Pasture characteristics affecting spatial distribution of utilization by cattle in mixed brush communities

M. KEITH OWENS, KAREN L. LAUNCHBAUGH, AND J.W. HOLLOWAY

Abstract

Utilization patterns of cattle were related to pasture characteristics in a nonrandom and complex manner. Six mixed brush pastures on the Rio Grande Plains (244–356 ha) that were topographically flat and homogeneous in soil type and range sites were studied. Two experiments were conducted: the first experiment was conducted when green forage was abundant and the second under conditions of little vegetative regrowth. A total of 340 random points were characterized for amount, frequency, and greenness of both grasses and forbs, brush and shade tree density, and distance to nearest fence, road, and water. These are variables that can be altered with management practices. When green forage was abundant, factor analysis identified 5 orthogonal factors (green herbage availability, grass quantity, brush abundance, remoteness from roads, and water availability) which accounted for 70% of the communal variation. Six factors (brush abundance, grass quantity, green forb frequency, road location, fence proximity, and water availability) accounted for 70% of the communal variation when herbage was limited. Regression analyses predicting percent utilization from the orthogonal factors indicated that when green forage was abundant, utilization was related largely to green herbage availability, grass quantity, brush abundance, and remoteness (R^2 = 0.54, RSD = 0.114). Remoteness, brush abundance, green forb frequency, and water availability were the factors associated with utilization when forage was limited (R^2 = 0.45, RSD = 0.152). Green herbage availability was less important under conditions of limited forage. In mixed brush communities, the actual amount of grass, brush abundance, and remoteness were the major factors affecting utilization.

Key Words: landscape, cattle foraging patterns, pasture spatial utilization

Uniform grazing distribution is desirable for grazing management because of positive impacts on current and potential grazing capacity. A manager must be able to assess, modify, and predict animal use patterns to improve grazing distribution. This requires knowledge of pasture characteristics which affect grazing distribution.

Management techniques proposed to improve grazing distribution include water development, fencing, strategic salt placement, herding, burning or mowing, brush control, and grazing system development (Williams 1954, Dodds 1981, Holechek et al. 1989). The economic feasibility of any of these practices depends on cost and success in altering utilization patterns (Workman and Hooper 1968). However, the impact of these modifications on grazing distribution is not well understood (Senft et al. 1985).

Studies of pasture characteristics which affect utilization patterns have provided descriptive (Mueggler 1965, Cook 1966, Clary et al. 1978, Roath and Krueger 1982) and in some cases predictive (Senft et al. 1983, Senft et al. 1985, Smith 1988) results. Factors affecting cattle utilization patterns vary greatly among studies but because the studies were correlative in nature, the results are localized and are not applicable to areas with radically different terrains (Senft et al. 1983, Smith 1988). In addition, the majority of landscape use studies were conducted in mountainous regions where topography and range site were important factors affecting utilization patterns (Mueggler 1965, Cook 1966, Senft et al. 1985). Complex topographic and plant community interactions make it difficult to isolate management factors affecting utilization.

Mechanisms governing habitat selection by cattle are complex and largely unknown. From a management standpoint, it is not necessary to produce detailed mechanistic models of livestock distribution if utilization patterns can be adequately predicted from pasture characteristics. Knowledge of pasture characteristics which affect utilization could lead to development of pasture management resulting in increased foraging capacity and uniformity (Smith 1988), and greater control of livestock diet selection and nutrient intake (Senft et al. 1983).

In this study, topography and range site were reduced as sources of impact on grazing pattern by selecting pastures which were uniform in range site and topographically flat. The objectives of this study were: (1) to determine if forage utilization by cattle is spatially random in relatively homogeneous pastures and if not (2) to identify the impact of pasture characteristics which can be controlled by management such as pattern of habitat structure, forage quality and quantity, brush density, shade, and the distance to the closest water, fence, and road on the distribution of utilization.

Materials and Methods

Field Data Collection

The research was conducted on the Texas Agricultural Experiment Station George Lyles Ranch near Uvalde, Texas (29° lat. 99° 52′ long.). The study area was on a silty clay loam range site located on nearly level upland with 9.1 m maximum topographic relief. The vegetation of the research area was a low, mixed-brush savannah with a grass understory. The dominant shrubs were mesquite (*Prosopis glandulosa* Torr.), twisted acacia (*Acacia tortuosa* Willd.), cat claw (*Acacia greggii* Gray), and spiny hackberry (*Celtis pallida* Torr.). The dominant grasses were Wrights three awn (*Aristida wrightii* Nash), red grama (*Bouteloua trifida* Thurb.), and buffelgrass (*Cenchrus ciliarus* L.). The distribution of plant species was uniform between all the pastures. Within each pasture, however, the distribution of plants was dependent on previous grazing history and mechanical treatment.

The region's long term annual precipitation averages 57.2 cm, occurring mainly in the spring and fall. An extremely wet spring preceded the study with 59.1 cm of precipitation falling from January to June 1987. However, the study period (July 1987 to April 1988) was dry with only 8.2 cm of precipitation. Thus, vegetation production was high at the beginning of the study but little regrowth occurred subsequently.

Uniform and patterned arrangements of vegetative structure were investigated using 6 pastures (3 uniform and 3 patterned) ranging from 244 to 356 ha. Patterned pastures were developed in 1985 by gridding the pastures in 185 × 750 m areas which were either (1) rootplowed, roller chopped and planted to buffelgrass; or (2) sprayed with .45 kg active ingredient of picloram and clopyralid; or (3) left as native brush. These treatments resulted in reduced

At the time of the research, authors were assistant professor, research associate, and professor, Texas Agricultural Experiment Station, 1619 Garner Field Road, Uvalde, Texas 78801. K.L. Launchbaugh is currently a graduate assistant, Range Science Department, Utah State University, Logan, Utah 84322.

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shrub canopy and increased grass and forb composition for 2/3 of each treated pasture. Uniform pastures were shredded in the early 1980's and regrowth of the shrub component was even-aged and of uniform height. Prior to this experiment the pastures were grazed in a 2 herd-3 pasture system.

The relationship between pasture characteristics and utilization patterns was studied in 2 experiments. Each experiment consisted of a pretreatment vegetation measurement period, grazing period, and a post-grazing period during which utilization was estimated. Pregrazing vegetation measurements were made on ungrazed, current season growth when biomass was high. Pregrazing measurements for the second experiment were made in the same pastures on grazed vegetation with little available regrowth. Pastures were measured and grazed in a sequential manner (Table 1). Pre- and post-grazing measurements were made within 1 week of the beginning and end of grazing in each pasture. Each pasture was grazed for 7 weeks by a total of 88 cow/calf pairs and yearling heifers. After the first experiment, each pasture was rested for 14 weeks before the second experiment began.

Table 1. Grazing schedule.

	Spatial arrangement					
	Uniform			Patterned		
Grazing dates	1	2	3	4	5	6
High biomass						
July 20 – September 7	x[a]			x		
September 7 – October 19		x			x	
October 19 – November 30			x			x
Low biomass						
November 30 – January 18	x			x		
January 18 – February 29		x			x	
February 29 – April 11			x			x

[a]Grazed during this time.

Twenty points in each pasture were randomly located during the first sampling period but sample size was increased to 30 thereafter to provide better spatial coverage of the pastures. At the end of both experiments, a total of 340 points had been sampled. Logistical restrictions prohibited sampling more than 30 points per pasture. The same sampling points were used in both experiments and these points were considered the experimental units. Each sampling point was characterized by 12 explanatory variables: grass and forb biomass and greenness, preferred and nonpreferred grass frequency, forb frequency, brush and shade tree density, and shortest distance to nearest fence, road, and water and the dependent variable of utilization (Table 2).

Six, 50-pace (15 m) transects were established radiating at 30° C increments from each sampling point for estimating utilization and percent green biomass. Utilization was defined as the proportion of use on the closest grass species at each paced step based on a subjective estimate dependent upon relative height per unit of basal diameter and categorized into 0, 1-10, 11-30, 31-50, 51-70, 71-90, or 91-100% categories. The same categories of classification were used for greenness as for utilization. Distance to roads, water, fence, and brush and shade tree density were determined for each point at the beginning of the study. All other variables were recorded at the beginning of each grazing period. Brush density of plants <2 m was estimated by counting all shrubs in 3 belt transects (1 × 15 m) which originated at the sampling point. Due to past brush control treatments in the early 1970's, shrubs were of a uniform height although canopy diameter varied according to plant species. Grass species were categorized as being either preferred or not according to known palatability and nutritional value (Blankenship et al. 1982). The number of shade trees (shrubs taller than 2 m) within a 15 m radius of each point was counted.

Grass and forb biomass were estimated in 6 randomly located plots at each point. Biomass was determined using a double sampling technique (Cook and Stubbendeick 1986).

Table 2. Mean and standard error of independent variables and utilization for 6 experimental pastures.

	Spatial Arrangements											
	Patterned						Uniform					
Pasture area (ha)	A		B		C		A		B		C	
Variables	337		267		244		356		324		244	
	High Biomass											
Utilization (%)	33.3	(2.6)	47.1	(3.1)	58.8	(1.8)	(30.9)	(2.0)	42.1	(1.5)	57.7	(2.2)
Grass biomass (kg/ha)	615.8	(126.6)	569.2	(100.2)	522.4	(109.4)	559.9	(97.7)	444.3	(47.7)	274.1	(46.6)
Forb biomass (kg/ha)	594.3	(96.5)	209.8	(26.1)	60.0	(10.3)	323.7	(57.1)	115.2	(14.4)	60.2	(8.5)
Grass greenness[1]	4.3	(0.2)	2.8	(0.2)	1.4	(0.1)	4.0	(0.1)	1.8	(0.1)	1.3	(0.1)
Forb greenness[1]	5.8	(0.1)	5.1	(0.1)	3.6	(0.3)	5.6	(0.1)	4.2	(0.2)	4.1	(0.2)
Herb greenness[1]	5.1	(0.1)	3.4	(0.2)	1.8	(0.1)	4.5	(0.1)	2.2	(0.1)	1.8	(0.1)
Grass frequency (%)	25.6	(4.2)	25.8	(2.2)	23.7	(2.1)	34.8	(2.0)	30.9	(1.7)	25.5	(2.8)
Forb frequency (%)	18.3	(1.8)	8.2	(0.8)	3.7	(0.5)	16.6	(1.6)	4.8	(0.4)	4.6	(0.6)
n	20		30		30		20		30		30	
	Low Biomass											
Utilization (%)	70.4	(2.5)	69.6	(2.0)	29.9	(2.0)	61.2	(1.8)	65.9	(2.1)	50.8	(2.7)
Grass biomass (kg/ha)	248.7	(62.7)	18.5	(36.3)	167.3	(32.6)	193.8	(37.3)	189.7	(30.2)	127.7	(37.4)
Forb biomass (kg/ha)	55.6	(37.0)	6.2	(1.6)	25.4	(7.5)	5.1	(1.3)	1.7	(0.7)	12.0	(2.8)
Grass greenness[1]	1.4	(0.1)	3.3	(0.1)	4.3	(0.1)	1.3	(0.1)	1.9	(0.1)	2.5	(0.2)
Forb greenness[1]	5.2	(0.1)	5.7	(0.1)	5.9	(0.1)	5.1	(0.2)	4.0	(0.4)	5.8	(0.1)
Herb greenness[1]	2.6	(0.2)	3.7	(0.1)	4.8	(0.1)	2.4	(0.2)	2.0	(0.1)	3.1	(0.2)
Grass frequency (%)	17.9	(2.2)	15.6	(1.1)	15.0	(1.4)	18.3	(1.5)	19.7	(1.1)	15.2	(1.8)
Forb frequency (%)	5.4	(0.5)	3.6	(0.5)	5.5	(0.7)	6.3	(0.8)	1.5	(0.2)	3.1	(0.5)
n	30		30		30		30		30		30	
	High and Low Biomass											
Brush dens, (stems/ha)	4147.0	(300.7)	4092.2	(320.7)	4469.6	(327.9)	6495.7	(298.20)	5027.0	(228.0)	4565.8	(234.9)
Shade trees (#/1000²)	4.4	(1.3)	2.7	(0.56)	5.1	(0.8)	7.2	(1.0)	3.8	(0.4)	12.0	(1.8)
Distance to fence (m)	257.5	(26.9)	191.7	(19.4)	241.8	(21.4)	187.1	(20.1)	199.2	(17.9)	204.2	(21.1)
Distance to road (m)	256.5	(22.1)	154.3	(15.8)	173.2	(16.0)	389.2	(28.5)	219.0	(20.9)	147.8	(12.9)
Distance to water (m)	780.1	(51.7)	605.8	(42.0)	675.0	(25.1)	881.8	(49.9)	901.7	(61.2)	648.5	(37.2)

[1]See text for an explanation of the units in estimating greenness.

Statistical Analysis

Initial analyses of variance employed a split plot design in which pattern of vegetative structure (patterned vs. uniform structure) was the main plot and experiment (high biomass vs. low biomass) was the subplot. These analyses indicated that distribution of utilization varied greatly among pastures and between experiments but not between vegetative structures. Subsequent analyses were conducted for each experiment separately and designed to determine: (1) if pattern of utilization within these pastures was random and (2) what characteristics of a particular point attracted cattle to utilize vegetation at that point. Nonrandomness was assessed by having a nonzero correlation coefficient associated with a statistically significant model. At the outset, it was hypothesized that the 12 variables listed above could be indications of attractiveness and reasons for nonuniform utilization patterns. Since these variables were interrelated and the list was too long for succinct description of point attractiveness, a factor analysis for each experiment was performed to simplify the description of each point. These analyses provided orthogonal component variables (factors) that accounted for linear relationships among observed variables (Mulaik 1972). Each component variable consists of a linear combination of all 12 explanatory variables. The dominant factor which accounts for most of the variation between the observed variables for each point was determined and ascribed a meaning. Observed variables with high loading scores in the factor are combined to describe that factor. Additional factors were calculated until 70% of the total variation between observed variables was accounted (SAS 1988). Correlation between the original observed variables allowed factors to be dominated by more than one variable. This technique, although not common, has been used in other ecological research (Moloney 1989, Jensen 1990).

The number of explanatory variables were reduced to a more manageable number of orthogonal factors using this technique. Subsequently, factor scores were calculated for each sampling point and were used as independent variables in regression procedures to explain the sources of variation impacting spatial distribution of utilization by cattle. Percent utilization observations were not normally distributed (Shapiro-Wilk statistic = 0.967, $P<0.001$) so an arcsine square root transformation was made to conform to regression analysis assumptions of a normal distribution.

Results and Discussion

Pasture Description

Experimental pastures are described in Table 2. Grass and forb biomass was generally much greater during the first sampling period of each pasture (Experiment 1) and thus will be characterized as high biomass. This was the result of large amounts of rain during the 14-week rest period prior to Experiment 1. This rain and rest resulted in not only larger quantities of forbs but a shift in species from that usually found. Annual broomweed (*Xanthocephalum texanum* DC) was the dominant forb under the high

Table 3. Factor analysis of descriptive variables taken under conditions of high and low biomass[a].

	Factors					
	1	2	3	4	5	6
	High Biomass (Experiment 1)					
Ascribed meaning	Green herbage availability	Grass quantity	Brush abundance	Remoteness	Water availability	
Variables						
Grass biomass	0.068	0.857	−0.139	−0.014	0.090	
Forb biomass	0.815	−0.004	−0.043	−0.110	−0.172	
Grass greenness	0.886	0.187	−0.029	0.100	0.106	
Forb greenness	0.722	0.040	−0.150	−0.086	−0.038	
Preferred grass frequency	0.025	0.706	−0.361	−0.248	0.052	
Nonpreferred grass frequency	−0.114	0.612	0.388	0.434	−0.051	
Forb frequency	0.899	−0.167	0.110	0.092	0.069	
Brush density	0.036	−0.054	0.836	−0.015	0.214	
Shade density	−0.114	−0.194	0.647	−0.141	−0.124	
Distance to fence	−0.066	−0.085	−0.093	0.750	−0.270	
Distance to road	0.219	0.001	−0.125	0.638	0.459	
Distance to water	−0.104	0.087	0.082	−0.110	0.842	
Eigen values	2.928	1.836	1.397	1.258	0.961	
Cum portion	0.241	0.161	0.116	0.105	0.080	
	Low Biomass (Experiment 2)					
Ascribed meaning	Brush abundance	Grass quantity	Forb frequency	Road location	Fence proximity	Water availability
Variables						
Grass biomass	−0.350	0.762	0.003	0.007	−0.141	0.009
Forb biomass	−0.284	−0.441	0.068	0.395	0.061	0.005
Grass greenness	−0.301	−0.041	0.486	−0.593	0.178	0.305
Forb greenness	−0.063	0.033	0.845	0.102	0.021	−0.175
Preferred grass frequency	−0.586	0.244	−0.111	−0.012	−0.537	0.130
Non-preferred grass frequency	0.155	0.790	−0.123	0.157	0.141	−0.027
Forb frequency	0.114	−0.240	0.714	0.295	−0.112	0.087
Brush density	0.807	0.176	0.016	0.016	−0.075	0.195
Shade density	0.658	−0.081	−0.059	−0.070	−0.045	−0.075
Distance to fence	−0.112	0.058	−0.066	0.107	0.874	−0.047
Distance to road	−0.097	0.123	0.117	0.790	0.170	0.138
Distance to water	0.040	−0.021	−0.077	0.060	−0.085	0.945
Eigen values	1.860	1.850	1.375	1.226	1.184	0.951
Cum portion	0.155	0.154	0.115	0.102	0.099	0.079

[a]Rotated factor pattern by the Varimax procedure.

Table 4. Coefficients of partial regression for predicting arcsine of utilization from factors computed.[a]

Independent variable	Biomass			
	High		Low	
Intercept	.7116		.9027	
Green herbage availability	-.0796	(Factor 1)		
Green herbage availability^2	+.0178			
Grass quantity	-.0467	(Factor 2)		
Brush abundance	-.0688	(Factor 3)	-.0559	(Factor 1)
Brush abundance^2	+.027			
Remoteness	-.0495	(Factor 4)		
Water availability			-.0392	
Water availability^2			-.0208	
Green forb frequency			-.0489	(Factor 3)
Road location			+.0668	(Factor 4)
Road location^2			-.0128	
Fence proximity			-.0571	
Brush abundance × green forb frequency			+.0517	
Forb frequency × fence proximity			-.0325	
Grass quantity × brush abundance	-.0247			
Road location × fence proximity			+.0358	
R^2	.54		.45	
RSD	.114		.152	

[a]The only variables included are those significant at $P<0.05$.

biomass experiment whereas western ragweed (*Ambrosia psilostachya* DC) was prevalent when overall biomass was low. This was especially true for the patterned pastures where disturbance had taken place. Utilization was generally lower during the first experiment but more variable than when low biomass was available (Table 2). When cattle have access to large amounts of standing crop, they apparently are more selective and this selectivity results in greater variation in spatial utilization of pastures than when less biomass is available.

Factor Analysis

Five factors explained 70.7% of the communal variation under conditions of high biomass, while 6 factors explained 70.4% of the communal variation in Experiment 2 (Table 3). The relatively large number of factors required to explain 70% of the communal variation is indicative of the complexity of the system. Apparently, these pastures had complex structures not easily defined with a limited set of statements. Also, the factors describing this structure changed as herbage availability decreased: Factor 1 under high biomass conditions had high positive loadings for forb biomass, grass and forb greenness, and for frequency and was defined as a green herbage availability factor, while the factor explaining the most variation under low biomass conditions had high positive loadings for brush and shade density and was defined as brush abundance. Under relatively dry conditions with low biomass, much less variation between sample points existed in green herbage and therefore the most identifiable source of variation in structure was in brush abundance. Even under these relatively dry conditions, however, grass quantity was still an important source of communal variation (Factor 2 under conditions of both high and low biomass, Table 3). Road location, fence proximity, and water availability factors explained less of the communal variation than variables associated with the forage under both biomass conditions.

Factors Influencing Utilization

Regression equations explaining variation in utilization are shown in Table 4. Over half of the variation in utilization was explained by the component factors when herbaceous biomass was high, but under low biomass conditions only 45% of the variation in utilization was explained (Table 4). These significant regression models demonstrate that utilization by cattle was not random but was associated with measured variables. Randomness (variation from nondefinable sources) apparently increased as biomass declined, as demonstrated by the decrease in the coefficient of determination.

Utilization at random points decreased as remoteness of sampling points (distance to fence and road, Table 3) increased when biomass was high. Most of the fences on these experimental pastures are electric and have been maintained using a road grader to reduce vegetation in the fenceline. The fences therefore act as an avenue allowing access to the pasture. This was expected since ease of access is generally thought to facilitate animal movement (Williams 1954, Workman and Hooper 1968, Roath and Krueger 1982). However, under conditions of low biomass, the relationship between utilization and ease of access was more complicated since distance to road was curvilinearly related to utilization ($P<0.001$) and green forb frequency interacted with distance to fence. As the distance to a road increased, utilization increased in a curvilinear manner when forage availability within the pasture was limited. This may be the result of 2 equally likely circumstances. First, it is possible that under low biomass conditions the animals were forced further from the roads to utilize remaining forage. An alternative explanation is that there was little vegetation remaining close to the road during the second experiment, and therefore utilization would appear to be low.

Forage quality is generally reported to have a positive effect on utilization when quality is assessed prior to grazing (Hunter 1962, Low et al. 1981, Senft et al. 1985). Utilization of grasses decreased as the distance to the nearest fence increased when biomass was low, but this relationship was affected by the green forb frequency associated with each point. As the frequency of green forbs (Factor 3) increased, utilization of grasses decreased at a faster rate when the distance to a fence was great (Fig. 1). This may have been a result of the livestock switching diet selection to use the abundant green forbs. When the distance to a fence was near the maximum and green forb frequency was high, diet selectivity should have been greatest due to abundant forage and the low concentration of livestock.

When biomass was high (Experiment 1), utilization decreased curvilinearly ($P<0.05$) as green herbage availability increased but green herbage availability was unrelated ($P>0.10$) to utilization when biomass was low. The negative relationship of green herbage

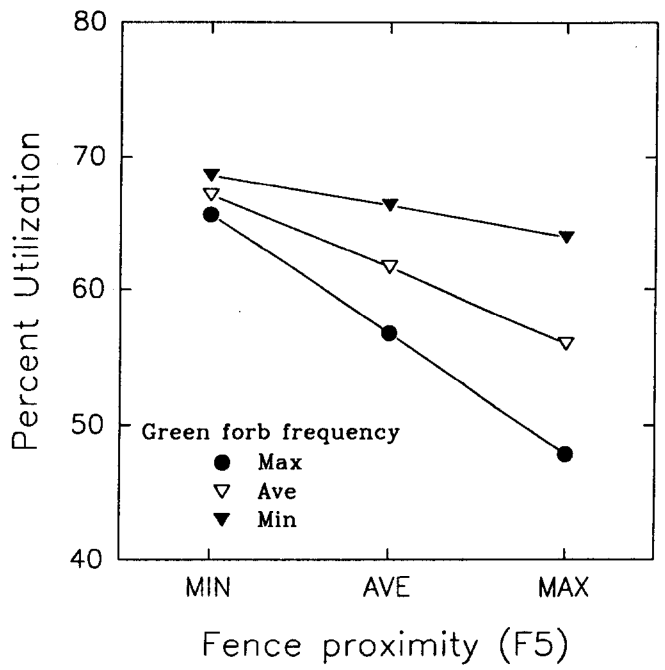

Fig. 1. Influence of Green forb frequency (Factor 2) and Fence proximity (Factor 5) on utilization under conditions of low biomass.

availability to utilization was surprising since most reports indicate that animals are attracted to areas that allow them to maximize biting rate (Hunter 1962, Clary et al. 1978, Low et al. 1981, Senft et al. 1985). Many areas possibly became inaccessible when biomass was high because of relatively dense stands of annual broomweed resulting in reduced utilization. Much of the variation in herbage availability was due to variation in forb availability (i.e., annual broomweed) and since there was sufficient forage in areas of lower forb abundance, ease of access made these relatively attractive areas to graze. Other studies have also shown that cattle avoid sites

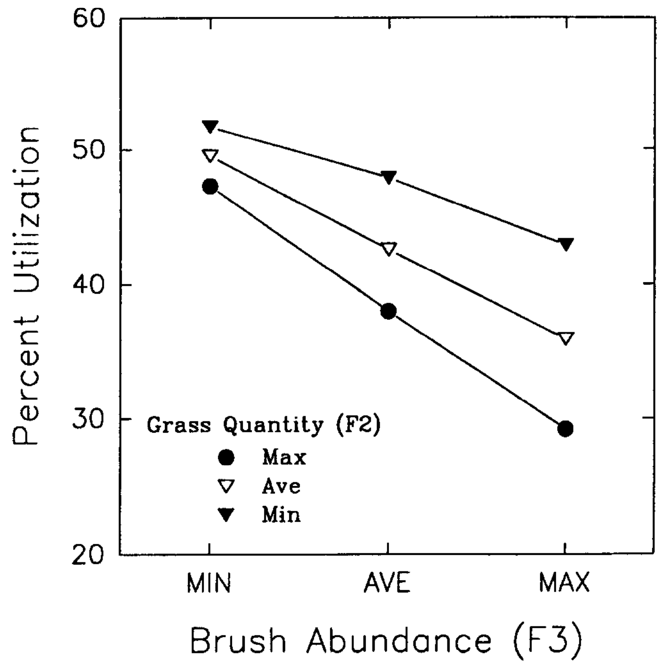

Fig. 2. Influence of Grass quantity (Factor 2) and Brush abundance (Factor 3) on utilization under conditions of high biomass.

with large amounts of nonpreferred plants (Williams 1954, Cook 1966, Senft et al. 1985).

The effect of brush abundance was evident in both the high and low biomass experiments. A slightly curvilinear effect of brush abundance on utilization was evident under high biomass conditions (Table 4). The main impact of brush abundance, however, was evident in the interaction with grass quantity (Fig. 2). As brush abundance increased, utilization of the grasses decreased, most probably due to the physical barrier presented by dense shrublands. Large quantities of grass were required to attract cattle into thick stands of brush whereas in areas low in brush abundance, amount of grass had little impact on utilization (Fig. 2).

The relationship between brush abundance and utilization was affected by green forb frequency under conditions of low biomass (Fig. 3). When green forbs were abundant, utilization of grasses

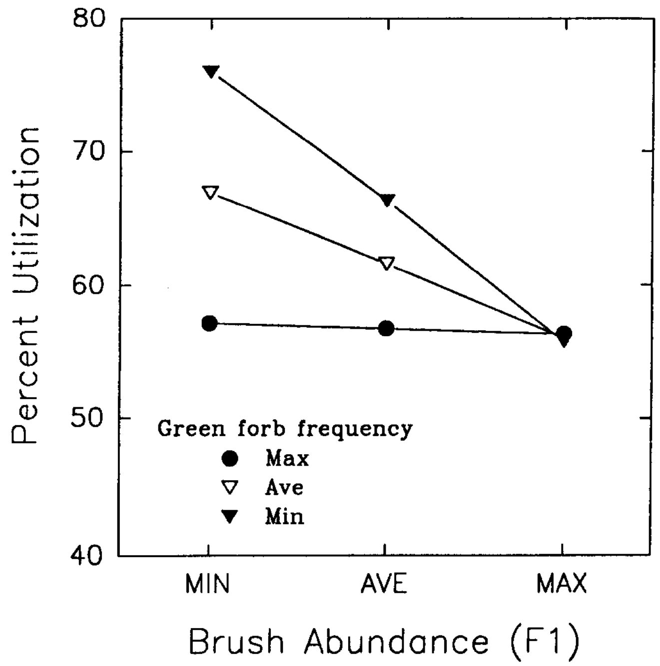

Fig. 3. Influence of Green forb frequency (Factor 2) and Brush abundance (Factor 1) on utilization under conditions of low biomass.

was low regardless of brush abundance. As green forb abundance decreased, utilization of grasses increased probably because animals were less able to be selective. The rate of increase in utilization, however, decreased as brush abundance increased. At very high levels of brush abundance, the frequency of green forbs had no effect on grass utilization (Fig. 3), indicating that when brush stands are dense, increased forb frequency will not attract cattle to penetrate.

Water availability (Factor 5) was not related (P>0.10) to utilization under high biomass availability. This was surprising since intense grazing is generally reported around water sources and varies inversely with distance from water (Cook 1966, Clary et al. 1978, Roath and Krueger 1982). The mean distance to water was 816 m but ranged from 40 to 2,140 m. The maximum distance to water was 2,140 but only 12 points had greater distances to water than 1,500 m. These distances may not have been of sufficient magnitude to result in a detectable impact on utilization. Other authors have suggested spacing water points approximately 1,600 m apart in pastures with gentle terrain (Martin and Word 1970, USDA 1976, Holechek et al. 1989).

When biomass was limited, as in the second experiment, water availability became a significant factor affecting utilization (Fig.

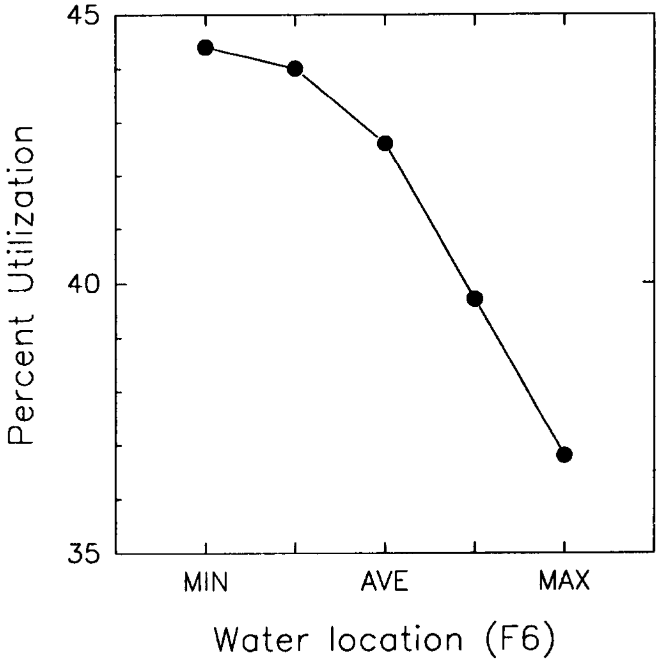

Fig. 4. Utilization of grasses relative to distance from water when biomass is limiting.

4). There was very little effect of water availability up to the average distance from water (816 m) but utilization decreased sharply at greater distances.

Conclusions

Factors which affect utilization changed relative to the amount of herbaceous biomass in the pasture. When biomass was high and forage relatively abundant, the major factors affecting utilization were plant related. Linear combinations (factors) of variables thought to be related to utilization were used to determine that the total amount of vegetation, the amount of grass biomass and brush abundance all contributed to cause a nonrandom use pattern within the experimental pastures.

When total biomass within the pastures was limiting, the physical design of the pasture, as well as the vegetation structure, affected utilization. Road, fence, and water location were the dominant abiotic factors in addition to the biotic factors of frequency of grass and forbs and brush abundance. A smaller portion of the variance could be explained then under high biomass conditions but the utilization pattern did have a nonrandom component. Utilization in these pastures apparently had a nonrandom component but the pattern of utilization was related to a complex interplay among pasture and herbage characteristics. The effect of this interplay on utilization patterns was dynamic over time.

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