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ORIGINAL PAPER

Comparing annual vertebrate road kills over two time periods, 9 years apart: a case study in Mediterranean farmland

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Abstract We surveyed road kills occurring along a 26-km stretch of a major national road (Portugal) in two different years: 1996 and 2005. For analysis purposes, we divided the data into seven vertebrate groups: amphibians, reptiles, carnivores, prey mammals (shrews, moles, rodents, rabbits and hares), hedgehogs, owls and passerines. Main factors influencing vertebrate road casualties were evaluated using redundancy analysis and variance partitioning techniques, focusing on three sets of variables: land cover, landscape metrics and spatial location. We also took into account meteorological conditions and changes in traffic intensity specific to each of the surveyed years. The percentage of variance explained by the explanatory variables was greater in 1996 (67.5%) than in 2005 (48.1%). Many variables influencing road kill incidence were common to both years. The most significantly associated factor was the distance to the Natural Park of Serra de São Mamede (NPSSM): road kills decreased steadily as our survey moved south, away from the NPSSM border. Moreover, an increased incidence of road losses occurred in forested areas, such as *montado* and traditional olive groves. As 2005 was a climatically drier year, additional variance factors became prominent, including the distance to water reservoirs, suggesting a greater influence of water availability. Traffic flow increased by almost 150% from 1996 to 2005, which may explain the overall increase in road kills, with the notable exception of the amphibian group, whose road fatalities incidences decreased approximately sixfold. We expect that our survey will provide a comprehensive understanding of the most critical factors currently influencing vertebrate road fatalities and aid in improving the effectiveness of mitigation measures to reduce them.

Keywords Mediterranean farmland · Redundancy analysis · Variance partitioning · Vertebrates

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Introduction

One of the most visible effects of roads on wildlife is road kill, a major threat to biodiversity conservation (Forman 1998; Forman and Alexander 1998; Trombulak and Frissell 2000; Sherwood et al. 2002; Forman et al. 2003; Coffin 2007). Roads can affect all types of life form on Earth, from small invertebrates, such as slugs, to large animals, like moose and brown bears (Smith-Patten and Patten 2008). Indeed, several ecological researchers have pointed out that roads are one of the main causes of modern-day vertebrate population decline and in the decrease of viability across generations (Crooks and Sanjayan 2006; Ament et al. 2008). This may be especially true for small mammals, on which barrier effects include the reluctance to cross roads, thereby leading to local extinctions (Rico et al. 2007; McGregor et al. 2008). Among larger and rarer species like the Iberian lynx (*Lynx pardinus*), road kills are the principal cause of death among cubs in Doñana (southwest Spain; Ferreras et al. 1992). In Britain, carnivores like badgers lose