

# **Chihuahuan Desert Small Mammal Exclosure Study Vegetation Quadrat Field Data Collection Procedures**

## **Jornada Basin LTER**

Last Updated: 3/5/2004 by Dara Parker

### **I. STUDY SITE AND EXPERIMENTAL DESIGN DESCRIPTION**

A creosote shrub study site and a black gramma grassland study site have been established at each of the Sevilleta, Jornada and Mapimi research locations. Each study site is 1 km by 0.5 km in area. Three rodent trapping webs and four replicate experimental blocks of plots are randomly located at each study site to measure vegetation responses to the exclusion of small mammals (see the photocopied map) for diagrams of the two Jornada sites). The blocks of study plots are oriented on a site in an X/Y coordinate system, with the access road to each site forming the X axis. The Jornada grassland site is oriented to the north, and the Jornada creosote site is oriented to the south. Treatments within each block include one unfenced control plot (Treatment: C; control), one plot fenced with hardware cloth and poultry wire to exclude rodents and rabbits (Treatment: R; rodent), one plot fenced only with poultry wire to exclude rabbits (Treatment: L; lagomorph), and one plot fenced with barbed wire to exclude cattle (Treatment B; bovine). Note that there are cattle exclosure plots only at the Jornada grassland site where cattle are present, for a total of 4 measurement plots at each of the grassland site blocks. There are no bovine exclosure plots at the creosote site, and so there are only 3 measurement plots at each of the creosote site blocks. The treatments were independently randomly assigned to each of the four possible plots in each block; their arrangements differ from block to block. Plots in a replicate block are separated by a 20-meter buffer zone (see the diagram on the back of the laminated Quick Reference Sheets).

Each experimental measurement plot measures 36 meters by 36 meters. A grid of 36 sampling points is positioned at 5.8-meter intervals on a systematically located 6 by 6 point grid within each plot. A permanent one-meter by one-meter vegetation measurement quadrat is located at each of the 36 points. The 36 quadrats are numbered 1-36, starting with number 1 in the top left corner of each plot, and running left to right, then down one row, and then right to left, and so on in a snaking pattern. A 2-foot high rebar marks the lower right corner of each quadrat, and an aluminum tag on the rebar gives the quad number. Three inch nails were originally placed in the top left corner of each quadrat to mark the far corner of the quadrat, but many have been replaced with 6 inch whole gutter spikes. A 3-meter wide buffer area is situated between the grid of 36 points and the perimeter of each plot.

### **II. WORKING ON THE STUDY PLOTS**

Always avoid walking on the quadrats. Do not walk across plots or anywhere within a block unless absolutely necessary, as we are attempting to measure the effects of rodents and rabbits on plants and soils, not the effects of humans. When working on a plot, always walk on a line just below or to the right of the rebar and quadrats (see dotted lines in Figure). Please try to walk gently and flat-footed on the study plots to minimize soil disturbance. When placing the vegetation measurement frame on a quadrat, be careful not to disturb the soil with the frame legs or your feet. When leaning over the measurement frame, be careful not to put your foot on the quadrat. *We must measure all human-caused disturbances to the soil surface of each quadrat.*

Walt Whitford has also installed soil disturbance study areas in the plots. In each plot, the soil disturbance study subplot is located in the upper left corner of the plot, stretches approximately halfway down the left side, and is delineated visually by flags. Do not walk on these areas. Be especially careful when entering plots and measuring quadrats 1, 12, and 13 as they are immediately adjacent to the soil areas. The subplots are delineated by pinflags on each corner, most of which no longer have the plastic flag attached.

### III. VEGETATION QUADRAT MEASUREMENTS

The foliage canopy area and maximum height of each plant species, live and dead, are measured in each quadrat. Several other variables are also measured in each quadrat, including soil surface disturbance, soil surface leaf litter cover, soil surface cryptogam crust cover, rabbit feces, and termite mud casings. All cover values are measured using the vegetation measurement frame, which is 1 meter by 1 meter and partitioned into a grid of 100 10 cm by 10 cm squares. Cover is measured by counting the number of 10 cm squares that are occupied by the foliage canopy of a particular plant species, or by the soil disturbance, leaf litter, etc. Portions of the 10 cm squares are also measured, down to 0.1 of a square. Detailed descriptions of measurement techniques are given below for each of the different variables measured.

### IV. PLACEMENT OF THE VEGETATION QUADRAT MEASUREMENT FRAME

Walk from quadrat to quadrat along the lines mentioned above. When you reach a quadrat, place one leg of the frame immediately next to and touching the 2-foot rebar, over the quadrat. Place the leg for the opposite corner of the frame (from bottom to top of a diamond shape) just inside of the 3 inch nail or 6 inch gutter spike located at a 315 degree angle from the rebar on the plot's X/Y and compass coordinate system (the top of the diamond). The frame should be positioned so that the sides are parallel to the sides of the plot, directly over the quadrat, and in line with the rows of rebar (see Figure 4). You may not be able to see the nail. If not, line the sides of the frame with the rows of rebar as accurately as you can and make a written note of the quad number so that the nail can be replaced during the next round of maintenance activities. Many of the old nails have been replaced by 6 inch white gutter spikes, and any quads that have old nails that are missing or are difficult to see should be noted and the nails replaced.

### V. RECORDING DATA

Each time you start recording data for a new plot (even if you are just helping someone else finish a plot), always start your recording by stating: "*These are vegetation quadrat measurements for the Jornada small mammal exclosure study.*" Then state your name, the date (month, day, year), the site (JG or JC), the block (1, 2, 3, or 4), the plot (1, 2, 3, or 4), and the treatment (C, R, L, or B). If you are helping someone else on a plot, state so, and record the name of whose plot you are working on. This information should also be given at the beginning and end of each side of a tape or voice file (so try to leave a little room at the end of a side of an analog tape). This makes it much easier for the data entry person to reference the tapes/voice files and find particular quads. Following are lists of which plots have been assigned to which treatments at each site.

#### Creosote Site

BLOCK 1 PLOT 2 TREATMENT C  
BLOCK 1 PLOT 3 TREATMENT R  
BLOCK 1 PLOT 4 TREATMENT L

BLOCK 2 PLOT 1 TREATMENT L  
BLOCK 2 PLOT 2 TREATMENT C  
BLOCK 2 PLOT 4 TREATMENT R

BLOCK 3 PLOT 1 TREATMENT L  
BLOCK 3 PLOT 3 TREATMENT R  
BLOCK 3 PLOT 4 TREATMENT C

BLOCK 4 PLOT 2 TREATMENT C  
BLOCK 4 PLOT 3 TREATMENT L  
BLOCK 4 PLOT 4 TREATMENT R

## Grassland Site

BLOCK 1 PLOT 1 TREATMENT B  
BLOCK 1 PLOT 2 TREATMENT C  
BLOCK 1 PLOT 3 TREATMENT R  
BLOCK 1 PLOT 4 TREATMENT L

BLOCK 2 PLOT 1 TREATMENT L  
BLOCK 2 PLOT 2 TREATMENT C  
BLOCK 2 PLOT 3 TREATMENT B  
BLOCK 2 PLOT 4 TREATMENT R

BLOCK 3 PLOT 1 TREATMENT L  
BLOCK 3 PLOT 2 TREATMENT R  
BLOCK 3 PLOT 3 TREATMENT B  
BLOCK 3 PLOT 4 TREATMENT C

BLOCK 4 PLOT 1 TREATMENT B  
BLOCK 4 PLOT 2 TREATMENT C  
BLOCK 4 PLOT 3 TREATMENT L  
BLOCK 4 PLOT 4 TREATMENT R

For each quadrat you will be taking measurements from, record the quadrat number (1-36) before you start recording data by stating "*starting quadrat (n)*". Note that (n) means whatever the appropriate number is. When you are finished recording data for that quadrat, state "*end quadrat (n)*." Then go on to the next quadrat, and so on. When you have finished collecting data from the plot, state "*End quadrat measurements on plot (n), of block (n), treatment (letter) at site (Jornada Creosote or Jornada Grassland) for (your name) on (the date including year)*."

## VI. ADDITIONAL OBSERVATIONS, CORRECTIONS, AND COMMENTS

Comments are useful if you are uncertain about something, see something unusual, are measuring dead plant material (see "Plant Foliage Canopy Cover and Height Values" section below), or have any additional information that would be useful when analyzing the data. If there is a comment that needs to be associated with a particular reading, record the reading as usual and then, at the end of the reading, state "*comment*," record whatever relevant information you have, and then state "*end comment*." Try to minimize use of comments, though. If necessary, you can make a comment that applies to the entire plot after the first quad that the comment is relevant to so you do not have to say it each time you encounter a similar situation. Be sure to clarify what quads the comment refers to if it applies to more than one quad.

At any time while you are recording a reading, if you realize that you just recorded incorrect data, simply state "*correction*" and then give the correct value. Always start corrections with the statement "*correction*" so the data entry person knows he/she will need to erase something. If you have already finished recording data for a variable (i.e. a particular plant species) but while looking over the quadrat later you find more to add to the reading, you may either make a correction to the previously recorded values, or make another observation. A correction should only be made if you cannot distinguish what had been measured already in the previously recorded reading from the new individuals that need to be included. In this case, state "*Correction on the reading for SPP XXXX; the reading should be SPP, cover (n), height (n)*," etc. However, it is much easier for the data entry person if a new observation is made that can simply be added to the previous observation after entry. So if it is possible to accurately measure, for example, newly discovered individuals in a separate reading, do so. On the tape/voice file, simply say that you have another reading for that species and record the second reading the way you would record any other reading.

Keep a written log of any corrections made to readings that were not done immediately after the incorrect number was stated. This makes it easier for the data entry person; it saves a lot of time if corrections are known in advance since corrections must be done in a separate program. However, if readings are simply being added, these do not have to be written in the log unless the additional readings are recorded after the quadrat has already been finished and another one has been begun. If there is a doubt as to whether something should be written down, write it!

If you are using an analog tape recorder, do not try to rewind the tape and record over mistakes, in order to ensure that no data will be recorded over and erased by accident.

## **VII. CHECKING YOUR ANALOG TAPE RECORDINGS AND VOICE FILES**

If you are using an analog tape recorder, frequently play back a small portion of your tape to verify that the tape recorder is working properly. Checking your tape after every quadrat is the best strategy. This way, if something happens, you do not need to re-measure more than one quad.

If you are using a digital recorder, make sure you can hear yourself in the headset each time you say a reading. Check at the beginning of each file that the recording is advancing as you speak, and that the HOLD button is on.

## **VIII. LABELING YOUR ANALOG TAPES AND VOICE FILES**

### **1. Analog Tapes**

Label your analog tape, both on the cardboard case insert and directly on the tape. Use the following format to label your tape: SMESVQxyy-zzn,

Where: SMES = Small Mammal Exclosure Study  
VQ = vegetation quadrat data  
x = season (S for Spring, F for Fall)  
yy = last two digits of the year  
zz = initials of person taking measurements  
n = the number of the tape. Tapes are numbered separately for each person.

For example, if Dave Lightfoot was taking measurements in the fall of 1996 and had already used one tape and was recording on his second, the tape would be labeled SMESVQF96-DL2. On the case insert also write down, for each side, the date, plot identification, and quadrat numbers for all quads measured by that person on that side of the tape. It is best to write this information down as you finish each plot, rather than when you finish measurements at a site.

### **2. Voice Files**

See the *Using the Digital Recorder* protocol.

Offload voice files into Techs\Study\Voice\SMES\YYYYSeason\JDBEPFTG,

Where: YYYY = year measurements were taken  
Season = season measurements were taken, spring or fall  
D = Creosote site or Grassland site  
E = Block number  
F = Plot number  
G = Treatment; C for control, R for rodent, L for lagomorph, or B for bovine.

At the beginning of each season, the first person to offload their data should create a new YYYYSeason folder with the appropriate subfolders. This can be done by copying the folder Techs\Study\Voice\SMES\BLANKSMESfolder. No data should be placed in this folder, in order to keep it as a template folder structure for each new season.

### 3. Recorder Notes

All notes on data recorded or maintenance needed, whether on analog or digital media, should be recorded in Techs\Study\Animal\SMESQUAD\RecorderNotes. To make a new form, copy SMESNOTESFORM.doc and save it as smesvqxyz.doc,

Where: smes = Small Mammal Exclosure Study

vq = vegetation quadrat data

x = season (s for spring, f for fall)

yy = last two digits of the year

z = initials of the people recording their notes in this file. For individuals, there should be two letters (first letter of first name and first letter of last name) and for all people who took measurements, use "all."

It is better for all people to have their notes in the same file, so "all" should be used for the initials in the file name most frequently. For example, if Dara Parker, Andrea Campanella, and Jamie Lamit were taking measurements in the spring of 2004, the tape recorder notes file would be named smesvqs04all.doc. If Dara Parker was doing the measurements alone, the notes file would be smesvqs04dp.doc.

## IX. PROCEDURES FOR VEGETATION QUADRAT MEASUREMENTS

Below is a thorough description of procedures, values, and ranges of values that you should follow and record for each of the variables measured on the vegetation quadrats.

**IMPORTANT NOTE!!!** Be sure to record an entry for all six of the following variables, even if the measurement or count is zero. So, for example, if there are no rabbit feces, record "*rabbit feces count zero*" or if there is no termite casing, record "*termite casing zero*," etc. If a variable is not recorded, in the future it would be impossible to tell if the value really was zero or if the person taking the measurements forgot about the variable and did not measure it. Get into a routine of examining each quadrat for each of the 6 variables in the same order each time. For example, start with plant cover, beginning with the dominant plant species, then look for leaf litter, then look for cryptogam, then look for soil disturbance, then look for rabbit feces, then look for termite casing. Going in the same order makes it less likely that you will forget to measure a variable and makes it easier for the data entry person to enter the data. It also helps identify the beginning and ends of quads in case, for example, you forget to state that you are beginning a new quad.

At the end of each plot or each day, cross off the quads you have measured on the Quad Checklist, which can be found at Techs\Study\Animal\SMESQUAD\quadchecklist.doc. With this type of tracking, we can make sure all quads are measured and no quads are measured twice.

### 1. Plant Foliage Canopy Cover and Height Values

All plant species are named according to the NPP protocol, except for YUELC, YUELL, and YUELI. These should all be named as one individual, YUEL. At the Creosote, call all Lesquerella LEGO and all Xanthocephalum XAMI. At the Grassland site, call all Lesquerella LEFE and all Xanthocephalum XASA. These identifications are based in IDs made by Dave Lightfoot in the lab during the first years of the study.

In the fall, all plant species are measured. In the spring, only annuals are measured. Even dominant perennial species are ignored in the spring. The only exception to this is LEFE, which is always read even though it is a perennial. It is best to read species in order of dominance and functional group. Measure the larger species first to minimize disturbance to plants that have not been measured yet.

For SMES, unlike NPP, dead plant material and live plant material should both be read, but in separate readings. In all cases, be sure to measure all plant material that is within the boundaries defined by the frame, whether it is rooted in the quadrat or is sticking in from a plant rooted outside the quadrat. Do not measure any part of any plant, regardless of where it is rooted, if it does not lie within the vertical boundaries of the quadrat. If a dead annual has died recently, and was clearly from growth this season, read it as live cover. The newly dead plants should be yellowish in color. If the dead annuals are from another previous season, then record them as dead cover. Those dead plants should be gray in color, except species like DEPI, ESME, etc. Use phenology knowledge to decide what grew when in these cases.

Read all plant species before moving on to the next variable. If there are no plants, live or dead, state "*Plants: NONE, N-O-N-E.*"

For plants, canopy cover is measured in terms of the number of 10-cm squares occupied by the species on the quadrat. You may record a value ranging from 0.1 to 100. For large cover values (5+), you should generally record in increments of 1.0 or 0.5. For small cover values (<5, and certainly <1) it is more appropriate to state values in increments of 0.1 or 0.5. Remember that your accuracy level generally decreases with increasing cover, and so should the precision of your measurement. Sum the cover values for all individual plants of a given species in the quadrat to get one overall cover value for that species.

There are some important differences between cover measurements for SMES and cover measurements for NPP besides the acceptable units of measurement. For SMES, do not duplicate overlapping canopies as is done for NPP readings, just record the total canopy cover on the horizontal plane when looking down on the quadrat through the grid, as if it were an aerial photograph. Also unlike NPP, OPVI, OPPH, and OPIM are read as normal cover, not as centimeter measurements of each pad. For YUEL, measure the cover for the plants as wholes. Do NOT measure YUELC, YUELL, and YUELI separately as would be done for NPP. Finally, in NPP each individual that in reality has a cover of less than 0.01 is considered to have a cover of 0.01. In SMES, this is not the case. If 5 individuals together make up a 0.01 and there are 50 individuals, the cover would be  $(50 / 5) * 0.01 = 0.1$  (NOT  $50 * 0.01 = 0.5$ ). For SMES, we are interested in the actual cover of a species and not measurements of individuals or canopy systems. Keep in mind, though, that the minimum cover measurement recorded is 0.1, NOT 0.01 as in NPP, so if you had only one individual of a species that had an actual cover of 0.01, you would still record it as having a cover of 0.1.

Bare branches are measured with the foliage as in NPP, not separately. However, if bare branches stick out from the foliage, the cover should be measured as in NPP, with each 10 cm counting as a cover of 0.5, but the maximum cover for a square is a cover of 1.0. If branches are dense, then measure them as foliage. This applies to both live and dead plants.

For live plants, the maximum height in centimeters for that plant species in the quadrat is also recorded. For annuals, measure from the highest part of the plant, whether it is a reproductive structure or vegetative structure. For perennials, including perennial grasses, measure to the highest vegetative structure and do NOT include the any reproductive structures. Find the tallest part of appropriate foliage for that species in the quadrat (even if it is a small part of a plant sticking in to the quadrat), and measure it in whole centimeters to the soil surface directly below it using your tape measure. The height for bare branches is from the ground to the highest point if the bare branch is the highest point for the species. (Bare branches are measured with the foliage as in NPP, not separately.) In terms of what parts of the plants are used for measuring the height, SMES methodology is the same as NPP methodology. In terms of where the lower extent of the height measurement is delineated, SMES is different than NPP in

that, for SMES, height is measured from the top of the highest appropriate foliage to the ground, NOT to the bottom of the foliage. No height measurement is taken for dead plants.

### **A. Live Plant Foliage**

For a reading of a live plant species, state the following on the tape:

1. Plant species' four-letter code, state "XXXX."
2. Spell the code at least the first time you use it in each quad, if not every time. State "X-X-X-X."
3. Canopy cover, state "*cover (n).*"
4. Height, state "*height (n).*"
5. If necessary, include a comment. State, "*comment: blah, blah, blah, end comment.*"

An example of a live plant reading would be "ERDI, E-R-D-I, cover 2.5, height 8." If a comment is necessary, it should be read like "ERDI, cover 2.5, height 8, comment: *most individuals in this quad seem to be heavily grazed. End comment.*"

### **B. Dead Plant Foliage**

If a plant is dead, but still rooted in the soil, state "dead" at the end of the species name. For dead plant foliage, just record the cover, do not measure the height. If some of the individuals of a plant species, or if portions of the foliage of an individual plant on the quadrat are dead and some alive, provide two separate readings for the dead and living foliage. If both live and dead foliage are intermixed and difficult to separate, as in some bunch grasses and shrubs, just record the foliage as live. Do not measure dead material that overlaps in vertical space with live material of the same species; only measure dead material that would not overlap with live material of the same species if an aerial photograph was taken of the quadrat.

If a plant is dead and not rooted at all (ie, it was blown into the quad by the wind) do not measure it. Be especially careful with dead ERTR, as many times dead, uprooted individuals will be blown into a quadrat by wind transport and will get caught on dead individuals that are rooted in the quad. Only those that are rooted should be measured. Any dead plant foliage that is not still attached to the soil is considered leaf litter.

If a dead individual is in poor shape and cannot be identified, do not measure it. Always attempt to measure dead annuals, but don't worry about going back to re-measure if they are not measured for a group of quads (i.e., someone forgot that they were supposed to measure them). Do make a comment on your data tape that you did not measure dead annuals on which ever quads apply, and write the same note in the recorder notes file.

It is best to record the "dead" reading of a species directly after you record the live reading for the same species.

If plant material is dead, follow this protocol:

1. Plant species' four-letter code, state "XXXX dead."
2. Spell the code at least the first time you use it in each quad, if not every time. State "X-X-X-X dead."
3. Canopy cover, state "*cover (n).*"
4. (You do not need to record a height.)
5. If necessary, include a comment. State, "*comment: blah, blah, blah, end comment.*"

An example of a dead plant reading would be "ERDI dead, E-R-D-I dead, cover 1." Add a comment to the end if necessary.

### **C. Unidentified Species**

The SMES name coding system is the same as for NPP readings in all cases except YUEL, including methods of naming unidentified species. See Techs\Study\NppQuad\nppfield.doc for more information.

Keep a written log of all unidentified species and their descriptions in case identification is possible later. This information should be written in the recorder notes file. In terms of codes, XXXX1 should be reserved for plants that will not be identified, so the first potentially identifiable species that the readers intend to identify later on (such as those that can be identified to species level after flowering) should be designated XXXX2. Continue with 3, 4, etc. throughout the SMES measurement season. Species are numbered within the season, not by the unknowns read by individual people. Having multiple codes with the same numbers used by different people for different plants is highly confusing when analyzing the data. Therefore, be sure to inform all readers if you have an unknown species so that the numbering can be done correctly and so all people will name the same unidentified plant with the same code.

Try to collect a voucher specimen of each unidentified species, and label it with the name that you called it. State in your tape recording/voice file that you have collected a voucher, and state the code. Press the voucher and save it for identification and/or archival into the reference collection. Collect the voucher from outside the study plot, if possible, or at least off of the quadrat. Do NOT collect a specimen from a quadrat, even if there are no other plants to collect. Be sure to keep detailed notes of who collected it, the date of collection, where it was collected, and the code used to name it with the specimen.

## **2. Cryptogam Cover**

Cryptogams include lichens, algae, and moss. Only measure cryptogam cover that is in the open, do not attempt to measure within clumps of grass, etc. All cryptogams are pooled into one observation, and the cover of cryptogam crusts on the soil surface of the quadrat are measured in terms of 10-cm squares. No height is measured. For cover values less than 5, use increments of 1.0. For cover values greater than 5, use increments of 5.0.

Some cryptogam cover has distinctive margins and is easy to define and measure. However, many cryptogam crusts consist of many diffuse small patches that are separated by bare soil, and distributed throughout the quadrat. For such diffuse cover, determine the actual cover in one typical 10 by 10 cm square (ie., 0.3), then count the number of squares with diffuse cover (ie., 5), and multiply the number of squares by the actual cover for a typical square for the total cryptogam cover (ie.,  $0.3 \times 5 = 1.5$ , then round to 1.0 or 2.0, or if the value had been greater than 5, round to the nearest increment of 5.0). There is a great deal of variability in how individuals read cryptogam cover and even in what they consider to count as cryptogam. Therefore, in the final analysis, cryptogam cover will be averaged over 5 years to look for broad patterns of change only. However, at the beginning of each season, the way in which cryptogam will be measured should be discussed amongst all readers. In most years, only very dark (dark brown or black) cryptogam will be measured. The light gray that can be confused between cryptogam and abiotic crust if a sample is not taken and crumbled should not be measured.

On the tape, state "*cryptogam cover (n).*" If there is no cryptogam cover, state "*cryptogam cover zero.*"

## **3. Leaf Litter Cover**

Leaf litter includes all detached (unrooted) dead plant material on the soil surface, including woody branches. Measure leaf litter just like cryptogam cover above, in terms of appropriate cover values and increments to use. No height is recorded.

On the tape, state "*leaf litter cover (n).*" If there is no leaf litter, state "*leaf litter cover zero.*"

## **4. Soil Surface Disturbance from Animals**

Look for any soil surface disturbance caused by animals (including humans) and measure the cover of the disturbance in increments of no less than 0.1. (Do not measure soil disturbances caused by water movement, plant movement, or any other non-animal disturbance.) Always include the entire area affected by the disturbance in your cover measurement. For example, if there were a rodent burrow, you would include the hole, the mound, and any piles of excavated soil in the measurement. Also measure the height, which is the maximum vertical extent of the disturbance in centimeters. Vertical extent



includes depth of holes and height of mounds; often both are involved with a particular disturbance. For holes and burrows, measure the depth only as far as you can see. Do not attempt to actually measure to the bottom of the burrow. In the example above, you would measure the height from the lowest visible part of the burrow hole to the top of the highest excavated dirt pile.

If you can identify the type of animal that caused the disturbance, state the kind of animal and the type of disturbance. Typical disturbances are rodent digs, rodent burrows, rabbit tracks, rabbit dust baths, rabbit digs, coyote tracks, antelope tracks, spider burrows, ant mounds, disturbances from unidentified arthropods, human footprints, and disturbances from the tape measure dropping onto the quadrat. If you can identify disturbances to species with confidence, like ant mounds, do so. If you cannot determine what type of animal caused the disturbance, just state "*unknown soil disturbance*." Record a separate observation for each type of disturbance, but pool all cover values for each particular type of disturbance, and record the maximum vertical extent for all individual disturbances caused by the same animal/process as a group. For example, you would record one pooled reading for all rodent digs and burrows, another pooled reading for rodent tracks, another pooled reading for all ant mounds, and another for all spider burrows.

If there is more than one type of disturbance on the same area of soil, count them both separately. We are interested in the impact of different animals on the condition of the soil, and so any spatial overlap between disturbance types is unimportant. For example, if there were rabbit tracks across an ant mound, you would measure the ant mound as it is and then the tracks. If the tracks caused the height of the ant mound to be slightly lower than it would have been had a rabbit not trampled it, you would not attempt to adjust your measurement for what the height would have been. Measure disturbances exactly as they manifest.

Record the readings for all disturbance types before measuring the next variable.

On the tape state "*soil disturbance from (type of disturbance), cover (n), height (n)*." If there is no soil disturbance, state "*soil disturbance, none*."

## 5. Rabbit Feces

Count all individual rabbit pellets occurring within the boundaries of the quadrat. Be sure to check next to and under plants. If there are some that are old (grey and possibly falling apart) count these as a separate reading and record a comment that they are old pellets.

On the tape state "*rabbit feces count (n)*." If a separate reading is necessary for old pellets state "*rabbit feces count (n), comment: old pellets, end comment*."

## 6. Termite Mud Casing

Look for termite mud casings on plant litter, the soil surface, and standing plant material on the quadrat. There will usually be a number of separate occurrences of casing. You will usually measure each casing as a separate observation (see next paragraph for more information). Use your tape measure to measure the length, diameter, and height for each occurrence of casing in units of whole centimeters. The minimum measurement for each dimension is one centimeter. Most casings will be flat on the surface, covering leaf litter, stems, and rabbit feces, etc. In some situations, the casing will cover something vertical such as standing dead plant stems. For the height measurement, measure the vertical height of the mud casing perpendicular to the length and width, which is not necessarily from the ground surface. This is *unlike* plant measurements in NPP and SMES. We estimate volume from these measurements, and so all measurements of a casing are genuine measurements taken at the actual orientation of the casing in space. Do NOT measure the casing using measurements taken in the plane perpendicular to the pull of gravity unless that is the way the casing is oriented.

In situations where there are many vertical mud casings covering stems right next to each other (for example, on a dead clump of grass), just measure the height, length, and width of the entire clump, not each stem. If there are many individual occurrences of termite casings on a single quadrat (about 10 or more) then simply record a pooled visual estimate of all of the mud casing with one set of three dimension measures (e.g., length 20, diameter 20, height 5). Record a comment that you have made a pooled visual estimate. Old termite casings can look like regular soil and can be difficult to detect. If you are uncertain whether or not mud was produced by termites, do not measure or record it.

On the tape, state "*termite casing (length) by (width), height (n).*" If a pooled estimate was made, state "*termite casing (length) by (width), height (n), comment: pooled estimate, end comment.*"

## X. SUPPLY LIST

ITEM	QUANTITY	LOCATION	PURPOSE
analog tape recorders	1 extra	Wooton 108, equipment cabinet	to record data in the event of a digital recorder failing
analog tapes	2	Wooton 108, equipment cabinet	to record data
Digital voice recorders	1 per person	Wooton 108	to record data
Headsets with mute buttons	1 per person	Wooton 108	to record data hands free
plastic wrap or Parafilm	1 roll	Wooton 163 or 161	to protect the digital recorders and headsets from wind and dust
magnifying glasses	1 per person	Wooton 163, NPP bucket	to aid in plant ids
3m metric tape measures	1 per person + 1 extra	Wooton 163, NPP bucket	to measure plant height
plant key	1 per person	Wooton 108	to id plants
SMESvegquadprotocol	1 per person	server, Dara Parker	for clarification
SMES Annual Species for 1996-2000.doc	1 per person	server, Dara Parker	to aid in plant IDs
plant press	1	Wooton 108 or Wooton 264 (Herbarium Room)	to bring back unknown plants
niners	1 per person	Wooton 163, NPP bucket	to measure cover
plastics	1 per person	Wooton 163, NPP bucket	to measure cover
NPP quad frames	1 per person + 1 extra	Wooton 163, NPP bucket	to measure cover and define quads
frame legs	4 per frame	Wooton 163, NPP bucket	so frames work!
scrap paper	1 piece	LTER lab	to make labels for press
field notebook	1 per person	Wooton 108	to record notes on data, maintenance, and unknowns
quad checklist	1	server, Dara Parker	to keep track of all quads measured
pen/pencil	1 per person	LTER lab	to make labels for press
extra batteries	2 per person	Wooton 108	for recorders
block layout cheat sheet	1 per person	Dara Parker	to locate plots

## **XI. QUICK REFERENCE SHEET FOR VEGETATION QUADRAT MEASUREMENTS**

### **1. Plant Foliage Canopy Cover and Height Values**

Record the plant species. In the fall, measure annuals and perennials. In the spring, only measure annuals. Record separate observations for live and dead plants by species.

Record the entire canopy cover in increments of 0.1 to 1.0 for each species. Record the maximum height (cm) for the species on the quadrat using vegetative structures for perennials and vegetative and reproductive parts for annuals.

For unidentified plants use the NPP naming scheme. Collect a voucher, and record a comment. Also keep a written log of unidentified species.

### **2. Cryptogam Cover**

Record cryptogam cover in increments of 1.0 for values less than 5, and by increments of 5.0 for values greater than 5.

### **3. Leaf Litter Cover**

Record leaf litter cover in increments of 1.0 for values less than 5.0, and by increments of 5.0 for values greater than 5.0.

### **4. Soil Surface Disturbance from Animals**

Record animal caused soil surface disturbance in increments of 0.1 for area, and the vertical extent of the disturbance in centimeters for height.

Pool the area measures for all occurrences by a particular type of animal/animal process into one observation with the maximum vertical extent. Record separate observations for disturbance caused by different types of animals.

Record the type of animal, and the measurement values.

If you don't know what type of animal caused the disturbance, state unknown soil disturbance, and record the measurement values.

### **5. Rabbit Feces**

Count the total number of rabbit feces (pellets) that you see on each quadrat. Record this number. DO a separate count for old pellets.

### **6. Termite Mud Casing**

Measure the length, width, and diameter of all occurrences of termite mud casing on the quadrat to the nearest centimeter. Record each occurrence as a separate observation. For quadrats with large numbers (10+) of individual occurrences, record a pooled visual estimate of all the casing and comment that it is a pooled estimate.

### **7. Reminders**

Record values for all six variables for every quad, even if the value is "zero" or "none."

Record variables in the same order for each quad.

Do not record over mistakes. Add new readings or make corrections to replace old ones verbally on tape.

Keep a written log of all corrections made (for the data entry person), unidentified plants, and needed maintenance.

Check your recorder to ensure the data is being recorded properly.

## **XII. MAINTENANCE**

All non-control plots should be checked every other month for fence condition and evidence of animals gaining access to plots that they should be excluded from. Any repairs should be made as soon as possible and the animals trapped out of the plot immediately after maintenance has been finished. All maintenance and trapping should be recorded in the history log, including how many and what species were removed from a plot. Additionally, all fences should be checked after large rain events and repairs made as necessary. (During the summer of 2002, two fences were literally bent down to the ground by rain flow.)

The condition and placement of all nails should be checked as measurements are done each spring and fall. Any needed changes should be noted so the quads can be returned to easily. This also includes keeping notes on which nails are difficult to find so that flags can be placed near the nails to make measurements easier in the future.

## **XIII. CHANGE LOG**

**03/04/1997** by D. Lightfoot. "Last update."

**07/12/2000** by J. Anderson. Added block, plot, and treatment identifiers after the section "Recording data." Added footer with file name, page numbers, and date printed.

**4/10/01** by D. Parker. Added Section 7: Supply List.

**3/28/02** by Dara Parker. Clarified many sections to reflect answers to questions that came up in previous seasons.

**4/1/02** by Dara Parker. More clarification, changed the way a reading is stated on tape from saying the full Latin name of a species to saying the NPP code and spelling it, changed "Unidentified Plants" section from the original paragraph ("If you are not able to identify a plant to species, state that you are not able to identify the plant to "unidentified", state the genus, and state a number (e.g., "Bouteloua, one"). If you don't know the genus, state the family (e.g., "Poaceae, one"). If you don't know the family, state the life form (e.g., "grass, one"). If you find another unidentified plant in the same genus, family, or growth form, state as such and give it the next highest number (e.g., "Bouteloua, two"). Try to collect a voucher specimen of each unidentified species, and label it with the name that you called it. State in your tape recorder that you have collected a voucher, and state the code. Take the voucher back to the field station, press it and give it to Kimberly for identification and/or archival into the reference collection. Collect a voucher outside of the quadrat, and off of the study plot, if possible. For unidentified seedlings, state "unidentified seedling one" and so on."). Identification of unknowns are now read using the same code system as described the NPP protocol. Put in sentences about reading all plant species in the fall but only annuals in the spring, which does not reflect a change in protocol, just that this information is no longer missing from the protocol. As rabbit pellets are no longer collected, "Count and collect into a plastic zip-lock bag the total number of rabbit feces (pellets) that you see on each quadrat. Place all rabbit feces from all quadrats on one plot into the same bag. Be sure that the bag is labeled with the date, site, block, plot, and treatment." was deleted from the "Rabbit Feces" section. There is no indication in the history logs as to when collection ceased.

**4/2/02** by Dara Parker. Added examples to illustrate protocol, changed plant height measurements from measuring to the top of foliage except for grasses to matching the NPP protocol in terms of what structures are measured for height (vegetative and reproductive structures for annuals, vegetative structures only for perennials). This height distinction does not reflect an actual change in the way measurements have been done, just a clarification in the written protocol. Added information about Walt Whitford's study.

**11/01/02** by Dara Parker. Added *Maintenance* section with information about checking fences after large rain events and clarified techniques for measuring bare branches and dead parts of shrubs (based on conversation with DL 10/02).

**3/19/03** by Dara Parker. Added "The height for bare branches is from the ground to the highest point if the bare branch is the highest point for the species. (Bare branches are measured with the foliage as in NPP, not separately.)" to the live foliage cover and height section. Took out info about the height of dead bare branches in the dead foliage section since we don't measure height of dead material.

**11/25/03** by Dara Parker. Added "If a dead annual has died recently, and was clearly from growth this season, read it as livecover. The newly dead plants should be yellowish in color. If the dead annuals are from another previous season (fall 2002), then record them as dead cover. Those dead plants should be gray in color." and "Always attempt to measure dead annuals, but don't worry about going back to re-measure if they are not measured for a group of quads (ie., someone forgot that they were supposed to measure them). Do make a comment on your data tape that you did not measure dead annuals on which ever quads apply." (all based on the email from Dave Lightfoot in October 2003)

**5/27/02** by Dara Parker. Added info about *Lesquerella* and *Xanthocephalum* species at each site to reflect the way Dave Lightfoot has wanted plants named in the past.

**1/16/04** by Dara Parker. Added use of the quad checklist.

**3/4/04** by Dara Parker. Reformatted corrupted file. Added changes made on 11/01/02, 3/19/04, and 11/25/04 that were done on another version of the protocol that had been saved on the local drive when the server was having problems. Changed the order of sections X and XI (Quick Reference Sheet changed to Section XI and Supply List changed to Section XI). Added information about the use of white gutter spikes to replace the old nails, "end comment" to the end of each comment to bring suggested wording into line with protocol for digital recorders (and hopefully voice transcription technology), and info about being able to make a general comment for a whole plot as long as the area the comment applies to is made clear.

**3/5/04** by Dara Parker. Added sections VIII 2 on Voice files and 3 on recorder notes, changed all info based solely on analog tapes to reflect the digital recorders as well, noted that LEFE/LEGO and XAMI/XASA Ids were based on IDs by DL during the first years of the study, added info about dead plants that are not yellow in color even when they have been around for more than one season (such as DEPI, ESME, etc.) and to use phenology knowledge to decide what grew when in these cases, included discussion of bare branch measurements ("Bare branches are measured with the foliage as in NPP, not separately. However, if bare branches stick out from the foliage, the cover should be measured as in NPP, with each 10 cm counting as a cover of 0.5, but the maximum cover for a square is a cover of 1.0. If branches are dense, then measure them as foliage."), clarified when dead material should be measured separately from live material (overlapping in vertical space or not) and the aerial photo descriptions, more info on how cryptogam should be measured ("However, at the beginning of each season, the way in which cryptogam will be measured should be discussed amongst all readers. In most years, only very dark cryptogam will be measured. The light gray that can be confused between cryptogam and abiotic crust if a sample is not taken and crumbled should not be measured."), clarified that only soil disturbances caused by animals (including humans) should be measured, changed the wording of "undetermined soil disturbance" to "unknown soil disturbance" in order to reflect what people have been saying in the field over the last three years and also to bring it in line with wording used in other studies, added info about the use of the Quad Checklist (which apparently was not saved when the file was corrupted on or after 1/16/04), added items to the supply list (field notebook, quad checklist, Digital voice recorders, Headsets with mute buttons, SMESvegquadprotocol, SMES Annual Species for 1996-2000.doc, and plastic wrap or Parafilm), changed some basic wording and clarified certain sentences with no change to meaning. Besides references to the digital recorders and the Quad Checklist, the information included in the changes made today and yesterday do not reflect changes in the protocol; they simply provide additional clarification or describe new situations that have come up recently.

**4/27/05** by Dara Parker: Changed to LEGO at the Creosote site and LEFE at the Grassland site. (Before was written LEGO at the Grassland and LEFE at the Creosote.) JA checked all data and the two were reversed from Spring 2003 until now, but JA will fix the data.