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Original Articles

Identifying critical thresholds to guide management practices in agro-ecosystems: Insights from bird community response to an open grassland-to-forest gradient

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ABSTRACT

Landscapes are showing increased fragmentation and habitat loss due to land-use conversion and intensification, leading to species-poor and homogeneous communities. The identification of ecological thresholds above which major changes in community composition take place, may prevent the critical downfall of biodiversity while improving the effectiveness of conservation, resource management and restoration practices. In this study, we provide a new insight on how species distribute along a highly variegated agro-ecosystem in the Mediterranean region. We aim to define the thresholds of occurrence of a bird community inhabiting a tree canopy gradient, and determine the patterns of community change. We fit Huisman-Olff-Fresco models to bird occurrence data (assuming non-linear responses) to identify species-specific responses to the gradient, species richness, and turnover patterns. The tree canopy gradient is responsible for major changes in bird community likely related to the variation of the tree stratum and canopy enclosure which reflect different niche segregation opportunities. Maximum species richness was reached at 10% canopy cover while total turnover rate was higher than expected from a null model up to 10% canopy cover. Ecological thresholds can be used as indicators of specific resource limits responsible for changes in community composition and species occurrence, identifying where populations may be more sensitive. Choosing a single management scheme will invariably result in winners and losers, but optimal levels of management can be explored in order to maximize species diversity across Mediterranean agro-ecosystems.

1. Introdution

Several studies (e.g., Andrén, 1994; Mönkkönen and Reunanen, 1999; Fahrig, 2001) specify the existence of ecological thresholds to gradients of habitat alteration (the fragmentation threshold), beyond which major changes in species occupancy occur. Ecological thresholds provide an alternative to usual post-disturbance reactive tools such as endangered species legislation (Johnson, 2013) and costly restoration practices (Holl and Howarth, 2000), by establishing preventive targets on biodiversity loss to guide policy and resource management (Huggett, 2005). Moreover, it may improve the effectiveness of conservation efforts in natural resource management (Huggett, 2005), by documenting the sensitivity of species to threatening processes such as habitat loss, simplification or fragmentation (e.g., Betts et al., 2007), loss of genetic diversity (Bruggeman et al., 2010) or threat by invasive species (With, 2004). As landscapes worldwide have experienced strong changes over the last decades, caused by land-use conversion and intensification (Newbold et al., 2015), such concrete environmental tools are needed to guide policy goals aiming to prevent biodiversity loss (Balmford et al., 2003).

In agro-ecosystems these changes have been particularly noticed (Tscharntke et al., 2005), as the European Common Agricultural Policy (CAP) is triggering a shift from traditional extensive agro-forestry management to intensive agriculture and forest production areas (Jones et al., 2011). For instance, these changes have had a great impact upon the Portuguese 'montado', a characteristic large scale variegated landscape where tree cover varies gradually from presence of scattered trees to dense forest (*sensu* McIntyre and Hobbs 1999; Pinto-Correia et al.,

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