Monitoring Manual

for Grassland, Shrubland and Savanna Ecosystems

Volume II: Design, supplementary methods and interpretation

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Collecting Line-point intercept data
in a south-central New Mexico desert grassland.

Chapter 9

Plant production

Total annual production, which includes woody material, is an expression of all aboveground plant production during a single growing year, regardless of accessibility or palatability to grazing animals.

Total annual forage production is the amount of total annual production composed of forage species, or species likely to be used by grazing animals.

Annual production can be divided into many different classes, such as herbage production for herbaceous species (grasses, sedges, rushes and forbs) or woody plant production for woody species (trees and shrubs). For woody plant production (trees, shrubs and half-shrubs), annual growth includes only leaders, leaves and fruit, or seed production for the current growing season, not the entire plant.

Annual production is an attribute of rangeland vegetation that is very difficult to quantify, but is important for management. There can be tremendous variation in annual production within a single pasture or management unit. As plants grow at different times of the year, determining when to quantify annual production and how to adjust for material that has not yet been produced or has been removed can be very difficult. In addition, total aboveground production can vary tremendously from year to year due to climatic variations (especially seasonal differences in precipitation), irrespective of management actions. Because of these challenges, and the time involved in data collection, most monitoring programs do not include annual or forage production methods.

When estimates of annual production are needed or desired, there are three basic methods for collecting data: (1) estimating (by weight units); (2) double sampling (an approach that includes estimating and harvesting to correct estimates); and (3) harvesting, an approach that uses clipping of plots and air drying harvested material to obtain a measure of dry matter production. Double sampling is recommended because it combines the efficiency of estimation with the accuracy of harvesting. All three methods

Figure 9.1. Weighing a clipped sample.

are detailed in the NRCS *National Range and Pasture Handbook*, Chapter 4, Inventory and Monitoring Grazing Land Resources, pages 4-3 through 4-13 (USDA-NRCS 1997). The double sampling method is described below.

The methods described here:

- Follow standard USDA-NRCS national protocols.
- Are based on English units, in order to maintain consistency with USDA-NRCS protocols. For metric conversions, please see Appendix B.
- Allow the inclusion of correction factors for material that has not yet been produced or has been removed.
- Generate production estimates for a single, user-determined (usually calendar) year.

Materials

- The same transect(s) used for other measurements
- 1 pair grass clippers
- 1 pair pruning shears for woody vegetation
- Quadrat frames (1.92, 4.8 or 9.6 ft^2)
- Paper bags for weighing samples
- Gram spring scales: 0-60 g; 0-100 g x 1 g, 0-300 g x 2 g; 0-600 g x 5 g
- Plant identification guides
- Ecological Site Descriptions
- Clipboard, Plant Production Data Forms and pencil(s)

Standard Methods (Rule Set)

1. Establish 10 subplots.

Rules

1.1 Randomly locate 10 sample locations. These can be located on the transect(s) used for other measurements.

1.2 The number of subplots commonly recommended is 10. The formulas in Appendix C can be used to calculate the optimum number of subplots. Additional guidance will be posted on the Internet when available (http://usda-ars.nmsu.edu).

1.3 Separate sample locations by at least 10 m (33 ft).

1.4 Record the sample location for each subplot on the data form under "Subplot position."

1.5 Place subplots with the edge of the sampling frame adjacent to the transect.

1.6 Locate subplots on the side of the transect not walked along for other vegetation measurements.

1.7 Determine production of herbaceous and half shrub species using 1.9, 4.8 or 9.6 ft^2 subplots. In most arid and semi-arid areas, 9.6 ft^2 is the best size. As production and plant density increases, smaller frame sizes are appropriate. For example, the 9.6 ft^2 is more appropriate in the desert, while the 1.9 ft^2 or 4.8 ft^2 would be more appropriate in tallgrass prairie and pasture ecosystems.

1.8 Where total production and/or woody production is of interest, expand a subset of subplots to 0.01 acre to measure tree and shrub production. The 0.01 acre expanded subplot is usually a circle with an 11 ft 10 in radius (3.6 m radius). However, you can also use a 21 by 21 ft square (6.4 m sides).

1.9 Woody production is more variable than herbaceous production. Where woody production is of interest, include a minimum of two expanded plots.

2. Record all species in a subplot.

Rules

2.1 At least 50 percent of the plant base must be located within a subplot to be recorded.

2.2 Record each species within a subplot once.

2.3 Record the species in the "Species code" column of the Plant Production Data Form, using one of the following: the PLANTS database species code (http://plants.usda.gov); a four-letter code based on the first two letters each of the genus and species; or the common name.

2.4 Record the subplot size for each species (see 1.6 and 1.7 for options).

3. Determine the weight unit for each species (for the first subplot) or determine the weight unit for each species not previously recorded (for the remaining subplots).

Rules

3.1 Within a species, a weight unit can consist of a plant part, an entire plant or a group of plants.

3.2 Grams are the unit of measure for herbaceous and half shrub species.

3.3 Pounds are the unit of measure for tree species. Grams or pounds may be used for shrubs.

3.4 Determine a weight unit appropriate for each species. Select a weight unit that is easy to identify, count and remember. Be careful not to select a weight unit that is too small, nor too large.

3.5 Select the equivalent of the weight unit and harvest it.

3.6 Determine the actual weight of the weight unit.

3.7 Repeat steps 3.4 through 3.6 until the weight unit can be accurately estimated.

3.8 Record the weight unit weight in the "Wt unit wt" column of the Plant Production Data Form.

3.9 Enter the unit of measure (grams or pounds) in the "Wt meas g/lb" column.

4. Estimate the number of weight units by species.

Rules

4.1 Enter the number of weight units located in each subplot for each species in the appropriate column of the form.

4.2 If only a trace amount of a species is detected, record "T" for that subplot.

4.3 At least 50 percent of the plant base must be located within a subplot to be recorded.

5. Repeat for all subplots and expanded plots.

Rules

5.1 Repeat steps 2 through 4 for all herbaceous subplots.

5.2 Repeat steps 2 through 4 for all woody expanded plots.

6. Clip species to allow for later calculation of the double sampling correction factor.

Rules

6.1 Select at least two of the ten subplots in which to clip and weigh each species. These subplots should include all or most of the species found in all the subplots.

6.2 Circle the subplots on the data form.

6.3 Record the clipped weight for each species in the "Clip wt" column.

6.4 Record a clipped weight for any species not found in your selected subplot(s) using a sample from another subplot. Make sure to note where the sample was collected.

6.5 Enter the appropriate values under "Clipped subplots Est wt" and "Clipped subplots Clip wt."

7. Record the subplot size conversion factor.

Rules

7.1 Record subplot size conversion factor in the "Size CF" column for each species.

7.2 Convert the sampled weight to pounds per acre using the appropriate conversion factor:

- CF = 50 where subplot size is 1.92 ft^2 with grams as the unit of measure
- CF = 20 where subplot size is 4.8 ft^2 with grams as the unit of measure
- CF = 10 where subplot size is 9.6 ft^2 with grams as the unit of measure
- CF = 0.22 where subplot size is 0.01 acre with grams as the unit of measure
- CF = 100 where subplot size is 0.01 acre with pounds as the unit of measure.

8. Enter the air-dry weight adjustment for each species.

Rules

8.1 Enter the appropriate air-dry weight (ADW) proportion in decimal form in the "ADW adj" column.

8.2 If available, use established charts and tables that convert green weight to dry weight based on various stages of growth. If local charts or tables are not available, vegetation can be air dried.

8.3 Repeat for each species.

9. Enter the utilization adjustment for each species where livestock and/or wildlife grazing has occurred.

Rules

9.1 Enter the proportion of the plant remaining after utilization, in decimal form, in the "Util adj" column.

9.2 Utilization can vary among subplots, so make sure to use the average utilization for the entire plot.

9.3 Example: if a plant averages 40 percent utilization, then 60 percent remains and you enter 0.60 in the "Util adj" column.

10. Enter the growth adjustment for each plant species.

Rules

10.1 Enter the cumulative proportion of growth (in decimal form) that has occurred during the current year in the "Gwth adj" column.

10.2 This proportion is relative to the total production expected *for that year*, regardless of climatic variation. The growth adjustment corrects for how much the plant has grown for that year, against its potential for the year (100 percent). For example, if growth adjustment on July 1 is 60 percent during a dry year, it is also 60 percent on July 1 during a wet year, even though the total amount of growth on July 1 of a dry year may be much less than that of a wet year.

10.3 Growth curves are available for most major rangeland species in the United States. These growth curves show the typical cumulative proportion of growth by calendar date. These curves are approximate, as they do not account for annual variability in rainfall distribution. Contact your local NRCS office or Extension office for further assistance.

11. Enter the weather (climate) adjustment for each plant species.

Rules

11.1 Enter the weather (climate) adjustment in decimal form in the "Wthr adj" column.

11.2 The weather adjustment is used to describe the kind of growing conditions that have occurred or are expected. This includes precipitation amount, intensity and timing, as well as temperature, and their relationships to one another.

11.3 Enter a value between 0.1 and 2.0.

11.4 This adjustment can be different for different species, depending on the moisture and temperature requirements of the plants.

11.5 Example: An adjustment of 1.0 would indicate that the growing conditions were normal for the site that growing year. An entry of 1.2 would indicate that the growing conditions exceeded normal by an amount sufficient to increase species productions by 20 percent. An adjustment of 0.75 would indicate that the growing conditions were only sufficient to support 75 percent of normal species productions.

Plant production calculations

1. Add the total weight units for each species.

Rules

1.1 Add the weight units in each subplot by species and enter this in the "Total wt units" column.

1.2 Record weight units to the nearest decimal.

1.3 Ignore trace amounts, or "T's."

2. Calculate the double-sampling correction factor.

Rules

2.1 For the clipped subplots only, enter the total estimated weight for each species in the "Clipped subplots Est wt" column.

2.2 Total estimated weight = total weight units (Total wt units) in the clipped subplot, multiplied by the weight unit weight (Wt unit wt).

2.3 Enter total clipped weight for each plant species for the clipped subplots in the "Clipped subplots Clip wt" column.

2.4 Calculate the double sampling correction factor by dividing the "Clipped subplots Clip wt" by the "Clipped subplots Est wt."

2.5 Enter the double sampling correction factor in the "Clip/Est CF" column.

3. Calculate pounds per acre for each plant species.

Rules

3.1 Use the following equation to calculate air-dry reconstructed weight in pounds per acre, where s = the number of subplots:

$$\text{lbs/ac} = \frac{\text{(Total wt units x Wt unit wt x 1/s x Plot size CF x ADW adj x Clip/Est CF)}}{\text{(Util adj x Gwth adj x Wthr adj)}}$$

3.2 Enter this value in the "Total wt (lb/ac)" column.

Example

Plant Production Data Form

Monitoring plot: North Pasture 1 **Observer:** Renee Smith **Recorder:** Keith Crossland **Page** 1 **of** 1

Line: 2 **Date:** 9 October 2003

Species code	Subplot position (record wt. units for ea. spp. under subplot pos.)															Total wt units	Wt unit wt	Wt meas g/lb	Clip wt	Subplot size	Size CF	ADW adj	Util adj	Gwth adj	Wthr adj	Clipped sub-plots		Clip/ Est CF	Total wt (lb/ac)
	(10)	20	30	40	50	5	15	(25)	35	45																Est wt	Clip wt		
PAVA2	5.5	0	0	0	0	0.1	0	0.75	0	0						6.35	34	g	138	9.6 ft²	10	0.6	1	1	1	212.5	138	0.65	84.12
ERAR5	8	2	1	1	2	0	0	1	0	0						15	3	g	40	9.6 ft²	10	0.6	1	1	1	27	40	1.48	40
CHAL7	6	0	0	0	12	0	0	10	0	0						28	1	g	15	9.6 ft²	10	0.7	1	1	1	16	15	0.94	18
BOAR	2	0	9	7	0	0	0	4	0	0						22	4	g	22	9.6 ft²	10	0.8	1	1	1	24	22	0.92	65
AMFI	1	0	0	0	0	0	0	0	0	0						1	1	g	2.5	9.6 ft²	10	0.7	1	1	1	1	2.5	2.50	2
HOGL2	0	0	0	0	0	0	0	3	0	0						3	1	g	5	9.6 ft²	10	0.6	1	1	1	3	5	1.67	3
CYDA	2	0	0	0	0	0	8	16	0	0						26	2	g	30	9.6 ft²	10	0.8	1	1	1	36	30	0.83	35
MACM2	0	0	0	0	0	0	0	1	0	0						1	2	g	3	9.6 ft²	10	0.9	1	1	1	2	3	1.50	3
OPEN3	0.5	0	0	0	0	0	0	0	0	0						0.5	0.25	lbs	0.3	0.01 ac	100	1	1	1	1	0.125	0.15	1.20	2
LYEX	1.2	0	1	0	0	0	0.3	0.6	0.6	0.6						4.3	0.2	lbs	0.25	0.01 ac	100	1	1	1	1	0.36	0.25	0.69	6
PRVE	1	0	0	0	0	1	1.5	0	1.5	0.5						5.5	0.3	lbs	0.25	0.01 ac	100	1	1	1	1	0.3	0.25	0.83	14
GUSA2	2	0	2	0	0	0.5	1	1	0	0						6.5	0.08	lbs	0.25	0.01 ac	100	1	1	1	1	0.24	0.25	1.04	5
LATR2	0	0	0	0	0	0	0	1	0	0						1	0.09	lbs	0.1	0.01 ac	100	1	1	1	1	0.09	0.1	1.11	1
ACCO2	1	0	0	9	2	0	1	8	0	0						21	0.1	lbs	1	0.01 ac	100	1	1	1	1	0.9	1	1.11	23
OPVE	2	0	0	0	0	0	0	0	0	0						2	0.15	lbs	0.25	0.01 ac	100	1	1	1	1	0.3	0.25	0.83	3

Total production (lbs/acres): 302.62

Plant Production Data Form

Monitoring plot: ____________________ **Observer:** ______________________ **Recorder:** ______________________ **Page**_____**of**_____

Line: _______________ **Date:** ______________________

Species code	Subplot position (record wt. units for ea. spp. under subplot pos.)															Total wt units	Wt unit wt	Wt meas g/lb	Clip wt	Subplot size	Size CF	ADW adj	Util adj	Gwth adj	Wthr adj	Clipped sub-plots		Clip/ Est CF	Total wt (lb/ac)
																										Est wt	Clip wt		

Total production (lbs/acres): [ ]