Available online at www.sciencedirect.com
ScienceDirect
Landscape and Urban Planning 82 (2007) 66–71
LANDSCAPE AND URBAN PLANNING
This article is also available online at:
www.elsevier.com/locate/landurbplan

Influence of roads on bird nest predation: An experimental study in the Iberian Peninsula

Moisés Pescador, Salvador Peris *

Departamento de Biología Animal-Zoología, Campus Miguel de Unamuno s/n, Facultad de Biología, Universidad de Salamanca, E-37071 Salamanca, Spain

Received 7 March 2006; received in revised form 12 January 2007; accepted 31 January 2007
Available online 1 March 2007

Abstract

Roads play an increasingly important role on the biology of wild animals living their natural surroundings, especially during the breeding season. The present work examines predation on artificial nests with respect to roadsides and the distance of such nests distance from roads in a woodland area in Western-Central Spain. Roads were classified according to traffic density, and field work was carried on from April to July in 2004 and 2005. A total of 720 nests were placed and 471 (65.4%) were disturbed by predators during the study. Nest fate was associated with the type of road ($P < 0.001$) and vegetation cover ($P = 0.001$). Such disturbances were greater ($P = 0.02$) at nests placed farther away (>25 m) from roads with high traffic density than on those located close to roadsides. Roads with a medium or low traffic density had a higher incidence of nest predation ($P = 0.012$ and 0.025, respectively) than nests distant from them. We conclude that predators do not use roads with high traffic density as travel corridors, and nor do they concentrate their foraging activities along them. Roads with a medium and low volume of traffic offer a greater probability of collisions with wild animals, and hence predators often use this type of roads to scavenge their food. We caution investigators to take into account the distances of nests to different types of edge when attempting to evaluate avian nesting success.

Keywords: Artificial nests; Edge effect; Forest; Traffic density

1. Introduction

Roads and human development cause significant conservation problems in many countries (Wilkie et al., 2000; Gutzwiller and Barrow, 2003). The major effects of roads on birds include mortality through roadkills (Mumme et al., 2000), loss of habitat through road construction and fragmentation (Reed et al., 1996), displacement caused by traffic noise (Reijnen et al., 1996; Peris and Pescador, 2004), and lower reproductive success associated with increased human access (Trombulak and Frissell, 2000).

Roads and highways should be considered as ecological systems with a character of their own: i.e., as specific barriers that separate the habitats of different plant and animal communities (Reed et al., 1996; Erritzoe et al., 2003). Roads break up the uniformity of habitats and offer a greater variety of food than can be found in the field. Roadsides have also been shown to have a greater abundance of birds and species richness than adjacent fields (Erritzoe et al., 2003). However, assessments of habitat quality on the basis of abundance data alone may be misleading, because the correlation between population density and reproductive success is often poor (Vickery et al., 1992). Strip-cover habitats, such as roadsides, can serve as corridors or travel lanes for predators, interconnecting non-linear, block-cover habitats (grasslands and woodlands), which may serve as potential sources of predators (Bergin et al., 1997). Roadsides may also prove to be "ecological traps", attracting high densities of nesting birds but leading to low nest success due to increased nest predation (Gates and Gysel, 1978; Lathi, 2001).

The traffic activity associated with roads may affect habitat use by breeding birds and by nest predators directly (Miller and Hobbs, 2000; Erritzoe et al., 2003). Nest predation is the primary cause of nest mortality for many bird species (Martin, 1988)

* Corresponding author. Tel.: +34 923294596; fax: +34 923294515.
E-mail address: peris@usal.es (S. Peris).

0169-2046/$ – see front matter © 2007 Elsevier B.V. All rights reserved.
doi:10.1016/j.landurbplan.2007.01.017

and is believed to influence both habitat selection and community structure (Sieving and Willson, 1998). Nesting birds may be affected indirectly if roads influence habitat use by predators and, as a result, predation pressure varies as a function of proximity to roads.

Avian nest predation is relevant to the understanding of life history patterns in general. Nest predation has a major effect on the reproductive success of birds and is the primary source of nesting mortality for many species (Martin, 1988; Rodewald and Yahner, 2001). Thus, birds are expected to select habitats for nesting that minimize the risk of nest predation (Martin, 1988). Actual nest predation events affect renesting locations, suggesting that nest predation may represent an approximate mechanism governing birds' choices about where to nest (Hass, 1998; Sieving and Willson, 1998). In this sense, previous work has shown that birds subjected to experimental nesting failure return to nest sites at lower rates in ensuing years than individuals that have nested successfully (Hass, 1998). Thus, avian community organization may be mediated by nest predation (Martin, 1988).

Studies of habitat edge effects provide conflicting results. In some landscapes, elevated nest predation rates have been documented along edges (Burkey, 1993; Burger et al., 1994; Paton, 1994; Robinson et al., 1995), while in others no edge effect is apparent (Yahner and Wright, 1985; Vickery et al., 1992; Esler and Grand, 1993; Nour et al., 1993). Edge effects have been measured in a large variety of forest types (Murcia, 1995) and many studies have examined the effect of edges on the nesting success of migratory passerine birds (Martin, 1988; Robinson et al., 1995).

Artificial nests are useful for studying edge effects because they provide flexibility in the experimental design by permitting the control of many parameters, such as nest height and distance from edges, and they also ensure a larger sample size than studies based on natural nests (Leimgruber et al., 1994). Unfortunately, such nests also have disadvantages: there is no parental or nestling activity at or around the nest; artificial nests are generally more visible than natural nests; their olfactory cues are different; the eggs used are often larger than those of small passerines, and each species places its nests in different specific locations. However, these shortcomings have been tolerated experiments employing artificial nests, since the objective is not to obtain precise estimates of predation on actual nests, but rather to obtain a measure of nesting success that can be compared among landscapes, habitat types, and at different distances from edges (Yahner and Wright, 1985; Pasitschniak-Arts et al., 1998; Davison and Bollinger, 2000; Zanette, 2002; Stuart-Smith and Hayes, 2003).

Here, we studied the effect of traffic density on the rates of nest predation activity in areas of wooded pastureland in Spain. In particular, we investigated the relationship between predation rates on artificial nests and proximity to roads. We also examined changes in the intensity of predation as the distance from road increased with a view to identifying the potential mechanisms underlying the overall patterns of nest loss.

2. Materials and methods

2.1. Study site

The study area comprised wooded pasturelands populated by holm-oaks (*Quercus ilex*). This type of landscape, either with holm-oaks or other *Quercus* species (*Q. faginea*, *Q. suber*, *Q. pyrenaica*), is known as a "dehesa" in Spain or "montado" in Portugal and these are mainly located in the west and southwest of the Iberian Peninsula, with a low human population density of 26 inhabitants/km^2. Traditional use of the dehesa/montado system has been open-range livestock farming (dating from the 16th century), which helps to support a greater diversity of passerines than neighbouring grasslands, denser woodlands, or arable areas (Tellería et al., 1994). Within this landscape, three sampling areas were chosen in the province of Salamanca (west-central Spain) (41°15′N6°35′W, at 800–700 m in altitude) on the basis of their homogeneous habitat, tree density and use as grazing sites for cattle.

(A) A road with a high traffic density (HT) extends from the city of Salamanca to the Portuguese border between the towns of Aldehuela de la Boveda and Fuente de San Esteban. This road cuts through a holm-oak wood with a density of 34–36 trees/ha. The estimated traffic density at the time of the study was 12,499 vehicles/24 h (Ministerio de Fomento, 2004). The traffic is quite heavy, with large vans, lorries and cars all year round, although it is denser in spring and summer, when increases in through-traffic to Portugal are common.

(B) The road from Vecinos to Tamames (with a medium traffic density, MT). This is a secondary road leading to the mountainous areas in the south of the province, much visited by the citizens of the City of Salamanca. The woodland density averages at 35–37 trees/ha, the estimated traffic density being 1674 vehicles/24 h (Ministerio de Fomento, 2004).

(C) Finally, the road between Tamames and La Laguna del Cristo (with a low traffic density, LT), which crosses a farmland area usually used only by local farmers, with some occasional visitors, was explored. Woodland density there is 36–37 trees/ha. The nearby traffic density is estimated at 196 vehicles/24 h (Ministerio de Fomento, 2004).

2.2. Methods

Fieldwork was carried out between April and July in 2004 and 2005 throughout the breeding season of all the bird species from the study sites. Experiments were conducted using artificial nests with Quail (*Coturnix coturnix*) eggs.

A total of 720 nests were placed, uniformly distributed among the three types of roads at the 2 study years. The nests were placed along each type of road following its layout. To prevent the nests being predated due to proximity, each single nest was separated at least by 150 m from the next one (Forman and Alexander, 1998). Each nest was randomly placed on either side of the road, and its emplacement distance from the road was