Journal for Nature Conservation **13** (2005) 247—256

Available online at www.sciencedirect.com

SCIENCE DIRECT®

Journal for Nature Conservation

www.elsevier.de/jnc

Estimating the consequences of land-use changes on butterfly diversity in a marginal agricultural landscape in Sweden

Christine Schneider[a,*], Gary Fry[b]

[a]*Swedish University of Agricultural Sciences, Department of Landscape Planning, P.O. Box 58, 230 53 Alnarp, Sweden*
[b]*Agricultural University of Norway, Department of Landscape Architecture & Spatial Planning, P.O. Box 5029, 1432 Ås, Norway*

Received 6 January 2004; accepted 18 February 2005

KEYWORDS
Abandonment;
Cost-distance analysis;
Grassland;
Landscape change;
Landscape planning;
Scenarios;
Species loss;
Sweden

Summary

Abandonment of farming with the resultant increase in forest cover is one of the major threats to semi-natural grasslands in marginal agricultural areas. In Sweden, the loss of semi-natural grassland is a serious nature conservation problem since it is one of the most species-rich habitats. In this study, the consequences of grassland abandonment and afforestation on butterfly diversity and butterfly dispersal costs are estimated and used to compare three different future land-use scenarios for a marginal agricultural landscape in Sweden. Based on previous butterfly surveys on grasslands in the area, a relationship between land-use type and butterfly diversity was established. By comparing land-use maps of different scenarios, the number of suitable habitat patches and total suitable habitat patch area with low, medium and high butterfly diversity could be estimated. To obtain an indication of possible fragmentation effects, a least-cost analysis was used to compare travel costs of the butterflies between suitable habitat patches for the different scenarios. The results show that different land-use scenarios affect butterfly diversity and travel costs differently. In the extreme case scenario of cessation of full-time farming and a reduction in part-time farming, nearly all valuable butterfly habitats will vanish, since the most species-rich habitats lie in the periphery of the settlement and are expected to be abandoned and afforested first. If, on the other hand, grassland management is less reduced the effect of abandonment on butterflies depends very much on which areas continue to be managed. To preserve the most important grasslands for butterflies an active management strategy for the whole study area would be needed.

*Corresponding author.
E-mail address: christine.schneider@lpal.slu.se (C. Schneider).

1617-1381/$ - see front matter
doi:10.1016/j.jnc.2005.02.006

While it seems relatively easy to identify the areas most important to conserve from a butterfly diversity perspective, it will be more difficult to find an optimal spatial solution that also minimises dispersal costs for butterflies.

Introduction

Large changes in the agricultural landscape of Europe have taken place as a result of the intensification of agricultural practices on the best land and the abandonment of marginal agricultural land (Jongman, 2002). Sweden has been no exception to this general trend (Ihse, 1995), even if levels of intensification are rarely as high as in Central Europe (e.g. in the southwest of Scania). Abandonment of marginal agricultural areas and the subsequent afforestation has taken place through large areas of Sweden. Most affected by this kind of land-use change have been areas where agriculture is unfavourable due to climatic reasons (North Sweden) and areas, which are difficult to improve due to thin and stony soils (as for example in some parts of Småland). The reduction in agricultural land in these areas has been between 30% and 50% (Statistiska Centralbyrån, 1998). The loss of low-intensity farming is a threat to many animal and plant species dependent on extensively managed agricultural areas (e.g. Bignal & McCracken, 1996; MacDonald et al., 2000; Stoate et al., 2001).

In Sweden, the loss of semi-natural grasslands due to the cessation of grassland management is seen as a major problem for biodiversity conservation in the agricultural landscape (Naturvårdsverket, 1997; Svensson, 1988; Svensson & Ingelög, 1990). In addition to habitat loss, fragmentation can have a negative effect on species diversity (Harrison & Bruna, 1999; Olff & Ritchie, 2002). Species conservation in semi-natural grasslands is thus a challenge for landscape management not only at site level, but also at the landscape and regional levels.

In this study, butterflies were chosen as a species group to investigate the consequences of possible land-use changes in a marginal agriculture landscape in southeast Sweden. The ecology of butterflies (including their dispersal behaviour) is well studied for many species. Since they react quickly to environmental changes they have been used as indicators of the ecological impact of different grassland management (Erhardt, 1985; Oostermeijer & van Swaay, 1998) and climate changes (Parmesan, 2003). In addition to the impacts of changes in habitat quality, butterflies have also been one of the most studied taxa in the field of landscape ecology. The role of landscape structure on butterfly dispersal and survival has been responsible for major advances in landscape theories (Hanski & Gilpin, 1997).

The objective of this study is to quantify the effects of potential land-use change scenarios on butterfly diversity and movement in a threatened cultural landscape in southern Sweden. Three possible scenarios – which represent different degrees of land abandonment and afforestation – are used to test the consequences of possible future land-use changes on butterfly diversity and butterfly movement. Both habitat quality and the spatial distribution of habitat were considered in the analysis. The results show that more species of butterfly are expected to survive in the studied landscape when the process of abandonment is steered compared to an undirected process.

Methods

Study area

The study area is situated in the southeast of Sweden, in Småland, ca. 20 km east of Oskarshamn (Kalmar län). The area is part of a village with a dispersed settlement pattern, called Bråbygden, and includes the surrounding open land and forest. The study site covers 266 ha (Fig. 1). Bråbygden is one of the areas where the small-scale structure of the agricultural landscape – typical for many parts of Sweden until the 1950s – is well preserved. The open areas consist of a small-scale mosaic of farms,

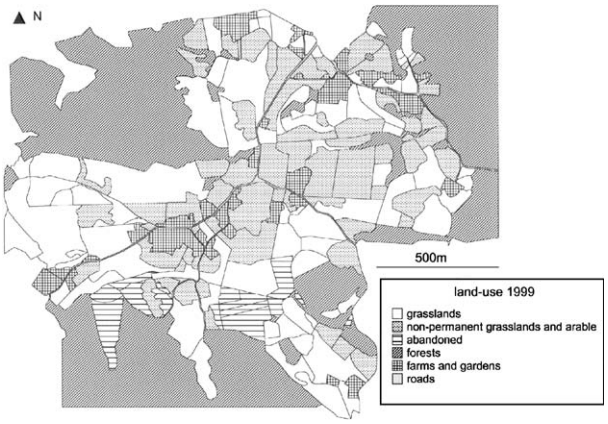

Figure 1. Land-use map of the study area Bråbygden (southeast Sweden, Kalmar län) in 1999.