the same for all growth stages, 400 to 500 ppm nitrate-N, when recently matured blade tissue was analyzed (Fig. 1, 2, and 3). Shoots were as good as recently matured blades for determining the critical concentration at the early vegetative growth stage. However, as the plants matured, the shoots became less reliable indicators of the N status of the grass (Fig. 3 and 4). The critical concentrations for the shoots were 400, 600, and 1300 ppm nitrate-N, respectively, for the early vegetative, late vegetative, and late boot growth stages. The critical concentration for the shoots changed as the plants matured because the shoot composition was so dissimilar. An example of this dissimilarity was when the plants were in the late boot growth stage, the shoot samples were composed of immature seed heads, various stem sections, and leaves ranging from immature to senescent. In contrast, recently matured blades were reliable indicators of the N status of the grass at all growth stages because these blades were anatomically uniform and were the same physiological age regardless of plant maturity. The critical concentration of recently matured blade tissue was therefore similar, 400 to 500 ppm nitrate-N, at all growth stages. This critical nitrate-N concentration should be substantiated by further research under various rangeland conditions, even though the preponderance of evidence indicates (Reuther et al., 1958; van Burg, 1966) that true critical mineral concentrations in leaves of crops are essentially the same for a particular species in all environments favorable for plant growth.

LITERATURE CITED

Nutritive Value of Clipped and Grazed Range Forage Samples

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Highlight

Esophageal-fistulated yearling steers were grazed on shortgrass range units under a rotation and a seasonlong system. The digestibility and protein values of clipped grasses and sedges were compared to fistula samples from the two units. In a dry year clipped forages contained protein levels comparable to those found in fistula samples. In a year with abundant early moisture, annual forbs were produced in abundance. These forbs were grazed readily and brought about higher protein levels and dry matter digestibilities in fistula samples than in clipped samples, especially during the early part of the grazing season.

Forage nutrient evaluations in the past have been conducted using clipped samples. There is a ques-

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decreased and crude fiber increased in fistula samples with the length of the grazing period.

Weir and Torrel (1959) compared the chemical composition of clipped forage samples with those collected from esophageal-fistulated sheep. Protein contents were higher in the fistula samples. Crude fiber was higher in clipped samples of ungrazed forage than in fistula samples obtained from the same areas.

Methods of Procedure

The study area was located at the Archer Substation in southeastern Wyoming. The pastures from which both clipped and fistula samples were obtained were located in the rolling shortgrass plains area. The vegetation was dominated by blue grama (*Bouteloua gracilis*), buffalograss (*Buchloe dactyloides*), western wheatgrass (*Agropyron smithii*), and needleleaf sedge (*Carex elata*). Forbs made up a very minor component of the vegetation.

Esophageal-fistulated steers were grazed along with nonfistulated steers on two range units. One unit was grazed seasonlong (June 1–September 1). The second unit was divided into three pastures which were grazed in a rotation system. In 1966 fistula samples were collected during four-day periods near the middle of each month. In 1967 samples were obtained at the beginning and end of each rotation period, as well as during the middle of each month. Two fistulated steers were grazed on each unit in 1966 and three on each unit in 1967.

Forage samples were clipped during the same periods that fistula samples were obtained. The species clipped were blue grama, buffalograss, western wheatgrass, needleleaf sedge, needelandthread (*Stipa comata*), prairie junegrass (*Koeleria cristata*), Sandberg bluegrass (*Poa secunda*), and threadleaf sedge (*Carex filifolia*). Entire plants of each species were clipped to one inch stubble heights.

Both the clipped samples and fistula samples were dried and ground to pass a 40-mesh screen. Nitrogen analyses followed A.O.A.C. procedures (1960). In 1967 samples were digested in an artificial rumen using the technique described by Smith et al. (1965).

Utilization expressed as a percentage of weight removed was estimated, using the ocular estimate-by-plot technique (Pechanec and Pickford, 1937). Utilization estimates were made on both grazing units during the midmonth sampling periods and at the end of each month.

Results and Discussion

Protein Content

In 1966, early summer moisture (April 1–July 1) was quite restricted. A limited amount of growth was made by the cool season species, but the warm season grasses produced very little growth until late July.

### Table 1. Percent crude protein (%) in range grasses and sedges during the summer grazing season, 1966.

<table>
<thead>
<tr>
<th>Sampling Periods</th>
<th>June</th>
<th>July</th>
<th>August</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue grama</td>
<td>6.8</td>
<td>8.8</td>
<td>13.9</td>
</tr>
<tr>
<td>Buffalograss</td>
<td>—</td>
<td>6.3</td>
<td>8.9</td>
</tr>
<tr>
<td>Western wheatgrass</td>
<td>8.3</td>
<td>7.4</td>
<td>11.5</td>
</tr>
<tr>
<td>Prairie junegrass</td>
<td>9.6</td>
<td>8.2</td>
<td>—</td>
</tr>
<tr>
<td>Needleandthread</td>
<td>6.4</td>
<td>—</td>
<td>11.3</td>
</tr>
<tr>
<td>Threadleaf sedge</td>
<td>—</td>
<td>9.1</td>
<td>12.4</td>
</tr>
</tbody>
</table>

Average crude protein contents of forage samples clipped in 1966 are shown in Table 1. Protein levels were highest during the August sampling period following July rains. Old plant material interspersed with the current season's growth undoubtedly tempered analytical values. Old plant material was not removed from the samples since observations of both forage stubble and fistula samples indicated that cattle were either taking all of the plant material or leaving it entirely. There was no apparent selection by the animals to avoid the old material.

Protein contents of fistula samples obtained during 1966 are given in Figure 1. These values followed the data for individual forages quite closely.

Utilization data indicated that the major components of the steer diets were western wheatgrass during the June period and western wheatgrass with blue grama and needleleaf sedge during the July and August periods.

Crude protein levels in the forage samples clipped in 1967 are shown in Table 2. There was a relatively uniform decline in protein content throughout the grazing season. Protein content declined from a range of 12.5 to 19.6% on June 1 to a range of 3.4 to 7.9% on August 31.
Table 2. Average crude protein content (%) of range grasses and sedges, 1967.

<table>
<thead>
<tr>
<th>Species</th>
<th>June 1</th>
<th>June 15</th>
<th>July 1</th>
<th>July 15</th>
<th>July 28</th>
<th>Aug. 15</th>
<th>Aug. 31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western wheatgrass</td>
<td>16.3</td>
<td>14.5</td>
<td>8.2</td>
<td>10.2</td>
<td>8.0</td>
<td>6.3</td>
<td>4.7</td>
</tr>
<tr>
<td>Blue grama</td>
<td>16.3</td>
<td>14.8</td>
<td>9.4</td>
<td>12.9</td>
<td>7.9</td>
<td>7.1</td>
<td>6.0</td>
</tr>
<tr>
<td>Buffalograss</td>
<td>19.6</td>
<td>12.7</td>
<td>13.3</td>
<td>10.2</td>
<td>8.6</td>
<td>3.3</td>
<td>6.1</td>
</tr>
<tr>
<td>Needleandthread</td>
<td>15.2</td>
<td>11.6</td>
<td>8.1</td>
<td>6.7</td>
<td>5.5</td>
<td>3.4</td>
<td>3.4</td>
</tr>
<tr>
<td>Sandberg bluegrass</td>
<td>12.5</td>
<td>9.7</td>
<td>7.6</td>
<td>7.1</td>
<td>6.8</td>
<td>5.6</td>
<td>6.3</td>
</tr>
<tr>
<td>Prairie junegrass</td>
<td>13.3</td>
<td>10.6</td>
<td>9.4</td>
<td>7.9</td>
<td>7.5</td>
<td>5.9</td>
<td>4.7</td>
</tr>
<tr>
<td>Needleleaf sedge</td>
<td>16.9</td>
<td>13.6</td>
<td>11.8</td>
<td>12.4</td>
<td>9.6</td>
<td>7.9</td>
<td>7.9</td>
</tr>
<tr>
<td>Threadleaf sedge</td>
<td>15.1</td>
<td>12.4</td>
<td>11.4</td>
<td>10.4</td>
<td>7.6</td>
<td>2.9</td>
<td>5.9</td>
</tr>
</tbody>
</table>

The early summer rainfall during 1967 was three times that during the same period in 1966. With this higher rainfall, a large amount of annual forbs developed. The steers sought and grazed the annual mustards (Cruciferae), fireweed summcypress (Kochia americana), and Russian thistle (Salsola kali). Annual forbs such as these are high in protein while green and growing. Crude protein in the fistula samples generally exceeded protein levels in the clipped grasses and sedges (Figure 2).

The discrepancies between the protein levels of steers grazing under the two systems were largely a function of the availability of annual forbs. When the steers were first introduced into a previously ungrazed pasture, the quantity of forbs grazed was large and the protein content in the diet was high. At the end of each rotation period, the animals were afforded little opportunity for selection and their diets contained less protein than diet samples from the seasonlong unit.

**In Vitro Digestion**

Clipped forage samples were digested in an artificial rumen (Table 3) and in vivo dry matter digestibilities were predicted from the results. Statistical analysis indicated significant differences between some species, although the actual differences were small. There was no appreciable decline in digestibility observed with advancing plant maturity over the period included in this study.

Predicted digestibilities of fistula samples showed greater variability than was found in the clipped forage samples (Figure 3). Increases in digestibilities were found in diet samples from the rotation unit when the steers were moved to a new pasture. Undoubtedly, these reflect the selection of annual forbs. As the opportunity for selection of the diet decreased due to heavier use, diets from the two grazing systems showed closer agreement. Digestibility of fistula samples did not decline appreciably with advancing plant maturity.

**Summary and Discussion**

Protein content and digestibility of fistula samples were compared to those of clipped range grasses and sedges, 1967.
and sedges. Samples were collected at monthly intervals during June, July and August of 1966 and at two week intervals during the same period in 1967. The clipped forages represented the major grasses and sedges found on the shortgrass range land. The fistula samples were obtained from a study comparing the nutrient intake of steers under seasonlong and rotation grazing.

Protein contents were determined from nitrogen analyses of all samples. In vitro digestion (artificial rumen) was used to estimate dry matter digestibilities of samples collected in 1967.

In 1966 protein levels of fistula samples were very similar to those of clipped samples. Early summer rainfall was limited and growth of the warm season grasses did not commence until late July. Highest protein levels in both clipped and fistula samples were observed during the August period.

In 1967 rainfall during the early summer period was high and large quantities of annual forbs developed. Fistula samples reflected the grazing of these forbs with protein levels generally higher than those found in the clipped grasses and sedges. Fistula samples from steers grazing under the rotation system indicated the effect of grazing intensity on forage selection. At the beginning of each rotation period these fistula samples were higher in protein and digestibility than samples from the season long unit. At the end of each rotation period, protein and digestibility were equal or lower. Digestibility of fistula samples tended to be higher than for clipped samples during June and July and were similar during August. Little decline in the digestibility of clipped or fistula samples was noted during the sampling period.

Competitive Uses of Nevada’s Range Forage

by Livestock and Big Game

The following comments are condensed from a report by A. L. Lesperance and Paul T. Tueller which appeared in the January 1969 issue of RNR Reports, published by the Renewable Resource Center, University of Nevada Cooperative Extension Service.

Primarily because of increased public recreational demands, considerable recent emphasis has been placed on the competition between livestock and big game species. A better understanding of this problem is urgently needed if the range livestock industry is to hold its position in multiple use management of public lands.

Total forage requirements of meat animals (sheep and cattle) are 7.9 million AUMs, one AUM being here defined as 600 lbs. of forage. Approximately 52% of this forage comes from range sources, the remainder from irrigated lands. Of the total range forage requirements, about 55% comes from BLM lands, 6% from National Forests, and 41% from private sources.

Forage utilization by big game cannot be clearly defined, but it is projected that big game species utilize 0.75 million AUMs of range forage annually.

In 1967 the meat animal industry in Nevada generated $77.4 million into the state economy: it is estimated that big game hunting contributes $4.6 million annually. It appears, therefore, that livestock contributes about 17 times more to the economy of Nevada than does big game, but uses less than 6 times as much range forage to do it.

A review of the literature on grazing habits suggests that on grass-brush vegetative types, livestock will consume primarily grass while big game species strongly prefer browse. Research on the botanical composition of cattle and deer diets indicates the following percentages of grass, browse, and forbs respectively in the diets:

- Cattle: 73% grass, 19% browse, 8% forbs
- Deer: 6% grass, 80% browse, 13% forbs

The data also indicate that these two animal species do not necessarily consume the same browse species—50% of the browse species consumed by deer have yet to be found in the diets of grazing cattle, and 25% of the deer diet consists of browse species only occasionally taken by cattle. Bitterbrush generally appears to be the most important browse species selected in common by cattle and deer. However, data from California foothill ranges indicate that proper cattle management can improve bitterbrush stands.

The successful management of (cont'd on p. 215)