

The range monitoring spreadsheet (Excel 2000, 2002 format) contains data forms and computerized summaries of data sheets for range monitoring. The spreadsheet is downloadable as either an Excel spreadsheet (FORAGDTA.XLS, 626 Kb) or in the zipped version of the same (FORAGDTA.ZIP, 129 Kb). Information on where to obtain monitoring protocol to accompany each procedure are contained in the article *Setting Up a Range Monitoring Program for Your Ranch* http://cals.arizona.edu/gila/animalsciences/documents/reading_range_newsletter.pdf.

The worksheets contained are:

- 1. Forage Utilization Data Form.** List species on top line with height ranges and enter hits in each forage utilization category in the line below. The worksheet will calculate a weighted average for the key area. The height ranges are determined by using a USFS Forage Utilization Gauge. Collect forage utilization data for at least 100 plants at the conclusion of the grazing season. Heights of at least 10-12 ungrazed plants are obtained to get an average. Next, using a scientific calculator, obtain the standard deviation for the plant heights. If it is greater than 20 to 30% of the mean (or average), then obtain additional ungrazed plant heights. When the ungrazed plant height is finalized, the USFS wheel for the ungrazed plant height is put on zero. Next, appropriate categories are determined as shown on the spreadsheet example. If the species are on the USFS wheel just follow the procedure above to determine appropriate categories. If major plant species present on the ranch are not on the USFS wheel, then you will need to calculate your own forage curves. See instructions below for spreadsheet # 20 for how to do this.
- 2. Hi-Elev Forage Utilization Example.** This is at approximately 7500 feet.
- 3. Mid-Elev Forage Utiliz. Example.** This is at approximately 5000-5500 feet.
- 4. Forage Clipping Data Form (30).** This is for 30 forage samples. Use this for high elevation sites since the variation between samples is greater. To generate new random numbers for new key areas:

Collect at least 30 random forage clippings from each key area in the Ponderosa pine type; for Upper Sonoran Desert, 20 random clipped frames are usually sufficient. The spreadsheet has a random number generator which will provide the distance in feet to step off from the starting point along with a compass reading. When you print off data forms, different random numbers can be called up by opening and closing the spreadsheet or alternately you may type in a number in one of the blank columns hit enter, then delete the number and a new set of random numbers will be generated. In other words, each time the spreadsheet is opened or a new value is entered for any column the spreadsheet will recalculate the random numbers. When clipping forage be sure to stay in the range site. If the compass reading and distance will move you outside the range site (e.g. into a ditch) just reverse the compass reading to stay within the range site. When recording data on the spreadsheet, each plot must have an observation, either a zero or the actual weight.

- 5. Forage Clipping Data Form (20)** is for lower elevation sites with less clumpiness to the forage base. When recording data on the spreadsheet, each plot must have an observation, either a zero or the actual weight. I use paper lunch bags for each sample which usually weigh 7 grams. Subtract the 7 gram bag weight from the wet field weight and record it on the bag. The samples can be dried at 150° F in an oven. I open up the bags and put them on the bottom tray of the oven on two cookie sheets. If you only dry a subsample of samples, you will need to multiply the wet weights by the subsample dry matter percentage divided by 100. In order to do this, you will need to remove the protection for the worksheet. Go to Tools, Protection, Unprotect. There are no passwords for any of the worksheets. Next go to cell A65 and type in the formula: = A61 * observed dry matter %/100 and then go to cell C65 and type in the formula = C61 * observed dry matter%/100. For example if the dry matter percentage of the subsamples was 65%, then the formulas would be =A61*.65 and =C61*.65.
- 6. Browse&Grass Forage Prod. (20).** Use this sheet for 20 samples if you wish to separate browse and herbaceous forage production. You must enter either a zero or a number in wet and dry weights for

BOTH grass and browse forage production or you will obtain errors.

7. Browse&Grass Forage Prod. (30). Use this sheet for 30 samples if you wish to separate browse and herbaceous forage production. You must enter either a zero or a number in wet and dry weights for BOTH grass and browse forage production or you will obtain errors.

8. Example Forage Production. A note: if you obtain greater than or less than 20 or 30 clipped samples the confidence interval multiplier and the number of samples in the equations in cells C61 and C65 will need to be changed for the confidence intervals. These confidence interval multipliers are found on the worksheet entitled Example Confidence Intervals.

9. Frequency & Dry Wt. Rank Data Form. This is the field data sheet for frequency, cover, fetch (nearest closest plant), and dry weight rank. On the lines provided for Distance to Nearest Plant, observations are separated by commas. Once plants are identified for each key area, names of plants can be pasted into column G to ease data collection. See next spreadsheet for an example.

10. Ex. Freq & Dry Wt. Data Form is an example field data sheet for a key area with plant names pasted into column G. Field data should be separated into at least 4 groups or transects (e. g., 4 groups of 50 or 25 quadrats) when collected to increase statistical validity and power.

11. Freq. & Dry Wt. Rank Computer. The cover data is only appropriate if two cover points are recorded for each monitoring plot frame. If only one cover screw is recorded for each plot frame, then the formula in cell J2 needs to be changed to =SUM(G12:G17). The observations for nearest closest plant are recorded in cells B68:K131. After these numbers are entered, the value for nearest closest plant will automatically feed up to cell C9.

12. Freq. & Dry Wt. Rank Example. This shows how to enter the data contained on the field data sheet in dot tally format into the electronic data summary. The discrepancy for 101% (instead of 100%) total forage composition (dry weight rank) was due to human error in recording dry weight ranks in the field. Discrepancies of 1 to 2% are not uncommon.

13. Frequency. This is for plant frequency and only one cover point per each monitoring plot frame. If you wish to record plant cover with two screws per monitoring frame, then either use worksheet # 11 or change the formulas on worksheet # 13 in cells K2 and K8:K12 by enclosing the formula with () and by adding a divisor of 2 to the end of the formula.

14. Line Intercept Transect is for browse monitoring. The instructions for data entry are contained in the worksheet entitled Line Intercept Instructions. An example data entry from field dot tallies is contained in the worksheet entitled LineIntercept Example.

15. Line Intercept Instructions.

16. LineIntercept Example.

17. Parker 3 Step. This is an electronic worksheet that will summarize Parker 3 Step Data that the USFS has used in the past. It is often a good idea to re-read Parkers before going through the NEPA process.

18. Parker Page 2. This is similar to what the USFS uses for page two of the Parker 3 Step Data form.

19. Parker 3 Step Example. This is the electronic version of page 1 of Parker 3 Step data actually collected on an allotment. Only page 1 is shown on this worksheet.

20. Deergrass Eq. This worksheet and the one following is for technical people. Deergrass plants without seedheads (culmless) were obtained and weighed at various heights by Dr. Janet Johnson Grove, Riparian Specialist for Tonto National Forest (see worksheet # 21). From these data, a logarithmic regression was used to calculate a height:weight forage curve similar to what is on the USFS Forage Utilization Gauge.

This was done by using the Data Analysis function in Excel. (Alternately, this could be done with a scientific calculator.) More details on using the Data Analysis option are contained below. In order not to have to repeat this clip and weigh procedure off the site where the data was collected and in a different year, then this curve will need to be placed on the USFS Forage Utilization Gauge. This was done by: a. Setting the ungrazed (0 % utilization) forage height shown in cell B24 on the USFS Utilization Gauge. b. Tape down the wheel so it doesn't move. c. Move to a blank spot in the window for one of the slide in utilization cards. This would be an area on one of the cards that is completely blank. d. Draw a vertical line the length of the window on the left side. e. Transfer a small hash mark (as shown on the printed

cards for each species) alongside the utilization height for 0, 10, 20, 30, 40, 50, 60, 70, 80, and 90 % and list the respective utilization numbers. A small horizontal hash mark would be placed on the left side of the window followed by respective utilization percentage. In this forage curve for deergrass the hash marks were placed at 37.8, 25.4, 17.0, 11.5, 7.7, 5.2, 3.5, 2.3, 1.6, and 1.1 inches for the utilization percentages of 0, 10, 20, 30, 40, 50, 60, 70, 80, and 90 %, respectively.

Using Data Analysis function in Excel for logarithmic regression equation solving:

Steps for analysis of data to calculate regression formula for plant curves (height:weight):

I. Go to a cell in the data range you want to calculate a forage curve for, e.g. spike muhly (see Forage Curve Raw Data Sheet # 25).

Click on Tools, then Data Analysis.

Note. When you click on the Tools command, if the Data Analysis command does not appear on the Tools menu, first click on Add-ins and make sure Analysis ToolPak is checked. If the Analysis ToolPak doesn't appear, you will need to run the Microsoft Excel Setup program to install the Add-in.

II. After you choose data analysis, then click on Regression in available list.

III. Next, input desired range. For X, use natural log of plant height in Column C for all observations (For Deergrass Eq worksheet it is on Deergrass Raw Data Sheet at \$C\$6:\$C\$89; For Spike Muhly Eq. it is contained on the worksheet Forage Curve Raw Data Sheet at \$C\$183:\$C\$214). Y is % utilization in Column D for all observations (On Deergrass Eq worksheet it is on Deergrass Raw Data Sheet at \$D\$6:\$D\$89; For Spike Muhly it is contained on the worksheet Forage Curve Raw Data Sheet at \$D\$183:\$D\$214). Leave the confidence interval setting at 95%. To get a report on separate sheet, click on New worksheet Ply : and name spreadsheet to be inserted. (For example, Deergrass Eq. or Spike Muhly Eq.) Click OK and the computer will run briefly then insert a new spreadsheet preceding the Raw Data Sheet. Adjust margins in cells on new sheet so you can read data.

IV. Lastly, copy cells A22:B33 from Spike Muhly Eq. worksheet to the newly formed spreadsheet at A22. This will calculate the height of the forage at 0, 20, 30, 40, 50, 60, 70, 80, and 90% utilization. If you desire to know the plant height at a different utilization, substitute that value in one of the cells A22:A33.

21. Deergrass Raw Data Sheet. This is referred to above and contains raw data from which a forage curve was constructed.

22. Deergrass Utilization Data Form. Using the constructed forage curve on the wheel, utilization ranges for plants are placed in cells C14:H14 and M14:R14. In columns B and L, the percentage of the plant actually grazed is visually estimated and entered as a percentage. This is done because deergrass plants can be quite large in diameter and animals may only graze one corner of the plant. Next, the respective height for the plant is listed in the appropriate utilization category. An adjusted utilization is then calculated for culmless plants. If you desire to do forage utilization for a population of deergrass plants with characteristics of almost all plants containing seedheads, then a new forage curve will need to be constructed. This is explained further for worksheet # 25.

23. The Deergrass Utilization Example shows how data would be inputted into the data form.

24. The Spike Muhly Eq. worksheet is explained under worksheet # 20.

25. The Forage Curve Raw Data Sheet contains actual plant height data for species not listed on the USFS Utilization Gauge. From these eight plants and 32 data points, a forage curve was constructed for each species. The procedure for doing this after the data was entered into this spreadsheet in columns B and D

is explained more fully under worksheet # 20. The procedure used for actually obtaining the plant height data for the plant species in worksheet # 25 is as follows:

- I. Select at least 8 ungrazed plants for the species in question. Clip at ground level, save leaves, and make sure no dirt is on the plant. Flick with finger if some dirt is present. After clipping, if bottom leaves try to fall off, then secure with a piece of thread.
- II. Balance the clipped plant at 50% utilization with a small string looped around the plant. When plant is level, then 50% utilization will occur at that length of plant.
- III. Record the height from ground level to 50% utilization.
- IV. Record the total length of the plant and record as height at 0% utilization.
- V. Cut the plant at the 50% utilization height and rebalance upper end of the plant with string.
- VI. Measure length of the upper end of the plant balance point from the end you just cut and add this amount to the inches recorded at 50% utilization to obtain 25% utilization height.
- VII. Rebalance the lower end of the plant and measure distance from bottom of the plant.
- VIII. Record inches at 75% utilization for lower end of plant balance point.
- IX. Since most of the plant weight occurs near the bottom of the plant, you will need to do a logarithmic regression for the 32 data points you recorded. You can either do this with the Excel spreadsheet (using the data analysis function) or with a scientific calculator which has a linear regression function. I used a Casio fx-300v calculator which was fairly cheap to buy.

26. Forage Utiliz. CI Calculator. This worksheet will calculate a confidence interval for forage utilization for a particular species. Enter utilization point hits in columns B to AI. The number of samples will be calculated in column AJ, the standard deviation of the sample points in column AL and the 90% lower confidence interval in column AN and the upper 90% confidence interval in column AO. If you desire to do a confidence interval for a larger sample, you will need to add columns and change the formulas in columns AJ, AK, and AL.

27. The Example Confidence Intervals worksheet will calculate 90% confidence intervals for a sample of data points. You may change any of the items shown in red. As the standard deviation increases and/or the number of samples decreases, the confidence interval or margin of error for a sample average will increase in size. For example, if forage utilization was 55% and 8 plants were measured, and the standard deviation (measure of variation among sample data points) was 10%, then the 90% confidence interval would be 48 to 62%. In other words, we are 90% confident (statistically speaking) that the true average forage utilization for this site was somewhere between 48 and 62%.

28. Drought Evaluator. This worksheet evaluates the effects of drought through two sets of criteria: plant height and plant mortality. This should be combined with forage production to get a more accurate assessment of a particular site. In cells A9:M37, the average plant height by species are entered. In cells A48 to M53, hits on each plant measured for height is tallied for plant vigor (as estimated by green, dormant, dead, etc.).

29. The Drought Evaluator Example did not have plant vigor separated by forage species, but shows some actual data collected during the drought of 2001-2002.

30. Estimated Stocking Rate. Use this spreadsheet for planning and ESTIMATING stocking capacity. It should not be used as a sole criteria but should be used with "stock and monitor" carrying capacity evaluations. Forage utilization mapping should also be combined with this technique to assess livestock distribution. All the cells in red and blue can be changed. If you delete or add rows for more or less pastures, make sure the formulas transfer appropriately. Set your cow weight in cell A2 and the forage intake factor in cell B2. For public land grazing, the intake factor is usually set to .026 for 26 lbs./cow/day for a 1000 lb. cow. If calves are weaned and it is wintertime, intake should drop to 2% of body weight per day, or 20 lbs. for a 1000 lb. cow. For yearlings, use an intake factor of .023 to .025. In column G, you will need to enter a figure for the percentage of the pasture that should be excluded from carrying capacity estimates due to steep slopes or lack of water. In column H, you will need to enter the agreed

upon forage utilization level specified by your annual operating instructions. This will usually be from .40 to .50 (40 to 50%). In F5 the amount of available forage (of that allowed by the use guidelines in column H) that will be consumed by cattle is listed. In areas of heavy elk use, this figure may be as low as 30 to 40%. If you will scroll over to column R, this will show the number of days you can stay in a particular pasture with the forage production levels shown in column C and with the cow herd size specified with the desired forage utilization levels. This is only a rough guess. A more crude estimate of carrying capacity is shown in cell S34. This is calculated by comparing the actual average end of season forage utilization in cell O34 to that desired in cell P34. Carrying capacity for the set of conditions outlined in this worksheet are shown in cells P41 (this year) and P46 (a year that is drier and only has 70% of the production of this year).

31. The Strip Grazing Calculator will only be used if you are using high intensity strip grazing (electric fencing) with irrigated pasture. All cells shown in red can be changed. The square footage of daily forage allowance is shown in I13 and the size of one side of a square to provide is shown in cell J13. These estimates are rough estimates and will vary with climatic conditions and the growing season.

That's all!