Esophageal, Fecal and Exclosure Estimates of Cattle Diets on a Longleaf Pine-Bluestem Range

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Abstract

Microhistological analysis of esophageal or fecal materials provides an accurate and efficient method for evaluating botanical compositions of cattle diets on native longleaf pine-bluestem range. For practical purposes fecal analysis is the preferred method. Plant species that were most important to cattle during the present study were the bluestems and panicums.

Southern pine ecosystems serve as range for livestock and wildlife. These forest ranges have potential for high production of red meat with minimum inputs (Pearson and Whitaker 1974; Pearson 1975; Sternitzke and Pearson 1975). Cattle impact on ecosystems is related to the animal's dietary needs, preferences, and available forage.

The purpose of this study was to estimate cattle diets on longleaf pine-bluestem range. Specific objectives were to contrast cattle diets estimated from esophageal and fecal samples with estimates obtained from exclosures.

Study Areas

This study was conducted from April 1971 through March 1974 on the Palustris Experimental Forest in central Louisiana. A stand of second growth longleaf pine *(Pinus palustris)* (≃ 15-years-old) existed on the area. Predominant herbaceous vegetation was pinehill bluestem *(Andropogon scoparius)*. Other bluestem grasses were prominent, as were the panicums (*Panicum* spp.) and paspalums (*Paspalum* spp.). Principal browse included southern waxmyrtle *(Myrica cerifera)*, oaks (*Quercus* spp.), blackberries (*Rubus* spp.), and blueberries (*Vaccinium* spp.).

Methods and Procedures

Range utilization and production were determined by a paired plot technique similar to the plucked quadrat method (Grelen 1967). Sixty pairs of quadrats (≃ 1m^2, one in an exclosure, one grazed) were randomly established throughout the range. Quadrats were paired on the basis of herbage composition. Herbage in each exclosure was plucked to the height of plants in quadrats that were grazed and was oven-dried to a constant weight. The clippings from each plant species were weighed and clippings from all species were mixed together to simulate a cattle diet. Since the actual dry weight compositions of these mixtures were known, they were used as quality control samples to test technician accuracy during microscopic analysis.

In March 1971, esophageal and rumen fistulas were installed in crossbreed Brahman heifers. Samples of forage were collected from esophageal fistula on three consecutive days at monthly to bimonthly intervals for the grazing seasons of 1971–1973. Due to fistula problems one of the animals was omitted from the study after the first collected period and only two esophageal fistulated cattle were used for the remainder of the study. The fistulated cattle were allowed to graze freely for about 1 hr or until 3–4 liters of forage had collected in fistula bags; grazing began about 7 a.m. on each collection day. Fecal samples were taken by rectal palpations from six intact animals during the first year; only three of the animals were used in subsequent years, and sampling was done to coincide with esophageal collections. Esophageal and fecal samples were oven-dried and ground through a 1-mm screen. Individual samples were analyzed to study variation among cows and days. Each collection period, subsamples were composited to make one sample for all cows and all days.

Diet and quality control samples were analyzed by a microscope method (Sparks and Malechek 1968). Five slides were prepared and 20 fields were quantified for each slide so that a total of 100 fields were quantified for each sample. About 6 months training and development of reference plant materials were necessary prior to diet sample evaluations. Known mixtures prepared from exclosure clipping were used as quality control samples. Data were compared using Kulczynski's similarity index and correlation procedures (Johnson 1979). Similarity indices were treated as normally distributed, independent variables. Results reported here as means ± SE.

Results and Discussion

Cattle consumed large amounts of grasses and more than 50% of all diets were bluestems (Table 1). It was not possible to distinguish different bluestems from each other by microscope analysis. Because we usually observed cattle taking pinehill bluestem and since it is very abundant in comparison to other bluestems, we believe that pinehill bluestem makes up most of this category. Panicums were the second most important diet category, making up about 10% of the dry matter ingested. A large variety of browse and forbs were taken in small amounts.

Pine needles constituted more than 8% of fecal materials but were probably over-estimated. The coarse textured, highly suberized needles are readily recognized in fecal samples compared to fragments from most plants.

There were certain other differences in esophageal compared to fecal samples. Esophageal samples were cleaner and less digested so that plant fragments were easier to identify. A few forbs that were in the esophageal samples were not detected in fecal samples but fragments of plants that made up as little as 1% of esophageal contents were recognizable after digestion.

Compositions of test mixtures were estimated within 5% for individual plants and the total difference between plants in any test mixture and a technician's estimate of the percentages for all the

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Authors thank Helen Wofford for technical assistance in the laboratory. Harry Jacobson provided some of the reference materials used during the study. This research was conducted under Cooperative Agreement No. 19-276 between the Southern Forest Experiment Station and Mississippi Agricultural and Forestry Experiment Station.

Manuscript received October 1, 1979.

Table 1. Average (X ± SE) estimates of a cattle dietary composition (%) on longleaf pine-bluestem range in central Louisiana. Estimates were obtained by examination of exclosures, and esophageal and fecal samples.

Foods[1]	Exclosure method	Diet estimates	
		Esophageal samples	Fecal samples
Bluestems (*Andropogon* spp.)	57.3 ± 3.0	57.1 ± 2.3	54.0 ± 2.1
Arrowfeather threeawn *(Aristida purpurascens)*	2.8 ± 0.5	2.4 ± 0.3	5.6 ± 0.6
Common carpet grass *(Axonopus affinis)*		tr	tr
Purple lovegrass *(Eragrostis spectabilis)*	2.7 ± 0.5	4.0 ± 0.7	2.9 ± 0.4
Bearded skeletongrass *(Gymnopogon ambiguus)*	1.8 ± 0.4	1.2 ± 0.2	2.0 ± 0.4
Cutover muhly *(Muhlenbergia expansa)*	4.4 ± 0.8	1.0 ± 0.2	1.0 ± 0.9
Carolina jointtail *(Manisuris cylindrica)*		1.5 ± 0.8	1.0 ± 0.9
Panicums (*Panicum* spp)	13.7 ± 1.4	10.5 ± 1.3	10.6 ± 1.3
Paspalums (*Paspalum* spp)	1.9 ± 0.3	1.6 ± 1.3	1.1 ± 0.4
Knotroot bristlegrass *(Setaria geniculata)*		1.6 ± 1.3	1.7 ± 0.4
Yellow indiangrass *(Sorghastrum nutans)*		tr	tr
Prairie wedgescale *(Sphenopholis obtusata)*	tr	1.2 ± 0.4	1.7 ± 0.3
Uniolas *(Uniola laxa)*	tr	tr	1.0 ± 0.5
Sedges and rushes (*Carex* spp and *Juncus* spp)	tr	1.2 ± 0.3	2.8 ± 0.8
Swamp sunflower *(Helianthus angustifolius)*	1.3 ± 0.3	tr	tr
Hymenopappus *(Hymenopappus artemisiaefolius)*	3.4 ± 1.1	4.8 ± 1.2	1.9 ± 0.5
Unidentified legumes (Leguminoseae)	2.7 ± 1.0	tr	tr
Unidentified composites (Compositae)	5.2 ± 1.2	3.4 ± 1.2	1.7 ± 0.6
Flowering dogwood *(Cornus florida)*		1.5 ± 0.5	tr
Southern waxmyrtle *(Myrica cerifera)*	2.4 ± 1.2	1.6 ± 0.5	
Longleaf pine *(Pinus palustris)*	2.8 ± 0.7	4.7 ± 1.0	8.5 ± 1.7

[1]Other plants identified in trace (<1%) amounts were: pineywoods dropseed *(Sporobolus junceus)*, purpletop tridens *(Tridens flavus)*, showy partridgepea *(Cassia fasciculata)*, littleleaf tickclover *(Desmodium ciliare)*, daisy fleabane *(Erigeron strigosus)*, white eupatorium *(Eupatorium album)*, southern brackenfern *(Pteridium aquilinum)*, slender rosinweek *(Silphium gracile)*, pencilflower *(Stylosanthes biflora)*, Virginia tephrosia *(Tephrosia virginiana)*, American beautyberry *(Callicarpa americana)*, Japanese honeysuckle *(Lonicera japonica)*, oaks (*Quercus* spp.), poison-ivy *(Rhus radicans)*, blackberry (*Rubus* spp.), sassafras (*Sassafras albidum)*, greenbriers (*Smilax* spp.), huckleberry (*Vaccinium* spp.), summer grape *(Vitis aestivalis)*, and unidentified grasses and browse.

species in any mixture was never greater than 10%. Microscopic estimates from quality control samples were highly (87 ± 1%) similar to the actual exclosure clippings and estimates of botanical composition were significantly correlated ($p < 0.05$) with actual dry weight compositions (Table 2). This supports the hypothesis that all plants eaten by cattle were detected in esophageal or fecal samples; and the proportions of plants were accurately estimated. Diets were 72 ± 4% similar among cows and 68 ± 2% similar among days. The high similarities observed in these comparisons suggests that the number of days and/or cows used in the study were sufficient for extrapolating results to a larger population.

Estimates from esophageal and fecal samples were about 90% similar but each of these diet estimates was less than 80% similar to data obtained from exclosures. Regardless of the technique, all three diet estimates were highly correlated ($r = 0.99$). Exclosures provide data on plants removed by all herbivores in an ecosystem so that data are not representative of cattle diets alone. Utilization is difficult to detect when it is light (Smith and Shandruk 1979). Data obtained here were reasonable estimates of cattle diets because utilization was heavy.

Reasons for doubting the accuracy of diet estimates obtained from fecal analysis have been recently, adequately stated (Smith and Shandruk 1979). Smith and Shandruk (1979:279) said that more work was needed before fecal analysis could be evaluated as a technique for quantifying ruminant diets even though their pooled estimates of rumen and fecal contents were more than 85% similar. There is considerable controversy over the accuracy of fecal analysis to the point that persons on both sides of the issue hold on to their prejudices regardless of the body of data available, even if it is their own. However, reliable data can be obtained from fecal analysis in spite of these criticisms when technicians are carefully trained (Johnson 1979).

Microscope analysis of botanical compositions is as much an art as it is a science. Technicians must be trained in a program designed to build their confidence and skills for accurately quantifying compositions of mixtures. We know of no investigators with carefully trained technicians who reported an inability to find plants in feces that made up significant proportions of an animal's diet, and results have been within reasonable limits (Free et al. 1979; Voth and Black 1973; Anthony and Smith 1974; Dearden et al. 1975). In addition, our results demonstrate the technicians can be trained to accurately estimate compositions of plant mixtures when grasses and different forbs (which may fragment in different ways) are found in the same mixtures.

For the practical purposes of sampling without killing animals and avoiding the problems associated with utilization techniques, fecal analysis is the superior method for estimating diets of herbivores.

Table 2. Botanical compositions (%) of quality control mixtures (A) compared to estimated compositions obtained by microhistological analysis. (B).

	June 1971		July 1971		Sept 1971		Dec 1971		Jan 1972	
Plant taxa	A	B	A	B	A	B	A	B	A	B
Bluestems	79	74	67	61	44	44	62	60	46	50
Panicums	tr	4	8	8	8	7	16	17	11	15
Paspalums	2	2	3	3	2	1		2	tr	tr
Cutover muhly	7	6	1	3		1	6	6	13	10
Other grasses	2	4	9	12	31	22	11	7	22	19
Grasslikes								tr	tr	1
Composites	4	5	6	12	8	20	3	5	7	9
Legumes	4	5	2	1	1		tr	1		2
Other forbs	2		4		6		2			
Pine						5		2	3	
	Mar 1972		May 1972		June 1972		Aug 1972		Sept 1972	
Bluestems	25	24	68	52	71	64	49	44	47	48
Panicums	30	20	6	12	5	9	6	11	7	6
Paspalums	0	3	2	3	2	1	1	1	tr	4
Cutover muhly	16	14	2	4	2	3	2	3	4	1
Other grasses	4	8	9	10	7	11	15	19	23	27
Grasslikes	5	1	1	3	tr	1				tr
Composites	20	25	7		10	11	15	21	14	14
Legumes		1	5	3	0	12	1	5	tr	
Other forbs				4						
Pine										
	Nov 1972		Dec 1972		Feb 1973		May 1973		July 1973	
Bluestems	54	42	42	39	52	46	45	46	50	35
Panicums	10	15	21	20	19	25	16	16	12	17
Paspalums				2	1	1	5	3	1	2
Cutover muhly	4	6	2	2	2	2	3	5	1	3
Other grasses	17	18	24	16	13	17	12	15	15	21
Grasslikes				1		2	1		tr	1
Composites	14	14	11	18	10	2	10	11	11	15
Legumes	1	3			3	5	6	3	10	6
Other forbs								1		
Pine		2		5						
	Sept 1973		Dec 1973							
Bluestems	37	33	38	44						
Panicums	12	19	22	23						
Paspalums	3	2	tr	1						
Cutover muhly	2	3	4	7						
Other grasses	20	24	18	8						
Grasslikes		tr								
Composites	18	17	14	8						
Legumes	8	2	4	4						
Other forbs										
Pine				5						

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