Invasion of *Calamagrostis epigejos* in sandy dry grassland: effects on biodiversity and effectiveness of restoration measures

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Introduction

Wood Small-reed (*Calamagrostis epigejos*) is recently expanding into many dry grasslands throughout Germany. Its invasion turns species-rich dry grassland stands into species-poor *Calamagrostis epigejos* dominance communities. Although there is a wide awareness of this conservational problem, there are no suitable restoration techniques available so far. This may partly be due to the fact that previous studies only were short-term.

With our descriptive and experimental study over six years (2007-2012), we aim at addressing the following questions:

- How fast is *Calamagrostis* expanding into the dry grasslands?
- Which effect does *Calamagrostis* invasions have on vegetation and grasshopper communities?
- How is *Calamagrostis* affected by different restoration measures?

Study area

The study was conducted in the Wendland (district Lüchow-Dannenberg, Lower Saxony) in the Biosphere Reserve "River Landscape Elbe". Four test sites within a perimeter of 1 km were analysed. They are mainly covered by sandy dry grassland communities of the alliances ***Armerion elongatae*** and ***Corynephorion canescentis***. All test sites are subject to low-intensity grazing by sheep in spring and autumn each year.

Methods

In the **descriptive part** of our study, we use transects of 10 m length and 1 m width to analyse the speed of the expansion of *Calamagrostis* without specific treatment and its effect on vegetation structure, composition, and diversity (Fig. 1 left). The transects are arranged at the perimeter of six differently sized *Calamagrostis* polycormons in two of the study sites.

In the **experimental part** of our study, we apply five different treatments (ploughing once, intensive grazing once a year, mowing 1x, 2x, and 4x a year) in addition to the regular low-intensity grazing. Additionally, we have control plots with ("no treatment") and without ("outside") *Calamagrostis* (Fig. 1 right). These treatments are applied to 100-m² plots in each of the four study sites. Within every large plot, we analysed four 1-m² plots in detail.

The study will last at least 6 years. Here, we present the results of the first 2 years (2007-2009).

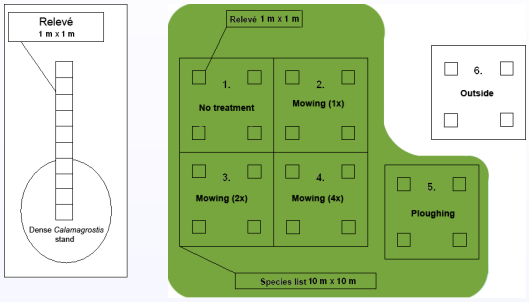


Fig. 1: Layout of the descriptive transects (left) and of the experimental plots (right). The location of the *Calamagrostis* polycormons at the beginning of the study is marked with the oval (left) and in green (right).

Expansion of *Calamagrostis*

The transect analysis revealed that untreated *Calamagrostis* polycormons (n = 6) expanded by 1.11 ± 0.50 m (mean ± SD) in the first year and by 0.73 ± 0.76 m in the second year. The detected maximum expansion of a polycormon was 1.95 m in one year. The variation in expansion speed was higher among different polycormons than between years. The analysis revealed a non-significant tendency that intermediately-sized (c. 100 m²) polycormons spread faster than both smaller and larger ones.

Effects of *Calamagrostis*

The cover of *Calamagrostis* had strong negative effects on plant diversity, explaining 37% of the variance in species richness (p < 0.001; Fig. 2). On average, species richness in plots with 90% *Calamagrostis* cover was less than half that of plots without *Calamagrostis*. The effects of culm density of *Calamagrostis* (p < 0.001; R^2 = 29%) and of litter cover (n.s.) on species richness were less pronounced.

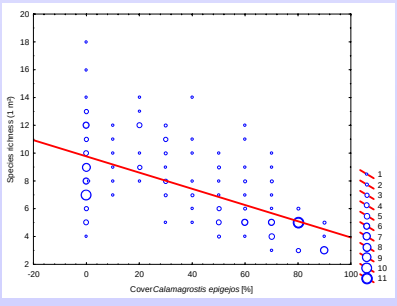


Fig. 2: Linear regression of species richness on Calamagrostis cover for the data of 2007 (n = 164).

Restoration measures

After two years, *Calamagrostis* cover was significantly reduced only by ploughing and by mowing at least twice a year (Fig. 3).

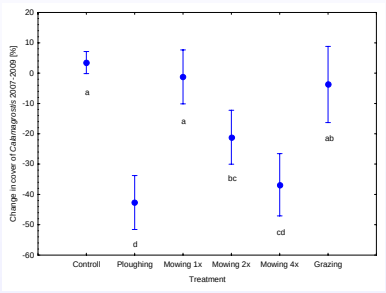


Fig. 3: Effects of different treatments on the cover of *Calamagrostis* after two years (ANOVA, p < 0.001). The bars indicate 95% confidence intervals and the letters denote homogeneous groups (at α = 0.05).

Species richness was affected positively compared to the controll only under intensive mowing (2x or 4x annually; Fig. 4).

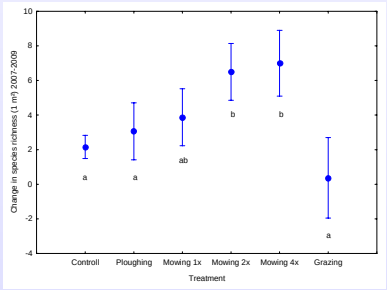


Fig. 4: Effects of different treatments on the richness of plants at 1-m² scale after two years (ANOVA, p < 0.001). The bars indicate 95% confidence intervals and the letters denote homogeneous groups (at α = 0.05).

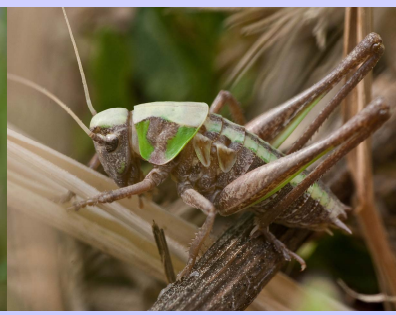
Conclusions

(1) *Calamagrostis* is spreading fast and has strong negative effects on the plant diversity of dry grasslands.
(2) After two years, only high-intensity management techniques, such as ploughing and mowing at least twice a year had significant effects, while grazing and mowing once a year did not.
(3) A continuation of the experiment is necessary to assess the overall benefits of the different treatments (e.g. after two years ploughing was most effective in reducing *Calamagrostis* cover but least effective in increasing species richness).

Calamagrostis polycormon spreading into a sandy dry grassland.

Intensive sheep grazing was not effective in reducing *Calamagrostis* and increasing biodiversity after two years.

Pseudolysimachion spicatum and *Viola tricolor* are two typical species of sandy dry grasslands that are threatened by the invasion of *Calamagrostis*



Decticus verrucivorus. We will also analyse the effects of *Calamagrostis* invasion and treatments on grasshopper communities