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The biodiversity cost of reducing management intensity in species-rich grasslands: Mowing annually vs. every third year

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Abstract

Mowing is an important management method for species-rich semi-natural grasslands in Europe. Since mowing is costly, it is important to find a balance between mowing frequency and conservation benefits. We compared vegetation data from eleven field trials situated in southern Sweden that involved two mowing regimes, annually and every third year, as well as a no-management control. After approximately 14 years, mowing every third year showed (i) a drop in species richness and Shannon and Gini–Simpson diversity indices, (ii) an increase in woody species, and (iii) increases in tall-grown species. However, there were no apparent changes in (iv) species that were indicative of poor management, nor (v) those indicating good management. For one of the trials, data after 38 years were also evaluated. Compared with annual mowing, there were strong negative changes in the number of species in the untreated control, while the results were conflicting for mowing every third year. In conclusion, the expected loss of conservation values from reduced mowing intensity was 50–60% of the loss after abandonment. The outcomes, however, varied among the eleven sites.

Keywords: Cutting; Indicators; Meta-analysis; Mowing; Odds ratio; Response ratio; Semi-natural grassland; Sweden

Introduction

Ongoing changes in agriculture mean that it is a challenge for conservation efforts to maintain the rich biodiversity that is associated with traditionally managed semi-natural grasslands in Europe (Kull & Zobel 1991; Poschlod, Baumann, & Karlik 2009; D'Aniello, Stanislao, Bonelli, & Balletto 2011; Wilson, Peet, Dengler, & Pärtel 2012; Habel et al. 2013; Babai & Molnár 2014). Grazing and mowing are the two options for exploiting the biomass of grass-dominated vegetation, and both seem relatively similar in regard to the benefit that they provide for preserving biodiversity (Tälle, Fogelfors, Westerberg, & Milberg 2015; Tälle et al. 2016). However, the amount of available cattle for conservation-oriented grazing is decreasing (Kumm 2003), while the labour costs for annual mowing in most cases remain high (Schreiber, Brauckmann, Broll, & Krebs 2009; Török, Vida, Deák, Lengyel, & Tóthmérész 2011).

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Although not the first choice, reduction of management intensity might allow more land to be managed. Managers can skip mowing every second year and thereby double the acreage that is mowed or reduce the stocking density (e.g. a limited number of animals spread over a larger area; or rotational grazing with grazing-free periods). Theoretically, there should be an optimal balance between the available resources (e.g., number of animals, cost of labour), area covered and biodiversity benefits provided. Put another way, a larger area with relaxed management (intensity or type) might be preferred over a smaller area under the best management option as long as the losses in biodiversity are acceptable. Hence, it is important to estimate the "cost", in terms of lost biodiversity, for reducing management intensity (Marriott et al. 2004).

As grazing intensity is difficult to estimate and to maintain at a uniform level over many years, experiments that vary the stocking density are less suited to address this issue than experiments assessing the effect of different mowing intensities on biodiversity. The results from studies comparing the effect of higher and lower mowing intensities vary, with some in favour of higher mowing intensities (e.g., Köhler et al. 2005; Noordjik, Delille, Schaffers, & Sýkora 2009), and others in favour of lower mowing intensities (e.g., Everwand, Rösch, Tscharntke, & Scherber 2014; Kőrösi, Szentirmai, Batáry, Kövér, & Örvössy 2014). However, few studies have examined the effect of mowing less than once per year (but see e.g., Bakker, Elzinga, & de Vries 2002). Hence, there is still room for improvement in our understanding of the effect of different mowing intensities on biodiversity. In general, the outcome could be expected to resemble secondary succession when management ceases, that is, woody species and tall-grown species increase while the diversity indices and richness decrease.

Here, we analyse data from a series of eleven field trials in southern Sweden in which mowing every year was compared with mowing every third year as well an unmanaged control. Two of these trials have previously been reported in full elsewhere (Hansson & Fogelfors 2000; Wahlman & Milberg 2002) but then with mainly qualitative assessment of treatment and ignoring the substantial value of including replications over sites (which was the original intention of the series of trials). We intended to estimate the rate of loss of conservation values based on all eleven grasslands over 14 years. At one site, data were also available after 38 years. More specifically, when converting to more infrequent mowing, we expected:

(i) a decrease in the number of species and diversity indices (Shannon, Gini-Simpson, Shannon evenness),
(ii) a decrease of species indicative of good management (i.e. one that maintains species-richness typical of traditional grassland management),
(iii) an increase in species indicative of poor management,
(iv) an increase in woody species,
(v) an increase in tall-grown species.

Materials and methods

Study sites

In the early 1970s, a long-term experiment was established at eleven experimental sites at nine locations in southern Sweden (Fig. 1). Two of the locations (Ekenäs, Tagel) had two experimental sites each. The mean annual temperature in southern Sweden is approximately 6 °C, mean annual precipitation is 500–1000 mm (Alexandersson, Karlström, & Larsson-McLann 1991) and growing period is 180–220 days (Sjörs 1999).

The sites were selected with the aid of local conservation authorities, to ensure continued management for a long time, preferably 20 years (Steen 1976). The aim was also to strive for diversity in soil type, and land use history, thereby reflecting the type of marginal grassland that in the early 1970s was at risk of abandonment and becoming overgrown (Steen 1976). Overall, the study sites represent different types of open land that have been under grazing for a long time (Steen 1976). Before the start of the experiments, most of the sites were grazed. However, one of the sites (Dämkärr) had not been managed for three years, and one site (Gränö) had been mowed for a decade and then irregularly fertilized. Furthermore, two of the sites (Gränö and Tagel/former field) had a history as fertilized arable field (up until ca. 10 and 20 years prior to onset of the experiments, respectively) (Table 1, Hansson 1991). It is worth noting that these former, small arable fields were embedded in old-style, small-scale agricultural landscapes, where there used to be some degree of alteration between mowing and arable farming (Ekstam & Forshed 1996). It is also worth noting that during its 20 years under grazing, Tagel/former field had been regularly fertilized (Hansson 1991). To conclude, at the onset, three of the trials (Dämkärr, Gränö, Tagel/former field) might have been less floristically diverse and consequently less suited to manifest losses in biodiversity relevant for conservation. However, their response to treatments turned out well within the range of the other eight experiments (Figs. 2, 4), and they were therefore included in our analyses.

The sites differed in vegetation type and productivity, but the majority of the sites were of the mesic meadow type (Table 1; Hansson 1991). If using the Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (Swedish Environmental Protection Agency 2011), the sites are semi-natural dry grasslands (6210), hay meadows in submontane zones (6510), Fennoscandian wooded pastures (9070) or wet meadows (Molinion caeruleae) (6410).

Experimental design

The experiment was set up with the aim of assessing vegetation changes as a result of the introduction of several management methods (Steen 1976; Fogelfors 1982; Hansson