Modelling grazing animal distributional patterns using multi-criteria decision analysis techniques

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Introduction Predicting livestock distribution is crucial to reducing livestock impacts on environmentally critical areas. Attempts to model livestock distribution on rangelands have met with varying levels of success. Most of these models described conditions at specific sites and did not work well when they were applied to other sites. In part, the weakness of these models arises from a lack of connection to the spatial arrangement of the study area and the pattern shown by animal distributions. To model the influence of the factors on livestock distribution we developed the Kinetic Resource and Environmental Spatial Systems (KRESS) Modeller. The KRESS Modeler is a multi-criteria decision analysis program that can use GIS layers to predict the suitability of positions in a pasture for animal use.

Methods The KRESS Modeller builds GIS layers from abiotic and biotic landscape data (e.g. slope, distance from water, solar radiation and forage quantity) that can influence cattle distribution. KRESS scales the landscape data so that it can be weighted proportionally, determines the spatial and temporal relationships of the landscape data, builds a spatial model describing landscape suitability for cattle grazing, evaluates the model using GPS-generated cattle positions and applies the model to new landscapes. Spatial data that described abiotic and biotic characteristics of California foothill pastures were entered into the KRESS Modeler. Ground resolution of the information was 10 m by 10 m. Data included digital elevation models, forage standing crop, and distance from water. A series of decision rules defined suitability of positions in the pasture for grazing and resting activities for beef cows based upon our knowledge of animal food requirements, water requirements, ability to travel, and thermal requirements. Factors were weighted and applied using the weighted sum multi-criteria algorithm in the KRESS Modeler. The models were saved so that they could be applied to other pastures in this vegetation type. Models were tested by using data collected by either 24-hour visual observations or with data from cows fitted with GPS collars. The frequency of occurrence of cattle in each cell on the landscape was calculated and the distribution of animals was compared to the patterns predicted by the multi-criteria model using ROC analysis.

Results and Discussion The KRESS Modeller integrated abiotic and biotic landscape characteristics into a cattle suitability map for California foothill pastures containing steep and gentle terrain (Figure 1). The validity of the landscape suitability maps was tested by comparing with beef cow positions from visual mapping and GPS collars using ROC analysis. The results of this study show that the frequency of cow positions located in landscapes mapped as highly suitable for cattle exceeded that expected if the cows were distributed randomly. These results indicate that the KRESS Modeler is a useful tool for predicting and understanding livestock distribution on rangeland.

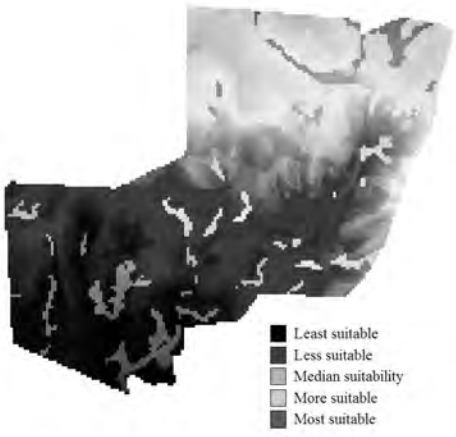

Figure 1 Cattle suitability map