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Goat paddock grazing improves the conservation status of shrub-encroached dry grasslands

Verbesserung des Erhaltungszustandes von verbuschten Trockenrasen durch Ziegenbeweidung auf Rotationsstandweiden

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Abstract

European dry grasslands are predominantly semi-natural communities. Commonly, they have been used as pastures for sheep and goats. Due to their richness in biological diversity and the large number of threatened species, they are recognized as being of high conservation value. However, in the last few decades, a dramatic decline in dry grassland areas has been observed throughout Europe. Pasture abandonment followed by grass and shrub encroachment are the main causes of dry grassland loss, especially at isolated marginal sites. The introduction of goat paddock grazing can be an efficient method for restoring shrub-encroached dry grasslands, but most recommendations are still based on anecdotal evidence. Hence, this study investigated the impact of goat paddock grazing with a relatively high grazing pressure (0.6 to 0.8 LU/ha/yr) over seven years on habitat structure and species richness in six encroached dry grassland localities of the lower Saale River valley in Central Germany. In each paddock, we analyzed 25-m² plots in highly (initial woody species cover of ≥ 25%) and less encroached areas (initial woody species cover < 25%) and compared the development of woody species, grass encroachment indicators, litter cover and the share of bare soil as well as the coverage and number of target and ruderal species with that of ungrazed control plots.

We observed the following effects of restorative goat paddock grazing: Woody plants and litter layer cover declined significantly in all paddock plots. In addition, the share of bare soil increased significantly in the less encroached paddock plots. The number of target species increased significantly in the formerly highly encroached plots, whereas the already high target species richness slightly increased on originally less encroached plots. Besides short-lived target species, even red list species were able to colonize the grazed plots. Furthermore, we observed a slightly increasing number of ruderal species, but at a very low level of coverage. An opposite trend was recorded in the ungrazed plots: The cover of woody and competitive grass species, as well as litter coverage, increased significantly over time. While the cover of target species decreased significantly in the highly encroached plots, the number of target species stayed stable in both types of control plots, showing the restoration potential of the encroached grasslands.

Based on our findings, we conclude that goat paddock grazing with a relatively high grazing pressure can be an effective tool to restore encroached dry grasslands. The reduction of encroachment and the increasing number of target species correlates with the improved conservation status of these highly valuable dry grassland habitat types. Finally, recommendations for the implementation of restorative goat grazing are given.

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Erweiterte deutsche Zusammenfassung am Ende des Artikels

1. Introduction

Due to their high biodiversity (VEEN et al. 2009, WILSON et al. 2012) and the large number of threatened species (KORNECK et al. 1998, VAN SWAAY et al. 2006), dry grasslands are recognized as being of high conservation value (CALACIURA & SPINELLI 2008, DENGLER et al. 2014, JANSSEN et al. 2016). Dry grasslands mainly originated from a long history of seasonal grazing by sheep and goats, occasionally in combination with other land use practices (e.g., mowing) (POSCHLOD & WALLISDEVRIES 2002, POSCHLOD et al. 2009, ELLENBERG & LEUSCHNER 2010). Shrub encroachment resulting from pasture abandonment is considered to be an important driving factor for the unfavourable conservation status of many of these habitats, especially in isolated marginal areas (WALLISDEVRIES et al. 2002, DIERSCHKE 2006, CALACIURA & SPINELLI 2008, HEGEDUŠOVÁ & SENKO 2011, EUROPEAN COMMISSION 2015, DEÁK et al. 2016). Similarly, inappropriate late summer grazing at low intensity may also result in the spread of competitive tall grasses such as *Arrhenatherum elatius*, *Brachypodium pinnatum* or *Bromus erectus*, increasing litter accumulation and species loss (JÄGER & MAHN 2001, WEDL & MEYER 2003, DOSTÁLEK & FRANTÍK 2012).

Many semi-natural dry grassland communities are listed as habitat types of community interest in Annex I of the EU Habitats Directive (EUROPEAN COMMISSION 2013). These habitat types have to be maintained at or, where appropriate, restored to a favourable conservation status. Manual shrub removal can be a temporary solution to reduce shrubbery, but must be repeated in relatively short intervals because of the fast re-growth of many woody species (BACON 2003, MACCHERINI et al. 2007, ELIAS et al. 2014). In addition, mechanical shrub removal requires a huge effort regarding manpower/machinery, and it is often extremely expensive particularly on steep slopes (recently up to 8000 €/ha in the lower Saale River valley). Thus, in order to restore and maintain these dry grasslands, management plans should be developed based on historical land use in which goat pasture often played a prominent role, especially at marginally productive sites on steep slopes (GLAVAC 1983). Currently, due to the preference of goats for browsing than grazing, they are commonly used to control shrub encroachment worldwide (STRANG 1973, LUGINBUHL 1999, HOLST et al. 2004, SMART et al. 2006, CELAYA et al. 2010, ASCOLI et al. 2013), but in Central Europe only a few studies have dealt with goat grazing, especially in dry grasslands (RAHMANN 2000, CZYLOK et al. 2013). Sheep grazing is often still preferred, even at heavily encroached sites. Hence, there is little information about the effects of goats as browsers and grazers for biodiversity conservation in semi-natural dry grasslands.

For reducing shrubbery and dense grass cover, grazing with a comparatively high stocking rate and an early start of grazing in spring is mandatory during a restoration phase of the first five to seven years (CROFTS & JEFFERSON 1999, ELIAS & TISCHEW 2016). Experiences in Central Germany has shown, that at small and isolated dry grassland localities, the economic feasibility of such a grazing regime can only be achieved by paddock grazing with permanent fences. However, nature conservationists are often concerned that paddock grazing and an early start in spring may lead to negative effects through excessive trampling and the spread of nitrophilous ruderal plant species, and finally to the loss of valuable target species.

In this study, we evaluated the success of goat grazing in the restoration of strongly encroached dry grasslands in Central Germany that still hold a high number of endangered species. We focused on the following specific questions: (1) Can shrub and grass encroachment be reduced significantly by restorative goat grazing and how do litter layer and bare soil coverage develop under goat grazing? (2) How does goat grazing affect the number and coverage of target species (characteristic species of dry grassland habitat types and red list species) of dry semi-natural grasslands? (3) How does restorative goat grazing affect the number and coverage of ruderal species?

2. Study area and goat grazing pilot project

The study was carried out in the lower Saale River valley between Halle and Könnern in the south of the German federal state of Saxony-Anhalt in Central Germany. The climate is sub-continental with an average annual precipitation of 476 mm and a mean annual temperature of 9.0 °C (climatic station Halle; see REICHHOFF et al. 2001). Elevations range from 70 to 150 m above sea level.

Sheep and goat livestock have been present since Neolithic times in Central Germany (BENECKE 1994). The tradition of migratory herding of sheep and goats in combination with varying geomorphological and soil conditions resulted in the formation of attractive mosaics of different dry grassland habitat types. Some of the characteristic plant communities are listed as natural habitat types in Annex I of the Habitats Directive (e.g., 6210 Semi-natural dry grasslands on calcareous substrates, 6240* Sub-pannonic steppic grasslands).

Socio-economic changes after German reunification in 1990 led to an accelerated abandonment of sheep grazing, whereas goat breeding had already been in decline since the middle of the last century (JÄGER & MAHN 2001, RICHTER et al. 2003). These actions have resulted in species-rich dry grasslands being heavily endangered by shrub and grass encroachment.

However, species-rich remnants of dry grassland habitats as well as numerous populations of red list plants were still present on a number of sites when we started our study in the lower Saale River valley in 2006. All sites were situated on steep slopes and partly surrounded by dense shrubbery or woodland making migratory herding laborious or even impossible. Therefore, a pilot project for goat paddock grazing was initiated in cooperation with local farmers. The paddocks were enclosed using permanent pasture fences to make grazing of such marginal and isolated sites economically feasible. Farmers were urged to pasture with high grazing pressure to reduce shrub and grass encroachment. Additionally, they were invited to avoid supplementary feeding (except for minerals) which was largely respected. The first paddocks were established in 2007. Over time, a total of 16 pastures are being grazed by goats, partially together with sheep or cattle, supported by our model project within the Saale River valley.

3. Material and methods

3.1 Experimental design

The study was conducted at six paddocks (Table 1). Since we studied grazing management within a real-life pilot project, where the paddocks were gradually established, the starting point of grazing varied between paddocks, but have consistently lasted at least seven years up to 2018. Before the grazing started, all sites were abandoned for many years and characterized by a mosaic of open grassland patches and patches of more or less intensive shrub encroachment. The woody vegetation was dominated by thermophilic shrub communities (*Berberidion*), which include different thorny and spiny species such as *Berberis vulgaris*, *Crataegus* spp., *Prunus spinosa* and *Rosa* spp. (shrub height was on average 2 meter, but some individuals reached 6.5 meter). These species are typical for abandoned pastures in the whole region. Grass encroached parts of the paddocks were dominated especially by *Arrhenatherum elatius*, *Bromus erectus*, *Brachypodium pinnatum*, *Festuca rupicola* and *Poa angustifolia* (compare also PARTZSCH 2000). Despite the partly heavy encroachment, the paddocks were still characterized by remnants of species rich dry grasslands (Table 1). Moreover, they still harboured populations of german (KORNECK et al. 1996) or regional (FRANK et al. 2004) red list species such as *Astragalus exscapus*, *Oxytropis pilosa*, *Scabiosa canescens* or *Seseli hippomarathrum*. The dry grassland communities of the lower Saale River valley were described in detail by PARTZSCH (2000) and ELIAS et al. (2015). ELIAS et al. (2015) included also a description of the goat paddock Nelbener Grund.

All investigated paddocks were grazed by Boer goats and crossbreeds. The grazing season extended generally from March–April to October–November depending on weather conditions and subsequent fodder availability. The paddock size varied between 1.0 and 8.3 ha (Table 1) and the annual stocking rate ranged from approximately 0.6 to 0.8 LU/ha/yr, meaning 6–8 goats per hectare in relation to a grazing period of eight months.

Vegetation development was analyzed on 25-m² permanent plots. The plots were established on southeast to southwest exposed slopes in formerly less intensive (initial woody coverage < 25%) and intensive encroached parts (initial woody coverage ≥ 25%) inside each paddock as well as outside each paddock in abandoned dry grasslands (maximum distance 100 meter). We analyzed one paddock plot as well as one control plot per structure type (in total 24 plots per year, 6 paddocks x 2 structural types x 2 grazing treatments) over a time period of seven years. The locations of the analyzed plots were selected on the basis that the paddock and the control plots showed similar habitat features (topography, soil depth, species composition).

Table 1. Characterization of the paddocks, initial level of shrub encroachment (LSE), target habitat types and number of red list species (RL spec.: includes only grasses and forbs; KORNECK et al. 1996, FRANK et al. 2004).

Tabelle 1. Charakterisierung der Weideflächen, Anfangsverbuschungsgrad (LSE), Ziel-Lebensraumtypen und Zahl der vorhandenen Rote-Liste-Arten (RL spec.: nur Gräser und Kräuter; KORNECK et al. 1996, FRANK et al. 2004).

Paddock	Geographical position	Size (ha)	Start of observ.	LSE (%)	Target Habitat types of Annex I	RL spec.
Nelbener Grund	51°39'60"N, 11°45'00"E	8.3	2008	40–50	6110*, 6130, 6210, 6240*	30
Zickeritz	51°38'54"N, 11°44'52"E	2.3	2008	40–50	6210, 6240*	5
Tannengrund	51°38'22"N, 11°45'27"E	4.8	2011	20–30	6210, 6240*	18
Dobis	51°37'30"N, 11°45'20"E	6.1	2007	60–70	6210, 6240*, 8230	12
Mücheln	51°34'45"N, 11°50'05"E	1.0	2007	20–30	4030, 6210, 6240*, 8230	14
Salzatal	51°29'45"N, 11°47'04"E	4.9	2007	50–60	6210, 6240*	18

4030: European dry heaths

6110*: Rupicolous calcareous or basophilic grasslands of the *Alysso-Sedion albi*

6130: Calaminarian grasslands of the *Violetalia calaminariae*

6210: Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*)

6240*: Sub-pannonic steppic grasslands

8230: Siliceous rock with pioneer vegetation of the *Sedo-Scleranthion* or of the *Sedo albi-Veronicion dillenii*

With the beginning of goat grazing, the percentage cover of all species and layers was surveyed annually (beginning of June to end of July) for seven years for each plot. Furthermore, we recorded litter cover and the share of bare soil. Both parameters are good indicators of management intensity assuming that high grazing intensity corresponds with low litter cover and a high proportion of bare soil, while adandoment results in high litter cover and a low share of bare soil.

Nomenclature of vascular plants follows JÄGER (2011). When it was possible, specimens were identified at the species level. Due to the difficulty of determination under the influence of grazing, individuals of *Rosa*, *Rubus* and *Cerastium* were only identified to genus. Furthermore, due to the frequent occurrence of the hybrid *Potentilla x subarenaria* in our study region (FRANK 2016), *P. cinerea* subsp. *incana* and *P. neumanniana* were pooled together.

3.2 Data analysis

In line with the study objectives, we first evaluated the cover of all woody species (including the genus *Rubus* L.) and the grass encroachment indicators (cumulative cover of *Arrhenatherum elatius*, *Brachypodium pinnatum*, *Bromus erectus*, *Festuca rubra*, *F. rupicola*, *Poa angustifolia*).

Second, we selected particular target species to evaluate the species compostion. We defined as target species all species that are characteristic of the following habitat types: 4030 (European dry heaths), 6110* (Rupicolous calcareous or basophilic grasslands of the *Alysso-Sedion albi*), 6130 (Calaminarian grasslands of the *Violetalia calaminariae*), 6210 (Semi-natural dry grasslands and scrubland facies on calcareous substrates, *Festuco-Brometalia*), 6240* (Sub-pannonic steppic grasslands), 8230 (Siliceous rock with pioneer vegetation of the *Sedo-Scleranthion* or of the *Sedo albi-Veronicion dillenii*) (SCHUBOTH & FRANK 2010), or that are listed in the red lists of Germany (KORNECK et al. 1996), or Saxony-Anhalt (FRANK et al. 2004). The competitive grass species *B. pinnatum*, *B. erectus* and *F. rupicola*, that often formed dense swards when grazing sites had been abandoned, were analysed in the group of grass encroachment indicators although they are characteristic for habitat type 6210.

Third, we selected ruderal species to evaluate possible negative effects of grazing disturbance. Ruderal species are nitrophilous plant species which belong to the *Agropyretea repentis*, *Sisymbrietea officinalis* or *Artemisietea vulgaris*. The classification of ruderal species was derived from literature (SCHUBERT 2001, JÄGER 2011).

Since the data were not normally distributed (even after data transformation) and because of the small sample size, non-parametric Friedman tests were applied to evaluate the development of habitat structure and species group variables within the paddocks and ungrazed plots. Furthermore, we used Mann-Whitney U-tests to compare the values between grazed and ungrazed plots in each year. All analyses were conducted using IBM SPSS Statistics version 22.0.

4. Results

4.1 Development of habitat structure parameters

Within seven years, the browsing activity of goats resulted in a significant decrease of woody species cover within paddocks, both in less and more intensively encroached plots (Table 2). On the contrary, the coverage of woody species increased significantly in ungrazed controls in both structure types (Table 3). This was confirmed by the paired U-tests too; woody coverage showed no significant difference between the grazed and control plots in the initial three years, but woody coverage was significantly lower in the grazed plots than in the controls in the last four years (Fig. 1).

The cover of grass encroachment indicators declined slightly, but not significantly, in the pastures (Table 2), whereas on the less intensively encroached control plots we observed a significant increase of grass encroachment from 39.4 to 54.8% during the seven observation

Table 2. Development of grazed plots (n = 6). Mean values and standard deviation (± SD). $p \leq 0.001$ = extremely significant, $0.01 \geq p > 0.001$ = very significant, $0.05 \geq p > 0.01$ = significant, $p > 0.05$ = not significant.

Tabelle 2. Entwicklung der Weideflächen (n = 6). Mittelwerte und Standardabweichung (± SD). $p \leq 0{,}001$ = extremely significant; $0{,}01 \geq p > 0{,}001$ = very significant; $0{,}05 \geq p > 0{,}01$ = significant; $p > 0{,}05$ = not significant.

	Intensive encroachment (Initial woody coverage ≥ 25%)										Less intensive encroachment (Initial woody coverage < 25%)									
	Years							Friedman Test			Years							Friedman Test		
	1	2	3	4	5	6	7	*df*	*Chi-s.*	*p*	1	2	3	4	5	6	7	*df*	*Chi-s.*	*p*
Woody species (%)	39.7	28.3	21.6	15.5	16.8	17.0	16.4	6	21.546	0.001	13.2	5.6	5.3	4.5	4.0	3.3	2.8	6	20.108	0.003
±SD	11.5	18.1	15.9	13.0	15.7	15.4	14.2				7.5	4.3	3.3	2.7	3.4	2.0	1.9			
Grass encr. ind. species (%)	33.8	25.7	26.0	24.9	28.4	29.2	28.1	6	8.101	0.231	25.8	26.8	25.1	25.3	23.7	23.3	22.7	6	2.540	0.864
±SD	20.2	10.0	7.5	10.1	8.8	8.5	10.0				18.0	16.3	15.8	16.6	17.1	15.8	15.8			
Litter layer (%)	40.0	30.8	26.7	26.8	26.5	26.7	26.3	6	13.928	0.03	25.0	17.7	14.6	14.2	14.3	14.3	12.8	6	13.091	0.042
±SD	19.5	24.2	24.7	24.5	21.3	20.8	18.6				7.7	10.5	13.8	10.1	9.4	8.9	8.9			
Bare soil (%)	10.0	22.0	27.5	23.7	23.2	20.8	19.8	6	9.778	0.134	14.8	25.7	31.2	29.5	30.8	32.5	29.5	6	15.485	0.017
±SD	8.2	15.5	18.7	18.4	15.3	16.0	16.7				11.7	18.5	21.3	22.7	19.3	14.7	15.6			
Target species (%)	14.3	14.3	15.0	16.2	17.0	18.8	19.3	6	6.429	0.377	29.0	21.3	20.1	17.9	19.8	21.8	20.8	6	9.714	0.137
±SD	7.5	9.7	12.4	13.0	11.2	13.7	13.3				13.9	12.4	13.0	12.1	10.8	15.2	14.7			
Target species (number)	11.7	12.5	14.8	14.0	15.5	16.0	15.7	6	13.141	0.041	13.5	14.3	15.5	14.5	14.3	15.5	16.0	6	9.541	0.145
±SD	5.9	6.1	7.3	7.1	7.5	7.9	7.3				4.6	4.2	4.8	5.6	5.2	5.6	4.7			
Ruderal species (%)	7.3	5.9	5.1	3.3	3.9	3.8	3.3	6	2.827	0.83	2.5	1.6	1.8	1.8	1.4	1.8	2.9	6	5.876	0.437
±SD	14.9	13.0	11.4	6.4	6.3	8.0	6.3				4.2	3.2	3.3	1.8	1.5	2.0	3.0			
Ruderal species (number)	3.5	3.0	4.0	3.3	4.0	3.8	4.2	6	6.317	0.389	1.7	1.8	2.8	2.7	2.7	3.3	4.8	6	12.448	0.053
±SD	3.8	3.3	4.9	3.4	3.4	3.9	3.8				2.9	2.7	3.2	2.2	2.2	2.1	4.4			

Table 3. Development of ungrazed plots (n = 6). Mean values and standard deviation (± SD). $p \leq 0.001$ = extremely significant, $0.01 \geq p > 0.001$ = very significant, $0.05 \geq p > 0.01$ = significant, $p > 0.05$ = not significant

Tabelle 3. Entwicklung der unbeweideten Kontrollflächen (n = 6). Mittelwerte und Standardabweichung (± SD). $p \leq 0,001$ = extremely significant; $0,01 \geq p > 0,001$ = very significant; $0,05 \geq p > 0,01$ = significant; $p > 0,05$ = not significant

	Intensive encroachment (Initial woody coverage ≥ 25%)										Less intensive encroachment (Initial woody coverage < 25%)									
	Years							Friedman Test			Years							Friedman Test		
	1	2	3	4	5	6	7	*df*	*Chi-s.*	*p*	1	2	3	4	5	6	7	*df*	*Chi-s.*	*p*
Woody species (%)	42.6	44.8	42.1	45.0	49.3	54.8	58.9	6	17.857	0.007	11.0	14.6	16.4	19.5	20.3	21.1	28.2	6	18.500	0.005
±SD	17.4	14.8	20.0	17.9	16.8	19.6	17.2				7.7	12.2	12.1	11.3	12.7	12.1	20.2			
Grass encr. ind. species (%)	33.6	35.6	35.6	40.3	42.6	41.6	43.4	6	9.878	0.13	39.4	46.3	48.9	49.0	50.0	53.3	54.8	6	21.860	0.001
±SD	13.9	14.4	16.1	16.4	17.0	13.0	14.5				13.9	14.2	11.3	12.8	13.9	17.3	17.3			
Litter layer (%)	49.2	50.8	53.3	51.7	54.2	53.7	54.2	6	3.058	0.802	45.0	52.2	56.7	63.3	63.3	65.0	62.8	6	22.393	0.001
±SD	23.8	24.2	20.7	18.6	20.8	22.0	21.5				25.9	30.0	29.6	26.4	24.0	25.7	25.8			
Bare soil (%)	7.5	7.3	7.4	9.1	7.6	8.9	7.8	6	4.936	0.552	15.5	16.0	14.3	10.1	12.3	12.7	13.2	6	7.768	0.256
±SD	13.5	16.0	13.5	11.5	11.2	11.7	10.1				23.7	24.4	20.9	15.7	14.4	16.6	14.2			
Target species (%)	17.0	13.1	10.1	11.1	10.8	9.6	7.7	6	23.588	0.001	17.6	15.0	14.4	18.5	17.7	15.7	13.4	6	7.504	0.277
±SD	15.3	12.0	11.6	10.4	11.5	10.5	7.8				12.0	11.4	10.1	16.0	15.7	12.5	12.4			
Target species (number)	8.5	8.7	8.7	8.0	8.0	8.0	8.5	6	2.682	0.848	12.5	11.8	11.7	11.8	11.8	11.8	11.2	6	4.008	0.676
±SD	5.3	5.1	4.5	4.3	4.4	4.7	5.2				5.6	5.6	5.9	6.0	5.9	5.5	5.6			
Ruderal species (%)	1.0	0.6	0.8	0.5	0.6	0.7	0.8	6	4.788	0.571	0.7	0.4	0.3	0.2	0.4	0.3	0.4	6	3.083	0.798
±SD	1.3	0.9	1.3	0.9	1.1	1.3	1.5				0.9	0.5	0.5	0.3	0.5	0.4	0.4			
Ruderal species (number)	2.0	1.5	2.5	2.2	2.2	2.5	1.8	6	1.897	0.929	0.8	0.7	1.2	1.2	1.0	1.3	1.5	6	4.667	0.587
±SD	2.6	1.9	3.4	3.5	2.9	4.2	2.6				0.8	0.8	1.0	1.2	1.1	0.8	1.4			

years (Table 3). This was confirmed by paired U-tests; the cover of grass species was significantly higher in the control plots than in the pastures in the third to the seventh years (Fig. 1). On the strongly encroached control plots, the grass encroachment also increased from 33.6 to 43.4%, but not significantly (Table 3, Fig. 1).

Within seven years, we found a significant reduction of litter layer cover in the paddocks in both structure types (Table 2), whereas the litter layer significantly increased only within the less shrub encroached control plots (Table 3). Accordingly, the paired U-tests showed significant differences between the grazed and ungrazed plots in the less encroached structure type from year three to year seven (Fig. 1).

The share of bare soil significantly increased in the less encroached paddock plots from 14.8 to 29.5%, whereas we observed only a tendency for increasing shares of bare soil within the stronger encroached grazed plots (Table 2, Fig. 1). In contrast, the mean values and the results of the Friedman tests indicated no change in bare soil over time within the ungrazed control plots (Table 3, Fig. 1).

4.2 Development of target species richness

During the seven observation years, a total of 73 target species (including 20 red list species) were observed in all plots (25-m^2). Although the average target species cover decreased in the less encroached paddock plots, from 29.0% in the first observation year to 20.8% in the seventh year, the average species number slightly, but not significantly, increased, from 13.5 to 16.0 in this structure type (Table 2). There was a marginal trend of reduction of target species number and cover within the ungrazed control plots (Table 3). In contrast, we observed an increasing target species cover, from 14.3% to 19.3%, as well as a significant rise of species number, from 11.7 to 15.7 (Friedman test: $p = 0.041$), in the formerly intensively encroached paddock plots. The controls showed a significant reduction of target species coverage, from 17.0% to 7.7% during the seven years of observation, but no change in species number. U-tests showed no significant differences. A wide range of target species benefited from grazing, especially short-lived therophytes such as *Arenaria serpyllifolia*, *Cerastium* spp., *Draba verna* agg., but also perennial red list species such as *Bothriochloa ischaemum* and *Oxytropis pilosa* were able to expand in grazed plots.

4.3 Development of ruderal species

We counted a total of 52 ruderal species within all 25-m^2-plots over the seven observation years. These included nitrophilous ruderal species, such as *Galium aparine* or *Urtica dioica*, but also ruderal species which are typical of dry grasslands, such as *Convolvulus arvensis* or *Erodium cicutarium*. The cover of ruderal species did not change during the observation years in all structure and management types. The number of ruderal species slightly increased from 1.7 to 4.8 species within the less intensively encroached paddock plots, but this development was not significant (Friedman test: $p = 0.053$). Several species showed higher frequencies, for example *Bromus sterilis*, *Urtica dioica* and *Viola arvensis*. However, U-tests showed also no significant differences in all cases.

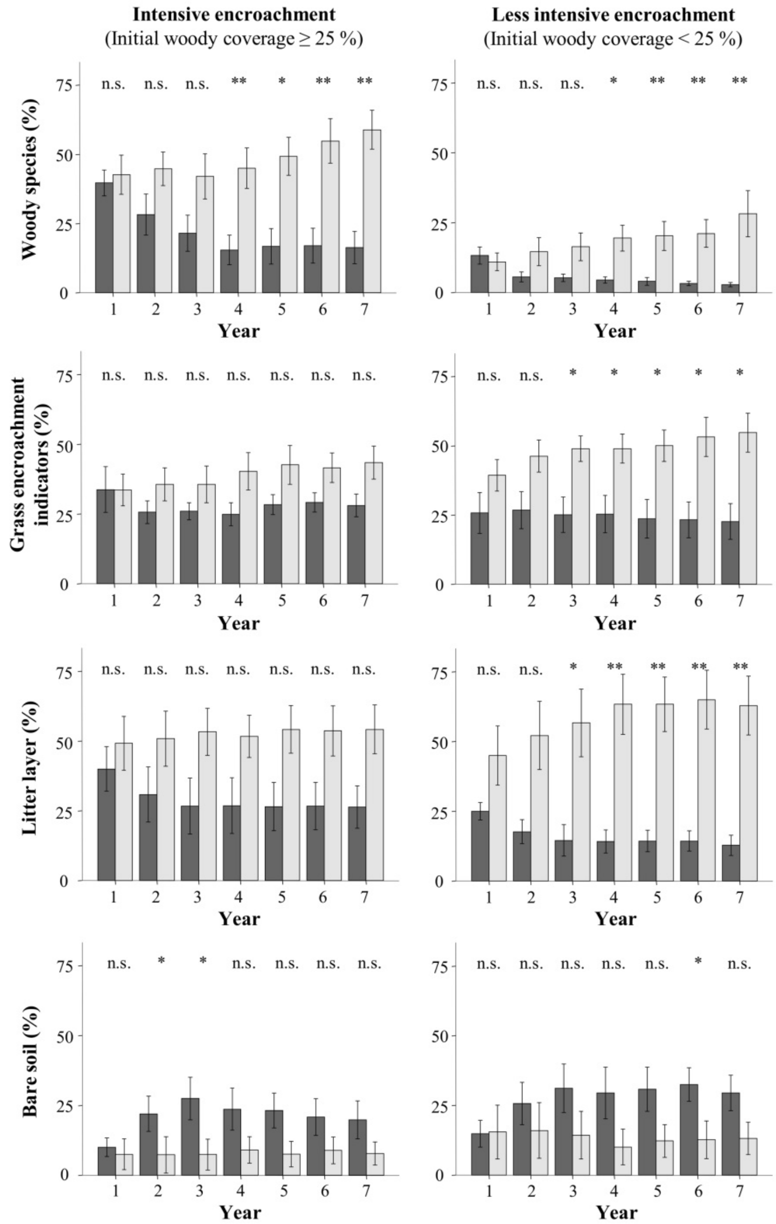

Fig. 1. Development of habitat structure variables within encroached dry grasslands in grazed (dark grey bars) and ungrazed (light grey bars) plots (n = 6). Values are means ± Standard error. Mann-Whitney U-test: $p \leq 0.001$ = extremely significant***, $0.01 \geq p > 0.001$ = very significant**, $0.05 \geq p > 0.01$ = significant*, $p > 0.05$ = not significant (n.s.).

Abb. 1. Entwicklung der Habitatstrukturen (Gehölzdeckung, Deckung brachetoleranter Gräser, Streudeckung, Offenbodenanteile) innerhalb beweideter (dunkelgraue Balken) und nicht beweideter (hellgraue Balgen) Dauerbeobachtungsflächen (n = 6). Mittelwerte ± Standardfehler. Mann-Whitney-U-Test: $p \leq 0{,}001$ = höchst signifikant***; $0{,}01 \geq p > 0{,}001$ = sehr signifikant**; $0{,}05 \geq p > 0{,}01$ = signifikant*; $p > 0{,}05$ = nicht signifikant (n.s.).

5. Discussion

5.1 Development of habitat structure parameters

In accordance with other observations in European dry grasslands (RAHMANN 2000, ZEHM 2008, VEITH et al. 2012, CZYLOK et al. 2013), our results clearly demonstrated a significant reduction of woody coverage by goat grazing, even when thorny and spiny species dominated the shrubbery (ELIAS & TISCHEW 2016). Goats are opportunistic intermediate feeders (HOFMANN 1989); when available, they show a preference for browsing (AHARON et al. 2007, EL AICH et al. 2007, ANIMUT & GOETSCH 2008). In addition, goats remove bark from woody plants which can effectively damage trees (FAJEMISIN et al. 1996, ZEHM 2008, HOLST et al. 2004). Furthermore, they often stand on their hind legs to maximize available forage height (RAHMANN 2000, EL AICH et al. 2007; Fig. 2a). Generally, there is a greater reduction of shrub cover under increasing grazing pressure by goats (MELLADO et al. 2003, JAUREGUI et al. 2008). Furthermore, spring grazing has a greater impact on the reduction of woody species as shrubs are more palatable to livestock when the leaves are fresh and the thorns of young shoots are still soft (DOSTÁLEK & FRANTÍK 2012, ELIAS & TISCHEW 2016).

We observed only a minor decline of grass encroachment indicators, but a significant reduction of the litter layer within the goat paddocks, combined with an overall positive effect on the share of bare soil (Fig. 2b, c). In contrast, competitive grass species and litter layer increased significantly in ungrazed plots with less intensive initial shrub encroachment, showing the positive effects of goat grazing in controlling competitive grasses. Generally, as with the woody species, intensive spring grazing is also more effective than late summer grazing in controlling competive grass species as their senescent herbage of low nutritive value is infrequently grazed by small ruminants (CROFTS & JEFFERSON 1999, DOSTÁLEK & FRANTÍK 2012, HEJCMANOVÁ et al. 2016). The observed decrease of the litter layer and increase in bare soil patches within our goat paddocks must be considered as a combined effect of feeding and trampling (e.g., ROSENTHAL et al. 2012).

Interestingly, in the intensively encroached control plots the spread of grass species and subsequent accumulation of litter slowed with increasing shrubbery. Similarly, DIERSCHKE (2006) observed decreased *Bromus erectus* coverage with increased shading by shrubs within calcareous dry grasslands near Göttingen (Germany). Therefore, the unexpected low reduction of grass encroachment indicators within our goat paddocks could be partly explained by the simultaneous improvement of light conditions by reduced shrub cover, which abrogated the reduction of grass biomass by goat grazing.

5.2 Target species

We observed significantly increasing numbers of target species by goat grazing within the formerly intensively encroached parts of the paddocks. This was primarily related to the browsing and grazing behavior of the goats. The decreased shading and competition from tall plants resulted in the expansion of suitable light conditions for low growing and less competitive dry grassland species (Fig. 2d). Similary, within encroached calcareous dry grasslands in Germany, RAHMANN (2000) documented decreased woody coverage and simultaneously an increase in light-demanding target species number by goat grazing, while woody and competitive grass species, particularly *Brachypodium pinnatum,* spread in

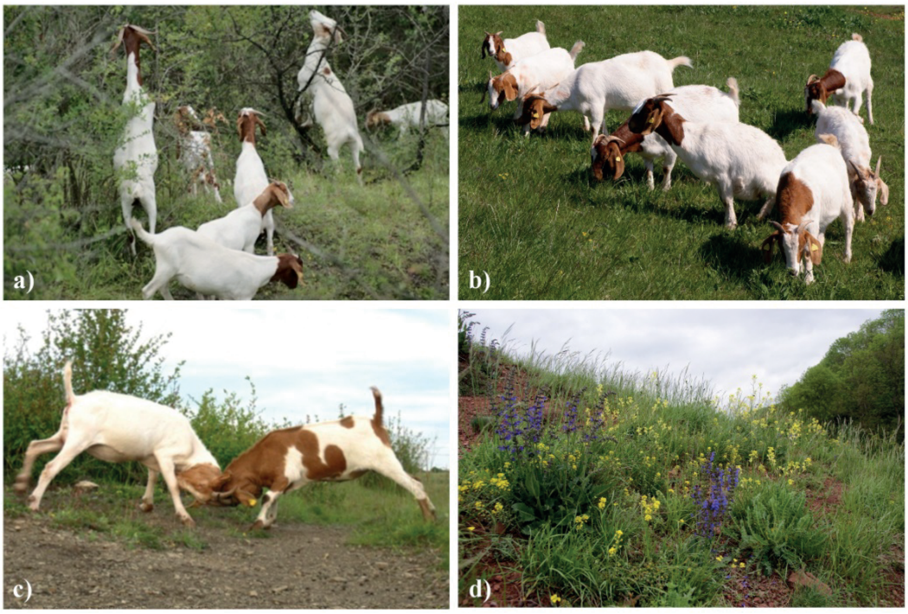

Fig. 2. Goat activities in the Nelbener Grund paddock. **a)** Browsing of shrubs by goats, frequently, they stand up on their hind legs to maximize their browsing horizon up to two meters. **b)** Grazing of swards is also a typical behavior of goats. **c)** In addition, the creation of bare soil patches by trampling is an important effect of grazing animals. Goat activities result in sparsely covered, but species-rich swards. Among other species, picture **d)** shows numerous target species such as *Alyssum alyssoides*, *A. montanum*, *Astragalus exscapus*, *Erysimum crepidifolium*, *Festuca csikhegyensis*, *Holosteum umbellatum*, *Potentilla neumanniana*, *Salvia pratensis*, *Sanguisorba minor*, *Thymus praecox* (Photos: 2a, b, d D. Elias, 2009, 2011 and 2013, respectively, and 2c S. Heinrich, 2009).

Abb. 2. Ziegenaktivitäten innerhalb der Weidefläche Nelbener Grund. **a)** Gehölzfraß an Gebüschen. Die Ziegen stellen sich häufig auf die Hinterbeine um ihren Fraßhorizont auf bis zu zwei Metern zu erhöhen. **b)** Aber auch der Fraß der Gras-/Krautschicht ist ein sehr typisches Weideverhalten von Ziegen. **c)** Ein bedeutender Effekt stellen auch Triffeffekte und die Schaffung von Offenboden-bereichen dar. Die Ziegenaktivitäten schaffen lichtreiche Konkurrenzverhältnisse in Bodennähe und lückige, aber sehr artenreiche Trockenrasenbestände, wie auch das Bild unten rechts zeigt. Neben anderen Arten beinhaltet der Bildausschnitt **d)** einige Zielarten, wie zum Beispiel *Alyssum alyssoides*, *A. montanum*, *Astragalus exscapus*, *Erysimum crepidifolium*, *Festuca csikhegyensis*, *Holosteum umbellatum*, *Potentilla neumanniana*, *Salvia pratensis*, *Sanguisorba minor*, *Thymus praecox* (Fotos: 2a, b, d D. Elias, 2009, 2011 bzw. 2013, and 2c S. Heinrich, 2009).

ungrazed controls. Similar observations were also made within shrub-encroached dry grasslands grazed by goats in Poland, with decreased shrub coverage accompanied by the spread of dry grassland species (CZYLOK et al. 2013). SCHWABE (1997) documented increased numbers of gap indicator species under the influence of goat grazing within shrubby heath vegetation of the montane zone of the southern Black Forest (Germany).

Generally, in addition to defoliation, trampling by livestock generates positive impacts through suppression of tall-growing species, increased litter decomposition and the creation of bare soil patches that provide opportunities for the recruitment of small, light-demanding plant species (FLEISCHER et al. 2013, SCHWABE et al. 2013, TÖRÖK et al. 2014, KÖHLER et al. 2016, RUPPRECHT et al. 2016). Additionally, feeding in conjunction with trampling can lead to the activation of the soil seed bank (RUPRECHT et al. 2010, SCHWABE et al. 2013). This is particularly applicable in neglected pastures with dense grass and litter coverage. Trampling by small ruminants can also enhance the incorporation of seeds into the soil, which may be positively linked to germination success (EICHBERG et al. 2005, EICHBERG & DONATH 2018). In addition, ruminant dung can contain germinable seeds of dry grassland species (WESSELS & SCHWABE 2008, BENTJEN et al. 2016) and a high trampling frequency can enhance number of dung-borne seedlings (FAUST et al. 2011).

As shown in our study, the creation of bare soil patches by grazing animals favoured target therophytes, which is in line with other studies (MCINTYRE et al. 1995, DUPRÉ & DIEKMANN 2001, ŠKORNIK et al. 2010). The recorded expansion of red list species was previously documented within our goat paddocks (e.g., *Astragalus exscapus*, *Gagea bohemica*; see ELIAS et al. 2014). As might be expected, we observed minor decreases of target species coverage within the less intensively encroached goat paddocks as a result of the goat grazing on the formerly abandoned sites. However, such results should not be interpreted as a negative effect, particularly as the number of target species did not decline but even increased slightly.

In contrast, the results within the ungrazed control plots confirmed that shrub as well as grass and litter encroachment pose a serious threat to dry grasslands of high conservation value. However, even after seven years, the target species richness has not yet been reduced, showing the high restoration potential of these encroached grasslands. Nevertheless, with increased shading and competition as a consequence of succession, typical light-demanding species and dry grassland plant communities will most certainly decrease in the near future, a situation demanding appropriate measures such as restorative goat grazing.

5.3 Ruderal species

We did not observe any relevant changes in the coverage of ruderal species in the paddocks, but we recorded a slightly (but not significant) increase of species number within the less encroached paddock plots. Due to the low abundance of ruderal species, this development cannot be considered as threatening in regards to the dry grassland communities. Similary, DOSTÁLEK & FRANTÍK (2008) also recorded an increased presence of nitrophilous and ruderal species after the introduction of co-grazing by sheep and goats, but, as in our study, the observed level did not exceed a tolerable level. In fact, to a certain extent, ruderal species are a typical component of grazed and sparsely covered dry grasslands (BRANDES & PFÜTZENREUTHER 2013).

Ruderalisation by faeces deposits depends on embedded endozoochorous seeds, nutrient input and their spatial distribution. It is likely that nitrophilous species (e.g., *Urtica dioica*: BENTJEN et al. 2016) are frequent in goat faeces, but such competitive species are only sporadically occuring in the dry grassland patches of our paddocks, which indicates the importance of water limitation as a filter for species not adapted to stressful environments such as dry grasslands (EICHBERG et al. 2007), especially on shallow soils (KRUMBIEGEL et al. 1998). Higher abundances of nitrophilous species were only locally observed near watering places, shelters and resting places in the studied paddocks, which were established outside of vulnerable dry grassland mosaics.

6. Conclusion

Our study clearly demonstrated the positive impacts of paddock grazing by goats with a relatively high grazing pressure on the habitat quality of encroached dry grasslands. Substantial processes initiated by goat grazing are browsing of woody species and grazing (especially grasses) as well as trampling (especially removal of litter) which results in a higher habitat and therefore species diversity of formerly abandoned dry grasslands. The reduction of shrub, grass and litter encroachment as well as the increasing number of target species correlates with the improvement of the conservation status of dry grassland habitat types.

We are aware that the number of analyzed plots per pasture is relatively small and it might be interesting to intensify the sampling effort to gain deeper insights into processes related to the goat grazing activities. However, the vegetation changes within the permanent plots were representative for the respective pasture.

7. Management implications

Generally, the selection of the livestock type and breed is crucial in biodiversity conservation and management (CROFTS & JEFFERSON 1999, TÓTH et al. 2018). Overall, goats and especially Boer goats, which were used for grazing in the investigation areas in the lower Saale River valley, are well adapted to remove or control shrub encroachment in sloping dry grasslands. Boer goats spend much time in exploratory behaviour that ensures browsing activities in all paddock parts. Within our investigation areas, goats did not avoid thorny or spiny shrub species (ELIAS & TISCHEW 2016), which are habitually neglected by other grazing animals such as sheep. Compared to exclusively mechanical shrub removal, goat grazing is a cost-effective and sustainable management tool (RAHMANN 2000, HART 2001, ELIAS et al. 2014).

Based on our experiences with restorative goat grazing in the lower Saale River valley, we suggest the following practical steps:

(i) If the shrubbery is dominated by plants higher than two meters (reachable browsing zone), manual shrub removal before the grazing regime starts will accelerate the restoration success.

(ii) For reducing shrub and grass encroachment, goat grazing should start in spring (between end of March and mid-April depending on fodder availability).

(iii) High grazing pressure is decisive for restoring neglected dry grassland sites. We recommend stocking rates between 0.5 and 1.0 LU/ha/year during a restoration phase of the first five to seven years, depending on the restoration goals and site conditions (e.g., level of encroachment, productivity). Due to rapid shrub re-growth, this is particularly applicable after mechanical clearance. If the grazing regime was successful in reducing the shrubbery, the stocking rate can be gradually lowered.

(iv) Supplementary feeding (except of minerals) should be avoided, because it might decrease the browsing intensity due to the presence of more easily available high-quality food.

(v) In order to hinder the goats from breaking out of the pastures, permanent electric fences with four to five strands proved to be useful.

(vi) If possible, shelters and waterering places should be established only outside of vulnerable dry grassland communities.

Erweiterte deutsche Zusammenfassung

Einleitung – Trocken- und Halbtrockenrasen stehen aufgrund ihrer Artenvielfalt (VEEN et al. 2009, WILSON et al. 2012) und der hohen Anzahl an gefährdeten Arten (KORNECK et al. 1998, VAN SWAAY et al. 2006) im besonderen Interesse des europäischen Naturschutzes (EUROPEAN COMMISSION 2013, JANSSEN et al. 2016). Die Aufgabe der vielerorts traditionellen Weidenutzung mit Schafen und Ziegen und die nachfolgende Vergrasung und Verbuschung der Bestände stellt aktuell eine Hauptgefährdungsursache dar (WALLISDEVRIES et al. 2002, DIERSCHKE 2006, CALACIURA & SPINELLI 2008, EUROPEAN COMMISSION 2015). Ziegen werden weltweit zunehmend für die Entbuschung eingesetzt (STRANG 1973, LUGINBUHL 1999, HOLST et al. 2004, SMART et al. 2006, CELAYA et al. 2010, ASCOLI et al. 2013), jedoch liegen aus dem mitteleuropäischen Raum nur wenige detaillierte Studien im Bereich von Trockenrasen vor, weshalb vielerorts nach wie vor Schafbeweidung bevorzugt wird.

Für die Entbuschung mittels Ziegen ist anfänglich eine intensivere Beweidung und möglichst eine Beweidung im Frühjahr erforderlich (ELIAS & TISCHEW 2016). Auf abgelegenen und verbuschten Standorten ist ein solches Beweidungsregime nur mit Rotationsstandweiden mit Festzäunen ökonomisch sinnvoll umsetzbar. Nach wie vor gibt es aber Bedenken Standweiden auf zwar bereits stark verbuschten, aber noch artenreichen Trockenrasen einzusetzen, da negative Effekte auf die Zielarten durch Trittschäden und Ruderalisierung befürchtet werden. In dieser Studie untersuchen wir den Einfluss der Ziegenbeweidung auf die Deckung von Gehölzen und brachetoleranten Grasarten sowie auf die Ausbildung der Streuschicht und die Anteile von Offenboden. Außerdem bewerten wir das Auftreten von charakteristischen und gefährdeten Pflanzenarten der Trockenrasen (= Zielarten) sowie von ruderalen Pflanzenarten.

Untersuchungsgebiet – Die Untersuchungen wurden auf sechs Ziegenweiden im Unteren Saaletal zwischen Halle (Saale) und Könnern in Sachsen-Anhalt (Deutschland) durchgeführt. Das Untere Saaletal besitzt subkontinentales Klima. In Verbindung mit der über Jahrtausende andauernden Nutzung der Trockenhänge, die überwiegend als Schaf- und Ziegenweide dienten, haben sich hier sehr artenreiche und seltene Trockenrasengesellschaften entwickeln können. Spätestens nach der politischen Wende in den 1990er Jahren wurde die Beweidung auf vielen Trockenrasenstandorten jedoch aufgegeben (JÄGER & MAHN 2001, RICHTER et al. 2003). Die Folge waren Vergrasung sowie insbesondere Verbuschung und der schrittweise Abbau des typischen Arteninventars. Dennoch sind nach wie vor artenreiche Trockenrasenrestflächen vorhanden, jedoch sind diese akut durch fortschreitende Verbuschung bedroht. Aus diesem Grund wurde im Jahr 2006 ein Ziegenbeweidungsprojekt im Unteren Saaletal initiiert. Die Landwirte wurden aufgefordert, die Flächen mit einer höheren Besatzstärke zu beweiden und auf Zufütterung zu verzichten, was weitgehend akzeptiert wurde. Detaillierte Beschreibungen zu Flora und Vegetation im Unteren Saaletal können PARTZSCH (2000) und ELIAS et al. (2015) entnommen werden.

Material und Methoden – Die Vegetationserfassung erfolgte über einen Zeitraum von sieben Jahren auf jeweils zwei 25-m^2-großen Dauerbeobachtungsflächen pro Weidefläche. Diese Dauerbeobachtungsflächen wurden in ehemals stark verbuschten (Ausgangsgehölzdeckung ≥ 25 %) und weniger stark verbuschten Bereichen (Ausgangsgehölzdeckung < 25%) eingerichtet. Darüber hinaus wurde jeweils eine Kontrollfläche pro Strukturtyp außerhalb jeder Weidefläche etabliert. Es wurden einmalig pro Jahr alle Arten und deren Häufigkeiten sowie ausgewählte Strukturparameter (Offenboden, Streu) erfasst. Die statistische Auswertung erfolgte mittels nichtparameterischer Verfahren (Friedman-Test, U-Test).

Ergebnisse – Nach sieben Jahren Ziegenbeweidung kann festgestellt werden, dass die Gehölz- und Streudeckungen signifikant abgenommen haben, zu geringeren Anteilen auch die der brachetoleranten Grasarten. Außerdem wurden signifikante Zunahmen bei den Offenbodenanteilen und der Artenzahl der wertgebenden Trockenrasenarten erfasst. Neben kurzlebigen Therophyten konnten sich auch einige Rote-Liste-Arten in den Dauerbeobachtungsflächen etablieren. Die beobachtete (nicht signifikante) leichte Zunahme der Artenzahl der Ruderalarten ging einher mit unverändert sehr geringen Deckungswerten.

Demgegenüber wurden auf den unbeweideten Kontrollflächen signifikante Zunahmen bei den Gehölzen, den brachetoleranten Grasarten und den Streudeckungen festgestellt. Die Deckung der Zielarten war zumindest auf den stark verbuschten Kontrollflächen signifikant rückläufig, während bei den Artenzahlen in beiden Strukturtypen keine nennenswerten Veränderungen zu beobachten waren. Ruderalarten kamen auf den unbeweideten Kontrollflächen nur mit sehr geringen Abundanzen vor.

Diskussion – Die bei unseren Untersuchungen erfassten Gehölzrückgänge auf den Ziegenweiden stimmen überein mit anderen Studien auf Trockenstandorten (RAHMANN 2000, ZEHM 2008, VEITH et al. 2012, CZYLOK et al. 2013). Ziegen gelten als opportunistische Mischfresser (HOFMANN 1989) mit Bevorzugung von Gehölznahrung, sofern verfügbar (AHARON et al. 2007, EL AICH et al. 2007, ANIMUT & GOETSCH 2008). Im Allgemeinen gilt, dass durch höhere Besatzstärken die Gehölze effektiver zurückgedrängt werden können (MELLADO et al. 2003, JAUREGUI et al. 2008). Außerdem wird Frühjahrsbeweidung gegenüber Spätsommerbeweidung als effizientere Methode eingeschätzt, weil die Gehölze dann frisch austreiben und die Dornen von jungen Trieben noch nicht verholzt sind (DOSTÁLEK & FRANTÍK 2012, ELIAS & TISCHEW 2016).

Wir haben nur geringe Rückgänge bei den brachetoleranten Grasarten, aber signifikant zurückgehende Streudeckungen erfasst. Insbesondere bei Vergleich mit den unbeweideten Kontrollflächen wird aber deutlich, dass Ziegenbeweidung die lokale Ausbreitung von konkurrenzstarken Gräsern kontrollieren und bereits entwickelte Grasfilzdecken auflichten kann. Ebenso, wie bei den Gehölzen bereits erwähnt, ist eine frühe und intensive Beweidung effizienter zum Zurückdrängen von dichten Beständen aus konkurrenzstarken Gräsern, da im Spätsommer aufgrund der dann reduzierten Futterwerte diese weniger stark verbissen werden (CROFTS & JEFFERSON 1999, DOSTÁLEK & FRANTÍK 2012, HEJCMANOVÁ et al. 2016).

Die erfasste Zunahme bei der Artenzahl der wertgebenden Trockenrasenarten steht in direktem Zusammenhang mit der rückläufigen Beschattung und Konkurrenz durch Gehölze und der zunehmenden lichteren Bestandsstruktur mit Offenbodenpatches. Ähnliche Beobachtungen gelangen auch RAHMANN (2000) im Bereich von verbuschten Kalktrockenrasen. Neben der Fraßtätigkeit der Ziegen sind positive Effekte durch Hufeinwirkung zu nennen, wodurch der Abbau des Streufilzes und die Entstehung von Offenbodenbereichen zusätzlich unterstützt werden. Durch Beweidung entstandene Offenbodenpatches können als Keim- und Etablierungsstellen für konkurrenzschwache und lichtliebende Trockenrasenarten dienen (FLEISCHER et al. 2013, SCHWABE et al. 2013, KÖHLER et al. 2016, RUPPRECHT et al. 2016). Außerdem kann durch Streuabbau als Folge des Huftritts die Diasporenbank aktiviert werden (RUPRECHT et al. 2010, SCHWABE et al. 2013). Dies gilt insbesondere für länger aufgelassene Trockenrasenflächen mit dichten Streufilzdecken.

Die im Zuge des siebenjährigen Beobachtungszeitraumes nach Einführung der Ziegenbeweidung erfasste geringfügige Erhöhung der Artenzahl von Ruderalarten ist nicht als bedenklich im Sinne einer Verschlechterung des Erhaltungszustandes einzustufen, da die Ruderalarten nur mit sehr geringen Abundanzen aufgetreten sind (vgl. DOSTÁLEK & FRANTÍK 2008). In diesem Zusammenhang ist darauf hinzuweisen, dass Ruderalarten bis zu einem gewissen Grad durchaus typische Komponenten beweideter und lückig bewachsener Trockenrasen sind (BRANDES & PFÜTZENREUTHER 2013). Ruderalisierungstendenzen durch Kotabsatz sind abhängig von den im Dung befindlichen Diasporen und der räumlichen Verbreitung von Dungkonzentrationen auf der Weidefläche. Vermutlich sind Diasporen von nitrophilen Arten im Ziegenkot durchaus häufig (z. B. *Urtica dioica*: BENTJEN et al. 2016). Solche konkurrenzkräftigen Arten treten aber in den beweideten Trockenrasen im Unteren Saaletal nur sporadisch auf, was mit den extremen Standorteigenschaften durch flachgründige und trockene Böden zusammenhängen dürfte (vgl. KRUMBIEGEL et al. 1998, EICHBERG et al. 2007). Höhere Abundanzen von nitrophilen Arten wurden auf den Weideflächen im Unteren Saaletal nur kleinflächig im Umfeld von Unterstand, Tränke und teilweise auf Lagerplätzen festgestellt.

Schlussfolgerungen – Die vorliegende Studie zeigt deutlich den positiven Einfluss von fest installierten Ziegenrotationsweiden mit höheren Besatzstärken auf die Habitatqualität von verbuschten Trockenrasen. Wesentliche Pflegeeffekte ergeben sich durch Gehölzfraß und das Auflichten von Gräserdominanzen und Streudecken.

Managementempfehlungen – Ziegen und insbesondere Burenziegen sind hervorragend für die Zurückdrängung von Gebüschaufwuchs im Bereich von Trockenrasen geeignet. Basierend auf den Erfahrungen mit Ziegenbeweidung können folgende Managementempfehlungen gegeben werden: 1) Sofern die Gebüsche durch sehr hochwüchsige Gehölze dominiert werden, verbessert eine mechanische Entbuschung vor Beginn der Ziegenbeweidung den Renaturierungserfolg. Dies gilt vor allem dann, wenn die Gehölze aus dem Fraßbereich der Ziegen bereits herausgewachsen sind. 2) Für eine effektive Zurückdrängung von Gehölzen und konkurrenzstarken Gräsern in Verbindung mit deren Streufilzdecken ist eine Frühjahrsbeweidung ratsam. 3) Wir empfehlen eine Besatzstärke von 0,5 bis 1,0 GVE/ha/Jahr (abhängig vom Verbuschungsgrad und der Produktivität der Fläche) während einer Renaturierungsphase von fünf bis sieben Jahren. Insbesondere nach einer mechanischen Entbuschung sind hohe Besatzstärken aufgrund des raschen Wiederaustriebsvermögens vieler typischer Gehölzarten erforderlich. Nach Rückführung der Verbuschung kann die Besatzstärke schrittweise reduziert werden. 4) Zufütterung sollte weitgehend vermieden werden (Ausnahme Mineralien). 5) Empfehlenswert ist weiterhin die Verwendung von Elektrozäunen mit vier bis fünf Litzen. 6) Unterstand und Tränke sollten, sofern möglich, außerhalb wertgebender Bereiche der Weideflächen eingerichtet werden.

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