Influence of Species, Breed and Type of Animal on Habitat Selection

Derek W. Bailey

Abstract

Improving grazing distribution may improve resource conditions of many rangelands. Land managers and livestock producers may be able to modify grazing use by selecting livestock species or wildlife that are more adapted to rugged terrain. Economic and management considerations must be carefully evaluated when selecting which species will be used. Livestock breeds differ in their use of rugged topography. Ongoing research is investigating the potential of selecting and culling individual animals to improve livestock grazing distribution. Cows with calves are more reluctant to graze steep slopes or travel far from water than cows without calves or yearlings. Managers should consider selection among animal species, livestock breeds, ages, nursing status, and perhaps culling and breeding individual animals as tools to improve grazing distribution.

Introduction

Cattle often utilize grasslands unevenly by grazing some areas more than others, leading to localized heavy grazing (Coughenour 1991). Uneven grazing distribution can reduce the carrying capacity of grasslands and the efficiency of livestock production (Anderson 1967). In the upland areas of Europe, low grazing pressure leads to the creation of unexploited areas that are increasingly covered with shrubs (Bailey et al. 1998a). These areas are more sensitive to fires, and may potentially erode and change aspects of the landscape. In the western United States, livestock often congregate along riparian areas (Smith et al. 1992) where trampling may reduce streambank stability and increase erosion (Kauffman et al. 1983). Concentrated grazing on uplands can reduce litter and vegetative cover which may reduce water infiltration, increase active erosion and increase the sediment load of waterways (Vallentine 1990). Livestock producers and land managers must consider spatial variation in grazing to adequately evaluate the impact of grazing by livestock and other herbivores (Coughenour 1991), and to prescribe appropriate management actions needed to remedy grazing distribution problems.

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Virtually all of the approaches currently used to improve livestock grazing distribution (water development, herding, salting and fencing) were described over 40 years ago (Skovlin 1957). Some of these management actions such as water development and fencing may require large capital inputs. Innovative and cost-effective techniques to improve livestock grazing distribution are needed. Choosing grazing animals that are more willing to graze further from water, graze steeper slopes and higher elevations may be an effective practice to reduce uneven grazing that is often observed in large, rugged pastures in extensive rangeland livestock operations. The objective of this paper is to discuss approaches that land managers and livestock producers can use, or may someday use, to select and produce animals whose grazing patterns achieve management objectives.

Selection of Animal Species

Selecting which livestock species is to be used should be based primarily upon management objectives, marketing opportunities and economics (Vallentine 1990). Ungulate species often utilize different types of topography and vegetation types, but the choices are often limited for a given producer. In the western United States, livestock producers generally graze cattle, sheep, goats and horses. Sheep and goats are generally considered more suitable for steep, rugged mountainous terrain than cattle (Bell 1973). Areas grazed by cattle and sheep in mountain rangelands in Utah were usually separated by topography (Ruyle and Bowns 1985). This separation is at least partially a result of herding that encourages sheep to use steeper terrain. A recent study in Idaho (Butler 1998) suggests that consistent herding, similar to that traditionally used with sheep, can minimize cattle use of riparian areas and increase grazing on upland slopes.

Horses usually travel directly to and from water, often on the run. This grazing characteristic suggests that they will more readily utilize areas that are further from water (Bell 1973). When grazed in common pastures in Wyoming, both feral horses and cattle spent most of their

time within 7 miles from water (Miller 1983). Salter and Hudson (1980) concluded that cattle and horses used different areas of the same pasture when both species were present.

Rangeland livestock producers may, in some situations, use other ungulate species such as bison, elk and deer to generate income from rangelands. Private game ranching and fee hunting have gained more attention and popularity. Anecdotal observations and some studies suggest that wild ungulate species utilize extensive rangeland areas more evenly than domestic livestock (Vallentine 1990).

Although ungulate species differ in their use of rangelands, only one or two species (usually livestock) can be practically or economically managed on a given parcel of rangeland. In the western United States, the focus has been on improving beef cattle grazing distribution (Vavra 1992, Walker 1995).

Breed Selection

Differences in grazing patterns have been observed among cattle breeds, suggesting that selection for grazing distribution within livestock species may be effective. Brangus cattle travel further during grazing than Hereford-Angus cattle (Herbel and Nelson 1966). Havstad and Doornbos (1987) found differences in distance traveled between Simmental and Hereford or Angus cattle, but differences were not consistent from year to year. Tarentaise cattle used higher terrain and steeper slopes than Hereford cattle for two successive years (Table 1). In one pasture at the same location, Piedmontese- and Charolais-sired first-calf heifers traveled further from water (horizontally and vertically) than Angus-sired heifers. However, in another pasture, grazing use was similar among these Angus-, Charolais-, Piedmontese- and Salers-sired first-calf heifers. Meuse-Rhine-Yssel cattle spent more time grazing patches with shorter and less stemmy vegetation, which resulted in a higher quality diet than obtained by Herefords (WallisDeVries 1994).

Although more research is needed, livestock producers and land managers may be able to identify cattle breeds that are more willing to travel from water and use rougher terrain. For example, Tarentaise cattle originated in the French Alps and may be better adapted for grazing steeper, more rugged topography. In warmer climates, cattle with Brahman breeding appear more willing to travel from water, especially at higher temperatures. Using more adapted breeds in extensive and rugged rangeland pastures, may increase uniformity of grazing and minimize localized areas of heavy grazing.

Selection of Individual Animals

Selecting livestock based on their grazing patterns has the potential for improving grazing distribution (Roath and Kruegar 1982). This suggestion was based on the observations that cattle formed social groups that grazed in different habitat types; these authors speculated that livestock grazing distribution could be improved if the social groups that preferred and remained in riparian areas were culled. Howery et al. (1996) found that cattle showed a high degree of fidelity to a home range, indicating that selective culling might change grazing distribution. Selective culling is a potentially cost-effective technique to improve grazing distribution if: 1) there is significant individual variation in the trait; 2) distribution behavior is heritable; 3) the trait can be readily identified, measured or predicted; and, 4) there are few adverse relationships between grazing distribution and animal performance.

Selection Differential

Managers may be able to take advantage of the large variation observed in individual behavior (Bailey et al. 1998b). For a selection program to be effective, the selection differential must be large. Greater progress will be made if the cattle kept for breeding are more likely to use rugged topography than cattle that are culled, and thus higher levels of variation among individuals are desirable.

In a foothills pasture in northern Montana, grazing patterns of individual cattle were observed 2 or 3 times per week for at least 6 weeks in each pasture. Use of slopes and distance traveled to water (horizontally and vertically) varied greatly among individual cattle (Table 2). Some cattle spent most of their time on slopes over 20% and climbed over 60 m (200 feet) above water, while others used more gentle slopes (10% or less) and climbed less than 15 meters (160 feet) above water.

Global Positioning System (GPS) tracking system equipment (e.g., Lotek GPS 2000) can track cattle and other animals at intervals of minutes to days with an accuracy of within 7 meters (20 feet). Cattle that were observed more frequently on steep slopes and ridges (hill climbers) or more frequently on gentle slopes near water (bottom dwellers) were tracked the following year. The GPS tracking system clearly showed a distinction between the grazing patterns of cattle previously classified as hill climbers and bottom dwellers (Fig. 1 to 4). The hill climbers in this sample (Fig. 1 and 2) used opposite sides of a high ridge; whereas the bottom dwellers concentrated in different areas (Fig. 3 and 4) but tended to avoid steep slopes. Most importantly, these

Table 1. Differences in use of slopes and horizontal and vertical distance traveled to water by cattle of Hereford and Tarentaise breeding in two foothill pastures.

		Slope (%)		Horizontal distance to water (m)		Vertical distance to water (m)	
Breed	Year	Pasture 1	Pasture 2	Pasture 1	Pasture 2	Pasture 1	Pasture 2
Hereford	1997	14.4	19.2^{ab}	349^{a}	440	31^{a}	48^{a}
	1998		19.4^{a}		468		53^{a}
¾Hereford-¼Tarentaise	1997	13.9	18.9^{a}	365^{ab}	460	34^{ab}	53^{ab}
	1998		20.0^{ab}		492		57^{ab}
½Hereford-½Tarentaise	1997	14.7	19.4^{ab}	371^{ab}	469	34^{ab}	56^{ab}
	1998		21.0^{ab}		494		61^{bc}
¼Hereford-¾Tarentaise	1997	14.2	21.3^{b}	373^{ab}	414	34^{ab}	60^{b}
	1998		21.8^{b}		461		63^{bc}
Tarentaise	1997	15.0	20.1^{ab}	382^{b}	430	38^{b}	59^{b}
	1998		21.6^{b}		475		64^{c}

Breeds with different superscripts for the same year and within the same column differ significantly (P<.05) for that trait.

Table was adapted from Bailey et al. (1998b).

Table 2. Variation in individual cattle use of slopes and horizontal and vertical distance to water in two foothill pastures.

	Slope (%)		Horizontal distance to water (m)		Vertical distance to water (m)	
	Pasture 1	Pasture 2	Pasture 1	Pasture 2	Pasture 1	Pasture 2
Year 1997						
Maximum	21.4	28.1	498	896	62	103
Minimum	7.7	10.1	210	236	11	15
Std. Dev.	2.7	3.6	52	120	11	17
Year 1998						
Maximum		29.1		834		87
Minimum		13.6		297		29
Std. Dev.		3.1		101		12

Adapted from Bailey et al. (1998b).

data show that grazing patterns of individual animals can vary greatly in Montana foothills rangeland. Howery et al. (1996) also observed that individual grazing patterns of cattle differed in a mountainous Idaho pasture. The wide variation in individual grazing patterns suggests that sufficient selection differential is available for a grazing distribution selection program to be effective.

Heritability

The differences in grazing patterns observed among cattle breeds mentioned above suggests that this behavior may be heritable. Grazing patterns of first-calf heifers were compared to the grazing patterns of their dams at our research center in Havre, Montana. The hypothesis of this study was that any observed relationships between cows and their female offspring would indicate that grazing patterns could be inherited, learned from their dam, or both. Dams and daughters were observed in the same foothills pastures during the same period. Preliminary analysis showed that in one of the two pastures there was a weak relationship ($P<0.10$) between a cow and her female offspring. In the other pasture, there was no relationship. Further observations and analyses are planned because younger cows tend to graze gentler slopes and lower elevations than older cows. In addition, younger animals are more influenced by their peers' use patterns than older animals (Howery et al. 1998). This age effect may confound any relationships between dams and their female offspring.

Other grazing behaviors appear to be heritable. Winder et al. (1995) suggested that diet selection may be highly heritable. Sires in their Brangus herd accounted for a significant amount of the variation in diet selection for certain forage species during certain times of the year. The corresponding heritability estimates were high (.51 to .87), but the standard errors for the estimates were also high (.49 to .52). Differences in diet selection in the Winder et al. (1995) study may be the result of variation in spatial grazing patterns. Cattle from some sire groups may have traveled further from water and selected a higher quality diet. Further studies are needed to determine if grazing distribution is heritable.

Predicting Grazing Patterns

In order to cull animals with undesirable grazing patterns (e.g., concentrated grazing in bottoms or riparian areas) or to select animals with desirable grazing patterns (e.g., dispersed grazing of upland slopes), managers must be able to characterize individual animals. However, determining whether animals have desirable or undesirable behavior is difficult and time consuming, especially because of the diurnal and day-to-day variations in grazing patterns (Low et al. 1981, Bailey et al. 1990). Readily observable traits are needed to predict individual grazing patterns.

Behavior of cattle during trailing may be related to grazing distribution. Position of animals within the herd during trailing appears to be a reliable, consistent trait. Repeatability of this trait was estimated to be over 60% for cattle (Bailey and Hoffman 1998). Cattle found in front of the herd during trailing generally grazed in higher elevations than cattle found in the back of the herd (Bailey and Hoffman 1998).

Other behaviors may also be useful as predictors of cattle grazing patterns. Grazing distribution may be related to animal docility with more aggressive animals

Figure 1. Locations of cow 2036 (3/4 Tarentaise, 1/4 Hereford) observed with a GPS tracking system at 5-minute intervals from Sept. 1, 1998 to Sept. 9, 1998. Cow 2036 was identified as a hill climber (more frequent use of steep slopes and high elevations) during 1997 using data obtained from observers on horseback.

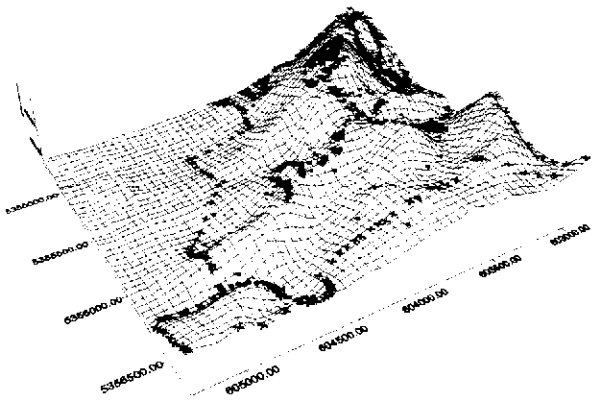


Figure 2. Locations of cow 3102 (3/4 Tarentaise, 1/4 Hereford) observed with a GPS tracking system at 10-minute intervals during the day and 20-minute intervals at night from Aug. 18, 1998 to Sept. 9, 1998. Cow 3102 was identified as a hill climber (more frequent use of steep slopes and high elevations) during 1997 using data obtained from observers on horseback.

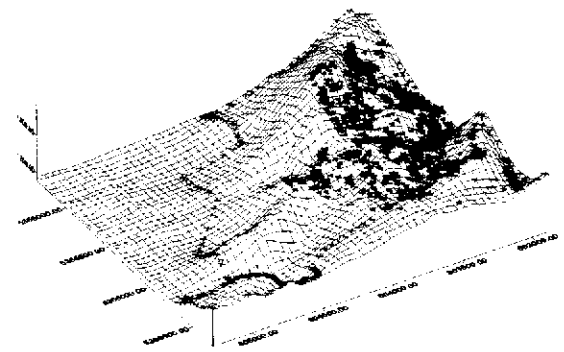


Figure 3. Locations of cow 3024 (1/4 Tarentaise, 3/4 Hereford) observed with a GPS tracking system at 10-minute intervals during the day and 20-minute intervals at night from Aug. 18, 1998 to Sept. 9, 1998. Cow 3024 was identified as a bottom dweller (more frequent use of gentle slopes and bottoms) during 1997 using data obtained from observers on horseback.

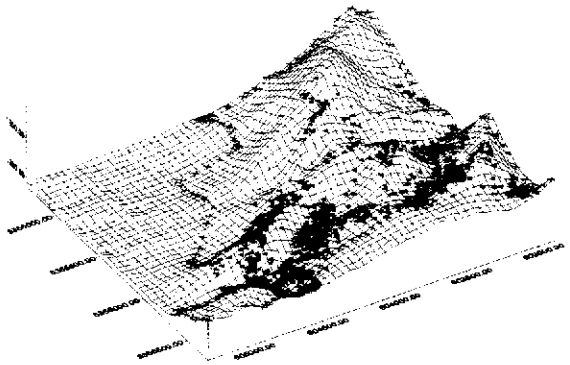
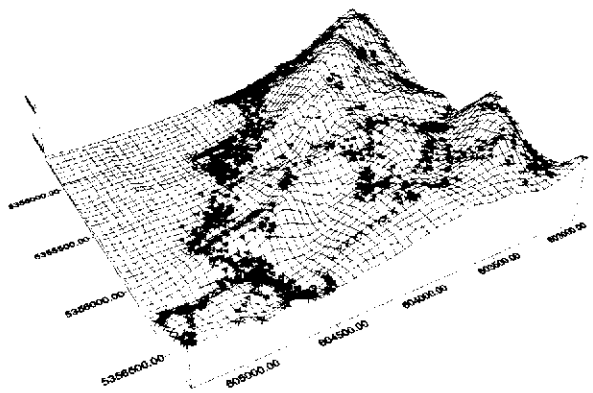


Figure 4. Locations of cow 3227 (1/4 Tarentaise, 3/4 Hereford) observed with a GPS tracking system at 10-minute intervals during the day and 20-minute intervals at night from Aug. 18, 1998 to Sept. 9, 1998. Cow 3227 was identified as a bottom dweller (more frequent use of gentle slopes and bottoms) during 1997 using data obtained from observers on horseback.



using rougher terrain than more docile animals. The order in which cattle tend to go through a working chute or scale may also be related to grazing distribution. Anecdotal observations at our research center suggest that cattle that tend to graze steeper slopes are usually the last cattle to go through a livestock handling facility. We plan to evaluate these and other behaviors and hope to find a readily identifiable behavior or trait that can be used to predict an animal's general grazing pattern.

Relationship Between Grazing Distribution and Performance

If animals are selected for grazing distribution, managers must consider the effect this selection pressure would have on performance. Culling cattle that concentrate their grazing in bottoms or riparian areas would be expensive if those cattle performed better than others in the herd. In northern Montana foothills pastures (Bailey et al. 1998b), grazing distribution was not related to age-adjusted weaning weight of calves, milk production, cow height or cow body condition score (Tables 3 and 4). Correlations between use of slopes and distances traveled to water (horizontal and vertical) were very low. In contrast, cows with older calves and correspondingly higher actual weaning weights used higher elevations and steeper slopes than cows with younger calves. Perhaps cows with older calves can travel further because the calves are better able to keep up with their dam, or the dams are more willing to leave older calves behind. Studies are being conducted at our research center to investigate this question.

Incorporating Social Interactions into a Selection Program for Distribution

Movements of domestic herbivores during grazing may be directed by a limited number of individual animals. Cattle have been classified as leaders, followers and independents with regards to movement of a social group during grazing (Sato 1982). High-ranking animals were usually leaders and low-ranking members were independent and did not always follow the group. Movement of the herd may be the cumulative result of high-ranking animals and independent movement of low-ranking animals. Small herds of cattle generally followed an animal that had special knowledge of locations containing highly palatable food (Greenwood and Rittenhouse 1997). In another study, one or two steers were in the lead when entering a patch, and the other two or three steers followed (Bailey 1995). This suggests that movements and grazing patterns of cattle herds could be changed by selectively culling a few key animals.

However, Prins (1996) reported from his studies of African buffalo that there were no herd leaders, and lead animals consistently changed during grazing and while traveling to feeding sites. Data from these studies suggest that the decision where to graze is a communal decision made at the end of a resting bout and before the grazing bout begins. If the results observed in African buffalo are confirmed for domestic livestock, then selectively culling high social ranking animals will have little impact on overall herd movements. The apparent contrast between the studies of cattle and African buffalo may be explained by differences in herd and pasture size. The cattle studies were conducted with small herds where individual animals may have more influence than in large herds of buffalo. In addition, decisions where to graze may be more distinct in large acreages than in the small pastures used for these cattle studies because animals often travel further before actively grazing. Obviously, more research is needed to evaluate the impacts of social interactions on herd movement patterns during grazing.

Will Selection for Grazing Distribution be Effective?

The most important component of a grazing distribution selection program is its effectiveness. To my knowledge, no direct tests of this approach have been completed. However, Mosely (this volume) and Mcdonald and Mosley (this volume, abstract) suggest that social competition may force subordinate individuals away from preferred areas. Correspondingly, other cows may fill the "vacuum" if cows grazing preferred areas are removed, and a culling and selection program would be ineffective. Our research center will begin a study next year to answer this question. We will observe cattle that have spent more time in the last two years in bottoms and near water in foothills pastures as well as cattle that used steeper slopes and higher elevations in separate, but similar, pastures. If the resulting forage utilization patterns differ and if the cattle that preferred more rugged topography exhibit a more even grazing pattern, selecting cattle for grazing distribution may become an important tool for modifying livestock grazing use in large pastures.

Animal Age and Status

It has long been recognized that yearling steers, yearling heifers or dry cows (without calves) will utilize extensive pastures more evenly than cow-calf pairs (Bell 1973). The presence of a nursing calf may hinder movement of cows; this effect may be more pronounced when the calf is young. As mentioned earlier, cows with older calves used steeper slopes and higher elevations

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Table 3. Residual Correlations Between Grazing Distribution Patterns and Characteristics of the Cow

Behavior	Cow wt	Hip height	Body condition score	Milk production (early lactation)	Milk production (late lactation)
Slope					
Pasture 1	.146 (.05)	.060 (.42)	.056 (.45)	.078 (.43)	.071 (.48)
Pasture 2	-.026 (.73)	-.002 (.98)	-.101 (.18)	.018 (.85)	-.020 (.84)
Horizontal distance to water					
Pasture 1	.037 (.62)	.003 (.97)	-.021 (.78)	.069 (.49)	.132 (.19)
Pasture 2	-.224 (.01)	-.110 (.14)	-.090 (.23)	.033 (.74)	-.094 (.35)
Vertical Distance to water					
Pasture 1	.107 (.15)	.067 (.37)	-.001 (.99)	.159 (.10)	.081 (.42)
Pasture 2	-.073 (.32)	.001 (.99)	-.101 (.17)	.132 (.18)	-.013 (.90)

Note: P-values are in parenthesis below the residual correlations. If the P-values are less than or equal to 0.05, the correlation between the grazing distribution behavior and the performance trait can be considered statistically significant.

Table 4. Residual Correlations between Grazing Distribution Patterns and Calving Date and Weaning Weights

Behavior	Calving date	Actual weaning wt.	205-day adjusted weaning wt.
Slope			
Pasture 1	-.033 (.68)	.050 (.53)	.004 (.96)
Pasture 2	-.205 (.01)	.148 (.06)	.098 (.22)
Horizontal distance to water			
Pasture 1	-.086 (.28)	.099 (.21)	.063 (.43)
Pasture 2	-.047 (.55)	-.027 (.74)	-.040 (.62)
Vertical distance to water			
Pasture 1	-.089 (.26)	.137 (.08)	.082 (.30)
Pasture 2	-.163 (.04)	.152 (.05)	.106 (.18)

Note: P-values are listed in parenthesis below the residual correlations. If the P-values are less than or equal to 0.05, the correlation between the grazing distribution behavior and the performance trait can be considered statistically significant.

than cows with younger calves (Bailey et al. 1998b). Dry cows used rougher terrain early in the season but not later in the season. However, Bryant (1982) reported that cows used Oregon mountain rangeland more evenly than yearlings. This apparent inconsistency may be the result of prior experience (Vallentine 1990). At our research center in northern Montana, first-calf heifers appear to use gentler slopes and lower elevations more than older cows with calves. More even cattle grazing distribution may be obtained in extensive rugged pastures if managers can graze yearlings or dry cows (e.g., after weaning).

Conclusions

Livestock producers and land managers can manipulate grazing distribution by selecting the livestock or wildlife species. Some species are more adaptable to rugged terrain. Distribution of herded animals (e.g., sheep) can certainly be controlled more than free-ranging animals. Management and economical constraints must be carefully considered when selecting which species to graze. Within livestock species, opportunities exist to select breeds that are more adapted to extensive pastures. Some cattle breeds tend to travel further from water and use more rugged topography than others. Managers should also consider the effects of animal sex, age and status (nursing or non-lactating) on grazing distribution. The presence of nursing offspring may hinder livestock from traveling further from water and using steeper slopes.

Individual cattle tend to repeatedly use the same general areas of large mountainous pastures, which suggests that selecting for a more even grazing pattern may be effective. Potentially, distribution could be improved by culling undesirable and selecting desirable individuals, and culling social leaders within the herd that have undesirable grazing patterns. Individual cattle vary in their use of rugged terrain, which promises relatively rapid genetic progress if these traits are heritable. Identifying individuals with desirable and undesirable grazing patterns is labor-intensive. Readily identifiable behaviors must be found so that the general grazing patterns of individuals can be characterized. No adverse relationships between livestock grazing patterns and animal performance have been observed, and cows that use more rugged terrain tend to have older calves at their side with higher weaning weights. Although the potential to use selection to modify and improve livestock grazing distribution is promising, more research is needed before we can conclude if it will be an effective and practical technique.