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A stochastic dynamic methodology (SDM) to facilitate handling simple passerine indicators in the scope of the agri-environmental measures problematics

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Abstract

The present paper examined the applicability of a holistic stochastic dynamic methodology (SDM) in predicting the tendencies of simple ecological indicators as a response to the changes in agricultural hedgerow networks. Although considerable effort has been made to identify appropriate agri-environmental indicators, yet most of them are far too complex to be comprehensively measured and quantified by non-specialists. The ecological integrity of the typical hedgerows can be partly assessed by the observation of the occurrence of passerine indicators. Since the conventional measures' regarding bird studies requires high-specialization levels, we proposed alternative simple, suitable and intuitive indicators capable of responding with comparable rigour to key changes in such agro-ecosystems. The dynamic model developed was preceded by a conventional multivariate statistical procedure performed to discriminate the significant relationships between conceptually isolated key-components of the studied hedgerows. The final model provided some basis to analyse the responses of simple passerine indicators to the agricultural scenarios that will characterize the region. Overall, the simulation results are encouraging since they seem to demonstrate the SDM reliability in capturing the habitat dynamics of the studied agro-ecosystems by predicting the behavioural pattern for simple measures, roughly associated with bird occurrence, habitat food resources and breeding conditions.

Keywords: Agro-ecosystems; Ecological integrity indicators; Agri-environmental indicators; Stochastic dynamic methodology; Hedgerows

1. Introduction

The Common Agriculture Policy (CAP) is changing the traditional agricultural pattern and landscape in countries of the European Union (EU). This is done

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by encouraging farmers to start intensive modern plantations and thus threatening traditional agro-ecosystems (Naveh, 1998; Baudry et al., 2000a; Beaufoy, 2001). Although South Europe has evolved over thousands of years with a gradual increasing role played by human activity (Naveh, 1998), the advent of the agricultural intensification quickly induced profound changes in landscape structure (Baudry et al., 2000a). Many species of wildlife have been unable to adapt to such radical changes (Pain, 1994; Pain et al., 1997; Naveh, 1998; Bignal and McCracken, 2000).

The use of ecological and environmental indicators is particularly helpful for conservation and management purposes as they reveal what effect changes of land use have on the ecological integrity of agro-ecosystems (Romstad, 1999; Medellín et al., 2000; Müller et al., 2000; Andreasen et al., 2001; Dale and Beyeler, 2001; Welsh and Droege, 2001). Although considerable effort has been made to identify appropriate agri-environmental indicators, final selection was not been made (Zalidis et al., 2004). Recent studies on agri-environmental indicators, such as species diversity or other aspects of biodiversity, have revealed widely differing views on why and what to measure and quantify (Büchs, 2003a; Büchs, 2003b; Duelli and Obrist, 2003; Zalidis et al., 2004). In ecological research, biodiversity indicators have a scientific background and can be used as quantifiable environmental factors (Duelli, 1997). Nevertheless, ecological integrity assessment and community studies usually result in complex biological data sets. When applied to contexts relating to environmental management, namely in order to find ecological relevant holistic patterns and tendencies from such sets of data, it is necessary to reduce all the information to a summarised and simplified form. Since the biodiversity is far too complex to be comprehensively measured and quantified by non-specialists (ranging from agro-technicians to conventional environmental managers, who are usually not biologists), other suitable and intuitive indicators have to be found.

Although the relations between birds and agricultural changes are complex, some studies have been produced using birds as ecological integrity indicators in agro-ecosystems, forests, wetlands, riparian areas, steppe and salt deserts (e.g. Croonquist and Brooks, 1991; Bradford et al., 1998; Canterbury et al., 2000; Santos and Cabral, 2003). In a previous overview of this problematic in Mediterranean agro-ecosystems, Santos and Cabral (2003) suggested that passerine communities present several characteristics that have justified their relevance as ecological indicators: (1) they usually occur in high densities in the studied habitats; (2) they are functionally placed at an intermediate position in the food webs (O'Connor and Shrubb, 1986; Wilson et al., 1999; Moreby and Stoate, 2001); (3) they provide cheap and easy measurements (due to their conspicuous nature) if standard methodologies are applied (Bibby et al., 1992; Ralph et al., 1993); (4) they are sensitive to landscape and agricultural changes (Santos and Cabral, 2003); (5) several species were studied intensively with regard to their natural variation (e.g. Brickie et al., 2000; Chamberlain et al., 2000; Henderson et al., 2000; Shutler et al., 2000; Siriwardena et al., 2000; Stoate et al., 2000); (6) for many species, demography, behaviour, distribution and phenology are connected with seasonal and spatial changes in farming practices (Omerod and Watkinson, 2000); and (7) they have the capacity for population recovery in response to good management procedures in previously disturbed ecosystems (Ryan et al., 1998; Chamberlain et al., 1999; McMaster and Davis, 2001; Peach et al., 2001). Since the conventional measures regarding bird studies requires high-specialization levels, the main question is if alternative simple indicators are capable of responding with comparable rigour to key changes in agro-ecosystems.

One of the great challenges in ecological integrity studies is to predict how anthropogenic environmental changes will affect the abundance of species, guilds or communities in disturbed ecosystems (Kareiva et al., 1993; Andreasen et al., 2001). The most popular tools to date have been biological indices, which reduce the dimensionality of complex ecological data sets to a single univariate statistic, and ordination methods, which summarize the multi-dimensionality of ecological data sets in a 2D or 3D plots (Pardal et al., 2004). Nevertheless, when a time factor is present within the data, they are unable to estimate, in a comprehensible way, the structural changes when the habitat conditions are substantially changing (Jørgensen and Bernardi, 1997; Pardal et al., 2004). Therefore, ecological integrity studies have been improved by creating dynamic models that simultaneously attempt