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# Are motorway wildlife passages worth building? Vertebrate use of road-crossing structures on a Spanish motorway

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**Abstract**

Numerous road and railway construction projects include costly mitigation measures to offset the barrier effect produced on local fauna, despite the scarcity of data on the effectiveness of such mitigation measures. In this study, we evaluate the utility of different types of crossing structures. Vertebrate use of 43 transverse crossing structures along the A-52 motorway (north-western Spain) was studied during spring 2001. Research centered on wildlife passages (9), wildlife-adapted box culverts (7), functional passages (6 overpasses, 7 underpasses) and culverts (14), with marble dust being used to record animal tracks. A total of 424 track-days were recorded, with most of the larger vertebrate groups present in the area being detected. All crossing structure types were used by animals, although the intensity of use varied significantly among them (Kruskal–Wallis test, $p<0.05$); culverts were used less frequently than other structures. Crossing structure type and width were identified as the most important factors in their selection for use. Wildlife passages and adapted culverts allowed crossing by certain species (wild boar, roe deer, Eurasian badger), which do not tend to cross elsewhere. These results highlight the importance of using both mixed-type structures and wildlife passages in reducing the barrier effect of roads.


*Keywords:* Barrier effect; Habitat fragmentation; Road ecology; Vertebrate; Wildlife crossing structures

## 1. Introduction

Animal population isolation produced by habitat fragmentation constitutes one of the commonest causes of local extinctions (Hunt et al., 1987; Clarke et al., 1998; Lodé, 2000; Fahrig, 2003). Linear infrastructures not only physically destroy habitats but also become barriers, which considerably limit movement and dispersion of terrestrial vertebrates (Oxley et al., 1974; Mader, 1984; Camby and Maizeret, 1987, Walker et al., 2003). As a result, over the last few decades, the inclusion of faunal passages or the modification of existing culverts to serve as crossing structures has frequently been recommended in Environmental Impact Assessments and Statements (Beier and Loe, 1992; De Santo and Smith, 1993; van Bohemen, 1998). Wildlife crossing structures aim to re-establish the movement of animals between both sides of a road or railway line, helping to connect the areas affected by the transport corridor (Saunders and Hobbs, 1991; Clergeau, 1993; Rodríguez et al., 1996, Putman, 1997).

Knowledge of the effectiveness of wildlife crossing structures is still scarce, although increasing quickly. The regular use of different wildlife passage types has been demonstrated for some vertebrate groups (Singer and Doherty, 1985; Foster and Humphrey, 1995; Bekker and Canters, 1997; Gloyne and Clevenger, 2001; Puky and Vogel, 2003; Taylor and Goldingay, 2003; Dodd et al., 2004) but others, like ungulates, are noteworthy for their reluctance to use most crossing structures (Reed, 1981; Vassant et al., 1993; Mata et al., 2005). The key elements for the design of effective mitigation measures are not yet well understood and different solutions may be needed for different faunal groups. The modification of construction projects to adapt culverts for vertebrates or to include wildlife passages imposes costs on new projects. Consequently, it is important to evaluate which characteristics of existing crossing structures affect their use by different species, in order to design cost-effective passages for target species in new projects. It is therefore important to

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determine the actual use of over- and underpasses specifically designed for wildlife, due to the high construction costs they represent (Rosell et al., 2003).

The present study had two objectives. Firstly, to discover which vertebrate groups use road crossing structures. This was determined through an analysis of structures specifically designed for wildlife, as well as normal structural features of the highway, such as culverts, which are designed for other purposes but which could also be important for wildlife (Hunt et al., 1987; Yanes et al., 1995; Rodríguez et al., 1996). Secondly, we looked at the relative importance of crossing structure design since structural parameters of passages (e.g. their width and whether they are over-or underpasses) could determine their effective use by wildlife (Olbrich, 1984; Clevenger et al., 2001). Of the 43 crossing structures considered here only 16 were included in our earlier study (Mata et al. 2005) and the present data was obtained 1 year earlier.

## 2. Materials and methods

### 2.1. Study area

The study was undertaken along a stretch of the Spanish A-52 motorway between Camarzana de Tera (Km 34, Zamora province) and Orense (Km 217, Fig. 1). This four lane highway is fenced along its entire length. It was opened to traffic in 1998 and carries approximately 4500 vehicles daily, 23% of them heavy vehicles.

The first few kilometers pass through the flat countryside of the northern Spanish plain. The relief increases gradually up to the town of Puebla de Sanabria, after which the landscape is mountainous (720–960 m a.s.l.). The increase in elevation coincides with a decrease in temperature and an increase in rainfall (from 400 to 950 mm). The vegetation along the first 10 km is dominated by continental Holm oak (*Quercus rotundifolia*), accompanied by gum cistus (*Cistus ladanifer*), broom spp. (*Cytisus scoparius* and *Cytisus multiflorus*), low shrubs (*Cistus laurifolius, Halimium umbellatum, Thymus mastichina, Thymus zygis*, *Lavandula stoechas* subsp. *pedunculata*) and pastures of *Agrostis castellana*. Cultivations of maize and non-irrigated cereals are also present but restricted to valley bottoms. There are also vineyards of limited extent. The next 45 km passes through patches of Pyrenean oak (*Quercus pyrenaica*), broom spp. and other low scrub (*Genista tridentata, Halimium ocymoides, Halimium lasianthum*) and moist meadows. The remaining section (in Orense province) is flanked by forests dominated by Pyrenean oak woodlands, some more heavily disturbed than others.

The progressive abandonment of fields and rural countryside, which is especially noticeable in Zamora province, is having an important impact on the fauna of the area. It has led to an intense regeneration of natural vegetation, leading in turn to an increase in the population of large herbivores, such as red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*) and wild boar (*Sus scrofa*). Additionally, the increase in herbivores has led to a dense wolf (*Canis lupus*) population (Blanco, 1998). These events led to the construction of specific crossing structures, and the modification of culverts along the highway, to reduce wildlife mortality from traffic.

### 2.2. Monitoring of crossing structures

A total of 39 crossing structures were studied along 57 km of road between Camarzana de Tera and Requejo (Zamora province). We also included four structures specifically designed or modified for wildlife (two overpasses, one underpass and one wildlife-adapted culvert), all of which were in Orense province (177.5–216.3 km). Our

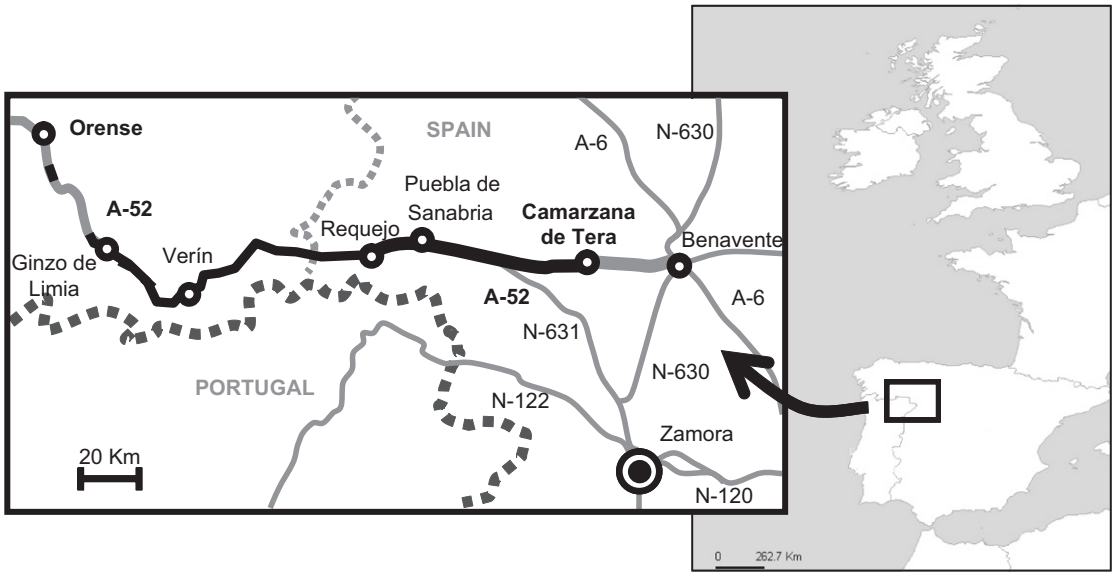


Fig. 1. Location of the study area and the monitored sections (in bold) of the A-52 motorway in the Iberian Peninsula.