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Year-round horse grazing supports typical vascular plant species, orchids and rare bird communities in a dry calcareous grassland

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ABSTRACT

Large herbivores, such as robust horse breeds, are increasingly used to develop and maintain open habitats. However, their use on calcareous grasslands has rarely been tested. On the one hand, conservationists fear an unequal use of the pasture with partial abandonment, encroachment or reduced ground light conditions, as well as partial over-grazing with negative effects as soil erosion, latrines, grazing lawns, disturbance to the ground or shrub nesting bird species due to enhanced trampling, or impairing of typical plant species. On the other hand, it is well known that large herbivore grazing is an economical alternative where traditional sheep grazing is no longer profitable. From 2010–2014, we studied horse activity (Koniks), habitat parameters (percent dung, shrub, short vegetation, and bare ground cover), and frequency of orchids and birds using a raster approach within a 90 ha year-round pasture. Vegetation composition and structure was sampled on 25 m² plots from 2009 to 2014.

All habitat parameters indicated a relatively equal horse utilization of the whole pasture and neither latrines nor partial abandonment were observed. After five years, shrub encroachment on the whole pasture was restricted from 13.7 (±17.0) to 12.0% (±15.3). Vegetation litter was reduced by 60% and the mean number of species typical for dry calcareous grasslands increased by one third on the 25 m² plots. The studied orchid species as well as the target bird species were not impaired by the grazers and plots not occupied by these species showed an equal or even lower grazing frequency. The positive grazing effects such as enhanced site conditions seem to outweigh the potentially negative effects through trampling or grazing. We conclude that in large-scale calcareous grasslands low-intensity year-round grazing with large herbivores is suitable for maintaining and even improving species diversity.

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1. Introduction

Year-round large herbivore grazing is increasingly used to develop and maintain open habitats harboring typical as well as rare plant or animal species due to the creation of a structure-rich vegetation, appropriate and effective biomass removal as well as improved ground-light conditions (Bokdam and Gleichnam, 2000; Vera, 2000; Ausden et al., 2005; Hejzman et al., 2005; Putfarken et al., 2008; Schaich et al., 2010; Rosenthal et al., 2012; Schwabe et al., 2013). But their use on calcareous grasslands has rarely been tested. Calcareous grasslands form important habitats relevant on a larger scale of the European landscape (Calaciura and Spinelli, 2008; Dengler et al., 2014). Semi-natural dry calcareous grasslands represent the main hotspots of global biodiversity besides tropical rain forests concerning maximum values recorded for vascular

plant species (Poschlod and WallisDeVries, 2002; Wilson et al., 2012). In Europe, these grasslands were historically developed and maintained by seasonal sheep and goat grazing (Poschlod et al., 2005). However, current management that predominantly is summer grazing by livestock (mostly sheep and cattle) has recently been observed to be largely insufficient to preserve the diversity of less-competitive, low-statured and stress-tolerant herbaceous species, which are typical for calcareous grasslands (Timmermann et al., 2015: numerous NATURA 2000 sites in Denmark). European-wide, an increasing grass and shrub encroachment mainly resulting from an abandonment of pastoral systems or insufficient grazing intensity is seen as important reasons for the inadequate conservation status of calcareous grasslands (European Commission, 2015). In addition, particularly seasonal small rudiment grazing dramatically declined due to economic changes (Poschlod and WallisDeVries, 2002). Therefore, in order to restore or maintain these grassland ecosystems, alternatives have to be explored and the suitability of alternative management tools has to be proven (Timmermann et al., 2015).

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Comparing traditional often small-scale grazing practices with year-round free-roaming of large herbivores, many studies assume the latter to be an efficient method for biodiversity conservation as well as cost-effective regarding economic sustainability (e.g., Hejcman et al., 2005; Schwabe et al., 2013; Timmermann et al., 2015). Contrary to seasonal (summer) husbandry, the costs of low-intensive year-round husbandry with robust breeds are minor, because management facilities such as barns, supply of winter forage and transportation are not necessary. Supplementary feeding is only necessary in strong winters, therefore, additional nutrient input to the habitat can be largely avoided. Using robust horses as grazers is particularly cost-efficient, because veterinary standards are lower than for cattle (Metzner et al., 2010). But conservationists and grassland managers fear an unequal utilization of the pasture with partial abandonment (Ausden et al., 2005; Putfarken et al., 2008), or encroachment (Buttenschön and Buttenschön, 2001; Cornelissen and Vulink, 2001), as well as partial over-grazing with negative effects such as soil erosion in steeper areas, grazing lawns or latrines (Edwards and Hollis, 1982), disturbance to the ground or shrub nesting bird species (Pakanen et al., 2011), or impacting sensitive plant species such as orchids (Fischer and Wipf, 2002; Calaciura and Spinelli, 2008; Sýkora et al., 2009). Therefore, year-round grazing with large herbivores is currently usually not recommended for the maintenance of biodiversity hot-spots, which include sites within the NATURA 2000 network harboring rare species such as orchids (Calaciura and Spinelli, 2008). In particular, the use of horses is questioned, because they are supposed to graze very selectively, browse the plant bases and damage turf with their weight and trampling (Calaciura and Spinelli, 2008).

A more frequent implementation of year-round large herbivore grazing is also hampered by the insufficient knowledge about the long-time and large-scale impact of that management on rare or sensitive species, such as bird populations (but see Zalba and Cozzani, 2004; Arthur et al., 2008). Studies on typical calcareous grassland orchids are completely missing in the recent literature, as well as studies assessing the impact of year-round grazing on rare plant and animal species simultaneously.

To improve the knowledge about this promising grazing practice, we used multi-year and multi-species datasets to investigate the effects of year-round horse grazing on small-scale vegetation composition, large-scale structural patterns, and rare target species in an orchid-rich calcareous grassland.

In this study, we focused on the following questions:

- (1) How does year-round low-intensity grazing affect the target plant community and parameters of vegetation structure?
- (2) Do horses utilize the pasture equally, and does year-round grazing show positive large-scale effects on important habitat parameters?
- (3) How does trampling and grazing affect sensitive plant species such as a regionally rare orchid?
- (4) Is there a link between horse grazing intensity and the dynamics of nesting bird populations?

2. Materials and methods

2.1. Study area

The study was carried out in an area of 90 ha in the nature reserve and Natura 2000 site “Tote Täler südwestlich Freyburg” in the Lower Unstrut Valley area in Central Germany, about 5 km northwest of Naumburg (51° 13' N; 11° 46' E) (Fig. S1). The climate is moderate to slightly continental with mild winters and warm relatively dry summers (mean annual temperature: 8.3 °C; mean

annual precipitation: 565 mm). The region is hilly (250 m a.s.l.) characterized by shallow loess Luvisols on middle Muschelkalk (Reichhoff et al., 2001). The average contents of soil macronutrients on the studied small-scale vegetation plots were total nitrogen 0.31%, available phosphorus 0.26 mg/100 g soil, potassium 19.05 mg/100 g soil, and carbon 8.9% which represent a low nutrient status. Nutrient availability is low with a C/N ratio of 28.7. Atmospheric N deposition is low to average (13 kg ha⁻¹ a⁻¹) (Bobbink et al., 2003; Umweltbundesamt, 2009). The soil contents were determined using a TruSpec CN-Analyzer by LECO, Mönchengladbach/Germany (nitrogen, carbon), a double-lactate-digestion-method (DL) and a Spekol 1100 by Carl Zeiss, Jena/Germany (phosphorus), and DL and atom absorption spectrometry (AES) with ContraAA 700 by Analytic Jena AG, Jena/Germany) (potassium).

The Lower Unstrut Valley area is characterized by species-rich dry calcareous grasslands covering a total surface of ca. 430 ha. 260 ha of these grasslands harbor valuable orchid species (Landesamt für Umweltschutz, Biotopkataster, unpubl. data, 2015). The calcareous grasslands occur on slopy as well as on plain, but shallow sites where the limestone is near to the surface. Historically, these grasslands were maintained by sheep and goat grazing. Due to the weak economic situation, sheep herding strongly declined leading to a large-scale abandonment of calcareous grasslands within the whole region.

The study area is characterized by a plain, semi-open landscape formed by large-scale dry grasslands, patches of *Rosa* spp., *Crataegus* spp., and *Prunus spinosa* as well as scattered old orchards. It is surrounded by deciduous forests. Several historical small-sized quarries are sparsely vegetated. From 1950–1992 the study area was used for military purposes. From 1995–2009 it was managed by sheep herding in order to maintain the calcareous grasslands, but habitat quality still decreased because of irregular grazing management with too low stocking rates and biomass removal. Before 2009 tall stands of characteristic but high competitive grasses like *Bromus erectus* and *Brachypodium pinnatum* dominated the study area. On slightly deeper soils, which occur in more or less evenly distributed patches across the whole pasture, the dry grassland was invaded by Arrhenaterion species such as *Arrhenaterum elatius* indicating abandonment. The vegetation litter layer was dense and high (up to 9 cm). The floristic species composition typical for the grassland type “Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia, * important orchid sites) (6210*)” (European Commission, 2007; Schuboth and Frank, 2010) was partially abundant with approximately 320 vascular plant species. Due to the poor management of the site, target species for calcareous grasslands did not regularly occur throughout the pasture. However, the grassland still inhabited orchid species like *Epipactis atrorubens*, *Listera ovata*, *Gymnadenia conopsea*, *Ophrys apifera*, *O. insectifera*, *Orchis militaris*, *O. purpurea* or *Platanthera bifolia* and *P. chlorantha*, although the populations sizes were low for most of the species. *Ophrys apifera* exhibited the largest orchid population with ca. 1000 individuals on the 90 ha site in 2009. Among the 50 breeding bird species in the 90 ha study area, the woodlark (*Lullula arborea*), red-backed shrike (*Lanius collurio*), barred warbler (*Sylvia nisoria*), skylark (*Alauda arvensis*), corn bunting (*Emberiza calandra*), Eurasian wryneck (*Jynx torquilla*), and turtle dove (*Streptopelia turtur*) were selected as target species according to their indicator function for semi-open landscapes.

In 2009, a year-round grazing system with one herd of the robust horse breed Konik Polski was introduced to manage the 90 ha large grassland. Konik horses are descendants of the last East European wild horses characterized by grey color with a dark eel back, stripes on extremities and heights of withers of 130–140 cm (Jeziński and Jaworski, 2008). During the vegetation period the

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