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Research Letters

Rodent occupancy in grassland paddocks subjected to different grazing intensities in South Brazil

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ABSTRACT

Livestock is promoting the global collapse of mammal populations. The discovery of the best management practices that reconcile conservation with production is urgently needed. We evaluated the effect of cattle grazing on the occupation of three rodent species (*Akodon azarae*, *Oligoryzomys flavescens* and *Oxymycterus nasutus*). We collected habitat covariates and sampled rodents, using live traps and tracking tunnels, in 20 paddocks subjected to different grazing pressures, from two research stations, across four seasons. We applied single-season occupancy modeling to determine whether rodent detection and occupation varied as a function of the covariates describing sampling occasions and grazing intensity. We ran sensitivity analyses to evaluate the effect of the differential sampling effort we applied across research stations. All species had higher detection probabilities during the winter. *O. nasutus* showed a higher detection probability under tall vegetation. *A. azarae* reached a higher occupation probability in ungrazed areas, although it also had a low probability of occupation in highly grazed paddocks. *O. flavescens* occupation seemed constant across the grazing gradient. *O. nasutus* reached a higher occupation probability in ungrazed areas. Decreasing stocking rates and maintaining ungrazed areas might compose the best management practices for small mammal conservation in the grasslands of Southern Brazil.

Introduction

The biomass of humans and their livestock far outweighs the biomass of extant or extinct mammals (Smith et al., 2016). Around 26% of the Earth's surface is dedicated to livestock farming (Ripple et al., 2014; Robinson et al., 2014), resulting in habitat conversion, overgrazing, soil erosion, high water wastage, high disease transmission risk and high emissions of greenhouse gases (Ripple et al., 2014, 2015; Phalan et al., 2016). Alteration of habitats for livestock is promoting the collapse of mammal populations globally (Ripple et al., 2015), and finding systems and practices that reconcile conservation with production are urgently needed (Phalan et al., 2016). Beef production in naturally growing pastures seems more environment-friendly than other alternatives (e.g., feedlots), as the adaptations of grassland plants and animals suggests coevolution with ungulates (Overbeck et al., 2007; Bond and Parr, 2010). This implies that grazing does not affect (Fig. 1A) and may even favor wildlife (Fig. 1B, dotted line). Here, we are concerned with the population-scale processes underlying the negative relationship between livestock grazing and the diversity of mammal communities in the Pampa biome (Pedó et al., 2010; Luza et al., 2016a), which might invalidate the neutral and positive responses of rodents to grazing (Fig. 1A and B, continuous line).

Grazing by large ungulates can directly (food competition, shelter/nest trampling) or indirectly (vegetation foraging) influence small mammals (Keesing, 1998; Matlack et al., 2001). Ungulate for-

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[1] http://www.ufrgs.br/ppgecologia/
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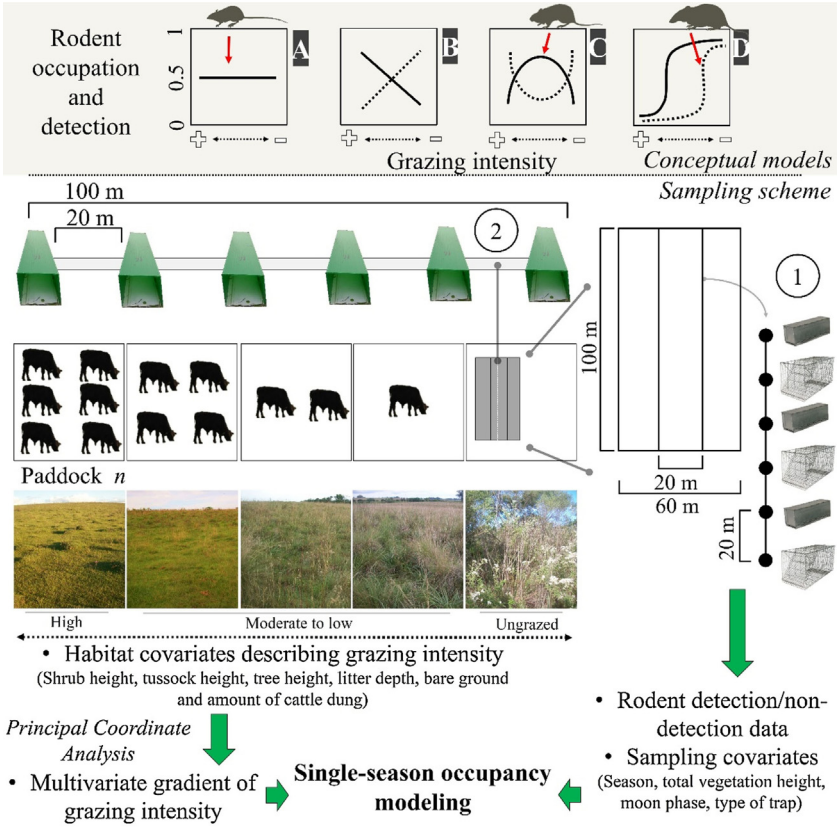

Fig. 1. Conceptual models (upper) and sampling scheme (lower) used in the study. Continuous or dotted lines in the conceptual models describe neutral (A), positive/negative linear (B), unimodal/bimodal (C) and logistic (D) relationships between rodent occupation/detection and grazing intensity. We sampled rodents using: (1) live trap grids and (2) tracking tunnel transects. We set grids and transects in ten paddocks subjected to different grazing intensities in each research station. We measured habitat covariates at each trapping point and sampling covariates for each sampling day, and related them to rodent detection using single-season occupancy modeling. Pictures show the variation in habitat structure across the gradient of grazing intensity (Pictures: A. L. Luza).

aging and trampling alters vegetation density, height and cover, as well as the formation and maintenance of litter cover and soil permeability (Matlack et al., 2001; Fox et al., 2003). While overgrazing promotes the growth of disturbance-tolerant plants (rhizomatous and stoloniferous) and the consumption of disturbance-intolerant plants, low/no grazing promotes the accumulation of flammable biomass and the growth of tussocks, shrubs and trees, which cover rhizomatous and stoloniferous plants (Duarte et al., 2006; Overbeck et al., 2007). Grassland habitat structure varies seasonally, because vegetation growth is slower during the winter, which influences cattle density (Nabinger et al., 2009; Trindade et al., 2012) and probably affects the occurrence of rodents (Pedó et al., 2010; Vieira and Paise, 2011). Experimentally manipulating the horizontal (e.g., distance between vegetation patches) and vertical (e.g., height) structure of the vegetation provides a valuable opportunity to evaluate the effect of changes in grassland structure on both beef production and wildlife (Nabinger et al., 2009; Trindade et al., 2012).

Tussock grasses, shrubs and trees assure the high abundance and resilience of small mammal populations in grasslands and grassland-forest ecotones (e.g., Pedó et al., 2010; Luza et al., 2016a). Grazing might exert a negative effect on animal populations when management regimes misuse environmental carrying capacities, potentially subjecting specialist and lightweight species requiring tall/dense vegetation to high mortality and low recruitment rates (Keesing, 1998; Moenting and Morris, 2006). Small mammals requiring tall/dense vegetation are able to colonize a disturbed area that has been abandoned (Fox et al., 2003). In contrast, only opportunist and non-resident species occupy continuously and intensively grazed habitats (Fox et al., 2003). Overgrazing is becoming increasingly common in South Brazilian landscapes, because the government and economy demands the intensification of beef production in grassland remnants, which are becoming smaller and more isolated due to their conversion into crop fields and tree plantations (Carvalho and Batello, 2009; Azpiroz et al., 2012). Thus, an analysis of the occupancy of rodent species with different life histories, in grasslands which are subjected to different grazing intensities, may aid the formulation of the best management practices for the South Brazilian grasslands.

We aimed to evaluate the relationship between cattle grazing and paddock occupancy by three rodent species (Fig. 1). Rodents are conspicuous inhabitants of grasslands and human-modified habitats due to their morphological and behavioral adaptations to diverse environmental conditions (Vieira and Paise, 2011; Sponchiado et al., 2012; Luza et al., 2016a). Studied species consist of the insectivores-omnivores Azara's grass mouse (*Akodon azarae* [Fischer 1829]) and long-nosed hocicudo (*Oxymycterus nasutus* [Waterhouse 1837]), and the herbivore-granivore yellow pygmy rice rat (*Oligoryzomys flavescens* [Waterhouse 1837]). To evaluate rodent occupancy we took the possibility of imperfect detection into account, because a species can be undetected even when occupying a given site (MacKenzie et al., 2002; Guillera-Arroita, 2017).

We expected that the scansorial and bipedal *O. flavescens* would not be influenced by the grazing gradient (Fig. 1A), because the species is extremely agile and able to exploit exposed habitats (Taraborelli et al., 2003). Conversely, we expected that the semi-fossorial *O. nasutus* should have both the highest detection in tall grasslands and the narrowest distribution across the grazing gradient (Fig. 1D – dotted line), because it is the less-vagile and has the largest body of the studied species. We expected unimodal detection and occupation probabilities for the cursorial *A. azarae*

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