Mosaic indicators for species diversity in agricultural landscapes

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Abstract

Problems and requirements regarding indicators are discussed for species diversity (wildlife species) in agricultural landscapes. A mosaic indicator approach has been developed, which takes into consideration the various natural site conditions and different historical development of the landscapes. Landscape-typical key species, e.g. several bird species, are regarded as indicators of the ecological situation of the area. Their ecological needs and requirements are the basis of measures to be taken for improving their habitat conditions.

Media summary

In consideration of the specific distribution patterns of wild species and the peculiarities of landscapes, a new indicator concept for species diversity was developed.

Keywords

Mosaic indicators, species, habitats, biodiversity, landscape, agriculture

Introduction

The loss of biological diversity is considered to be one of the main ecological problems world-wide (Wilson,1985, 1992; Heywood and Watson, 1995). In the course of agricultural intensification, , increased returns and optimization are the primary objectives, with less attention given to the ecological functions of agricultural landscapes. In central Europe a differentiated historical land use (from the early Middle Ages to around 1950) resulted in an increase in habitat diversity, improving the diversity of species (Kretschmer *et al*., 1997; Schumacher,1998; Sukopp and Zerbe, 1998). However, in recent decades, agriculture has become one of the main causes of the reduction in species diversity (Jedicke, 1997). For this reason, steps have been taken to quantify the effect of agricultural practices on biological diversity, to evaluate the diversity and to assess the current situation, as well as to encourage a more efficient recovery.

Problems and requirements regarding the selection of indicators

Indicators could be used to determine the effect of agricultural production on biological diversity, the current status of diversity in agricultural landscapes, as well as the reaction to modifications of the land use intensity (OECD, 1999). These indicators should represent key characteristics of species diversities (Walter *et al.*, 1998, Hoffmann and Greef 2001, 2003, Hoffmann et al. 2003). In order to use species as indicators in agricultural landscapes, some problems need to be discussed before the development of an indicator concept for species diversity is possible. Some aspects are:

- It is not necessary, nor possible, to use the total number of species – in Germany about 72.000 (Bundesamt f?r Naturschutz, 1999) – and all taxonomic groups. It would be sufficient to concentrate on key species from selected taxonomic groups, which are well known and which have been investigated (M?hlenberg, 1993).
- According to the differences of natural site conditions, landscape structure and also land use methods, species diversity is heterogeneous, e.g. the number of species is changing from area to area. The sensitivity and local function of species differ with changes in landscape units. Therefore, a subtle differentiated evaluation of regional and local species diversity is needed,

reflected by a reference level of the typical α-diversity (within-area diversity, measured as the number of species occurring within an area of a given size, habitat level) and γ-diversity (also a measure of within-area diversity; however, it usually refers to overall diversity within a large region, landscape level) (Whittaker, 1972), and special indicator-species, varying from one region to another.

- Species often have contrasting habitat requirements within an area, e.g. typical species of forest edges and interiors increase in frequency in proportion to forest cover or hedgerow density, while a low density of copses in agricultural landscapes attracts species of steppe-like landscapes (Hoffmann *et al*., 2001). While improving the abundance of one of these groups by different measures, negative effects for the other could result from those same efforts.
- The current presence and abundance of key-species within a landscape indicate their state in relation to the environment and land use conditions as possible state-indicators. To change the current situation, there exists a need for specific measures on the basis of targets of the species as possible target-indicators.

Investigations in various structured agricultural landscapes

Field investigations of the species diversity (birds, amphibians/reptiles, butterflies, ground beetles, flowering plants) in relation to the landscape units in various structured agricultural landscapes (Hoffmann *et al*., 2001), indicate their different functions for species diversity. A significant correlation between species diversity and the proportion of semi-natural habitats has been determined. While an increase in the area of semi-natural habitats leads to higher species diversity, the number of species in itself is not an adequate indicator (Bastian and Schreiber, 1994, Hoffmann, 1998). Each specific area provides a special ecological function for typical plant and animal species. Whereas the narrow structured area (Figure 1, A) was important for breeding birds such as *Emberiza citrinella* (Yellowhammer) or *Sylvia communis* (Whitethroat), an area with hardly any structure (Figure 1, C) was more important for migratory birds such as *Anser fabalis* (Bean Goose) and *Grus grus* (Crane) and specialists of steppe habitats.

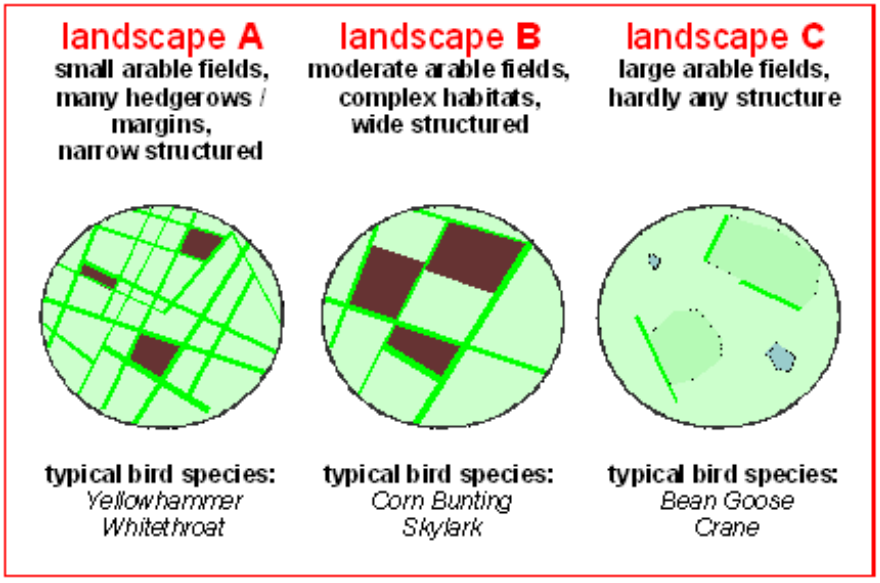

Figure 1. Agricultural landscapes in Northeast Germany with a different structure of habitats and of specific significance for species diversity (selected bird species).

Mosaic-indicator concept

It is important to identify regional indicators. First of all, a landscape mosaic type system (nature-space-structuring) on the basis of the natural and historical site conditions has to be developed (Hoffmann et al. 2004). This consists of a map with units of different landscape types in a landscape- mosaic (Figure 2, above). Next, different landscape-typical key-species have to be selected as state-indicators in each

mosaic-area. In relation to the change of the landscape, the composition of the indicator species is modified from area to area within every landscape-mosaic. The state-indicators (abundance of species) characterise the current situation. To improve the ecological situation in every area, targets have to be defined for the key-species on the basis of their habitat requirements. A distinction is made between species with optimal abundance (target: maintain the status quo), endangered species (target: improving abundance) and problem species, e.g. some weeds (target: reducing abundance). The comparison of the targets of the indicator species and the current state of the habitat conditions is the basis for defining the habitat targets and for special measures of improving the habitat conditions in every area. If the habitat conditions were to be changed, e.g. a better qualitative or quantitative structure of hedgerows, the possibility of improving the abundance of indicator species would be given (Figure 2).

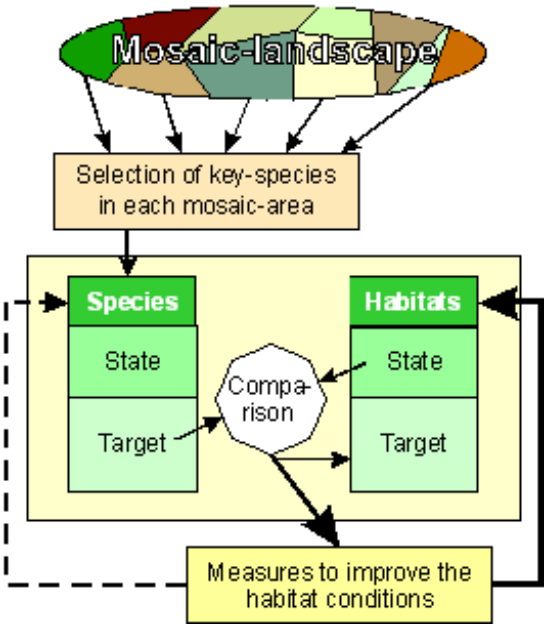

Figure 2. Scheme of the mosaic-indicator concept.

Conclusions

The mosaic indicator concept focuses on specific landscape characteristics, and on typical landscape habitat types and the species diversity within them. It is possible only to select a few key species for each single area, but with consideration to the differentiated natural site conditions and the structure of the historically developed agricultural landscapes. The identification of discrepancies between the species requirements and the habitat situation requires special measures to change this deficiency. Through this, the indicators are not only passive measures to characterize the state and target, but also an efficient source to answer the question: What could be done to improve the biological diversity in agricultural landscapes?

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