Modelling Grazing Animal Distributional Patterns Using Multi-Criteria Decision Analysis Techniques

M. R. George
University of California at Davis

N. R. Harris
University of Alaska

N. K. McDougald
University of California at Davis

M. Louhaichi
Oregon State University

M. D. Johnson
University of Southern California

See next page for additional authors
Follow this and additional works at: https://uknowledge.uky.edu/igc

Part of the Agricultural Science Commons, Agronomy and Crop Sciences Commons, Plant Biology Commons, Plant Pathology Commons, Soil Science Commons, and the Weed Science Commons

This document is available at https://uknowledge.uky.edu/igc/20/satellitesymposium3/45

The XX International Grassland Congress took place in Ireland and the UK in June-July 2005. The main congress took place in Dublin from 26 June to 1 July and was followed by post congress satellite workshops in Aberystwyth, Belfast, Cork, Glasgow and Oxford. The meeting was hosted by the Irish Grassland Association and the British Grassland Society.

Proceedings Editor: D. A. McGilloway

Publisher: Wageningen Academic Publishers, The Netherlands

© Wageningen Academic Publishers, The Netherlands, 2005

The copyright holder has granted the permission for posting the proceedings here.

Presenter Information

M. R. George, N. R. Harris, N. K. McDougald, M. Louhaichi, M. D. Johnson, D. E. Johnson, and K. R. Smith

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

M.R. George[1], N.R. Harris[2], N.K. McDougald[1], M. Louhaichi[3], M.D. Johnson[4], D.E. Johnson[3] and K.R. Smith[3]

[1]Department of Agronomy and Range Science, University of California, Davis CA, 95616, USA, Email: mrgeorge@ucdavis.edu, [2]Palmer Research Center, University of Alaska, Fairbanks, 533 E. Fireweed Ave., Palmer, AK 99645-662, USA, [3]Department of Rangeland Resources, Oregon State University, Corvallis, Oregon 97331-22180, USA and [4]Department of Mathematics, University of Southern California, Los Angeles, CA 90089-253, USA

Keywords: livestock distribution, global positioning, geographic information systems

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.
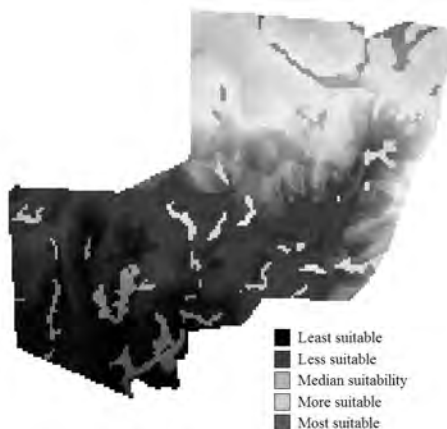

Least suitable
Less suitable
Median suitability
More suitable
Most suitable

Figure 1 Cattle suitability map