, it may be acceptable to take the photo while standing at the stake itself, or from a different height (but not above 5 ft), as long as this is noted and repeated on all subsequent visits. Never prune vegetation from a plot.

Re-photographing Plots

Remember that when you are photographing plots that have already been documented, you should make every attempt to duplicate the previous photos, no matter what technique was used, unless the previous photos are poor, e.g., pictures of plot stakes, but not the plot itself.

1. Always bring a copy of the establishing photos into the field to facilitate replication of earlier shots. This can be a set of photographic prints, scanned images, or color photocopies generated for this purpose and included in the “field packet” (see SOP #1).
2. If you find that the Photog Log is too large, or if you use multiple cameras, keep a small notebook with appropriately labeled pages in the camera bag at all times. Attaching the notebook to the camera bag will reduce the risk of losing the entire notebook and all the data with it.

**Vegetation Monitoring Procedure for the
Southern Plains Grassland Protocol**

**SOP #04: Determining Site Suitability, Establishing and Marking
Permanent Monitoring Plots**

Version 1.0
(March, 2011)

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Previous version #	Revision date	Author	Changes made	Reason for change	New version #

This SOP describes step-by-step instructions for determining site suitability, establishing and marking permanent monitoring plots for parks units in the Southern Plains. This procedure is carried out on the first iteration of sampling for a point after the transect origin point is located. This SOP has been adapted from the 2003 USDI-National Park Service Fire Monitoring Handbook.

Determining Site Suitability

Potential sampling sites will be selected prior to actual fieldwork and will be limited to areas where less than 10% cover by tree species occurs. These potential sites will be generated by a computer following a stratified random sample.

Prior to field work, all potential sites will be viewed using geographic information systems by overlaying the location on aerial photography or satellite imagery. This will eliminate many sites beforehand that are not in appropriate habitat (e.g., those potential sites on ponds, parking lots, or forested habitats). The remaining sites will be presented to the park's natural resource manager for final comments.

All potential sites that are not eliminated by the process described above will be visited for plot establishment and data collection. While at the site, the sampling crew will perform a final check with additional criteria as outlined below.

Criteria for Accepting or Rejecting Sampling Sites in the Field

Once a site is located in the field, it must be checked to ensure that the plot falls within acceptable sampling criteria.

1. All areas of the sampling point must fall within the designated habitat type. From the plot origin point, check the area against the monitoring type description on the Monitoring Type Description sheet. If the monitoring plot origin point and the area roughly within a 50 m radius of that point meet the criteria for the monitoring type, install a stake, which serves as the plot origin point (the 0 point).
2. There must not be any obstacles that present a safety hazard to the crew. This includes, but is not limited to, steep slopes (> 30%) within the sampling area, known high density of rattlesnake habitat, etc.
3. The sampling area must be > 50 m away from roads, trails, potential development and ecotones;

If the origin point and surrounding area meet one or more rejection criteria for the monitoring type, return to the origin point and orient 180° away from the previous randomly selected azimuth. If the second location meets one or more rejection criteria, reject the random point and proceed to the next one (in numerical order) and begin site assessment anew.

Establishing And Marking Permanent Plots

1. Locate Transect Origin Point

Locate the transect origin point by using your GPS (see also SOP # 2 Using a GPS) and predetermined UTM coordinates for the origin point. Care must be taken during origin point installation to prevent trampling of the surrounding vegetation, which will be sampled following transect establishment. Crew members and equipment should wait a minimum of 15 m away from the origin point until transect azimuth has been determined.

2. Install Origin Point Monument

A permanent monument consists of a bent rebar stake (0.5" x 18") pounded firmly into the ground and labeled. Ideally, the stake will protrude less than 30 cm above-ground. There are special requirements for rebar placement whenever a plot is highly visible to park visitors. If a piece of rebar is easily detectable from a road or trail, only leave about 10-cm of the bar above ground, or sink a stake to ground level, and note this in the comments of the data form. In high-use areas it may be necessary to partially camouflage stakes, or to mark beginning and end points with buried metal markers that can be relocated with a metal detector (or a magnetic locator).

At times rebar cannot be satisfactorily pounded into the ground. If this is the case at one of your plot points, try installing the rebar out a little further along the transect tape. Note the distance along the transect where the rebar is placed (i.e., at the start, the distance is 0). Another option is to sink the stake in at an angle so that the top is in the correct location. You can also pile up rocks around the rebar, but only if that won't affect the variable you are sampling and the cairn has a reasonable chance of remaining undisturbed.

3. Label Transect Origin Point

Install permanent plot identification tags on each stake as described below.

- Use rectangular or oblong brass tags; aluminum tags are likely to melt in areas of prescribed burns.
- Each tag should include the monitoring stake location code, plot purpose, plot identification code (see Step 9 below), and date of initial installation. An abbreviated format may be used to reduce the amount of minting. It includes the monitoring stake location code, plot purpose, vegetation code from the plot identification code, plot number and date.

Stamping the tags using a die set produces the most wear-resistant results, but is very time-consuming. Stamp the tags (except the date and the plot number, which can be added once the plot has been accepted) before going into the field.

4. Determine Azimuth of Transect

Using the random table in the field materials, select an azimuth for the transect. If the azimuth chosen is unsuitable for the transect (hazards, boulders, etc.), reorient 180 degrees at the origin point.

5. Establish Transect and Monument End Point

Anchor the beginning end of the tape to the plot origin stake and walk to the right side of the transect azimuth for 50 m. Once 50 m have been measured, pull the tape taut along the transect azimuth. If necessary, use steel pins to hold the tape in place at other points along the transect. Mark the end point of the transect with another rebar monument, following instructions in Step 3. Fasten the tape so that the 50 m transect tape is taut and as close to the ground as possible to avoid curvature in the line. In order to collect biomass data (SOP #8), a second transect tape should be run parallel to the primary tape. Refer to SOP #8 to determine placement of this tape, as it will vary each year to prevent negative impacts to vegetation.

6. Photograph Sampling Site

Once the tape is laid out, take a minimum of two photos at each plot, following the "Subject" sequence listed below (see also SOP #04 Photographing Plots). If necessary to better characterize the vegetation at the site, take

additional photos from a well-documented location. Place a flagged rangepole or other tall marker at the midpoint of the line being photographed. To minimize the effect of vegetation trampling on the photo, photograph the monitoring plot before you sample other variables, staying outside the plot as much as possible.

<u>Subject</u>	<u>Code</u>
1. From 0P toward 50P	0P-50P
2. From 50P toward 0P	50P-0P
3. From 0P toward reference feature	0P-REF
4. From reference feature toward 0P	REF-0P

A coded photograph identification “card” should be prepared and made visible in every photograph. The card should display, in large black letters, the plot identification code, date (if camera is not equipped with a date stamp), subject code and any other information that may be useful, e.g., park code, unit, or burn status.

7. Place Nails Along Transect

To insure the proper alignment of the sampling frame at each 10 meter mark along the transect, insert a metal nail flush with the ground at the 10 m, 20 m, 30 m and 40 m tape marks along the transect tape, and at all the above plus the 0 m mark along the secondary tape.

8. Collect Environmental Data

Determine the aspect and elevation of the sampling site. Using a clinometer (Refer to SOP # 02 – Navigation & Measurement Aids), determine the percentage of slope along the transect azimuth from 0 to 50 m. Record this data on the Plot Location Data sheet.

9. Complete Transect Establishment Sheet

Complete the Transect Establishment 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 start of the center transect. Note particular obstacles or hazards to be avoided at (and en route to) this particular site. This sheet will be updated annually By the Project Manager and provided to the crew for reference and additional information and notes.

- Assign and record the plot identification code if not already done. The plot ID number consists of the monitoring type code and the pre-assigned transect number.
- Record the date you established the plot, the unit name or number, crew member names, the azimuth of the transect and the declination used (See SOP #02 – Using a GPS, Navigation & Measuring Techniques).
- Record the Universal Transverse Mercator values, Estimated Horizontal Error, and datum used.
- Record the percent slope that the transect azimuth follows, the aspect, and elevation of the plot location.
- Record the road and trail used to travel to the plot.
- When needed, record the compass bearing (including declination) followed from the road or trail (or other relatively permanent reference point) to locate the monitoring plot. Mark on the topographic map where you left this well-known trail or road, and photograph this location if necessary
- Describe how to get to the monitoring plot, referring to the hand-drawn map to illustrate the written directions by including all your geographic references. Include the highly visible features from which you took your bearings.
- Identify permanent or semi-permanent reference features on the site in case the origin stake is hard to find or disappears. The reference feature should be easy to relocate.
- Record the true compass bearing and distance in meters from the reference feature to the origin stake.
- Describe the plot location accurately and thoroughly, referring to the hand-drawn map.

Transect Establishment Data Sheet

Park: _____ **Transect ID:** _____ **Date Established:** _____

Community: _____ **UTM Zone** _____

Slope (%): _____ **Aspect (°):** _____ **Azimuth (°):** _____ **Dec:** _____

TRANSECT LOCATION:

Rebar at transect origin		Rebar location (m)	Rebar at transect end		Rebar location (m)	Elevation m
UTM E	UTM N		UTM E	UTM N		
		0 M			50 M	

Directions to Transect: _____

LAST READ:

Species Found:

**Vegetation Monitoring Procedure for the
Southern Plains Grassland Protocol**

SOP #05: Method for Collecting Divided Quadrat Data

Version 1.0
(March, 2011)

Revision History Log

Previous version #	Revision date	Author	Changes made	Reason for change	New version #

This Standard Operating Procedure explains the procedures that are performed to collect data using the divided quadrat method in all parks of the Southern Plains. Following these procedures is important to collect valid data used in monitoring grassland health.

Primary vegetation data will be collected using a series of permanent transects consisting of 5 divided 2 x 1 m quadrats located every 10 m (beginning at 0 m) along a 50 m transect (Figure SOP-5-1). Quadrat sampling requires a two person team: one “observer” to call out species and cover, 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.

Set up the transect

Use a GPS to locate the coordinates of the start and end points of the transect (SOP #3). If a revisit, relocate the rebar posts marking the start and end of each transect using a metal detector if necessary. Avoid trampling the sampling area on the left side of transect (from the start point). Anchor the beginning end of the tape to the plot origin stake and walk on the right side of the transect towards the ending stake. Fasten the tape so that the 50 m transect tape is taut and as close to the ground as possible to avoid curvature in the line. If necessary, use additional steel pins to hold the tape in place at other points along the transect. Set up a second 50 m tape parallel and 10 m to the left of the transect tape to delineate to sampling area, being careful to align both tapes with the metal pins placed at the 10 m increment sampling marks. If this is an initial transect establishment follow SOP# 3 to lay out and mark the transect.



Figure 5-1. General plot layout for sampling grasslands.

Photograph the transect

Photos should be taken each time the permanent plot is revisited (SOP #4). Every attempt should be made to duplicate the establishing photos. A copy of establishing photos can be taken into the field to facilitate replication of earlier shots. Photos will be more useful if they show primarily the vegetation, and space taken up by the board and the crew is minimized.

Prepare Data Collection Sheet(s)

Record relevant information in the header of the Field Data Form in preparation for data collection. These data sheets can be printed both front and back, using one side of the sheet for each of the five quadrats.

Sample divided plots for cover and frequency

Care should be taken while performing the actions below so that vegetation along the transect tape is not trampled. Point-line intercept readings of the vegetation on the tape line should be taken prior to the divided quadrat readings.

Species present and cover data are collected in five 2x1 m quadrats located along each transect, spaced 10 meters apart. Along all transects, plots are located at 0 m, 10 m, 20 m, 30 m, and 40 m on the left side of the tape. For each quadrat, align the PVC sampling frame so that the quadrat begins at the meter mark and ends 2 m further along (for example 0 m to 2m or 20 m to 22 m). Begin by sampling a 1 m² area (0m – 1m), followed by a 2x1 area (0m – 2m) that includes the previously sampled area.

Record Species Codes

Species codes are assigned in a systematic way. Originally, they were assigned following Natural Resource Conservation Service methodology, as used in the USDA PLANTS Database (USDA NRCS 2001). This naming convention used a 4+ character alpha code beginning with the first two letters of the genus name and the first two letters of the species name. The following 0–2 characters were assigned as needed to avoid confusion of plants with duplicate codes. If there was no subspecies or variety, the next character(s) may not be needed or would be a one or two digit number representing the alphabetical ranking of that plant on the national list.

The many numbers following the four letter code has proven to be quite confusing and an easy vector for mistakes when entering data into the database. Therefore, a change has been made to the species code for the purpose of this protocol. The species code will now be a six-letter code +characters, consisting of the first three letters of the genus and the first three letters of the species, followed by a number if duplicate codes exist. While numbering may still be involved, there are normally no more than two numbers involved, decreasing the possibility of mistakes.

Examples:

<u>Original</u>	<u>Current</u>	
DACA	DALCAL	Dalea californica
DACA3	DANCAL	Danthonia californica
DACA13	DASCAL	Dasistoma calycosa

If the plant is a subspecies or variety, then the character in the seventh position will be the first letter of that infraspecific name, and if there are duplicates, a number will follow.

Examples:

<u>Original</u>	<u>Current</u>	
ACRUT	(ACERUBT)	Acer rubrum var. trilobum
ACRUT3	(ACERUBT2)	Acer rubrum var. tridens
DACAP	(DALCARP)	Dalea carthagenensis var. portoricana
DACAP3	(DANCALP)	Danthonia californica var. palousensis

Full species names can usually be completed after the transect visit and are used as verification of species. When in the field, complete the full species name if there is a possibility of confusion back in the office. This is very important when a number is included in the species code.

Table 5-1. Definitions of soil surface features for quadrat sampling.

Soil surface type	Definition
Bare soil, no overhead vegetation	Loose soil particles (0-2 mm diameter) exposed to erosion
Bare soil, under vegetation	Loose soil particles (0-2 mm diameter) protected by vegetation overhead
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
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)
Crust, undifferentiated	Anything from physical crust to weak biological crust but NOT including lichen, or moss
Scat, livestock	Any type of livestock scat

Vegetative Cover:

The observer estimates the cover of individual species in each of the divided quadrats using ocular estimation techniques (see below). Each individual percentage value alone cannot exceed 100%, but when combined the cover value for a plot may be greater than 100% due to layering. Only species rooted >50% in the plot are included in estimates of foliar cover. A reference list provided for each plot lists the names, but not the associated cover values, of species previously collected in a plot for comparison to those being recorded. If any species from the previous year was missed, the plot is searched again for the species. Comparison with the previous year's species list maintains consistency in species identification and creates a check for missing species.

To sample, first estimate and record the percent foliar cover of every plant species in the 1 x 1 m quadrat. Note any dead species by checking the "Dead" box on the datasheet. If you have both live and dead individuals of the same species, record them on separate lines so as to estimate cover separately for each. Once completed, repeat the cover estimates for all species across the entire 2 x 1 m quadrat. Record this data in the 2x1m column for species already listed, and adding any new species encountered as needed. Cover is estimated to the nearest percent allowing later grouping into cover classes (if needed).

Ground Cover:

After vegetative cover is estimated, for each 2x1 m plot, the ground-level cover of bare soil, litter and other attributes (Table SOP-5-1) is estimated using the same ocular estimation techniques (see below). When percentages are combined the cover value for a plot may not be greater than 100%.

Complete sampling at all quadrats along the transect.

After you finish sampling the first quadrat, repeat the above efforts to sample the remaining quadrats along the transect. Sample quadrats every 10 m as you move down the transect, making sure to sample all divided plots.

AID FOR OCULAR ESTIMATION

The validity of ocular estimation has come into question due to observer variability both within and across seasons. It is of critical importance that observers be well trained at the beginning of the season and recalibrate their estimations monthly during the field season. The best consistency will be achieved within a season's readings if they are made by the same person all season. During the first three field seasons implemented under this protocol, cover will be estimated using two different procedures: by ocular estimate and through Point-Line Intercept, which currently has greater validity within the scientific community. Comparisons of these two estimates will be made to determine the degree of observer error for future monitoring effort.

When cover estimates are made using the Divided Frequency method, vegetation cover estimates will be made for each divided quadrat (1 m² and 2x1 m) at the species level. Ground surface estimates will be made only for each 2x1 m quadrat.

Use the following visual aid to calibrate observer estimation.

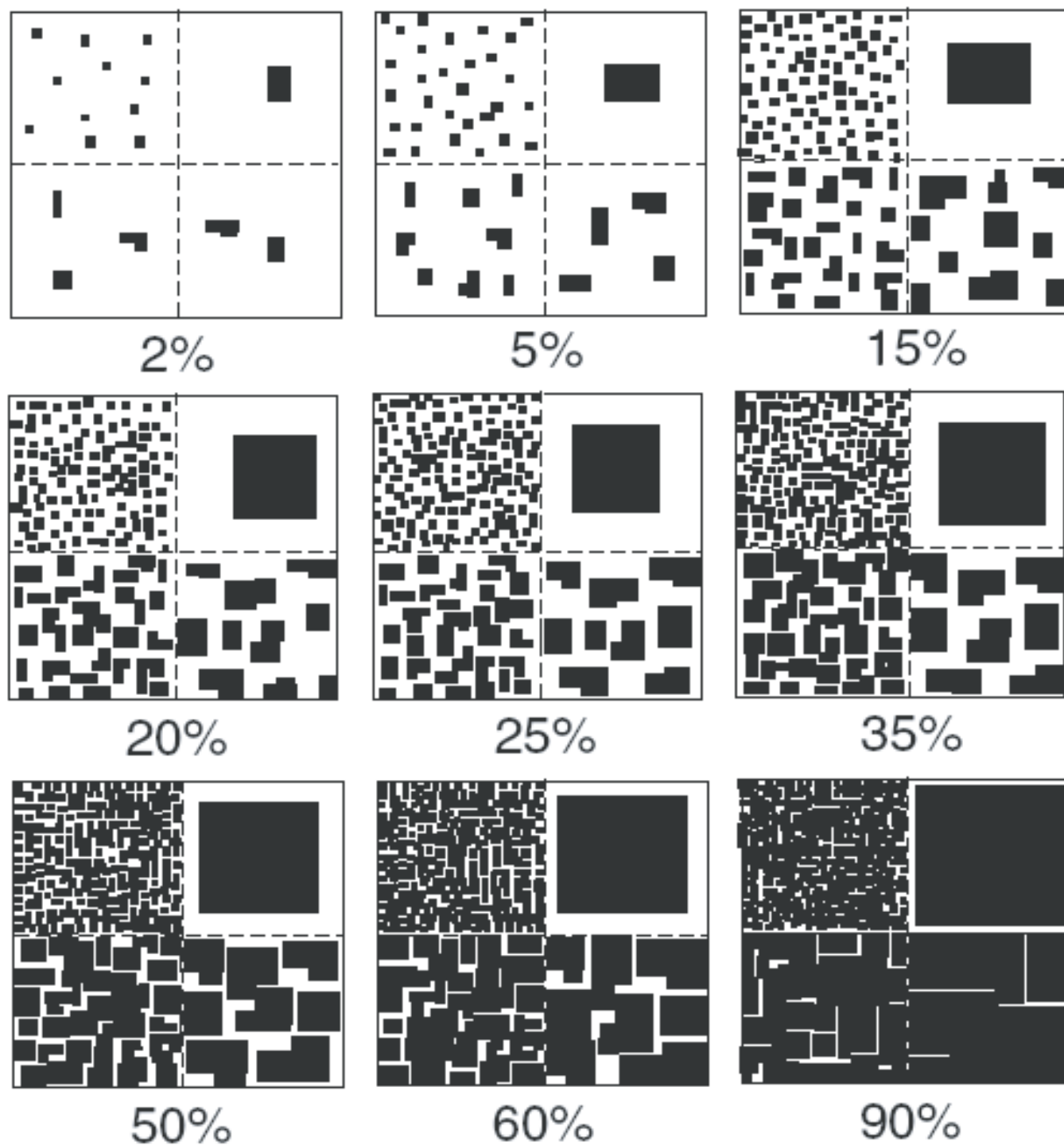


Figure 5-2. Examples of various plot cover percentages.

Presence and Cover, Data Sheet

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

[illegible]

Surface Feature % Cover	2x1 m
Bare soil, no overhead vegetation	
Bare soil, under vegetation	
Litter	
Woody debris	
Small rock	
Large rock	
Lichen	
Moss	
Crust, undifferentiated	

**Vegetation Monitoring Procedure for the
Southern Plains Grassland Protocol**

SOP #06: Point-Line Intercept Procedures

Version 1.0
(March, 2011)

Revision History Log

Previous version #	Revision date	Author	Changes made	Reason for change	New version #

This Standard Operating Procedure explains the procedures that are used to collect Point-Line Intercept data from monitoring transects. This SOP is adapted from the 2003 USDI-National Park Service Fire Monitoring Handbook.

Procedures

Use the appropriate form for 30 m transects or 50 m transects. Use a point intercept method to record the number of transect hits and to obtain relative and percent cover by species over time.

Locate the 0 point on the point intercept transect

The data collection starting point is at the 0P (origin stake) on grassland plots and follows the same tape transect used for obtaining nested divided quadrat data.

Collect number of transect hits

Drop a ¼ in diameter pole (a rigid plumb bob), graduated in decimeters, gently so that the sampling rod is plumb to the ground (on slopes this will not be perpendicular to the ground), every 30 cm along the transect line. Where the transect length is 30 m, there will be 100 points (50 m transects will be 166 points).

At each “point intercept” (Pnt), gently drop the pole to the ground, and record each species (Spp) that touches the pole on the Point-Line Intercept data sheet. Count each species only once at each point intercept even if the pole touches it more than once. Record the species from tallest to the shortest. If the pole fails to intercept any vegetation, record only the substrate (bare soil, rock, forest litter, etc.). Note: You can occasionally find vegetation under a substrate type; in this case you would ignore the substrate and record the vegetation. If the rod encounters multiple types of substrate, record only that which the pole hits first.

Do not count foliage or branches intercepted for trees over 2 m tall, but count all other vegetation, including shrubs, no matter its height. (This is because trees are better sampled using other procedures, and the target variables using the point intercept transect are shrubs and herbs.) If the sampling rod intersects the bole of a tree that is over 2 m tall, record “2BOLE,” or “2SDED” if the tree is dead. Note: Record uncommon species not intercepted but seen within the plant community on the bottom of the data sheet.

Tall Vegetation Sampling Problems

When recording vegetation height, if vegetation is unexpectedly taller than the sampling rod, try dropping the rod at the sampling point, then placing your hand at the 1 or 1.5 m point on the rod and sliding the rod up (without looking

up), elevating it by 1 or 1.5 m and recording where it touches the vegetation above you. If the vegetation is consistently taller, find a taller sampling rod.

Dead Herbaceous and Shrub Species Sampling Problems

You may encounter dead standing vegetation along your transects. Always record dead annual vegetation in the same way you record live individuals. Record dead biennial and perennial vegetation (except dead branches of living plants) by placing a “D” at the end of the species code. This permits dead vegetation to be treated separately from live vegetation. Dead perennials may not be included in species abundance indices, but their presence may provide information for estimating fire behavior and determining mortality. In general count dead branches of living plants as a live intercept. In the case of shrub and herbaceous species, this also applies if the main plant is dead but sprouting, and the dead part is encountered.

Sprouting Dead Trees

Trees under 2 m tall: If the bole (>2 m tall) is dead but sprouting at the base, consider any live sprout (<2 m tall) you encounter as live. Trees over 2 m tall: If you encounter a live basal sprout over 2 m tall, the sprout should be considered a tree (2BOLE) in its own right.

Shrub and herbaceous layer height

At every sampling point, measure the height of the tallest living or dead individual of each species (to the nearest decimeter, in meters) at the highest place on the sampling rod touched by vegetation. Record this height (Hgt) on the data sheet. A ¼ in wide sampling rod graduated in decimeters should make this measurement relatively easy. Do not record data for aerial substrate such as the leaves or stems attached to a dead and downed tree.

Record Species Codes

The species code is recorded as a six-letter code +characters, consisting of the first three letters of the genus and the first three letters of the species, followed by a number if duplicate codes exist. Species codes are assigned in a systematic way, however originally, they were assigned following Natural Resource Conservation Service methodology, as used in the USDA PLANTS Database (USDA NRCS 2001). This naming convention used a 4+ character alpha code beginning with the first two letters of the genus name and the first two letters of the species name. The following 0–2 characters were assigned as needed to avoid confusion of plants with duplicate codes. If there was no subspecies or variety, the next character(s) may not be needed or would be a one or two digit number representing the alphabetical ranking of that plant on the national list.

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DACA3	DANCAL	Danthonia californica
DACA13	DASCAL	Dasistoma calycosa

If the plant is a subspecies or variety, then the character in the seventh position will be the first letter of that infraspecific name, and if there are duplicates, a number will follow.

Examples:

<u>Original</u>	<u>Current</u>	
ACRUT	(ACERUBT)	Acer rubrum var. trilobum
ACRUT3	(ACERUBT2)	Acer rubrum var. tridens
DACAP	(DALCARP)	Dalea carthagenensis var. portoricana
DACAP3	(DANCALP)	Danthonia californica var. palousensis

FMH-16**30 m TRANSECT DATA SHEET**

Plot ID: _____

B/C (Circle One)

Date: ____ / ____ / ____

Burn Unit: _____

Recorders: _____

Burn Status: Circle one and indicate number of times treated, e.g., 01-yr01, 02-yr01

00-PRE ____ Post ____-yr01 ____-yr02 ____-yr05 ____-yr10 ____-yr20 Other: ____-yr____; ____-mo____

Phenological Stage: _____

(Circle One) Q4–30 m _w 0P–30P

Pnt	Tape	Hgt (m)	Spp; Species or Substrate Codes (tallest to lowest)					
1	0.3							
2	0.6							
3	0.9							
4	1.2							
5	1.5							
6	1.8							
7	2.1							
8	2.4							
9	2.7							
10	3.0							
11	3.3							
12	3.6							
13	3.9							
14	4.2							
15	4.5							
16	4.8							
17	5.1							
18	5.4							
19	5.7							
20	6.0							
21	6.3							
22	6.6							
23	6.9							
24	7.2							
25	7.5							
26	7.8							
27	8.1							
28	8.4							
29	8.7							
30	9.0							
31	9.3							
32	9.6							
33	9.9							
34	10.2							
35	10.5							
36	10.8							
37	11.1							
38	11.4							
39	11.7							
40	12.0							
41	12.3							
42	12.6							
43	12.9							
44	13.2							
45	13.5							
46	13.8							
47	14.1							

Date Entered: ____ / ____ / ____

Pnt	Tape	Hgt (m)	Spp; Species or Substrate Codes (tallest to lowest)					
48	14.4							
49	14.7							
50	15.0							
51	15.3							
52	15.6							
53	15.9							
54	16.2							
55	16.5							
56	16.8							
57	17.1							
58	17.4							
59	17.7							
60	18.0							
61	18.3							
62	18.6							
63	18.9							
64	19.2							
65	19.5							
66	19.8							
67	20.1							
68	20.4							
69	20.7							
70	21.0							
71	21.3							
72	21.6							
73	21.9							
74	22.2							
75	22.5							
76	22.8							
77	23.1							
78	23.4							
79	23.7							
80	24.0							
81	24.3							
82	24.6							
83	24.9							
84	25.2							
85	25.5							
86	25.8							
87	26.1							
88	26.4							
89	26.7							
90	27.0							
91	27.3							
92	27.6							
93	27.9							
94	28.2							
95	28.5							
96	28.8							
97	29.1							
98	29.4							
99	29.7							
100	30.0							

Species observed within ____ m of either side of the transect but not intercepted: _____

**Vegetation Monitoring Procedure for the
Southern Plains Grassland Protocol**

SOP #07: Shrub Transect Procedures

Version 1.0
(April, 2011)

Revision History Log

Previous version #	Revision date	Author	Changes made	Reason for change	New version #

This Standard Operating Procedure explains the procedures that are performed to collect data in shrub belt transects. This SOP is adapted from the 2003 USDI-National Park Service Fire Monitoring Handbook.

Collect and Record Shrub Density Data

Record shrub density within a circle bisected by the point intercept transect. The diameter of this circle is 20 m, using the 25 m mark on the transect as the center point and with a 10 m radius. Count each individual having >50% of its rooted base within the circle. Use the Shrub density data sheet to record the data. You may divide the circle into sections (pie slices) to facilitate counts. For this protocol, it is not necessary to record the interval (Int). Record data by species (Spp), age class (Age), whether it is living or dead (L or D), and number of individuals (Num) of that species. Tally any change in species, age, or live-dead as a separate entry on the data sheet (e.g., ARTTRI, M, L, would be tallied separately from ARTTRI, M, D). Under age class, identify each plant as either an immature-seedling (I), a resprout (R), or as a mature-adult (M) (see definitions below). Shrub density data should also include data on subshrubs (primarily Cactaceae).

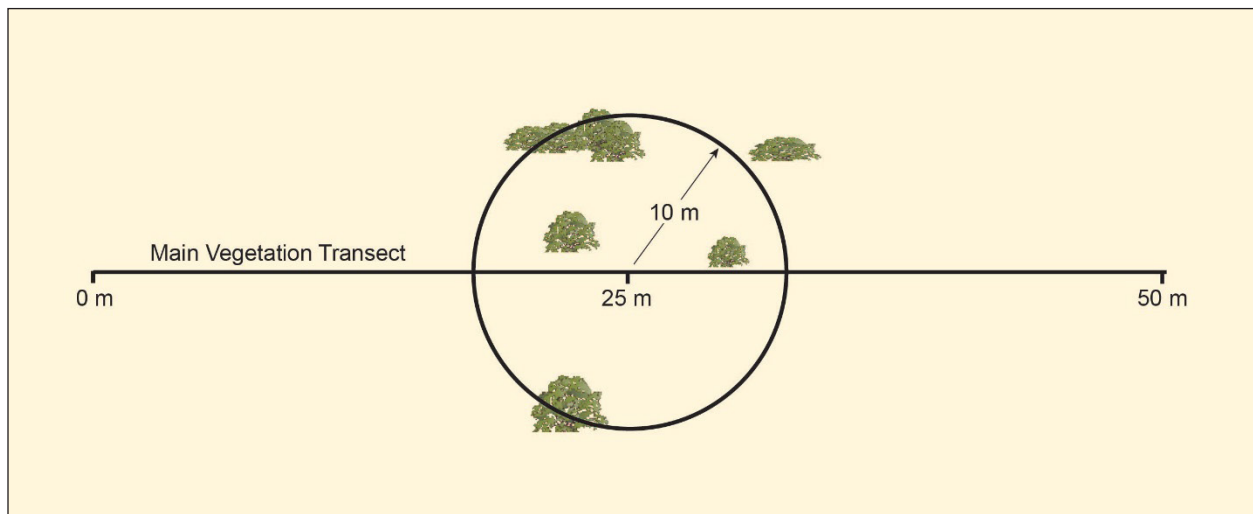


Figure 7-1.Plot layout for monitoring shrub density.

Definitions of Age Classes and Subshrub:

Immature/Seedling (Shrubs). An age class for shrubs without burls, that have emerged since the time of the last disturbance, or a shrub (with or without a burl) too immature to flower. This definition will vary by shrub, by ecosystem and by the time since the last disturbance.

Mature. An age class for shrubs able to produce flowers and seeds. Also called Adult.

Resprout. A shrub or seedling tree age class of shrubs or seedling trees that have resprouted after being top-killed by a fire or any other disturbance. Sprouting can be epicormic (from the stem) or basal (from the base of the plant).

Subshrub. Multi-stemmed woody plant species with a height of less than 0.5 m due either to genetic or environmental constraints. Also called dwarf shrubs.

Troubleshooting Shrub Data Collection

Dead burls

After dead burls have been counted at least once since dying, you can omit them from density sampling, but it may be useful to note them on the form in case they sprout again in another year.

Clonal or rhizomatous species

Shrub individuals may be very difficult to define in some species, and monitors may get very different numbers depending on their perception of what an individual is. Relative or percent cover may be a more accurate way to describe these species. However, it may be appropriate to count something other than the individual in this case, e.g., a surrogate plant part such as culm groups, inflorescences, or stems.

Examples:

Arctostaphylos spp. stems are often easy to trace to a basal burl. This usually defines the individual. The “burl unit” may be an appropriate delineator of individuals, even when two or more individuals have grown together.

Rubus spp. are often rhizomatous, making it difficult to distinguish an “individual.” The recommended response for dealing with rhizomatous or clonal species is to ignore these species when you collect shrub density data. Note: If these species are ecologically significant (e.g., for wildlife habitat), count stem density instead of individual density. The “stem unit,” in this case, becomes the basis for quantifying density.

The usefulness of these surrogates depends on the biological significance of changes within these surrogates. Consult with the project manager before you use a surrogate, or omit a species from shrub density sampling. Note any species for which you plan to use surrogates, or omit from monitoring.

Resprouts

Once a disturbance has caused a plant to die back and resprout, the plant should be considered a resprout for the first year, and then an immature until it is once again reproductive (mature).

**Vegetation Monitoring Procedure for the
Southern Plains Grassland Protocol**

SOP #08: Fine Fuel Load Sampling

Version 1.0
(April, 2011)

Revision History Log

Previous version #	Revision date	Author	Changes made	Reason for change	New version #

This sampling protocol is used to estimate fine fuel loading (standing biomass and litter) on a dry weight basis. The fuel loading is sampled by individually clipping and weighing forbs, grasses, subshrubs and litter of the vegetation community and expressed in tons acre⁻¹ or kg hectare⁻¹. The primary use of this data is as variable to model fire behavior and as an indicator of ecosystem recovery following fire disturbance. This provides a measure of how quickly fine fuel accumulates (standing biomass and litter) to levels observed prior to burning or some other disturbance that alters above ground biomass such as grazing or drought. Generally, sampling is conducted without regard to species composition but by life form. Species composition is obtained from nested frequency or point intercept data.

Equipment Needed:

For the field

- Sheers: Suggested Corona Forged Thinning Shear Model number FS 4350



- 2- Bundles of Paper Grocery Bags (500): 9-3/4 x 6-1/4 x 16-3/8" (Available online from GSAAdvantage.
- 4 - 6 Black Markers (for labeling bags)
- 3 - 0.25 m² Square Frame: Frame is constructed of 1/2 inch schedule 40 pvc pipe with the inside dimensions of 50 cm x 50 cm.
- 1 - 50-m Tape: For collecting fine fuel loading data and runs parallel to the permanently marked vegetation transect (Nested frequency or Point-Intercept).
- 2 - 30-m Tapes: Used to measure the 10 m offset distance from the permanent vegetation transect at 0 and 50m.
- 2 - 3 100g Scale (i.e. Pesola Micro-Line Spring Scale, 100g x 1g)
- 2 - 2 300g Scale (i.e. Pesola Medio-Line Spring Scale, 300g x 2g)
- 2 - 600g Scale (i.e. Pesola Medio-Line Spring Scale, 600g x 5g)
- 2 - Staplers for closing sacks retained for drying.
- 2 - PDAs (HP Ipaqs or Trimble Nomads)

For the lab:

- 1 - Electronic Balance measure two decimal places
- 1 - Bench Top Drying Oven: Must be able to be set to 100°C (212°F)

Preparing for the Field

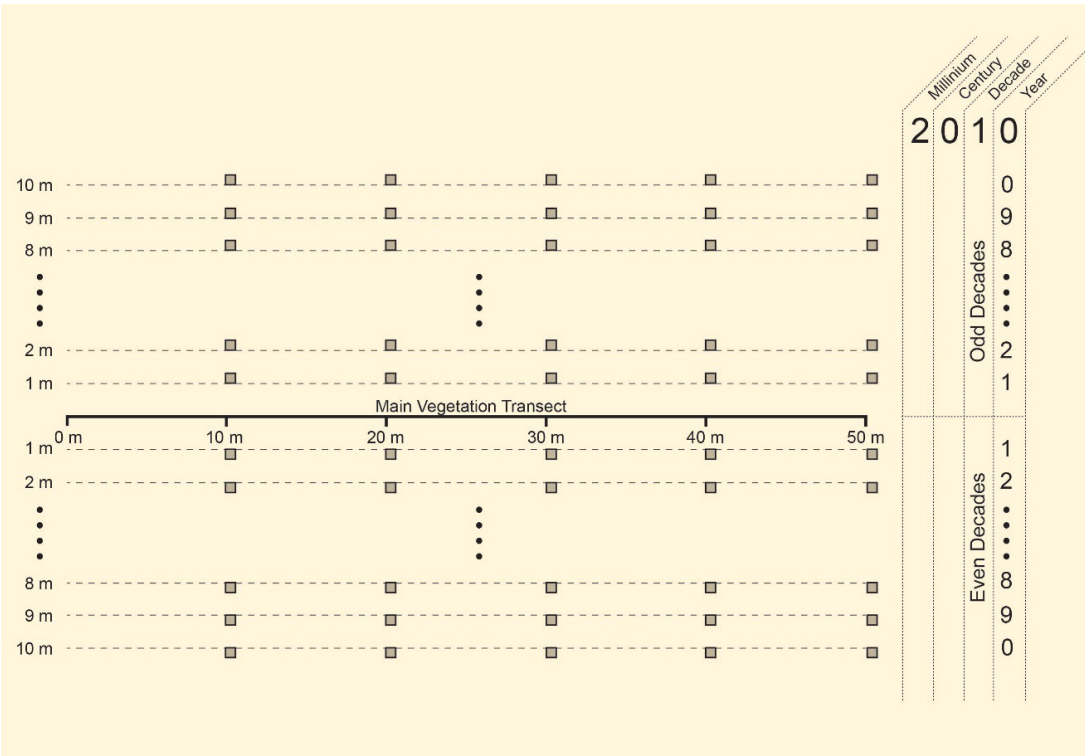
Prior to going to the field label the paper sacks in which biomass samples are to be returned to the office for further processing. There should be two samples per transect of grasses, forbs, subshrubs (Gutierrezia sarothrae, etc) and litter. The label should contain:

- the park code,
- the date,
- the transect number,
- the location along the transect from which the sample was taken, 20 or 40 meters, and
- contents of sack: grasses, forbs, subshrubs or litter.

Ten empty sacks should be dried at 100°C (212°F) for 24 hours and weighed on an electronic balance to obtain a mean tare weight for each of the sack sizes used. If possible be consistent in the size of the sack used when sampling a transect. Record the tare weight in the FFL spreadsheet. A copy of this spreadsheet will be loaded onto the pda (Trimble Nomad of HP IPaq) for field entry. Extra blank sample sacks should be taken for quadrats with large samples. These sacks should be labeled accordingly and the number of the sack with the total number of sacks used per sample for example 1 of 2, 2 of 2, etc. If the sample is being discarded fill as many bags as needed, weigh each bag as they are filled; don't wait until all the bags are full. Enter values and then discard the sample. Keep the sacks for further use.

Transect Placement

The fine fuel load (ffl) transect is offset and parallel to the permanent vegetation transect and can be placed on either side depending if it's an odd or even decade (the third number in the year i.e 20[1]1). The origin (0P) of the ffl transect is on the same end as the vegetation transect. The offset distance varies annually to avoid clipping the same area from year to year. The offset distance ranges from 1 to 10m depending on the last number of the year. So for 2011 the offset is 1m, for 2015 it would be 5m and 2020 it would be 10m (0=10m). If the third number of the year is odd the ffl transect is placed on the left side of the vegetation transect (standing at transect origin (0p) and facing the end of the transect 50p) and if it's even, on the right side. So for the decade 2010 to 2019, the third number, being odd, dictates that sampling occur on the left side. In the next decade, 2020 to 2029, the third number is even, therefore sample on the right side. Following this pattern an area is not sampled more than once every twenty years. Refer to Figure 8.1 for transect/quad diagram.



Quadrat Placement

The 0.25m2 quadrat frame (50cm x 50cm) is placed at five locations at 10m meter intervals along the 50m ffl transect; at 10 to 10.5m, 20 to 20.5m, 30 to 30.5m, 40 to 40.5m, and 50 to 50.5m. When the third number in the year is odd, the quadrat is placed on the left side of the ffl transect and when even, on the right side, similar to placement of the fine fuel transect.

Figure 8.1. Transect/quadrat placement diagram for Fine Fuel Loading sampling.

Sampling

Prior to sampling, it may be necessary to reweigh the sample sacks to determine if there is a departure (+1g for small sacks and +2g for large sacks) from the tare weight on the ffl spreadsheet on the pda. If there is, reweigh 10 empty sacks in the field, determine the mean and replace the wet mean lab tare weight with the new field wet tare weight. It may be necessary to frequently check (30 minutes to an hour) sack tare weights, particularly when the relative humidity is high.

Clip all grasses, forbs and subshrubs rooted within the 0.25m² quadrat frame to within 1 cm of the soil surface. Clip, bag and weigh subshrubs first, forbs second and, grasses third. Standing dead from previous growing season is sampled with the current years standing biomass. Pick up as much litter as possible with as little soil as possible. Cacti are not clipped. Once sack is filled, do not wait too long before weighing the sample (>5 min). Enter the value into the pda on the ffl excel spreadsheet. Samples collected at 10, 30 and 50m are discarded after the weights are recorded. Samples from 20m and 40m are retained to determine moisture content when processed in the lab. The sacks are sealed by folding and stapling the top closed. Use additional sacks as needed.

Sample Processing

Two samples from the transect, 20m and 40m, are retained for further processing to account for the moisture in the field weighed samples in order to express fuel loadings on a dry weight basis. This is obtained by oven drying the retained samples for a minimum of 24 hours at 100°C. After 24 hours the samples are removed from the oven and weighed on the electronic balance and the values are entered in the ffl spreadsheet. Within the spreadsheet the oven dry weight is then divided by the wet (field weight) minus the tare weights to obtain the moisture correction factor (mcf) for each sample.

$$\text{Moisture Correction Factor} = \frac{\text{Dry wt} - \text{Tare wt}}{\text{Wet wt} - \text{Tare wt.}}$$

The two samples for each transect are then averaged so that one mfc is obtained for grasses, one for forbs, one subshrubs and one for litter. Each mfc is then multiplied by the five samples along the transect so that the fuel load is expressed on a dry weight basis for the four fine fuel components: grasses, forbs, subshrubs and litter. Once the five samples have been corrected they can then be averaged resulting in one mean value for grasses, forbs, subshrubs and litter for the transect, which can then be summed to obtain a total fine fuel loading in grams per 0.25m². This value is converted to kg per hectare by the following equation

$$kg\ ha^{-1} = \left(\frac{x\ g}{0.25m^2} \right) \times \left(\frac{10,000m^2}{1ha} \right) \times \left(\frac{1kg}{1000g} \right)$$

where:

x = the moisture corrected average fuel load values.

g = grams

kg = kilograms

ha = hectares

m^2 = meters squared

And into tons per acre by the following:

$$t\ ac^{-1} = \left(\frac{x\ kg}{1.0\ ha} \right) \times \left(\frac{0.001102\ t}{1.0\ kg} \right) \times \left(\frac{1.0\ ha}{2.471\ ac} \right)$$

where:

x = the fuel loading values in kg per ha.

t = tons

ac = acres

kg = kilograms

ha = hectares

**Vegetation Monitoring Procedure for the
Southern Plains Grassland Protocol**

SOP #09: Collecting Fuels Data

Version 1.0
(March, 2011)

Revision History Log

Previous version #	Revision date	Author	Changes made	Reason for change	New version #

This Standard Operating Procedure explains the procedures that are performed to collect data in shrub belt transects. This SOP is adapted from the 2003 USDI-National Park Service Fire Monitoring Handbook.

On all monitoring plots, measure dead and detached woody fuel as well as duff and litter depths. These measurements are taken along fuel inventory transects, which must be relocatable to allow evaluation of postburn fuel load. Transects extend in random directions originating from the main transect at 10, 20, 30, and 40 m. Unlike herbaceous transects, fuel load transects can cross each other (Brown 1996). Each transect length is 50 ft.

Lay out the appropriate length tape along the transect in a random direction. Place a labeled tag at each end of the transect. Measure the percent slope of the transect (from end to end) in percent.

Working along the transect, tally each particle intersected along a preselected side of the tape, categorized by size class. Measurement of all particles is taken perpendicular to the point where the tape crosses the central axis (Figure 9.1). Count intercepts along the transect plane up to 6 ft from the ground. Count dead and down woody material, but not cones, bark, needles and leaves. Do not count stems and branches attached to standing shrubs or trees (Brown 1974; Brown and others 1982). For additional details on tallying downed woody material, refer to the notes on the reverse side of the Forest Plot Fuels Inventory Data Sheet.

Differentiate between 3 in (or larger) diameter particles that are sound and those that are rotten. Rotten wood is that which is obviously deteriorating or punky. Measure the particle diameter to the nearest 0.5 in with a diameter tape or ruler. Ignore particles buried more than halfway into the duff at the point of intersection. Visually reconstruct rotten logs as a cylinder and estimate the diameter. This reconstructed diameter should reflect the existing wood mass, not the original sound diameter.

Take depth measurements for litter and duff at 10 points along each fuel transect—that is at 1, 5, 10, 15, 20, 25, 30, 35, 40, and 45 ft. Do not take measurements at the stake (0 point); it is an unnatural structure that traps materials. At each sampling point, gently insert a trowel or knife into the ground until you hit mineral soil, then carefully pull it away exposing the litter/duff profile. Locate the boundary between the litter and duff layers. Vertically measure the litter and duff to the nearest tenth of an inch. Refill holes created by this monitoring technique. Do not include twigs and larger stems in litter depth measurements. Record the above dead and downed fuel data on the Forest plot fuels inventory data sheet

Table 9-1. Suggested lengths of transect lines to tally fuels by size class.

Size Class	Suggested Length
0-0.25" (0-0.62 cm) diameter (1 hour)	tally from 0-6 ft
0.25-1" (0.62-2.54 cm) diameter (10 hour)	tally from 0-6 ft
1-3" (2.54-7.62 cm) diameter (100 hour)	tally from 0-612ft
>3" (>7.62 cm) diameter (1,000 hour)	measure each log from 0-50 ft

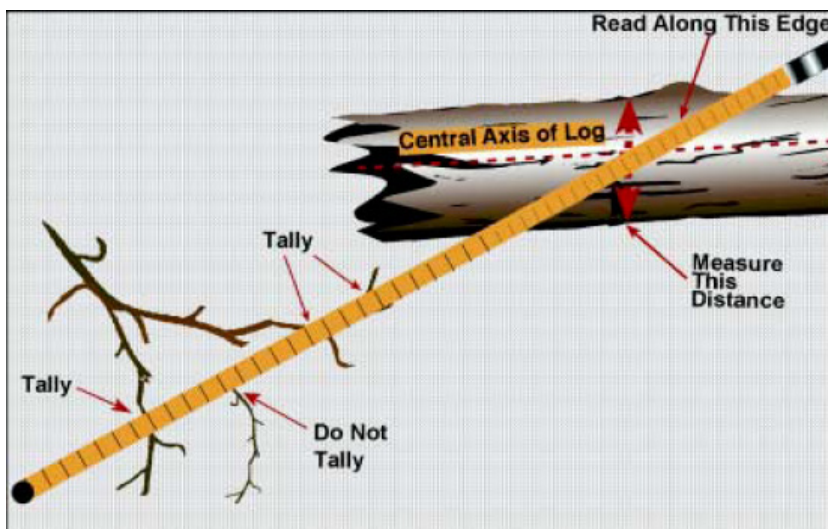


Figure 9.1. Tally rules for dead and down fuel. Count all intersections, even curved pieces. All intersections must include the central axis in order to be tallied.

When an Obstruction is Encountered Along the Fuel Transect

If the fuel transect azimuth goes directly through a rock or stump, in most cases you can run the tape up and over it. If the obstruction is a tree, go around it and pick up the correct azimuth on the other side. Be sure to note on the FMH-19 on which side of the bole the tape deviated so that it will be strung the same way in the future.

Occasionally moss, a tree trunk, stump, log, or large rock will occur at a litter or duff depth data collection point. If moss is present, measure the duff from the base of the green portion of the moss. If a tree, stump or large rock is on the point, record the litter or duff depth as zero, even if there is litter or duff on top of the stump or rock. If a log is in the middle of the litter or duff measuring point, move the data collection point 1 ft over to the right, perpendicular to the sampling plane.

**Vegetation Monitoring Procedure for the
Southern Plains Grassland Protocol**

SOP #10: Management of Unidentified Taxa (Unknowns)

Version 1.0
(March, 2011)

Revision History Log

Previous version #	Revision date	Author	Changes made	Reason for change	New version #

This global standardized operating procedure (GOP) gives step-by-step instructions on how to collect field samples, enter unidentified taxa (referred to hereafter as “unknowns”) into the protocol database and how to edit the records once the unknowns have been identified. This SOP will also provide directions on how to manage the unknown records created in the protocol’s field database species list.

1. Collect field sample of unknown plants

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 transect, 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 transect. Collect a sample of the plant with leaves, flower and/or fruit, place it in a press or field notebook, attach a sample label it and fill in the requested information. Assign an unknown code that is unique from all other unknown codes in the park. This specific code will be used whenever the same plant is encountered again during monitoring in that park

2. Assign/create an unknown taxonomic record

Use the attached Unknown Plant Species Tracking Log to manage the record number assignments and identification of unknowns. When digital data entry is performed in the field on a laptop computer, the field crew will need to add codes for these unknowns to the database species list. The field crew assigns a code that has meaning only to the field crew to each unidentified taxon (e.g., UNKWHITEFLOWER for an unidentified plant with white flowers). Suspected Family or Genus names and/or numbers may also be used. The same assigned code is used for every record of each unknown taxon entered into the database.

3. Identify unknowns from the field

As soon as possible following collection, the field crew identifies the unknowns collected from the field. When possible, digital scans of the fresh specimen should be made at 600 dpi to preserve the specimen’s identifying features. Scans should be labeled as PARKCODE_UNKCODE_DATE(mmddyyyy). Further identification is done either at the network office with the assistance of the plant ecologist or at the local approved herbarium.

4. Edit the unknown taxonomic records

4.1. Unknowns identified to species (or sub-species)

- 4.1.1. The species matches an existing record in the protocol's species list – Go to step 4.1.4.
- 4.1.2. The species does not exist in the protocol's species list – Go to step 4.1.3.
- 4.1.3. Add the appropriate scientific nomenclature and associated information for the new species into the database species table.
- 4.1.4. Use the *Edit* function in the protocol database to change the field-assigned unknown code to the correct species code.
- 4.1.5. Notify the project lead that the Field database is ready to be appended to the Current database.

4.2. Unknowns identified to general unknown categories

- 4.2.1. Use the *Edit* function in the protocol database to change the field-assigned unknown code to the general unknown code already available in the protocol database (*e.g.*, UNKSHR for an unknown shrub).
- 4.2.2. Notify the project lead that the Field database is ready to be appended to the Current database.

5. Manage the protocol species list

This section will be written when SQL Server is up and running.

Datasheet Version: 1.0

Edits to Copies date: _____

Location and Event Information

Park Code:		Date (mm/dd/yyyy):	
Plots/Polygons/Transect:			Observer Name(s):
Protocol Name: Multi-Network Exotic Plant Monitoring		Protocol Version: 1.0	

[illegible]

Park Code:		Date (mm/dd/yyyy):	
Plots/Polygons/Transect:			Observer Name(s):
Protocol Name: Multi-Network Exotic Plant Monitoring		Protocol Version: 1.0t	

[illegible]

Scientific Name:	
MorphoName:	Collector:
Park:	Date:
Site:	Tran./sub.:
Elevation:	Aspect:
Habitat/Associates:	
Habit:	
Flower/Fruit:	
Root:	
Notes:	

Scientific Name:	
MorphoName:	Collector:
Park:	Date:
Site:	Tran./sub.:
Elevation:	Aspect:
Habitat/Associates:	
Habit:	
Flower/Fruit:	
Root:	
Notes:	

Scientific Name:	
MorphoName:	Collector:
Park:	Date:
Site:	Tran./sub.:
Elevation:	Aspect:
Habitat/Associates:	
Habit:	
Flower/Fruit:	
Root:	
Notes:	

Scientific Name:	
MorphoName:	Collector:
Park:	Date:
Site:	Tran./sub.:
Elevation:	Aspect:
Habitat/Associates:	
Habit:	
Flower/Fruit:	
Root:	
Notes:	

**Vegetation Monitoring Procedure for the
Southern Plains Grassland Protocol**

SOP #11: Collecting Plant Voucher Specimen

Version 1.0
(March, 2011)

Revision History Log

Previous version #	Revision date	Author	Changes made	Reason for change	New version #

This document details the appropriate collection and curation protocol for voucher specimen collections made in the course of research activities conducted by the Integrated Southern Plains grassland monitoring team. Plant collections provide primary documentary evidence for the presence of a vascular plant species at the park unit. This document details the appropriate protocol for voucher specimen collections from collection in the field, through identification, to curation at appropriate herbaria.

Field Data Collection

Voucher specimen collection is a necessary component of any integrated data collection system for research on vascular plants. For Southern Plains researchers, this includes voucher specimen collections made in the course of grassland monitoring, vegetation mapping, and opportunistic collection efforts conducted at park units. Prior to any collection effort, appropriate collection permits must be obtained for each park by the Project Manager and carried in the field by the crew leader.

Voucher Specimens

Voucher specimens are to be collected at the discretion of the field research crews. All crews have appropriate equipment to make voucher specimen collections, including a field press and newspapers for specimen collection, GPS device for location information, and sufficient data sheets. Crews will follow this procedure for collecting plants:

1. Identify the plant as best as possible in the field, taking care to note if it is potentially rare, threatened or endangered. Potential T&E plants should not be collected. These plants should be photographed (see SOP #04) and precise location should be recorded. The 10% rule should always be observed in the collection of all plants, such that no entire plant should be collected if there are fewer than 10 specimens in the immediate vicinity.
2. Care should be taken to obtain flowers, fruits, and roots as practicable.
3. Using a single fold of newspaper per plant, the specimen should be laid out and arranged to display all floral parts for ease of future identification. Arrangement should take care to have half the leaves up and half down, resemble actual plant architecture (where appropriate given size limitations) and carefully open flowers so that all floral parts are visible upon drying. Each newspaper should be labeled with the best guess of specimen identification, the date, park code, and collector initials.

4. Fill out the Voucher Specimen Documentation Form in its entirety using pencil. Record the plants identity, all appropriate location information using UTM coordinates, elevation may be in feet or meters, and note the plant's status in the park, and whether you took a photo. Additionally, take care to fill out habitat description as clearly as possible, referring to both community type and associated species. This form remains with the specimen.

Care of Voucher Specimens post-collection

Appropriate handling of voucher specimens does not end with collection in the field. At the earliest practical opportunity, those collections that have been made using a field press need to be transferred to an appropriate herbarium press for further drying and curing of the specimen. At the time of transfer, if no firm identification of the specimen has been made, another attempt at identification should be made using appropriate floras and literature. This identification (if different than the field identification) should replace the original on the form, do not consider this an annotation, but note the determiner (if different from the collector) in the appropriate field on the data sheet. Properly secure the specimens and allow them to cure. Upon return to the office, notify the SOPN botanist of the collections that have been made for transfer to the herbarium and once the plants are dried and ready for transfer place in the herbarium cabinet in the office.

From Field Collection to Herbarium

Upon receipt of the specimens, the SOPN botanist will verify the collections and identifications prior to their transfer to the appropriate herbarium of record. The following procedures will be followed once the specimens are transferred to the herbarium:

1. Obtain the vouchering protocol from the appropriate herbarium and follow all instructions.
2. The collections are packaged appropriately and placed in the freezer to guard against insect infestation. This process takes a minimum of a week.
3. At the completion of the freezing process, the specimens are removed and placed on SOPN/NPS holding shelves. If further identification of unknowns is necessary, at this point an effort is made by SOPN botanists to clarify and identify all specimens. All those specimens deemed of insufficient quality are discarded.
4. All satisfactory specimens are then given to herbarium staff for verification of identity. All verification and annotation (if necessary) take place prior to accessioning into the appropriate herbarium collection and NPS cataloging. Once verification has taken place, all specimens will be collected by SOPN staff and sorted into park-specific batches.
5. All specimens that have received appropriate NPS catalog numbers will then be accessioned into the herbarium collection. All labeling of these specimens will utilize appropriate NPS labels which prominently bear the arrowhead logo and the NPS catalog number.
6. As per the loan agreement, specimens will remain at the herbarium for the duration of that agreement.

**Vegetation Monitoring Procedure for the
Southern Plains Grassland Protocol**

SOP #12: Crust Friendly Field Procedures

Version 1.0
(April, 2011)

Revision History Log

Previous version #	Revision date	Author	Changes made	Reason for change	New version #

This Standard Operating Procedure explains the procedures that are implemented when Biological Soil Crust (BSC) is encountered in and around monitoring plots. BSC is an important system component of the Southern Plains. BSC plays a critical role in nitrogen fixation, and in soil stability. BSC is easily destroyed through trampling, and the relatively long regeneration time of well-developed crust (maybe as long as a century) is problematic. Southern Plains monitoring efforts must exercise considerable effort to minimize ‘crust busting’ for several reasons. First, park values in general must not be compromised by monitoring efforts. Second, on-plot destruction of crust can impact the validity of the monitoring data – that is, monitoring information is undermined by the effects of monitoring. The latter introduces bias and provides a false representation of ‘natural’ system dynamics. The latter, of course, is what monitoring is intended to observe. The following procedures were adapted from those used by USGS researchers working in the Colorado Plateau. All crew members must become familiar and follow these procedures.

Walking into a monitoring plot.

Footprints last a long time in the semi-arid grassland systems of the Southern Plains. Walking the same route from a road or trail to a monitoring plot can quickly create the appearance of an ‘established’ trail. Park visitors tend to gravitate to such trails and over time, the plot-access route can become heavily trampled. Additionally, such trails increase the chance of monitoring-plot disturbance by visitors, which is always to be avoided.

- To avoid trail development always use a separate route to and from a monitoring plot where your footprints will create a noticeable trail.
- When traversing to and from a monitoring plot, select a route that crosses slick rock or other large rocks than can be used as stepping stones, and in washes. Tracks in the latter will be erased during the next rain storm. At all times, avoid stepping on crust, no matter the developmental stage.
- When walking on soil, only leave one set of footprints. That is, walk in single file and step in the footprints of preceding crew member(s).

Walking on a monitoring plot.

Site evaluation, site establishment, and measurement procedures require crew members to restrict their impact to specific areas on a plot.

- When walking around the plot select a pathway that optimizes stepping on rock, dead vegetation, and washes. If these features are not available, walk at least 20-m away from the edges of the plot.

- Avoid huddling with other crew members to look at the GPS unit, to look at an unknown plant species, when taking a break from the afternoon sun, etc.
- During plot set-up and measurements, carry your water bottle and other necessities with you so a trip across the plot to reach your backpack is not necessary.
- Always leave one set of footprints by walking in existing footprints.
- Measurement procedures described in other SOPs are designed to minimize leaving the area along the transect. For example, closer inspection of species occurring at the outer-edge of a quadrat can be accomplished by leaning over the quadrat, or using stepping-stones afforded by rock or dead plant material.

Re-measuring a monitoring plot

If soil disturbance due to previous visits is extreme, note this on the site-impact form, photograph the disturbance (if possible without walking onto the plot), do not re-measure the plot, and immediately report the disturbance to the Principle Investigator. Extreme disturbance is where soil erosion originating from previous footprints is noticeable, or where deep furrows with loose soil were obviously created from previous trampling. The plot will either be rested before consideration for re-measurement, or abandoned to avoid further degradation. Detailed description and pictures will be useful to determine the proper course of action.

**Vegetation Monitoring Procedure for the
Southern Plains Grassland Protocol**

SOP #13: Daily Data Management

Version 1.0
(April, 2011)

Revision History Log

Previous version #	Revision date	Author	Changes made	Reason for change	New version #

This document outlines the specific daily data management tasks for all data collected in the field for this protocol. This includes tabular data, spatial data and photographs. Storage locations are suggested.

Compile data sheets

- Data sheets are compiled, organized by transect and placed into a manila folder labeled “PARK_YYYYMMDD”
- If some data is collected electronically, use the database print out function to generate paper sheets for these and store with other datasheets.
- Verify all datasheets complete and attempt to verify any unknown plants. Adjust datasheets and database as needed.
- Scan datasheets into a .pdf file for each transect, named “PARKlast 2 digits of year + Transect name” and stored on computer in Park/ PARKlast 2 digits of year_Data.
- If needed, additional hard copies of data sheets can be made and stored in a separate location.

Scan Unknown Plant samples

- At the end of every field day any unknown plant samples collected must be scanned at 600dpi resolution. Freshness of the sample scanned is paramount to future identification efforts. Refer to SOP #10 for more instruction.
- Scan each sample separately and save as a .jpeg file. Name each file “PARKlast 2 digits of year + Unk #” and stored on computer in Park/PARKlast 2 digits of year_Unks.
- Scotch tape each sample to its notation sheet and place into a manila folder labeled “PARK_YYYYMMDD_Unks”.

Transfer photos

- Photos are transferred onto computer (en masse) and each labeled “PARKlast 2 digits of year_TransectName_CodeDesignation(as follows)” .

<u>Subject</u>	<u>Code Designation</u>
1. From 0P toward 50P	0P-50P
2. From 50P toward 0P	50P-0P
3. From 0P toward reference feature	0P-REF
4. From reference feature toward 0P	REF-0P

For example, SAND10_ULAND-LT02_50P-0P. Refer to SOP #4 for more details.

- Photos are stored on computer in Park/ PARKlast 2 digits of year_PlotPhotos.

Electronic data entry - Backup MDB

- If data is collected electronically in the field using laptops or other units, place a copy of the most recent database backend or other file type (excel) used in the field (FIELD_YYYYMMDD) – with the date distinguishing beginning of current field tour, into the appropriate folder on an external hard drive or computer for back-up.
- At end of work week (once back in office) transfer all files to the network server and notify project lead or data manager of status. If using a database ‘field copy’, this should be appended into the current version of the parent database. All files should also be copied onto the appropriate FTP site and Project Manager(s) notified of data upload.

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National Park Service
U.S. Department of the Interior



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