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in

Porqueddu C. (ed.), Ríos S. (ed.).
The contributions of grasslands to the conservation of Mediterranean biodiversity

Zaragoza : CIHEAM / CIBIO / FAO / SEEP
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 92

2010
pages 55-58

Optimizing the location of water and feeding sites to decrease cattle contamination of natural streams

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Abstract. Grazing of cattle in open rangelands has lately been seriously considered as a potential pollution source of streams and lakes. The objective of this research was to evaluate the effects of locating external water troughs, feeding sites and shade in grazed paddocks, on cattle distribution. In a series of experiments, conducted during three summer seasons at the Karei Deshe experimental farm in Northern Israel, cattle movements were documented using GPS collars. We placed these external resources in various locations > 500 m away from a natural water source, and compared the resulting cattle spatial distribution pattern with that of an earlier reference period in which no external resources were introduced. The location of each of these resources affected cattle distribution. We found a decrease of 50-100% in utilization of the areas surrounding the natural spring and/or stream. These initial results indicate the potential of selecting locations of external resources to manipulate cattle movement and to improve rangeland management, such as decreasing the pollution of streams.

Keywords. Pasture – GPS collar – External resources.

Optimisation de l'emplacement des points d'eau et d'alimentation pour diminuer l'utilisation des cours d'eau naturels par les bovins

Résumé. Le pâturage des bovins sur prairies est depuis peu considéré comme une source de pollution potentielle des ruisseaux et des lacs. L'objectif de cette recherche était d'évaluer si l'installation dans les pâturages de points d'eau et d'alimentation externes ainsi que de sites ombragés avaient un effet sur la distribution des bovins. Lors d'une série d'expériences conduites au cours de trois saisons estivales à la ferme expérimentale de Karei Deshe dans le nord d'Israël, les mouvements des troupeaux ont été enregistrés grâce à des colliers munis de GPS. Nous avons introduit ces ressources externes dans diverses localisations situées à plus de 500 mètres d'une source d'eau naturelle et avons comparé le modèle de distribution spatiale à une période de référence antérieure où aucune ressource extérieure n'avait été introduite. L'emplacement de chacune de ces ressources a affecté la distribution des bovins. Nous avons pu observer une baisse de 50 à 100% de l'utilisation des zones environnant la source naturelle et/ou le cours d'eau. Ces premiers résultats indiquent le potentiel existant dans le choix de l'emplacement des ressources extérieures destinées à agir sur les mouvements des troupeaux et à améliorer la gestion des prairies, notamment en faisant baisser la pollutions des cours d'eau.

Mots-clés. *Bovins – Pâturage – Collier GPS – Ressources externes.*

I – Introduction

Many of the rangelands in the world are located near rivers that serve as major sources for drinking water. Cattle feces may contaminate water with nitrogen, phosphorus and infectious bacteria, and thus decrease water quality (Kenneth *et al.*, 2003). Grazing adjacent to springs and streams, especially during the dry season is a major cause of contamination of the natural water resources. Previous studies that assess the spatial distribution of cattle and feces in pastures (Kenneth *et al.*, 2003; Henkin *et al.*, 2008; Ganskopp and Bohnert, 2009) have dealt with these phenomena and lay down the initial basis for this work.

The behavior of cattle is affected by the availability of herbaceous vegetation (Henkin *et al.*, 2003; Dolev *et al.*, 2008). Generally, cattle utilize different parts of the pasture differently; some areas are used intensively, while others are visited infrequently (Gillen *et al.*, 1984; Bailey *et al.*, 1996; Ganskopp, 2001; Henkin *et al.*, 2008; Ganskopp and Bohnert, 2009). Cattle distribution affects feces distribution and consequently basin contamination (Kenneth *et al.*, 2003). It is therefore important to expand our knowledge of the movement behavior of cattle in pastures, particularly in relation to feeding sites and water troughs (Ganskopp, 2001), seasons, topography, natural water sites (Henkin *et al.*, 2008), shade (Bailey, 2004) and pasture biomass.

GPS tracking systems enabled us to study cattle'~~s~~ use of the range along a whole day in a reliable and accurate way (Turner *et al.*, 2000). Previous works that used these devices demonstrated the importance of water troughs, feeding sites and trees in areas preferred by cattle (Ganskopp, 2001; Henkin *et al.*, 2003, 2008; Bailey, 2004; Dolev *et al.*, 2008; Ganskopp and Bohnert, 2009). Kenneth *et al.* (2003) proposed that altering the location of external resources (water trough, feeding site and shade) may change the pattern of feces distribution in river basins and decrease contamination.

Our aim was three-fold: (i) to study the spatial distribution of cattle in pastures; (ii) to assess the effect of external resources and their specific location on cattle distribution pattern; and (iii) to evaluate the use of external resources as potential management tools for decreasing river contamination by increasing cattle use of areas further from natural water sources in pastures.

II – Materials and methods

The study was conducted at the Karei Deshe Experimental Farm (35°35' E; 32°55' N; 0-250 m a.s.l.) in Northern Israel and took place during 2007 and 2008. The range is characterized by a moderate to steep hilly pasture on a volcanic stony area with a protogrumosol soil. The vegetation is rich hemicryptophytic grassland (Zohary, 1973) dominated by *Hordeum bulbosum* L., *Echinops* spp., *Psoralea bituminosa* L. and many annual species. The climate is Mediterranean, characterized by wet and mild winters. The average annual rainfall is 555 mm, falling entirely from October to April.

The study was conducted in two paddocks (p5, p6) sized 135 ha and 75 ha, respectively. In each paddock there is a natural spring that usually supplies the cattle drinking water and a few trees that function as preferable resting sites during the day. GPS collars (LOTEK LR3300) were fitted to 4-7 cows in a herd of 20-30 cows (stocking rate of 3.7-4.5 ha/cow), and recorded their locations at 10 min intervals.

Following Henkin *et al.* (2008), we defined two distinct seasons: (i) early summer (June-July), when poultry litter is the only supplementary feed; and (ii) late summer (August-September), when poultry litter and straw are provided as supplementary feeds. We thus conducted two sampling sessions in each year, during these two respective seasons. Each session lasted 4-5 weeks. We used the Latin square to place the trough, feeding site and their location (details in Results) as treatments to assess the cattle spatial use adjacent to the spring. Each treatment continued for one week. The first two days of each session were omitted from the analysis and regarded as acclimatization time.

III – Results and discussion

This research includes results from early and late summer during two consecutive years. The spatial distribution of the herd was assessed summarizing all locations recorded by all GPS collars. The results of a single session in early summer 2008 (May-June) in paddock 5 are presented in Fig. 1. Five weeks of tracking 5 cows yielded 18,538 locations (~3700 per cow). Figure 1 illustrates the differential use of the paddock for each 5-day treatment. Colors represent visitation rate.

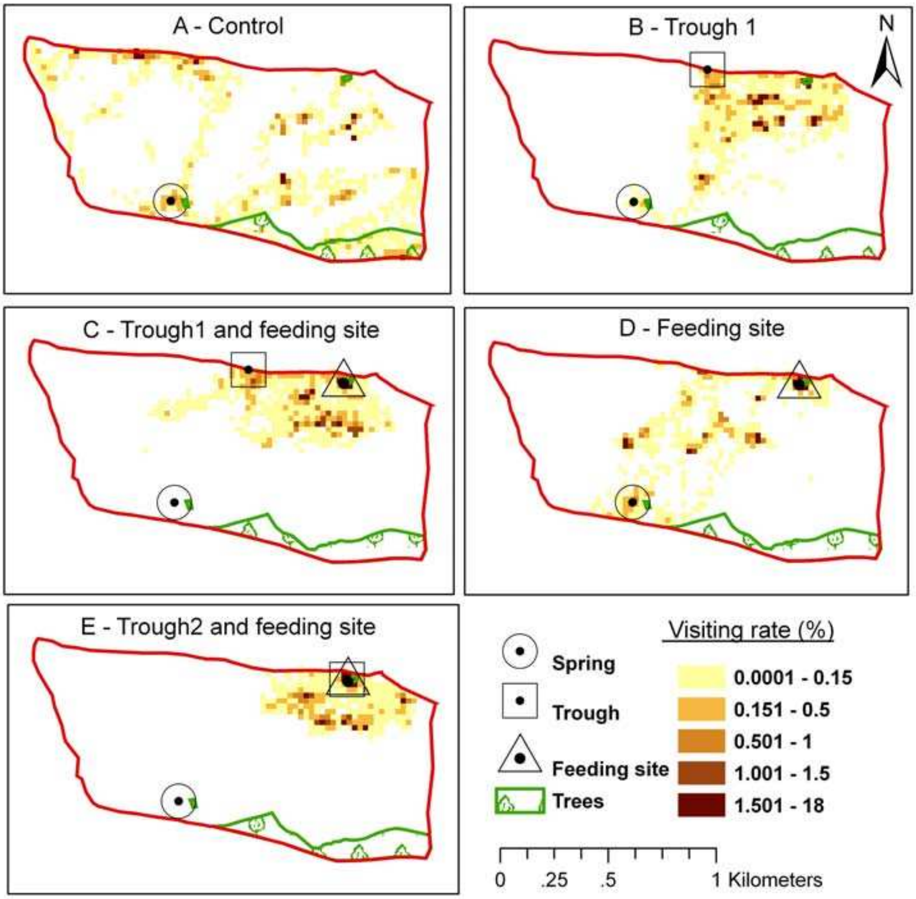

Fig. 1. Cattle' use of resources in plot 5 during five different treatments.

In the control treatment (Fig. 1A) the pattern of cattle distribution reveals many focal points of cattle concentration across the paddock. When trough 1 was filled with water (Fig. 1B), the herd concentrated around the trough and the trees in the northern part of the paddock. The supply of poultry litter at the feeding site located >400 m from trough, in addition to water in trough 1 (Fig. 1C), shifted cattle activity to the northern part of the paddock, and the spring area was entirely abandoned. In response to the elimination of trough 1 (Fig. 1D) and continued feed supply in the feeding site, cattle distribution shifted and it is observed clearly a connection between the spring and the feeding site. Next, we added trough 2 near the feeding site (Fig. 1E). This changed cattle distribution dramatically, the concentrated in a small area (<200 m) around the trough, the feeding site and the few trees nearby.

This preliminary work is the first stage in developing tools that will enable us to change the spatial distribution of cattle in pastures. Controlling cattle location in the field can be done by manipulation of external recourses, such as trough, feeding site and shade.

IV – Conclusions

Placing external resources such as water troughs and feeding sites in specific locations can cause dramatic decrease in cattle's use of areas adjacent to natural springs and rivers even without fencing. Better understanding of this issue is important for improving cattle management so as to avoid contamination of natural water sources.

Acknowledgements

The research funded by the Ministry of Environment, Israel.

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