Techniques to Determine Utilization

Many techniques have been devised to estimate utilization the major techniques are listed here however a greater discussion can be found in the Interagency Technical Reference (1996), Cook and Stubbendieck (1986) and Bonham (1989).

I. Ocular Estimates and Qualitative Assessments

Several techniques have been developed that simply require the technician to take and "educated guess" at how much forage has bee removed:

A. Advantages

1. Most ocular estimation techniques are quite quick and allow for coverage of large areas.

2. These techniques are non-destructive.

3. Ocular estimation can be accurate if the technician is well trained.

4. Mathematical calculations of utilization are simple.

B. Limitations

1. Undisturbed or ungrazed areas are required for adequate training.

2. Appropriate training can be time consuming.

3. It is difficult to document or repeat exact procedure and accuracy of estimates cannot be determined. Therefore ocular estimates are seldom used when legal challenges are possible or pending.

4. Accuracy of estimates depends on the individual making estimates.

C. Proper training protocol. The accuracy of most ocular estimates depends on the experience and training of the observer. Therefore, a strict protocol for training should be developed and followed every day before estimation

1. Find an ungrazed area or several ungrazed plants

2. Set plot of select individual plants (depending on method to be used)

3. One person clip part of the plot/plant to simulate grazing. Weight the amount removed (portion A)

4. The other person should estimate the % utilized from the plot/plant.

5. Clip and weight the remainder of the plot (portion B)

6. Calculate % utilization = $\frac{A}{A+B} \times 100$

7. Adjust estimate and repeat until estimates are within 5% of actual utilization.

8. Note that this clip and weight method of training could be used as a double sampling technique to adjust estimates for the rest of the day.

D. Major Techniques

1. Ocular Estimation (pg 76-80 in Interagency Tech. Ref.)

    a. Appropriately place a transect in a key area or critical area

    b. Transects can be line-transects of pace-transects

    c. At designated intervals along the transect, select the key species nearest to the point and estimate and record the % utilization

    d. Quadrats can also be used. Place quadrat and estimate average % utilization of the key species in the plot. If key species does not occur in the plot, proceed to next plot.

    e. Final calculation is simply an average utilization of all plots or plants examined.

2. Key Species (pg 81-88 in Interagency Tech. Ref.) - This technique is very similar to the ocular estimate technique except that % utilization is placed in 7 categories based on a description of what is observed.

    a. Appropriately place a transect in a key area or critical area

    b. Transects can be line-transects of pace-transects

    c. At designated intervals along the transect, select the key species nearest to the point and estimate and record the % utilization in one of 7 “Utilization Classes”. Utilization classes are printed on the data form (pg 86 Interagency Tech. Ref.). There are 2 sets of classes; one for herbaceous plants and one for woody plants.

    d. Quadrats can also be used. Place quadrat and estimate average % utilization of the key species in the plot. If key species does not occur in the plot, proceed to next plot.

    e. Final calculation is an average utilization of the mid-points classes for all plots or plants examined. For example, if a plant is recorded in the class 21-40% utilized, its % utilization would be listed as 30% for calculating an average.

3. Grazed Class (pg 109-118 in Interagency Tech. Ref.) This technique is very similar to the Key species technique except that the % utilization if placed in a utilization class with reference to a photo guide instead of a written description.

    a. Appropriately place a transect in a key area or critical area

    b. Transects can be line-transects of pace-transects

    c. At designated intervals along the transect, select the key species nearest to the point and estimate and record the % utilization with the aid of a photoguide.

d. Photoguides are available for many key species, but care must be taken to make sure the plants in the photoguide are of similar vigor and morphology as those being estimated. A photoguide can be prepared by removing know %'s of utilization and then taking a picture of the plant.

e. Quadrats are not easily used in this technique.

f. Final calculation is an average utilization of the grazed classes for all plots or plants examined.

4. Landscape Appearance Method pg (119-125 in Interagency Tech. Ref.). Utilization in this method is assessed by comparing the general appearance of the range to written descriptions of utilization classes.

a. Select long walking transects to traverse the pasture and note location of transect on a map or areal photo.

b. Locate origin of the transect, set bearing of transect, locate a point on the horizon to walk toward.

c. At predetermined observation points along the transect (more than 10 paces apart), carefully examine the vegetation immediately in front the observation point. Judge utilization based on written descriptions of 7 utilization classes listed on the data form (pg 123 Interagency Tech. Ref.).

d. Final calculation is an average utilization of the mid-points classes for all plots or plants examined. For example, if an area is recorded in the class 41-60% utilized, its % utilization would be listed as 50% for calculating an average.

II. Indirect Measures

A. Because utilization is impossible to measure directly, several techniques have been developed to quantitatively measure attributes of the plant that are related to utilization (e.g., number of tillers removed).

B. Advantages

1. The techniques are quantitative and objective.

2. Techniques are repeatable and could therefore be used in litigation

3. Little training or experiences is required to precisely estimate utilization

C. Limitations

1. Techniques work well for perennial bunch grasses but are not well adapted to sod grasses.

2. The height-weight technique cannot be used for forbs or woody plants.

3. The indirect measure must be calibrated to known utilization levels. This can be time consuming and must be repeated when the growth form of the grasses varies due to precipitation, phenology, or site differences.

4. Calibration requires access to ungrazed plants, this may be difficult in places.

D. Height-Weight Relationships (pg 89–102, Interagency Tech. Ref.)

1. In bunch grasses, the height of the grazed plant is highly related to the % utilization. Therefore, a relationship between height and weight can be developed and heights of plants can be subsequently measured to estimate % utilization.

2. First, a height-weight curve most be obtained from previous studies, a "utilization gauge (pg 97-99 Interagency Tech. Ref.), or by clipping 10 or more plants as described on pg 92-93 in the Interagency Tech. Ref.

3. Appropriately place a transect in a key area or critical area.Transects can be line-transects of pace-transects

4. At designated intervals along the transect, select the key species nearest to the point and record the average stubble height of the plant.

5. If the plant has not been grazed, record the height of the plants. At least 20 ungrazed plants must be measured on the transect to obtain a reliable cross section of ungrazed plant heights. It sufficient ungrazed plants are not located along the transect it may be necessary to extend transect.

6. Final calculation are listed on page 91-92 of the Interagency Tech Ref. The basic concept is that heights are converted to % utilized with adjustments made for the average ungrazed height of plants.

E. Stem Count (pg 125, Cook and Stubbendieck)

1. The number of stems grazed on a plant is directly related to the % of biomass removed from the plants. The grazed stems on a bunch grass or browse plant can be measured with little error due to personal or procedural biases.

2. Randomly locate key plants along a transect

3. Count the number of grazed stems (GS)and ungrazed stems (US)

4. Repeat 30-50 times to get a good average.

5. % utilization = $\frac{GS}{GS + US} \times 100$

6. This technique is seldom used because it does not work well for all species and can require can take significant time to count stems.

III. Direct Comparison Between Grazed and Ungrazed

A. Several techniques have been developed that compare the weight of grazed plots or plants to ungrazed plots/plants.

B. These techniques are often preferred because they measure actual weight of plants and

utilization is a measure of weight removed.

C. The basic concept:

1. grazed plants or plots are clipped and weighed (GP)

2. ungrazed plants or plots are also clipped and weight (UP)

3. % Utilization = [1-($\bar{x}$ wt of GP / $\bar{x}$ wt UP)]× 100

D. Advantages

1. Simple and direct measures of utilization

2. Little training is required for accurate measures of utilization

E. Limitations

1. These techniques are time consuming

2. Ungrazed plants/plots must be located or created with cages

3. The method is destructive because plots are clipped and new plots must be located after each sampling period.

F. The comparison between grazed and ungraed plots/plants can be accomplished in several ways:

1. Caged Comparison or Paired Plot Technique (pg 70-75 Interagency Tech. Ref.)

a. Within a key or critical area, small areas are protected from grazing with cages or small exclosures to create ungrazed plots.

b. Many designs for cages have been suggested (pg. 151-161 Interagency Tech. Ref.)

c. If ungrazed plots are located within permanent exclosures, caution must be taken to ensure that the area inside and outside of the exclosure are in the same ecological condition.

d. If temporary cages are used to create ungrazed plots, the cages must be moved every year; this can be time consuming.

2. Weight Before and After Grazing

a. Ungrazed plots can also be estimated, for comparison purposes, by clipping plots in the key area before the grazing period.

b. Grazed plots can be clipped during or after the grazing period and compared to the “before grazing” plots.

c. The problem is that plants are growing during the grazing period. Therefore this technique only works well:

(1) with very short grazing periods such as in short duration grazing

(2) in the dormant season when plant growth is low or not occurring

G. Actual Weight method (pg 103-108 Interagency Tech. Ref.) This is an individual-plant based method where utilization is estimated by comparing the average weight of grazed plants to ungrazed plants.

1. A series of ungrazed plants are located, clipped and weighed.

2. A series of grazed plants are located, clipped and weighed.

3. The % utilization is calculated (pg 107, Interagency Tech. Ref.)

a. Calc. the average weight of ungrazed plants

b. Calc. the total weight of all clipped plants as if none had been grazed.

c. Calc. the % of total production (weight) remaining

d. Calc. the % utilization

IV. Residual Biomass Estimates

A. Measurement of utilization is often criticized because it requires measurement of a fraction that has been removed (i.e., is no longer present). Additionally, the most important factor affecting the plant's ability to survive grazing is the amount of phytomass remaining not the amount removed. Therefore, several researchers have suggested that the amount of biomass remaining after grazing (residual biomass) should be measured.

B. Residual biomass can be measured by nearly all of the techniques designed to phytomass, forage, or biomass.

C. Advantages

1. Residual biomass can be directly and objectively measured

2. Some methods are easily used and require little training (e.g. stubble height)

3. The attribute being measured is physiologically and ecologically important

a. Affects plants ability to survive grazing

b. Maintains sufficient biomass to protect watersheds and riparian areas

c. Allows sufficient forage to remain for wildlife

D. Disadvantages

1. Several techniques (i.e. clip and weight) are quite time consuming.

2. The amount of biomass that should remain after grazing is often hard to determine and affected by season and topography.

3. Difficult to estimate mean residual biomass because of spatial variation:

    a. due to topographic, edaphic and hydrologic variation

    b. due to uneven distribution of grazing

E. Commonly used techniques from measuring residual biomass:

1. Stubble Height (pg 51-56 Interagency Tech. Ref.)

    a. Basically, the stubble height of grazed plants or the height of herbage left ungrazed is measured.

    b. Transects are appropriately placed through a critical or key area

    c. At predetermined intervals along the transect, the key plant nearest to the point is measured for average stubble height

    d. The average stubble height can then be calculated

    e. Acceptable stubble heights must be set by species and could vary by season.

    f. Stubble height techniques are currently being promoted because they are objective and can be used by managers and users of rangeland resources.

2. Comparative Yield (pg 62-69 Interagency Tech. Ref.) - Comparative yield is a double sampling method where the biomass in quadrats is compared to 5 reference quadrats . This technique is describes in the biomass estimation techniques section of this course and will not be repeated here.

3. Any method used to estimate biomass can be used to estimate residual biomass.

V. Browse Removal Estimation

A. Several techniques described above can be used to estimate browse utilization (e.g., stem count, utilization class, landscape appearance). However, many techniques designed for herbaceous plants are not well suited for browse. Therefore, several techniques specifically designed for shrubs have been proposed.

B. Twig Removal Method (pg 25-33 Interagency Tech. Ref.)

1. This method is used primarily on wildlife winter range.

2. Utilization is determined by measuring twigs on 25 to 50 browse plants after full annual growth has occurred and again after the period of use.

3. The difference between the two measurements is an estimate of the amount of browse that has been utilized.

4. Separate transects are run for different browse species.

C. Cole Browse Method (pg 34-42 Interagency Tech. Ref.)

1. This method provides data for the browse component of the plant community.

2. Browse plants along a transect are classified and assessed on:

    a. age and form class

    b. availability and hedging

    c. estimated utilization and growth

    d. use indexes

3. Different transects are required for different browse species

D. Extensive Browse Method (pg 43-50 Interagency Tech. Ref.)

1. A pace-transect method used to collect browse vegetation data

2. Plants along the transect are classified and assessed for:
    a. Species (to later determine species composition)
    b. Age class
    c. Form class
    d. Availability
    e. Hedging

Important References

Bonham, C.D. 1989. Monitoring and evaluation. pp. 265-315 In: Measurements for Terrestrial Vegetation. John Wiley & Sons, New York.

Cook, C.W., and J. Stubbendieck. Methods of measuring herbage and browse utilization. pp. 120-132. In: Range Research: Basic Problems and Techniques. Soc. For Range Mgmt., Denver, CO.

Interagency Task Force (Coop. Ext. Serv., USDA-Forest Service, USDA-Nat'l. Res. Cons. Service, and USDI-Bureau of Land Mgmt.) 1996. Utilization studies and residual measures. Interagency Technical Reference. BLM/RS-96/004+1730.