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Mountain grassland biodiversity: Impact of site conditions versus management type

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Summary

Grasslands of the Swiss Alps provide agricultural goods, ecological services, disaster protection, and scenic beauty. We identified influences of site conditions and management type on grassland biodiversity, and specifically evaluated the effectiveness of the agri-environmental programme in the Alps. Vascular plants and grasshoppers were mapped in conventionally managed cut meadows, cut meadows of the ecological compensation programme (ECA meadows), and conventionally managed pastures ($n = 324$). We determined climatic and topographic site conditions, quantified the degree of remoteness of all plots in GIS, and estimated the habitat diversity in the vicinity of the sampling sites. The data were analysed by discriminant analysis, rank-correlation analysis, non-parametric ANOVA, general linear models, and ANCOVA. Plant biodiversity hot spots were in economically unattractive, remote sites. These were the typical site conditions of ECA meadows. Hence we concluded that the ecological compensation programme was effectively ensuring management at these sites, and thus protecting mountain grassland plant species richness. Grasshoppers seemed not to benefit from mountain ECA meadows, which were probably often situated at the climatic limit of several species. Pastures were the most species rich management type (plants and grasshoppers), but conversion from cut grassland to pastures should be limited, as negative economic and ecological effects have been reported. We propose that the

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co-existence of well-managed pastures and long-term ECA meadows might best conserve mountain grassland biodiversity.

Introduction

Agricultural landscapes of the Alps are dominated by managed grasslands. In the Swiss mountainous regions they make up 88% of the utilised agricultural area (UAA) (CIPRA, 2001). Other than providing food and fibre, these agricultural landscapes provide ecological services (nature conservation, soil and water protection), disaster protection, e.g. against landslides, and further non-agricultural services such as scenic beauty and space for recreation.

The dramatic decline of biodiversity since the Second World War (e.g. Wilson et al., 1999) due to changing agricultural practices, has also affected mountain grasslands (Bätzing, 1994). While the management on economically attractive sites is being intensified, plots with poorer economic potential due to lower yields or in remoter areas have been abandoned (MacDonald et al., 2000; Mottet et al., 2006; Tasser & Tappeiner, 2002). Both intensification and abandonment eventually result in loss of biodiversity (Fischer & Stöcklin, 1997; Kruess & Tscharntke, 2002; Luoto et al., 2003; Schneider & Fry, 2005). Nevertheless, particularly species-rich grasslands can still be found in the mountains (Gotsch et al., 2004), which makes them an especially valuable landscape element within European agricultural landscapes (Bakker, 1989).

Profitable farming in the mountains is strenuous and hard to accomplish. However, it is crucial that mountain farming remains economically attractive and ecologically sustainable, to secure the multifunctionality (Van Huylenbroek & Drurand, 2003) of the agricultural landscape. Thus, besides other financial support, the Swiss government grants mountain farmers financial compensation for lower agricultural yields in exchange for landscape management and ecological services (Bundesrat, 1992). Since 1999, farmers must manage at least 7% of their farm as ecological compensation area (ECA) to be eligible for any direct payments by the government (Bundesrat, 1998). The most common type of ECA declared are meadows (ECA meadows) which are subject to a late first cut (at approximately 1400 m a.s.l. July 15th) and no or limited fertilisation. In the mountains they can make up as much as 60% of the UAA of individual municipalities, covering a total of 55,000 ha throughout the Swiss Alps (BLW, 2004).

In recent years several studies have indicated insufficient effectiveness and inadequate evaluation of European agri-environmental schemes (Kleijn et al., 2001; Kleijn & Sutherland, 2003; Kleijn et al., 2004, 2006; but also see: Carey et al., 2003; Van Buskirk & Willi, 2004). Kleijn et al. (2004) point out that farmers usually enrol fields less suitable for intensive farming in an agri-environmental scheme. These sites might support a higher biodiversity per se (Kleijn & van Zuijlen, 2004). The positive result of a pair-wise evaluation design, i.e. matching ECA meadows and conventionally managed meadows with similar site conditions in pairs, consequently does not necessarily indicate an increase of biodiversity due to the agri-environmental scheme.

The Swiss agri-environmental scheme has been evaluated in several studies with different research designs (Aviron et al., 2005; Herzog et al., 2005; Jeanneret et al., 2003; Knop et al., 2006; Studer, 2000; Walter et al., 2004), most showing positive results for plants and various groups of insects. These studies were carried out in the lowlands, either surveying solely ECA meadows and their surroundings or matching ECA meadows and meadows not enroled in the agri-environmental scheme for the above described pair-wise comparisons. A recent study, however, underlines the limitations of a pair-wise sampling design. Of 216 farmers interviewed by Jurt (2005), 81% stated that they allocated ECA meadows to plots which have only little potential for intensification. In the mountain zone the main reason was the steepness and required manual labour input. A total of 25% of the farmers also declared that the ECA meadows had traditionally been extensively managed for decades. This is reflected in the difficulties of Hoechstetter et al. (2005), who tried to apply a paired sampling design for the evaluation of the agri-environmental scheme in the Swiss mountains. In some municipalities it proved impossible to find suitable matched pairs because ECA meadows were systematically located on steeper, higher and more remote sites whereas conventionally managed meadows were mainly located in the valleys.

In order to overcome this difficulty, we approached the evaluation of the agri-environmental scheme in the Swiss Alps based upon a representative, random sample. In order to set the mountain ECA meadows into a wider perspective, in addition