GRAZING DISTRIBUTION AND HOW BEEF CATTLE NUTRITIONAL REQUIREMENTS INFLUENCE GRAZING DISTRIBUTION

Timothy DelCurto and **Kenric Walburger**
Eastern Oregon Agricultural Research Center, Union Station
Oregon State University
tim.delcurto@oregonstate.eduT

Approximately 70% of the land area in the 11 western states is grazed by livestock, demonstrating the importance of livestock grazing throughout western North America (Fleischner, 1994). Ruminants play a role in human nutrition, because they have the ability to transform energy in grassland vegetation to an energy and protein source directly consumable by humans (Briske and Heitshchmidt, 1991; Oltjen and Beckett, 1996).

In a study conducted on the Big Cimarron Cattle and Horse Allotment in Colorado, national forest visitors were surveyed from both developed and undeveloped recreation sites to determine their general reaction to livestock grazing in this area. Results showed that 60% of visitors were agreeable to grazing in the area, while one quarter of their responses were conditional on management practices (Wallace et al., 1996). This demonstrates the need for grazing management practices that: 1) are consistent with the objectives of multiple use management, and 2) aim to maximize livestock production or profitability on a sustainable basis (Briske and Heitshchmidt, 1991).

The demonstration and documentation of sustainable livestock grazing practices is an ongoing area of research, and a constant challenge for livestock and rangeland managers throughout the Western U.S. Perhaps the biggest challenge relates to achieving optimal distribution of cattle across the diverse landscapes of western rangelands. Numerous factors influence cattle distribution and, in turn, grazing patterns/nutritional opportunities for range beef cattle production. Landscape factors such as distribution of water sources, slope, aspect, elevation, soil depth (site productivity), and overstory canopy all influence cattle grazing behavior, and distribution patterns. Recent research also suggests that nutritional physiology factors such as cow age, stage of production, breed type, and supplementation strategy also influences cattle grazing distribution and resource selection dynamics (DelCurto et al., 2005).

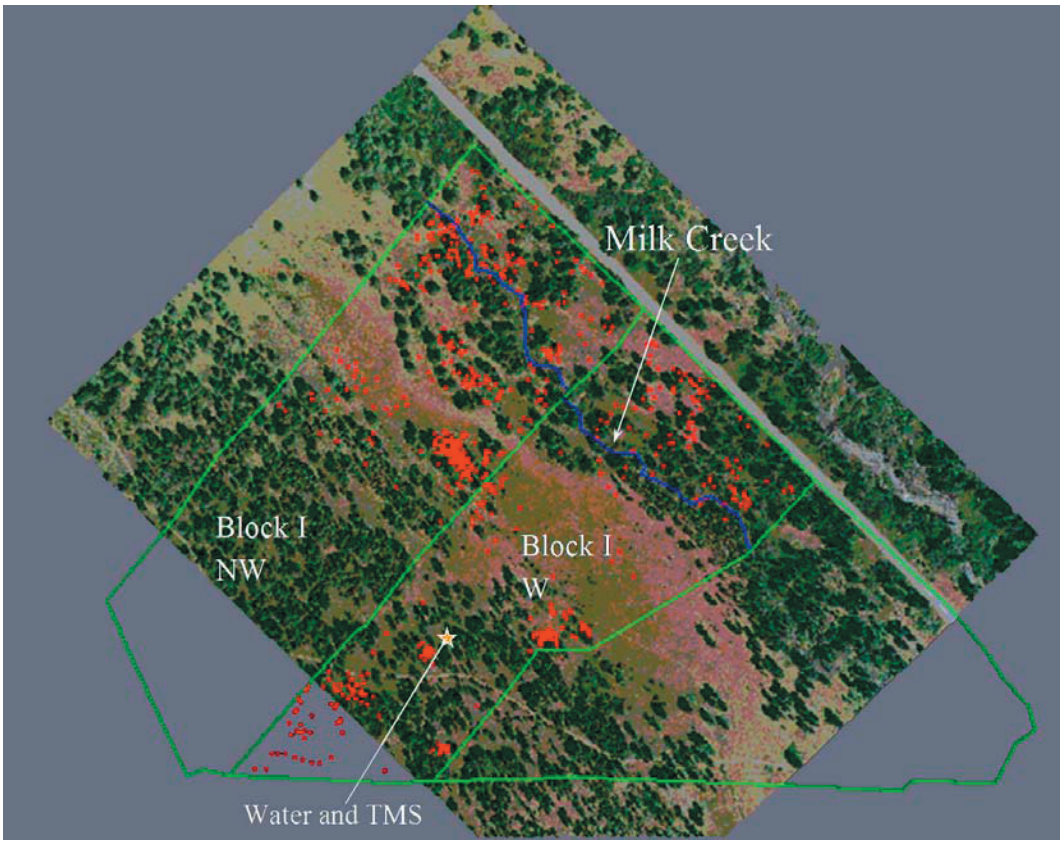

Figure 1. Distribution patterns of cattle with and without offstream water sources. Observations were taken every 3 h over a 6 d period during the daylight hours (data adapted from Porath et al., 2002 and DelCurto et al., 2005).

To date, most research has focused on how cattle distribute over diverse landscapes using telemetry, global positioning systems (GPS), and geographical information systems (GIS) technology. In contrast, limited data has been presented that discusses the role of nutrition in influencing cattle distribution and resource selection on the arid range landscapes of the western U.S. In fact, the Animal Science discipline has not fully participated in this area of research. The purpose of this manuscript, therefore, is to discus the possible relationships of nutrition and nutritional requirements on livestock distribution in the western U.S.

Water and Water Distribution

Water availability is perhaps the single most important factor contributing to cattle distribution and behavior within a grazing system. Briske and Heitschmidt (1991) discuss the tendency for large herbivores to focus their foraging activity around water, stating that these ungulates seek the most energy-efficient sources of forage referenced to known water sources. This tendency was observed in cattle on a number of studies, which evaluated grazing distribution relative to water sources. Cattle preferred to graze in areas within 200 m of water while avoiding areas greater than 600 m from water under a continuous grazing system (Gillen et al. 1985).

In a recent study conducted on Oregon State University's Hall Ranch, Porath and coworkers (2002) reported that the development of offstream water sources improved beef cattle distribution on forested rangelands with both riparian and upland vegetation types (Figure 1). Cattle with upland water used the uplands more during the morning period and seemed less reliant on the riparian area over the grazing period. In addition, cows with access to offstream water and trace minerals gain 11.5 kg more over the 42-d grazing period. Calves had a similar response, gaining 0.14 kg/d more than calves with the stream as their only water source.

Apparent water disappearance from the upland stock tanks averaged 21.7 liters per day for each cow/calf pair. Water requirements for lactating cows will range from 50 to 70 liters per day depending on ambient air temperature (NRC, 1996). Given the temperature regimes for the above study, and assuming a forage water content of 50%, the cows on this study were getting over 40% of their water from offstream tanks. Finally, as livestock producers and grazing managers search for improved management practices that make grazing increasingly compatible with other natural resource uses, they must consider the underlying factor of economic feasibility. The research at the Hall Ranch showed significant increases in cow and calf weight gains in the group that had access to offstream water as compared to the group that had the stream as its only water source. As a result, for the conditions of this study, the land manager would have had economic incentives to develop offstream water because of the improvements in distribution patterns and improvements in cattle performance (Stillings et al. 2003).

Water and Thermoregulation

Cattle tend to display diurnal patterns in respect to grazing distribution relative to water sources (Porath et al., 2002; Parsons et al., 2003; DelCurto et al.,

2005). During the summer and early fall grazing period, cattle will often go to water during the heat of the day. In a study evaluating early summer versus late summer grazing distribution, Parsons and coworkers (2003) observed similar patterns of cattle distribution relative to water during the daylight hours (Figure 2). During the early morning and evening period, which also corresponds to

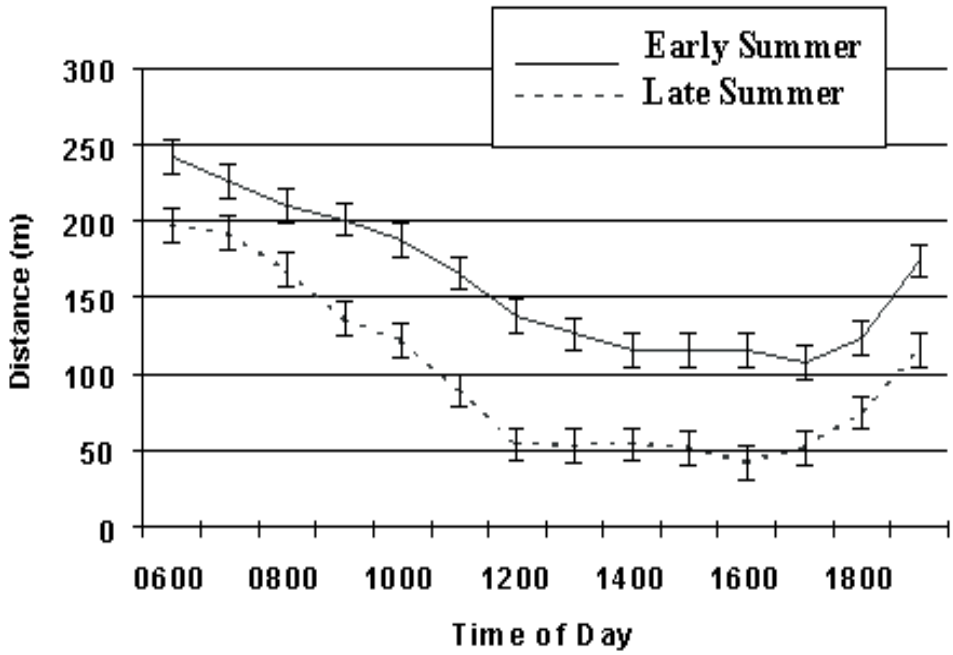

Figure 2. The influence of season of use (early summer vs. late summer) on beef cattle distribution relative to water sources (adapted from Parsons et al., 2003).

the most intensive grazing activity, cattle prefer uplands (away from water sources), but, during the heat of the day, move to water sources and/or riparian areas. It appears that the timing of water consumption is directly related to the animal's thermoregulation strategy. Likewise time spent grazing over a 24 h period appears to be most concentrated with the heaviest grazing periods corresponding to 1 h prior to and 4 h after sunrise, and 4 hours prior to and 1 h after sunset (Porath et al., 2002; Parsons et al., 2003). The physiological activity of grazing and drinking appear to be timed to provide the most energetic efficiency for the animal during the warm summer period.

The influence of topography on ambient temperature regimes has not gained significant attention relative to beef cattle grazing and/or distribution

patterns. However, the diurnal changes in beef cattle distribution relative to water sources suggest that landscape effects on temperature regimes may be important in predicting beef cattle distribution. More specifically, the observation that cattle prefer uplands (areas away from water) in the evening, night-time, and early morning hours suggest that temperature is influencing distribution. In a study

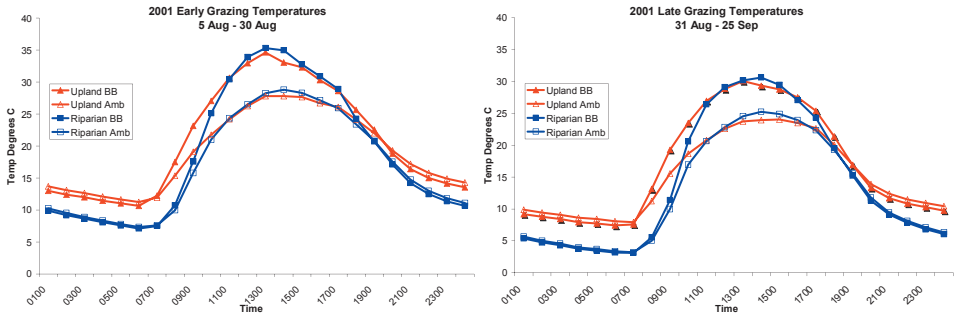

Figure 3. Ambient air temperature (Amb) and heat loads (BB) for riparian and upland areas on Bear Pasture of the USDA Starkey Experimental Forest (data adapted from Wells, 2003).

conducted on the USDA Forest Service Starkey Experimental Forest, Wells (2003) mapped temperature regimes over a 4,000 ha allotment pasture (Figure 3). The temperature regimes suggested a substantial difference in temperature between riparian areas (canyon bottoms) versus upland areas (canyon tops and benches). Cattle preference for upland areas appear to be related to the warmer temperatures (as high as 5^{o}C) that are associated with upland habitats during the evening, night-time, and early morning period.

Season of Use

Season of use also strongly influences animal distribution and may relate to the animals attempt to access more palatable and, in some cases, more nutritious diets. Parsons et al. (2003) demonstrated that cows grazing in early summer (June 15 – July 15) distributed more uniformly than cows grazing in late summer (August 15 – September 15). Specifically, cattle grazing when both upland and riparian forage are vegetative and succulent promotes uniform grazing distribution over the landscape. When upland forages have senesced, however, utilization will be disproportionately high in riparian areas. In a study on the Smith – Bally allotment pasture (4,000 ha) of the USDA Starkey Experimental

Forest, DelCurto et al. (2000) demonstrated similar results, with more uniform grazing patterns early in the grazing season (June 15 to August 1) as compared with beef cattle grazing patterns in the late summer and early fall (September 1 to October 15). In addition, during the early season period cattle tended to prefer southerly aspects on forested rangelands which typically were characterized by open grasslands and Ponderosa Pine vegetation communities as compared to late season, where cattle tended to prefer northerly aspects with denser overstory canopies and a greater diversity of understory shrubs and "woody" vegetation. Northerly aspects in the Pacific Northwest tend to have deeper soils, hold snow pack longer, have greater tree canopies, more diverse plant communities, and, provide more succulent and nutritious forage for the cattle during the late summer and early fall grazing period.

Obviously, one of the issues for range and livestock managers in the Pacific Northwest is managing cattle distribution when vegetation becomes dry (dormant or senescent) on upland and southerly aspects. This period of time is often characterized as the time when livestock tend to congregate in riparian areas and, depending on the vegetation characteristics and plant community composition, shift from herbaceous diets (grass, grasslikes, and forbs) to diets with significant shrub components. In a study designed to evaluate the changes in cattle utilization with advancing utilization and senescences of riparian vegetation, Darambazar et al. (2003) found that cattle will change to heavy consumption of riparian shrubs/trees when the herbaceous vegetation is no longer succulent (moisture less than 50%; Figure 4 & 5). Cattle prefer herbaceous

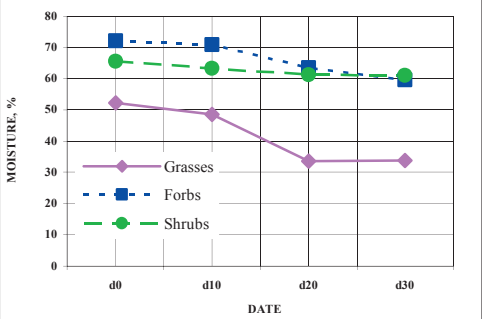

Figure 4. Moisture content of forages in Catherine Creek riparian area (July 30 to September 07)

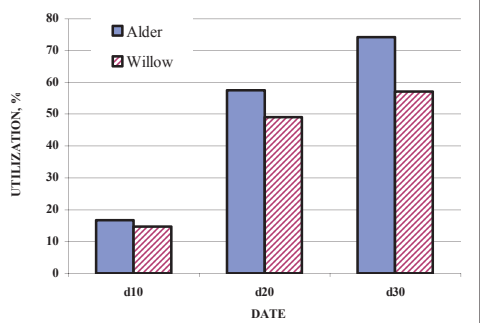

Figure 5. Shrub utilization in Catherine Creek riparian area (July 27 to September 04, 2001)

vegetation even when the shrubs/trees (snowberry, alder, and willow) are higher in nutritional value (crude protein and digestible energy). However, with continued use, cattle did switch to diets with willow and alder, and the timing of this switch corresponded to a substantial change in moisture content of the riparian grasses. This change in moisture content is due to both advancing senescences and the preferential selection/removal of green, succulent, plant parts with increased levels of riparian utilization. These authors suggest that late season riparian grazing should be closely monitored and planned to focus on cattle having adequate green herbaceous material available. Once the key grass species senesce (mature and lose succulence), cattle should be removed to avoid excessive consumption of shrubs and trees that are important to stream structure and function.

Cow Age and Production Stage

Cow age and lactation status have also been shown to influence cattle distribution and subsequent performance on forested rangelands (Morrison et al., 2002; Wells, 2003). Early weaning reduces beef cow requirements for energy, protein and water. This reduction in requirements, related to the increased nutrition required for lactation, prevents weight loss and in most cases allows for improved condition and weight coming off the range and into winter. In a study evaluating early weaning (150 d) vs. traditional weaning conducted in early fall, Walburger and DelCurto (unpublished data) observed that early weaned cattle were 41 kg heavier and were a 0.5 units of body condition (1 to 9 scale) higher following the grazing period than were traditionally weaned cattle. This increase in body weight (BW) and condition may give ranchers increased flexibility and opportunities during the winter feeding period. Another observed benefit to early weaning was that early weaned cattle distributed farther from water in the early morning than did the traditionally weaned cattle. This difference in distribution patterns may be closely associated with water requirements and moisture content in upland forages.

Age composition of a cow herd can have a significant influence on distribution patterns (Morrison et al., 2002; Wells, 2003). However, differences in age have largely been ignored in determining herd composition for range allotment livestock management. In a study evaluating the distribution and intake patterns of first calf heifers vs. mature cows on forested rangelands, Morrison et al. (2002) noted that first calf heifers tended to congregate more in riparian areas than older cows. In addition, first calf heifers did not gain as much BW or body condition yet consumed more forage than older cows when expressed on a percent

BW basis. Likewise, in a recent study conducted at USDA Forest Service Starkey Experimental Forest, Wells (2003) observed that animals of different ages partition themselves differently across a forested rangeland. In this study, animal locations were determined for peak grazing times, 1 h prior to and 4 h after sunrise, and 4 hours prior to and 1 h after sunset (Porath et al., 2003; Parsons et al., 2003). Water was the most important variable in determining animal location in late-summer, however, all age classes of cattle were further from water than the pasture average (Figure 6). Younger cattle were utilizing areas that were closer to water, had steeper slopes, higher in forage production and at lower elevations as compared to older cattle. This partitioning of age classes across the landscape may be due to social dominance, animal requirements, or grazing habitat experience.

Implications

Beef cattle grazing distribution on western rangelands are influenced by nutritional requirements and the vegetation attributes that influence palatability and nutritional quality. The availability of water and the diurnal pattern of grazing relative to water clearly illustrate the importance of water nutrition and sustainable grazing systems. The role of protein and energy status relative to sustainable grazing systems that optimize distribution and beef cattle performance is less clear. Changes in vegetation are a function of landscape characteristics and, as a result, are often confounded with attributes such as elevation, topography, aspect, slope, and surface water. The documentation of grazing distribution differences with differing cow breeds, age groups, and lactation status suggest that cow requirements may also influence grazing distribution patterns.

Literature Cited

Briske, D.D., and R.K. Heitschmidt. 1991. An ecological perspective. p. 11-26. *In:* R.K. Heitschmidt and J.W Stuth (eds.), Grazing Management An Ecological Perspective. Timber Press. Oregon.

Darambazar, E., T. DelCurto, C. J. Ackerman, G. D. Pulsipher, and D. Damiran. 2003. Changes in forage quantity and quality with continued cattle grazing in a mountain riparian pasture. Proc. West. Sec. Amer. Soc. Anim. Sci. 53:325-328.

DelCurto, T., M. Porath, C. T. Parsons, and J. A. Morrison. 2005. Management strategies for sustainable beef cattle grazing on forested rangelands in the

Pacific Northwest. Invited synthesis paper. J. Range Ecol. Manage. 58:119-127.
DelCurto, T., B. Johnson, M. Vavra, A. A. Agars, and P. K. Coe. 2000. The influence of season of use on distribution patterns relative to water and resource use by beef cattle grazing mixed forested rangelands. Proc. of West. Sec. of Amer. Soc. Anim. Sci. 51:171-175.
Fleischner, T.L. 1994. Ecological costs of livestock grazing in western North America. Conservation Biology. 8(3):629-644.
Gillen, R.L., W.C. Krueger, and R.F. Miller. 1985. Cattle use of riparian meadows in the Blue Mountains of northeastern Oregon. J. Range Manage. 38:205-209.
Morrison, J. A., T. DelCurto, C. T. Parsons, G. D. Pulsipher, and E. S. Vanzant. 2002. The influence of cow age on grazing distribution and utilization of mountain riparian areas and adjacent uplands. Proc. West. Sec. Amer. Soc. Anim. Sci. 53:53-57.
NRC. 1996. Nutritional Requirements of Beef Cattle, 7th ed. National Academy Press, Washington D.C.
Oltjen, J.W., and J.L. Beckett. 1996. Role of ruminant livestock in sustainable agricultural systems. J. Anim. Sci. 74:1406-1409.
Porath, M. L., P.A. Momont, T. DelCurto, N. R. Rimbey, J. A. Tanaka, and M. McInnis. 2002. Offstream water and trace mineral salt as management strategies for improved cattle distribution. J. Anim. Sci. 80:346-356.
Parsons, C. T., P. A. Momont, T. DelCurto, and J. L. Sharp. 2003. Effect of season of use on beef cattle distribution patterns in riparian areas. J. Range Manage. 56:334-341.
Stillings, A. M., J. A. Tanaka, N. R. Rimbey, T. DelCurto, P. A. Momont, and M. L. Porath. 2003. Economic implications of off-stream water developments to improve riparian grazing. J. Range Manage. 56:418-424.
Wallace, G. N., J.E. Mitchell, M.D. Wells. 1996. Visitor perceptions about grazing on a Forest Service cattle allotment. USDA Forest Serv. Gen. Tech. Rep. RM-RP-321. Fort Collins, Colo.
Wells, M. 2003. Influence of cow age/experience and landscape thermal regimes on distribution and grazing patterns of cattle in northeastern Oregon mixed conifer forested rangelands. Masters Thesis, Oregon State University, Corvallis.

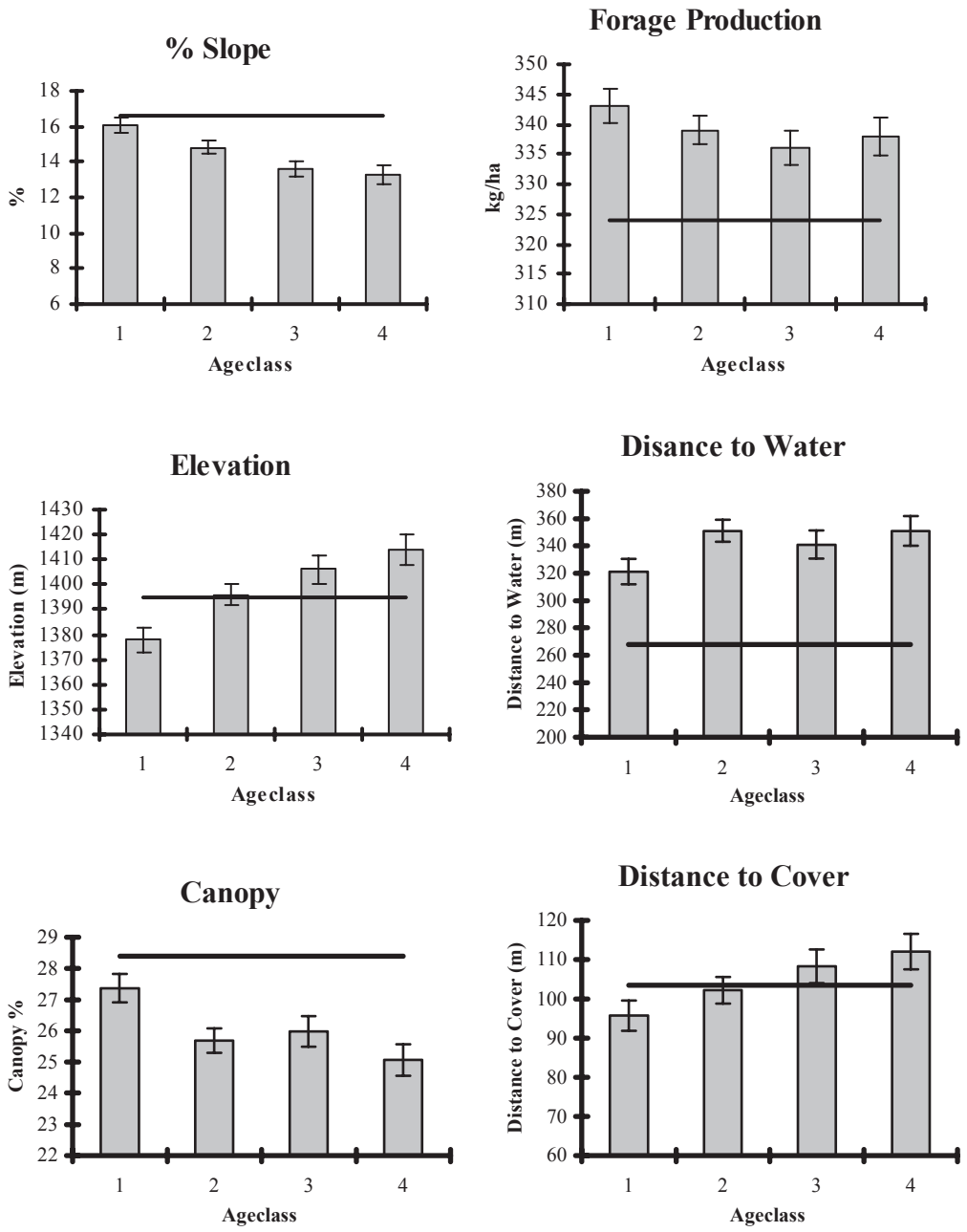

Figure 6. Mean for habitat variables of areas occupied by cattle in each age class during peak grazing hours (1hr before and 4 hrs after sunrise and 4 hrs before and 1 hr after sunset). Habitat variable mean for pasture is represented by the solid horizontal line. (Age class 1 – 2 and 3 years of age; Age class 2 – 4 and 5 years of age; Age class 3 – 6 and 7 years of age; Age class 4 – 8 years and greater)