Chapter 55
Structure Analysis of Hedgerows With Respect to Perennial Landscape Lines in Two Contrasting French Agricultural Landscapes

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ABSTRACT

Characterizing the spatial distribution of hedgerows over landscapes is important for understanding the effects of this distribution on the dynamics of plant and animal populations. Because hedgerows are planted or managed, the authors hypothesized that their distribution depends on the presence of other linear landscape elements, namely, roads and channels. Using proximity analyses, the authors thus assessed how the spatial distribution of hedgerows was impacted by the position of these linear landscape elements and the spatial extent of this impact for two contrasting agricultural landscapes. The results indicate that hedgerows were generally associated at short distances with other elements (100-150 m). Hedgerows had different association patterns depending on their orientation in one of the two landscapes. In that same landscape, within-landscape heterogeneity was related to different association patterns. These results indicate that models of the spatial distribution of hedgerows would gain from being based on the location of roads and channels in the studied landscape.

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1. INTRODUCTION

The structure of landscapes impacts the dynamics of plant and animal populations that live on these landscapes. This structure can be characterized by the landscape composition, i.e., the relative areas or numbers of elements that compose these landscapes, and the landscape configuration, i.e., the spatial distribution of these elements. Understanding how landscape structure impacts population dynamics is a key question for species conservation issues (e.g., Bennett et al., 2006) but is also important in agro-ecological studies (e.g., Geiger et al., 2009). In empirical studies, much attention has been devoted to understand how the spatial distribution of patchy habitats may affect the abundance and dispersal of particular species (e.g., Chaplin-Kremer et al., 2011; Mazzi & Dorn, 2012 for agricultural pests and pest enemies). Accordingly, numerous indices have been developed to characterize these elements and their spatial distribution. These indices may relate to the elements themselves (area, shape), to the connectivity among elements of a single type or to landscape heterogeneity at different scales (Riitters et al., 1995). These indices have also been used in modeling approaches that aimed to unravel how the interactions between landscape structure and population dynamics affect the observed patterns of species abundances and genetic structures (Wiegand et al., 1999).

The characterization of the spatial distribution of linear elements (i.e., elements that can be represented with lines, e.g., irrigation channels and hedgerows) over landscapes has received relatively little attention. However, hedgerows are a prominent linear landscape feature and play multiple roles for species inhabiting the landscape. They may furnish habitat for undercover or tree species, corridors facilitating movement of individuals between forest patches or, in contrast, an obstacle to dispersal for species specializing in open areas (Burel, 1996; Davies & Pullin, 2007). Furthermore, their windbreak and shade effects may produce local modifications of the microclimate and wind turbulence, and these effects may impact species survival or reproduction (e.g., Tyson et al., 2007).

The present study is methodological and does not consider ecological processes that are affected by hedgerows. Moreover, we focus on the characterization of the spatial distribution of hedgerows, in contrast to previous research that designed methods to characterize the type and composition of hedgerows (Paletto & Chincarini, 2012; Larcher & Baudry, 2013). Several landscape-level indices have already been proposed by Groot et al. (2010) and applied to hedgerows in an agro-ecological zone in the Netherlands. A recent study further characterized the density of green lines (hedgerows and grassy strips) over European landscapes (van der Zanden et al., 2013). However, local spatial interactions between landscape elements were not considered in these studies.

The locations of hedgerows over the landscapes are not random. At the European scale, van der Zanden et al. (2013) showed that spatial autocorrelation-based methods performed poorly because the locations of "green lines" depended on the occurrence of other land uses such as cash crops or the stocking densities of herbivores as well as on wind speed. In our study regions, hedgerows have been historically used as fences between neighboring fields and have been planted along roads, tracks and water courses for wood production for households (Meynier, 1958; Liagre, 2006). In windy regions, hedgerows are further grown for their wind-protecting effects (Guyot, 1997). In certain instances, hedgerows are also planted along field edges to promote pest enemies (Ouin et al., 2008). As a consequence, it can be expected that the spatial distribution of hedgerows over landscapes presents specific characteristics based on (i) the function of these hedgerows (e.g., fences or windbreaks) and (ii) the spatial distribution of other more perennial elements such as roads and water channels (or ditches). We address these two expectations in the present study, and we further characterize the spatial extent over which expectation (ii) is realized.