L. Comparative Yield Method

1. *General Description* This method is used to estimate total standing crop or production of a site. The total production in a sample quadrat is compared to one of five reference quadrats; relative ranks are recorded rather than estimating the weight directly.

   It is important to establish a photo plot (see Section V.A) and take both close-up and general view photographs. This allows the portrayal of resource values and conditions and furnishes visual evidence of vegetation and soil changes over time.

2. *Areas of Use* This method works best for herbaceous vegetation but can also be used successfully with small shrubs and half-shrubs. As with most production estimates, the comparative yield method can be used to compare relative production between different sites.

3. *Advantages and Limitations* The advantage of the comparative yield method is that a large sample can be obtained quickly. Total production is evaluated, so clipping calibration on a species basis is not needed. The process of developing reference quadrats for ranking purposes reduces both sampling and training time. This technique can be done in conjunction with the frequency, canopy cover, or dry weight rank methods. Identification of individual species is not required.

   Large shrub communities are not well suited for this technique. If used in conjunction with other techniques (frequency and dry weight rank), the quadrat size may need to be different. This technique can detect only large changes in production.

4. *Equipment* The following equipment is needed (see also the equipment listed in Section V.A, page 31, for the establishment of the photo plot):

   - Study Location and Documentation Data form (see Appendix A)
   - Comparative Yield form (Illustration 24)
   - Five sampling quadrat frames
   - Clippers
   - Paper bags
   - Kilogram and gram spring-loaded scale with clip
   - One stake: 3/4- or 1-inch angle iron not less than 16 inches long
   - Tally counter (optional)
   - Hammer
   - Permanent yellow or orange spray paint
   - Compass
   - Steel post and driver

5. *Training* Examiners must calibrate their estimates when sampling situations change (i.e., different sites, time of day, or season).

6. *Establishing Studies* Careful establishment of studies is a critical element in obtaining meaningful data. Depending on the objectives, comparative yield data can be collected on permanent transects or in a random or systematic design.

a **Site Selection** The most important factor in obtaining usable data is selecting representative areas (critical or key areas) in which to run the study (see Section II.D). Study sites should be located within a single plant community within a single ecological site. Transects and sampling points need to be randomly located within the critical or key areas (see Section III).

b **Pilot Studies** Collect data on several pilot studies to determine the number of samples (transects or observation points) and the number and size of quadrats needed to collect a statistically valid sample (see Section III.B.8).

c **Selecting Quadrat Size** The criteria for selecting the proper size quadrat is the same as any weight estimate procedure (see Section III.B.6.d).

(1) Determine the proper size quadrat(s) to use by doing preliminary sampling with different size frames.

(2) Use the same size quadrat throughout a study and for rereading the study.

d **Number of Transects** Establish one transect on each study site; establish more if needed.

e **Study Layout** Production data can be collected using the baseline, macroplot, or linear study designs described in Section III.A.2 beginning on page 8. The linear technique is the one most often used.

f **Reference Post or Point** Permanently mark the location of each study with a reference post and a study location stake (see beginning of Section III).

g **Study Identification** Number studies for proper identification to ensure that the data collected can be positively associated with specific sites on the ground (see Appendix B).

h **Study Documentation** Document pertinent information concerning the study on the Study Location and Documentation Data form (see beginning of Section III and Appendix A).

7. *Taking Photographs* The directions for establishing photo plots and for taking close-up and general view photographs are given in Section V.A.

8. *Sampling Process* In addition to collecting the specific study data, general observations should be made of the study sites (see Section II.F).

a A set of reference quadrats must be established. The sample quadrats will be compared and rated back to these reference quadrats. The reference quadrats represent the range in dry weight of standing crop that will be commonly found during sampling.

(1) Five reference quadrats are subjectively located. References 1 and 5 are located first. The first quadrat (reference 1) is placed in a low-yielding area which represents the low-yielding situations commonly encountered on the site (avoid bare or nearly bare quadrats). Reference 5 is determined by placing a quadrat on a high-yielding area, excluding unusually dense patches of vegetation which would have a rare chance of being sampled. The examiner should make a mental note of the amount of production in each of the reference quadrats. These references are then clipped and weighed. If the clipped weight in reference 5 is more than five times the weight found in reference 1, then two new sites should be selected as references 1 and 5. In establishing the initial reference quadrats, the weight in reference 5 is usually too high and the weight in reference 1 is too low. Make sure reference 5 does not represent a rare situation. When references 1 and 5 have been selected, reference 3 is located by placing a frame in an area considered to have a yield halfway between references 1 and 5. References 2 and 4 are located the same way by selecting the mid-point yield between references 1 and 3 and references 3 and 5, respectively.

(2) All five reference quadrats are clipped and weighed to compare the reference quadrats to a linear distribution of quadrat weights. This process is repeated by clipping additional quadrats until the weights of the five reference quadrats are approximately linear and observers are confident in their ability to rank quadrats relative to one of the five references. If the rankings are not linear, the precision of the method will be reduced. If more than five percent of the quadrats have no production, then a larger quadrat frame should be used.

(3) In areas with less than 500 lb/ac, small quadrats are difficult to evaluate. In these situations, larger quadrats should be used or three reference quadrats should be established instead of five.

b Collecting the Data

(1) Start a transect by randomly locating the first quadrat along the transect bearing.

(2) Read additional quadrats at specified intervals. To change the length of the transect, increase the number of paces between quadrats.

(3) For each quadrat, compare the total yield in the quadrat to the references and record the appropriate rank by dot count tally. It is appropriate to assign intermediate ranks if the yield is at the midpoint between two references. For example, if a quadrat has a yield between references 1 and 2, assign a rank of 1.5. If a quadrat yield greatly exceeds the yield of reference 5, then a higher rank may be estimated. For example, if a quadrat is 50% greater than reference 5, a rank of 7 could be recorded. If more than five percent of the quadrats are ranked above 5, the references were not properly selected.

(4) To calibrate the ranks, several quadrats representing each reference should be clipped and weighed independently of the transect. The total yield in

each quadrat is determined without regard to species. Be sure to save all clipped material. The reference quadrats can be used as part of these clipped quadrats. The more quadrats clipped, the better the calibration. Each distinct sampling period should have a separate calibration. Bags can be weighed in the field to determine green weight and then saved and dried to determine dry weight (see Section V.J.9.b.(6)). These weights are then used to determine average weight per reference.

9. *Calculations* The number of quadrats tallied for each ranking is totaled (Illustration 7, column 2) and multiplied by the ranking (column 1).

Rank x Tally = Weighted ranking

These weighted rankings (column 3) are summed and divided by the number of total quadrats. This indicates the average ranking for the site.

$$\frac{\text{Total rank}}{\text{Total number of quadrats sampled}} = \text{Average ranking for the site}$$

The average yield may be estimated with a ratio estimate (described below) or a least-squares regression technique. The ratio estimate is good for quick field calculations, but the least-squares regression should be used for final data analysis.

To use the ratio estimate technique, calculate the average rank and average clipped weight of the harvested quadrats by dividing the total of the clipped rankings and the total clipped weight by the number of harvested (clipped) quadrats (column 4 and 5).

$$\frac{\text{Total of clipped rankings}}{\text{Total number of clipped quadrats}} = \text{Average rank of clipped quadrats}$$

$$\frac{\text{Total clipped weight}}{\text{Total number of clipped quadrats}} = \text{Average weight of clipped quadrats}$$

The average clipped weight is then divided by the average rank to determine the average rank interval.

$$\frac{\text{Average weight of clipped quadrats}}{\text{Average rank of clipped quadrats}} = \text{Average rank interval (ARI)}$$

The average ranking for the site—which is based on the *estimated*, not clipped, quadrats—is then multiplied by the average rank interval to estimate the average yield per quadrat for the site.

Average ranking for the site x Average rank interval = Average yield/Quadrat.

The average yield in grams per quadrat obtained above can be converted to either pounds/acre or kilograms/hectare.

Use the following table to convert grams to pounds per acre if the total area sampled is a multiple of 9.6 ft^2.

Table 6

(# of plots x size	=	total area)					
(10 x 0.96	=	9.6 ft²)	multiply grams times	100	=	pounds per acre
(10 x 1.92	=	19.2 ft²)	multiply grams times	50	=	pounds per acre
(10 x 2.40	=	24.0 ft²)	multiply grams times	40	=	pounds per acre
(10 x 4.80	=	48.0 ft²)	multiply grams times	20	=	pounds per acre
(10 x 9.60	=	96.0 ft²)	multiply grams times	10	=	pounds per acre
(10 x 96.0	=	960.0 ft²)	multiply grams times	1	=	pounds per acre

To convert to kilograms per hectare, first determine the number of quadrats in a hectare by dividing the number of square meters in a hectare (10,000m^2) by the total area (in square meters) of the quadrat. Then divide the number of quadrats in a hectare by 1,000 to arrive at the conversion factor used to convert grams per quadrat into kilograms per hectare.

For example, if the quadrat size is 40 X 40 centimeters (0.4 X 0.4 meters), then the quadrat area would be 0.4 multiplied by 0.4, or .16m^2. The number of quadrats in a hectare is calculated by dividing 10,000 by .16, which works out to 62,500 quadrats per acre. Dividing this number by 1,000 results in the conversion factor, which is 62.5. The final step is to multiply the average yield per quadrat obtained from the final equation above by 62.5 to arrive at kilograms per hectare.

10. *Data Analysis* For trend analysis, permanent sampling units are suggested. If permanent transects are monitored, use the appropriate paired analysis technique. If the transects are not permanently marked, use the appropriate nonpaired test. When comparing more than two sampling periods, use repeated measures ANOVA.

11. *References*

Despain, D.W., P.R. Ogden, and E.L. Smith. 1991. Plant frequency sampling for monitoring rangelands. In: G.B. Ruyle, ed. Some Methods for Monitoring Rangelands and other Natural Area Vegetation. Extension Report 9043, University of Arizona, College of Agriculture, Tucson, AZ.

Comparative Yield

Study Number	Date	Examiner	Pasture

Allotment Name & Number	Number of Quadrats	Quadrat Size

Study Location

Sampled Quadrats			Harvested Quadrat	
Rank (1)	Tally (2)	Rank x Tally (3)	Clip Rank (4)	Clip Weight (5)
0				
.5				
1				
1.5				
2				
2.5				
3				
3.5				
4				
4.5				
5				
Total				
Average				

Notes