5.24 HEIGHT-WEIGHT METHOD. The Height-Weight Method involves the measurement of heights of ungrazed and grazed grass or grasslike plants to determine average utilization. Measurements of plant heights recorded along transects are converted to percent of weight utilized by means of a utilization gauge (Lomasson and Jensen 1943). The utilization gauge is developed from height-weight relationship curves. This method provides a mechanical tool which can be used for training, checking personal judgment, and promoting uniformity of results between examiners as well as for determining percent utilization.

a. Areas of Use. This method is adapted for obtaining utilization data where the key species are either bunch or rhizomatous/sod-forming grasses or grasslike species.

b. Advantages and Limitations. This method provides for uniform, accurate, and reliable utilization determinations for perennial grasses and grasslike species. It is an objective method; however, some estimation is required. Accurate utilization scales may not be available for the key species. The development of the height-weight relationship curves and preparation of utilization gauge scales can be time-consuming. This method is not used for determining utilization of forbs and shrubs.

c. Equipment.

(1) Study Location and Documentation Data Form. (See Illustration 1.)

(2) Utilization Study Data - Height-Weight Method Form. (See Illustration 5.)

(3) Utilization gauge. (See Illustration 6.)

(4) Utilization scales for key species. (See Illustration 6, pages 2 and 3.)

(5) Tape measure or ruler.

(6) Additional equipment needed to prepare utilization scales:

(a) Clipping shears 
(b) Thread 
(c) Paper trimmer (for clipping plants into segments) 
(d) Paper sacks 
(e) Scale calibrated in tenths of grams 
(f) Graph paper
(g) Blank card for utilization gauge.

d. Training. This method does not require intensive training for field application. Examiners must be able to identify the plant species. Examiners measure and record the height of grazed and ungrazed plants, determine the utilization of individual plants from the gauge, and calculate the average utilization by key species. (See Section 3, this Reference, and Section 4, Technical Reference 4400-1.)

e. Establishing Studies. Select key area(s) and key species and determine the number, length, and location of the transects. (See Section 3, this Reference, and Section 5, Technical Reference 4400-1.) Document the location and other pertinent information concerning a transect on the Study Location and Documentation Data Form. (See Illustration 1, this Reference, and Section 6, Technical Reference 4400-1.)

f. Sampling Process. Sample ungrazed and grazed plants encountered along a transect to determine the average ungrazed plant height and the average percent utilization. To secure reliable utilization determinations, it is essential to measure heights for an adequate number of ungrazed and grazed plants. The greater the variation in utilization between plants, the more plants required to determine the average utilization.

1. Measuring Plant Heights.
   
   (a) Best results are obtained by placing the measuring tape or ruler in the center of the bunch or turf circle, rather than along one side. The tape or ruler should not be forced down into the crown but should rest firmly on the cushioned portion of the plant.

   (b) Where rhizomatous/sod-forming grasses or grasslike plants are the key species, use a circle of turf two inches in diameter as one plant.

2. Sampling Plants

   (a) At each interval along the transect, select the plant of the key species (seedlings excepted) nearest the toe and measure the height of the plant to the nearest 1/4 inch. If plants are not evenly grazed, determine the average stubble height.

   (b) If the selected plant has not been grazed, record the height for that sample in the Ungrazed Height Column on Utilization Study Data - Height-Weight Method Form. (See Illustration 5.)

   (c) If the selected plant has been grazed, record the height for that sample in the Grazed Height Column on the Utilization Study Data - Height-Weight Method Form. (See Illustration 5.)
Section 5.24f(2)(d)

RANGELAND MONITORING - UTILIZATION STUDIES

(d) Measure at least twenty ungrazed plants to obtain a reliable cross section of ungrazed plant heights. If a sufficient number of ungrazed plants is not encountered along the transect on the key area, it may be necessary to extend the transect to pick up the additional ungrazed plant heights. In some cases it may be necessary to select, in a subjective manner, ungrazed plants on an adjacent area to determine average ungrazed plant height.

(e) Use only one kind of plant. When 80 percent or more of the plants measured produce culms or when 80 percent or more are without culms, the remaining 20 percent or less may be disregarded without great error.

(f) When a combination occurs with 80 percent or more culm-producing plants, and a plant lacking culms is encountered nearest the sampling point, measure the nearest culm-producing plant of the species. Corresponding procedure should be followed when the kind of plant selected is without culms and a culm-producing plant is encountered. These two combinations are those most commonly encountered in the field.

(g) When approximately equal numbers of culm and culm-less plants occur, measure plants of both kinds. The measurements for the plants with culms should be marked or kept separate on the form. Due precautions are necessary to use appropriate ungrazed heights and the correct utilization scales for plants with and without culms.

g. Calculating Percent Utilization. Calculate the percent utilization as follows:

(1) Divide the total of the ungrazed plant heights by the number of ungrazed plants sampled to calculate the average ungrazed plant height.

(2) Calculate the percent utilization of individual sampled plants of the key species with the gauge by using the "Average Ungrazed Height" and the height of the sampled plant. The sliding card in the gauge is pulled out of the envelope until the utilization scale for the key species appears in the window. The dial is then turned so that the number representing the previously calculated average ungrazed height is set at the arrow designated "Average Ungrazed Height". The percent utilization may then be read on the scale in the window opposite the number on the dial representing the measured stubble-height of the sampled plant. The utilization scale on the sliding card must fit the species being sampled. (See Section 5.24h.) Use the culmless curve for the key species when utilization studies are conducted on early growth of the plants.

(3) Calculate the average utilization for a key species by totaling the percent utilization for the individual sampled plants and dividing by the number of sampled plants of that species.
(4) Record the average height of ungrazed plants, percent utilization of individual sampled plants, and average percent utilization for the key species on the Utilization Study Data - Height-Weight Method Form. (See Illustration 5.)

h. Preparing Utilization Scales. Utilization scales used with the utilization gauge are prepared from height-weight curves developed for individual grass and grasslike species. Previously prepared utilization scales must be checked to see whether or not these scales fit the species on the rangeland where they will be used. (See Illustration 6, pages 2 and 3.) Where existing utilization scales do not fit, new scales will have to be prepared. Scales for a number of species are included on the same card.

(1) Developing Height-Weight Curves. Develop height-weight curves by collecting plants of a given species and determining the height-weight relationship for that species. The curve for any given species must be checked for variation between range sites and climatic regions. It is necessary to develop separate curves for culm-producing plants and culmless plants when a species only sporadically produces culms.

(a) Sampling Plants. Sample at least ten plants of a given species. Select only those plants which have reached maximum growth.

i. At each interval along a pace transect, choose the ungrazed plant of the given species nearest the toe. Use one square inch as a unit area for sod-forming species and a comparable number of stems as a unit area for single stem species.

ii. Remove all old leaves and stems of previous year's growth.

iii. Clip the plant to within 1/4 inch of the ground.

iv. Wrap the clipped plant with thread from base to top to retain all leaves and culms in their natural position.

v. Separate the plants with culms from plants without culms and consider each as a separate sample.

vi. Measure heights of clipped plants to the nearest inch and determine the average height.

vii. Calculate the number of plants that must be sampled to determine mean height with a standard error of ±3 to 5 percent at the 95 percent confidence level (Barrett and Nutt 1979, Freese 1962).

viii. Sample additional plants, if necessary.

ix. Measure the maximum height of each plant.
RANGELAND MONITORING - UTILIZATION STUDIES

**Section 5.24h(1)(a)**

x. **Clip the top 10 percent by height of each plant and place the clippings in a paper sack labeled 0 to 10 percent.** Clip additional height segments in 10 percent increments and place clippings in appropriately labeled sacks--11 to 20 percent, 21 to 30 percent, 31 to 40 percent, 41 to 50 percent, 51 to 60 percent, 61 to 70 percent, 71 to 80 percent, 81 to 90 percent, and 91 to 100 percent. A large paper trimmer with a guide to hold the plants in their proper position on the platform may be used to clip plants into segments. Label the sacks to show species, date, and location. Place a given height segment for all plants of a species collected in one paper sack.

xi. **Dry the clippings until a constant weight, to the nearest tenth of a gram, is achieved.** Leave clippings in the paper sacks for drying.

(b) **Determining Height-Weight Relationships.**

i. Weigh and record the weights for each of the ten height segments to the nearest tenth of a gram. Subtract sack weight before recording the dry weights of each height segment. (See Illustration 7.)

ii. **Total the dry weights of the ten height segments and record the total dry weight of the collected plants.** (See Illustration 7.)

iii. **Record the cumulative weight for each segment.** This includes the weight of the segment plus the weights of all preceding segments starting from the top of the plant. (See Illustration 7.)

iv. **Calculate the cumulative percent weight removed at each height segment by dividing the cumulative weight for each segment by the total weight and multiplying by 100.** (See Illustration 7.)

v. **Plot the cumulative percent height removed against the cumulative percent weight removed on graph paper.** The resulting curve portrays the height removed-weight removed relationship for the species. (See Illustrations 7 and 8.)

(2) **Transferring Data from Curves to Scales.** Transfer the height-weight relationship data portrayed on the height-weight curve to a utilization scale for use in the utilization gauge.

(a) **Turn the dial on the utilization gauge so that 10 inches is set at the arrow designated "Average Ungrazed Height."** With the dial set at 10, each inch increment from 9 to 0 on the dial represents 10 percent of the height. (See Illustration 9.)

(b) **Slide a blank card into the utilization gauge.**
(c) Use the height-weight curve to determine the percent height that would be removed when 10 percent, 15 percent, through 95 to 98 percent of the weight is removed. (See Illustrations 8 and 9.)

(d) Enter 10 percent, 15 percent through 95 to 98 percent weight removed on the scale in the window of the utilization gauge across from the point on the dial representing the corresponding percent height removed. With the dial set at 10 inches for "Average Ungrazed Height," the percent removed can easily be converted to inches removed. (See Illustration 9.)

(3) Documenting Scale Preparation. For each utilization scale prepared, maintain a record of the species, the data used to prepare the scale, the date the scale was prepared, and the areas of applicability.

5.25 ACTUAL WEIGHT METHOD. The Actual Weight Method involves the separate clipping and weighing of grazed and ungrazed plants along a transect. The difference between weights represents the amount of forage consumed by animals or otherwise destroyed during the period of use.

a. Areas of Use. The method is best adapted to clearly defined growth forms such as bunchgrasses. It is not recommended for areas where shrubs or rhizomatous plants are the key species. It can be used on sod-forming grasses if a small plot, 2 or 3 inches square, is used to delineate a unit.

b. Advantages and Limitations. The method is simple and accurate. It is restricted in use primarily to bunch and sod-forming grasses.

c. Equipment.

(1) Study Location and Documentation Data Form. (See Illustration 1.)

(2) Utilization Study Data - Actual Weight Method Form. (See Illustration 10.)

(3) Frames to delineate plots (if necessary).

(4) Clipping shears.

(5) Paper sacks.

(6) Spring scale, calibrated in grams.
<table>
<thead>
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<th>STUDY NUMBER</th>
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<th>EXAMINER</th>
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<table>
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<th>CULMLESS</th>
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</table>

<table>
<thead>
<tr>
<th>NUMBER OF UNGRAZED PLANTS</th>
<th>TOTAL HEIGHT OF UNGRAZED PLANTS</th>
<th>NUMBER OF SAMPLED PLANTS</th>
<th>TOTAL % UTIL FOR ALL SAMPLED PLANTS</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

| TOTAL HEIGHT OF AVERAGE UNGRAZED PLANTS | TOTAL PERCENT UTILIZATION | AVERAGE | |
|-----------------------------------------|---------------------------|---------|
|                                          |                            |         | 

NOTES (USE OTHER SIDE OR ANOTHER PAGE, IF NECESSARY)
# Utilization Study Data

## Height-Weight Method

**Study Number:** 0-3-21 8 Bar - 1

**Date:** 7/31/84

**Examiner:** Jack Border

**Allotment Name & Number:** Medicine Creek - 1083

**Pasture:** Spring Water

**Kind and/or Class of Animal:** Cattle - Cows & Calves

**Period of Use:** 7/1 - 9/30

## Key Species

<table>
<thead>
<tr>
<th>Height %</th>
<th>Height %</th>
<th>Height %</th>
<th>Height %</th>
</tr>
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<tbody>
<tr>
<td>1</td>
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<td>3</td>
<td>4</td>
</tr>
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<tr>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
</tr>
</tbody>
</table>

**Utilization Study Data**

- **Number of Ungrazed Plants:** 21
- **Total Height of Ungrazed Plants:** 272
- **Total % Util for All Sampled Plants:** 1039

\[
\text{Total Percent Utilization} = \frac{\text{Average Utilization}}{60} = \frac{17\%}{60} = 17\%
\]
INSTRUCTIONS FOR USE
A. Measure and record by species the heights of ungrazed plants total, and divide by the number to
determine average ungrazed height. If sufficient ungrazed plants do not occur on sampling area,
measure plants adjacent to it.

For seedstalk producing (culm) plants, measure tallest seedstalk to nearest 1"; non-seedstalk pro-
ducing (culmless) plants, the tallest leaf heights to 1/4".

B. Measure and record by species the heights of grazed plants. If plants are not cropped off evenly,
measure average stubble height of each plant.

C. Pull slide out of envelope until scale for species concerned appears in window.

D. Turn dial until average ungrazed height determined in "A" appears opposite Arrow so designated.

E. On dial find grazed heights recorded in "B" and opposite on slide read percent utilization for each
plant.

F. Repeat operation for each grazed height. total utilization percentages and divide by the total number
of plants. This gives average percentage utilization.
These utilization scales must be checked to see whether or not they fit the species on the rangeland where they will be used.

**Front Side of Card**

**Back Side of Card**
These utilization scales must be checked to see whether or not they fit the species on the rangeland where they will be used.
## Example Data Set for Determining Height-Weight Relationships for Preparing Utilization Scales

<table>
<thead>
<tr>
<th>Height Segment (percent)</th>
<th>Dry Weight by Height Segment (grams)</th>
<th>Cumulative Dry Weight (grams)</th>
<th>Cumulative % Height Removed</th>
<th>Cumulative % Weight Removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>2.8</td>
<td>2.8</td>
<td>10</td>
<td>0.9</td>
</tr>
<tr>
<td>11-20</td>
<td>5.6</td>
<td>8.4</td>
<td>20</td>
<td>2.6</td>
</tr>
<tr>
<td>21-30</td>
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<td>15.4</td>
<td>30</td>
<td>4.8</td>
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<td>75.7</td>
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</table>

322.5
Illustration 8

RANGELAND MONITORING - UTILIZATION STUDIES

EXAMPLE HEIGHT-WEIGHT CURVE USED FOR PREPARING UTILIZATION SCALES

Scientific Name and Code -
Common Name -
Culm Producing or Culmless Plants -
Allotment Name and Number -
Resource Area -
District -
Date -

Percent of Weight Removed

Percent of Height Removed
Rangeland Monitoring - Utilization Studies

Method for Transferring Data from Height-Weight Curves to Utilization Scales

Scientific Name and Code -

Common Name -

Date -

---

The percent height removed when 10%, 20%, etc., of the weight is removed is determined from the height-weight curve. (See Illustration 8.)