

Landscape-scale vegetation patterns influence small-scale grazing impacts



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ABSTRACT

Understanding the distribution of herbivory is of great importance to planning the conservation management of plant communities. Control of wild and domestic large herbivore populations at large scales is commonly used to manipulate their impacts. However, the relationship between large scale population density and local impacts is often weak as the spatial layout of plant communities, and the herbivores' preferences for them, can drive the herbivores' habitat use. We tested the effects of proximity of a preferred plant community at scales up to 3 km² on the grazing impact of red deer (*Cervus elaphus*) on four plant communities of conservation importance. We also tested the relationship between grazing impacts and herbivore density at the scale of deer management units on the site. Grazing impact was measured using direct and indirect indicators of grazing. The area of the preferred species-rich grassland in proximity to the target site influenced grazing impacts on both preferred (grassland) and less-preferred (heath) communities. Grazing impacts on heaths were higher when there was more species-rich grassland present within 1000 m. Grazing impacts on species-rich grasslands were lower when the area of species-rich grassland within 500 m was small, especially when there was also more species-rich grasslands in the wider area (500–1000 m away). Herbivore density was only weakly correlated to grazing impacts. Where plant communities with contrasting grazing sensitivity to or requirement for grazing to maintain them exist side by side, there is an inherent conflict in managing for the conservation of both. Our understanding of the role of spatial layout of adjacent communities as a determinant of herbivore impact may inform the management and prioritisation of the conservation of one plant community over others.

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1. Introduction

Herbivory is distributed unevenly across the landscape at many spatial scales (Bailey et al., 1996); understanding the causes and consequences of spatial heterogeneity in grazing is of importance in setting appropriate stocking levels to achieve vegetation and animal management goals in heterogeneous landscapes (Bailey et al., 1998; Stalmans et al., 2001; Ebrahimi et al., 2010).

The degree of aggregation, arrangement and distribution of preferred and less preferred food sources or vegetation community types within a landscape alters the spatial pattern of usage and impacts by large herbivores (Clarke et al., 1995; Bailey et al., 1996; Cromsigt and Olf, 2008). Increased grazing on a lower quality resource in proximity to a high quality one has been found at small scales (several cms to 10s of metres) for large herbivores grazing multiple plant species, or two community types in a mosaic (Clarke et al., 1995; Barbosa et al.,

2009; Oom et al., 2010). The opposite effect, where preferred species are utilised less in areas with a high proportion of unpalatable species has also been observed (Bee et al., 2009). However, few studies have looked at the effect of community patterns at larger scales (100 s of metres or more) on the utilisation of food resources. Those studies that have addressed the effect of the proportion of a high quality, preferred resource in the landscape at the daily or home range scale of the study animal, have found elevated use of less preferred resources in areas with more preferred plant communities (Palmer et al., 2003; Speed et al., 2009). Supplementary feed and mineral blocks (e.g. Probo et al., 2013) are also known to modify grazing distribution.

Conservation goals are often designed to protect individual species (e.g. IUCN Red List species) or community assemblages, e.g. NATURA priority habitats in the EU (Council of the European Communities, 1992). This presents a problem for managers of sites where several protected species or communities are present and which require different management (see e.g. Hierl et al., 2008). Management of wild herbivore populations is usually carried out by culling. However, since herbivore habitat use is unevenly distributed at smaller scales, population control will not necessarily prevent detrimental effects of heavy grazing occurring locally. Population size of large herbivores at the scale of management units (10s–100s km²) is generally not strongly correlated with herbivore impacts (e.g. Palmer et al., 2003; Albon

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et al., 2007; Månsson et al., 2007; Myrnerud et al., 2010). Differences in the density of large herbivores may be reflected in differences in levels of herbivory on some plant communities or species but not others in the same area (Albon et al., 2007; Myrnerud et al., 2010).

Understanding grazing heterogeneity at scales smaller than management units will aid managers in predicting areas where grazing is likely to be especially heavy or light, and assess the success of large-scale culls at maintaining target grazing levels. This in turn will allow managers to assess where conservation goals for particular communities are likely to be compromised. This will assist with assessing whether it is possible to maintain multiple communities in line with conservation targets using culling alone or whether other management interventions such as grazing with domestic stock or manipulation of free ranging grazers with supplemental feed or fencing (e.g. Gill and Fuller, 2007; Probo et al., 2013) would be necessary. If other management interventions are impractical or undesirable then knowledge of grazing patterns could be used to assist in making decisions about which communities to prioritise at a site and, if management is varied across a large site, where it is most efficient to prioritise a particular community.

We tested two hypotheses using grazing by wild red deer on the Isle of Rum, Scotland: firstly, that grazing impacts on both preferred and less preferred communities will be higher (on all plant communities) where there is a higher proportion of the preferred community at the scale of 100 s m to km; secondly, that grazing impacts would be higher in areas of higher deer density.

2. Methods

2.1. Study site

The Isle of Rum National Nature Reserve is an island (107 km²) located 25 km off the West Coast of Scotland (57° 00' N, 6° 22' W). The climate is oceanic, with an average annual rainfall of c. 2500 mm at sea level (Clutton-Brock et al., 1982). The study area encompasses the entire island outside of the deer fenced area (see Fig. 1). The main vegetation types are wet heath and blanket bog, with smaller areas of dry and herb-rich heaths (Pearman et al., 2008). Both acid and calcareous *Agrostis–Festuca* grassland are present on the coast and in upland areas (Fig. 1) (Bates et al., 2002; Pearman et al., 2008), and these are preferentially grazed (Charles et al., 1977; Gordon, 1989). It is well established that the botanical diversity of these grasslands (especially the species-rich types) is dependent on grazing (e.g. Hierl et al., 2008; Pearman et al., 2008), whereas high levels of herbivory are incompatible with conservation goals for heath communities (e.g. Pakeman and Nolan, 2009).

Data from a NATURA habitat monitoring exercise between 2001 and 2008 (Britton and Pakeman, 2009) provided an opportunity to test the above hypotheses. Rum was considered an appropriate place to test the hypotheses, as recent assessments of the status of NATURA communities concluded that current grazing management was having a negative effect on the condition of these communities on Rum (Dayton, 2008, 2011). However it was not clear what change in management

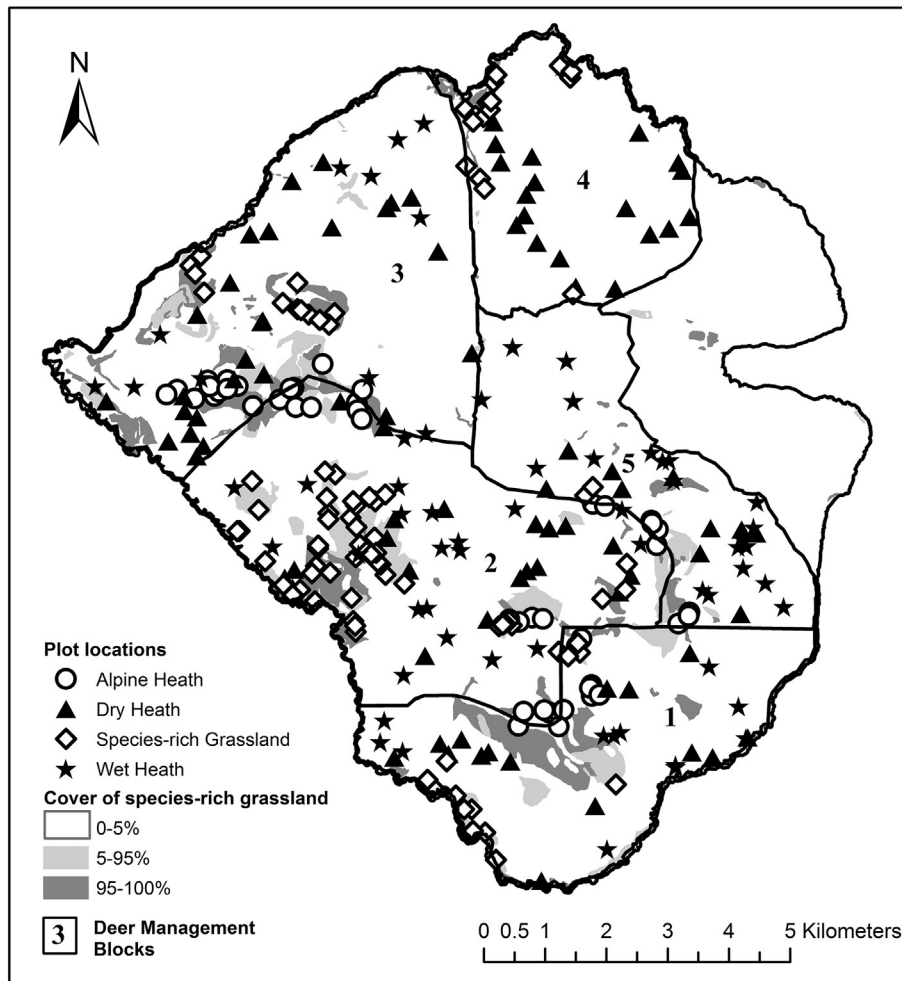


Fig. 1. Map of Rum, showing the boundaries of deer management blocks (DMB) and plot locations. Also shown are areas where species-rich grassland is present, either as sole vegetation type or as part of a mosaic including other vegetation types. Vegetation data was derived from Bates et al. (2002). The unlabelled area is surrounded by a deer fence and deer are not routinely counted in this area.

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