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Activity of European common bats along railway verges

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ABSTRACT

Linear infrastructures such as railways and roads are known to have major negative impacts on species and ecosystem dynamics, modifying landscape structure through artificialization, habitat changes, alteration and fragmentation. Nonetheless, infrastructure verges have also been shown to provide refuges or corridors to a large number of taxa.

Here we examine the potential use by bats of railway verges crossing woodland patches within an agricultural matrix as foraging/commuting habitats. We tested whether (i) at a large scale (national level), railways lines were globally an appreciated foraging/commuting habitat for common bats species, and (ii) at a local scale (landscape level), woodland-railway edges have an effect on bat activity compared to other habitat types like woodland-field edges, woodland habitats and field habitats. At local scale, we also looked for a pre-eminent influence of landscape composition on bat activity over habitat types.

Our results show that the presence of railway verges does not influence significantly the foraging/commuting activity of common bats, except for specialist species like the ones from the Myotis group, for which the effect is negative. In several cases (for *Pipistrellus pipistrellus* and *Nyctalus leislerii* at large scale and for *Nyctalus* ssp. at local scale), railway verges even seem to be a significant habitat in an intensive agricultural landscape where semi-natural elements, in particular linear structures like hedgerows, tend to disappear.

In a context of rapid biodiversity decline, our results suggest that railway verges should be considered by managers and engineers not only as a side aspect of the railroad, but also as elements having a potential role in maintaining common biodiversity, especially in human-dominated landscapes such as agricultural systems. In order to contribute to the maintenance of biodiversity, the management of these verges is crucial and some simple rules are considered. Nevertheless, we stress that further studies are needed to better assess the roles, both positive and negative, of railway verges, in order to propose more precise technical design and management recommendations.

1. Introduction

Land-use changes are important drivers of biodiversity loss (MEA, 2005). Linear infrastructures such as roads and railways play a particular role in this process. These are known to have major negative impacts on species and ecosystem dynamics, modifying landscape structure through artificialization, habitat changes, alteration and fragmentation (Trombulak and Frissell, 2000). They in turn affect community richness, composition and species interactions (Fahrig, 2003). Linear infrastructures can form barriers for connectivity (Jackson and Fahrig, 2011) and have strong impacts on populations (Fahrig and Rytwinski, 2009). They are also considered as corridors for invasive species (Brown et al., 2006). Linear infrastructures have strongly expanded over large areas associated with human population growth (Watts et al., 2007).

Infrastructure verges have nonetheless been shown to provide refuge or corridors to a large number of taxa (Merriam and Lanoue, 1990; Hodkinson and Thompson, 1997; Penone et al., 2012). They can ensure structural and functional connectivity when they penetrate artificial areas such as dense urban areas or agricultural-intensive landscapes (Tikka et al., 2001; Penone et al., 2012). In addition, they can be substitution habitats for grassland plants and insects (Saarinen et al., 2005; Wehling and Diekmann, 2009), hence contribute to the conservation of indigenous flora (O'Farrell and Milton, 2006) and fauna (Ries et al., 2001).

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The role of infrastructure verges as refuges/corridors may depend on their surrounding landscape. In natural habitats, infrastructure verges do not provide relevant habitat to threatened local species (O'Farrell and Milton, 2006), hence can even have negative effects (Brown et al., 2006). By contrast, in human-dominated areas such as intensive agricultural landscapes, where non-agricultural habitats are sparse and critical to the conservation of biological diversity and ecological processes (Burel, 1996), infrastructure verges are a relevant habitat, having a positive role in the conservation of biodiversity (Le Viol et al., 2008, 2012). Recently, the European Union's environmental policy has promoted this idea by considering such linear elements as potentially relevant pieces of a *Paneuropean Ecological Network* (Council of Europe, 2000).

Among studies examining the effects of linear infrastructure verges, very few focused on railway verges, the majority concerning roadside verges (Forman et al., 2003). Indeed, compared to roadside verges, railway verges are less important when considering their total length. Nevertheless, railway verges have at least two peculiarities worth considering compared to roadside verges. Their potential impact on biodiversity may be significant in human-dominated areas such as intensive agricultural landscape due to their greater width margins. In addition, with regards to management, railway lines of most countries are managed by one unique manager, allowing to reach large effects of realistic biodiversity friendly management (see Section 4).

A species group which might be especially sensitive to the presence of railway verges are bats.

Studies have shown that bat activity and species richness decrease when approaching a motorway (Berthinussen and Altringham, 2012). Some studies stressed particular negative effects, such as road casualties (Lesinski et al., 2010). Other studies found that a road formed a strong barrier to the movements of bats within the landscape (Bach et al., 2004; Kerth and Melber, 2009; Abbott et al., 2012).

Yet very few studies have focused on the potential positive effects of linear infrastructures such as railway verges while we know that some bat species fly along such features when commuting from roosts to foraging areas because these linear elements could constitute commuting paths away from predators and wind (Limpens and Kapteyn, 1991). In addition some species forage regularly along linear elements (Verboom and Huitema, 1997). Indeed, foraging activity is facilitated close to these features because of greater abundance of some preys (Verboom and Spoelstra, 1999).

These contrasting behaviours among species may be linked to their specific foraging ecology (Kerth and Melber, 2009). Currently, the impacts of roads and moreover railways on bats are barely known, despite the wealth of grey literature and management/mitigation guidelines on this taxa relating to linear infrastructures in Europe (Limpens et al., 2005; National Roads Authority, 2006; Highways Agency UK, 2011). Studies have mainly focused on 'natural' linear elements such as hedgerows and forest edges (Morris et al., 2010; Boughey et al., 2011b). A few studies have focused on the role of more artificial elements, such as forest tracks in logged and unlogged forests (Webala et al., 2011). Far fewer studies have been led on how proper roads or railways may affect bat activity other than negatively (Kerth and Melber, 2009; Berthinussen and Altringham, 2012).

We hypothesized that some species, particularly gleaner species generally linked with forest habitat (such as species from the *Myotis* genus) are impacted negatively by railway verges. These species could perceive railway verges as an inadequate habitat and in addition could be impacted by the fragmentation effect of these verges. On the opposite, aerial hawking species that generally forage in more open habitats, such as species of the genus *Pipistrellus*, *Nyctalus* or *Eptesicus*, could benefit from the edge effect of railway verges, using them as a commuting/foraging habitat. To test this hypothesis, we examined the potential use by bats of railway verges crossing woodland patches within an agricultural matrix as foraging/commuting habitats. We tested whether (i) at a large scale (national level), railways lines were globally an appreciated foraging/commuting habitat for different common bats species, and (ii) at a local scale (landscape level), woodland-railway edges had an effect on bat activity compared to other habitat types like woodland-field edges, woodland habitats and field habitats. At local scale, we also looked for a pre-eminent influence of landscape composition on bat activity over habitat types.

2. Methods

2.1. Study sites

The study was conducted along two recent high-speed railway lines (commissioned in 1994 and 2007) in the east and south-east of the Paris Ile-de-France region, France (Fig. 1). Although densely populated, with 20% of the national population and spreading urbanization, the Paris Ile-de-France region is still predominantly rural, with intensive farming covering 50% of the territory, woods and natural land more than 25%, and urban areas and transport infrastructures covering about 25% (DRIAAF-IAURIF, 2004).

Railway verges studied here vary from 10 m-wide to 20 m-wide and are composed of herbaceous species and shrubs. No vegetation management plan existed for these verges. Clearcutting of trees and mowing were applied on a case-by-case basis, when presenting threats for train security, e.g. risk of tree falling on overhead lines (personal communication from *Réseau ferré de France*). The railway traffic was quite insignificant during the night: starting from 9:30 pm (earliest hour of activity recording), only one train ran on the first high-speed line and a maximum of five ran on the other, depending on the day.

2.2. Experimental design

We identified ten sites chosen via aerial photographs and field visits in order for them to be the most similar: each site consisted of a portion or railway of 600 m to 2 km long fragmenting a woodland patch within a matrix of farmland. In each site, bat activity was sampled at ten sample points according to four different detector locations, called 'site types' below: 3 points on the sides of and parallel to railway tracks-woodland edges (railway edge); 3 points on the sides of and parallel to crop open field-wood edges (field edge); 2 points in plein woodland (wood); 2 points in open fields (field). Woodland and open field points were at least 100 m from hedgerows or forest edges. Points were further than 100 metres from each other (Fig. 1).

2.3. Bat sampling

We used two distinct sets of data. 'Local-scale' data from railway sites were sampled in summer 2010 following a similar protocol to the one designed for the French Bat Monitoring Programme (FBMP), from which we used 'large-scale' (national) data collected from 2006 to 2011. The protocol consists of a square of 2 km-side randomly chosen (by the Museum) in a radius of 10 km from the observer's home, within which ten point are chosen by the observer with at least five points representative of the habitats of the square, the other being located in 'favourable' places for bats such as river banks and wood edges, etc.

For both local-scale and national data sets, bat calls were detected using a Tranquillity Transect Bat detector (Courtpan Design Ltd., UK) and recorded over 6 min on a Zoom H2 digital