

Importance of road proximity for the nest site selection of the Red-backed shrike (*Lanius collurio*) in an agricultural environment in central Italy

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Abstract

The effect of road proximity on the breeding habits of the Red-backed Shrike (*Lanius collurio*) was investigated in a farmland landscape of the Marche Region (Central Italy). Surface and the density of shrubs, distance from buildings, distance from roads and type of roads, and elevation of the terrain around nesting sites were the factors considered.

The results indicate that this species prefers to nest in shrubs near to countryside roads (76% of the nests were constructed less than 25 meters from roads). It ignores shrubs with apparently similar characteristics which are located away from roads. It is reasonable to argue that suitable shrubs for nesting and the contemporary presence of bare soil for hunting, both of which exist close to countryside roads, might represent the favourable components of the breeding habitat selections made by the Red-backed Shrike.

Introduction

Roads and streets typically cross many ecosystems and types of cover in the land mosaic (Forman *et al.* 1997) of mainly agricultural landscapes. Because roads and buildings, which are important structural elements of human-based ecosystems, are respectively linear and point elements, a full understanding of their ecological impact on bird populations requires analyses of different spatial scales (Forman & Hersperger 1996; Forman *et al.* 1998). The major effects of roads on birds include habitat fragmentation during road construction (Reed *et al.* 1996), displacement caused by traffic noise (Reijnen *et al.* 1995, 1996; Forman & Deblinger 2000), and mortality from road kills (Mumme *et al.* 2000). Reduced reproductive success associated with

increased human interference has been also reported, although some birds seem to be unaffected by the presence of roads (Trombulak & Frissell 2000). Indeed, others like the Red-backed Shrike, *Lanius collurio*, even use the areas close by for nesting and hunting purposes (Bechet *et al.* 1998).

The Red-backed Shrike is an endangered bird whose populations have recently been in decline all over the world (Yosef 1994; PECBMS 2008). It is present in all regions of Italy as both a regular migrant to the country and a breeding species during the summer months (Dinetti 1997; Meschini & Frugis 1993; Foschi & Gellini 1987). It tends to prefer the transition zones between woods and grassland, lines of trees and thick hedgerows which often border roads, and open farmland with shrub or tree cover

(Morelli & Pandolfi 2009; Morelli 2007; Guerrieri & Castaldi 2006; Lefranc 1993; Cramp & Simmons 1980). Scattered trees or shrubs also provide natural perches for hunting (Tryjanowski *et al.* 2000; Farkas *et al.* 1997; Tucker *et al.* 1994, Lefranc 1993; Glutz von Blotzheim 1962).

The aim of this work is to investigate whether the proximity of roads is an important factor influencing the breeding site selection of the Red-backed Shrike in farmland and shrubland areas.

Accordingly, in this study, we analysed the Red-backed Shrike's nesting habitat preferences at two different locations in the Marche Region in Central Italy. This species has, however, become far less abundant in this region over the last 20 years (Forconi 2007; Pandolfi & Giacchini 1995; Pandolfi & Frugis 1987).

Methods

Study area

The study was conducted at two sites in the River Foglia catchment area in Central Italy (43°46'7.46"N-12°38'56.12"E and 43°44'54.79"N-12°43'3.09"E). The location has an elevation of 277.23 m (SD: 73.82 (110 to 470 m)) and very similar land use characteristics (Fig. 1). For this reason, we have processed the

data in a single pool, which totalled 1200 hectares of the surveyed area.

The area is composed of farmland (48 %), uncultivated shrubland (22 %), forest (19 %) and grassland (11 %). The roads, which mainly experience low traffic volumes, were 30.8 km in length (66.4 % unpaved and 33.6 % paved), producing a density of 2.58km/km².

Bird data collection

The data were collected during the 2009 breeding season. To obtain more accurate information about the distribution of the shrubs and nesting sites of the Red-backed Shrike, we chose to produce a "complete map" of the study area (Bibby *et al.* 1997).

In order to cover all of the various stages of the breeding phenology, the two areas were monitored regularly at least once a week (from mid May to the end of June) after the arrival of the birds from their winter grounds (Bibby *et al.* 1997; Blondel 1985).

Shrub data collection

Each shrub was regarded as "suitable" according to: selected plant species (Blackthorn *Prunus spinosa*, Dog rose *Rosa canina*, Elm-leaf Blackberry *Rubus ulmifolius* and Common Hawthorn *Crataegus monogyna*); size (minimum height of suitable shrubs (fixed empirically and from the literature at a minimum of 0.5 m)); and density of foliage (we primarily

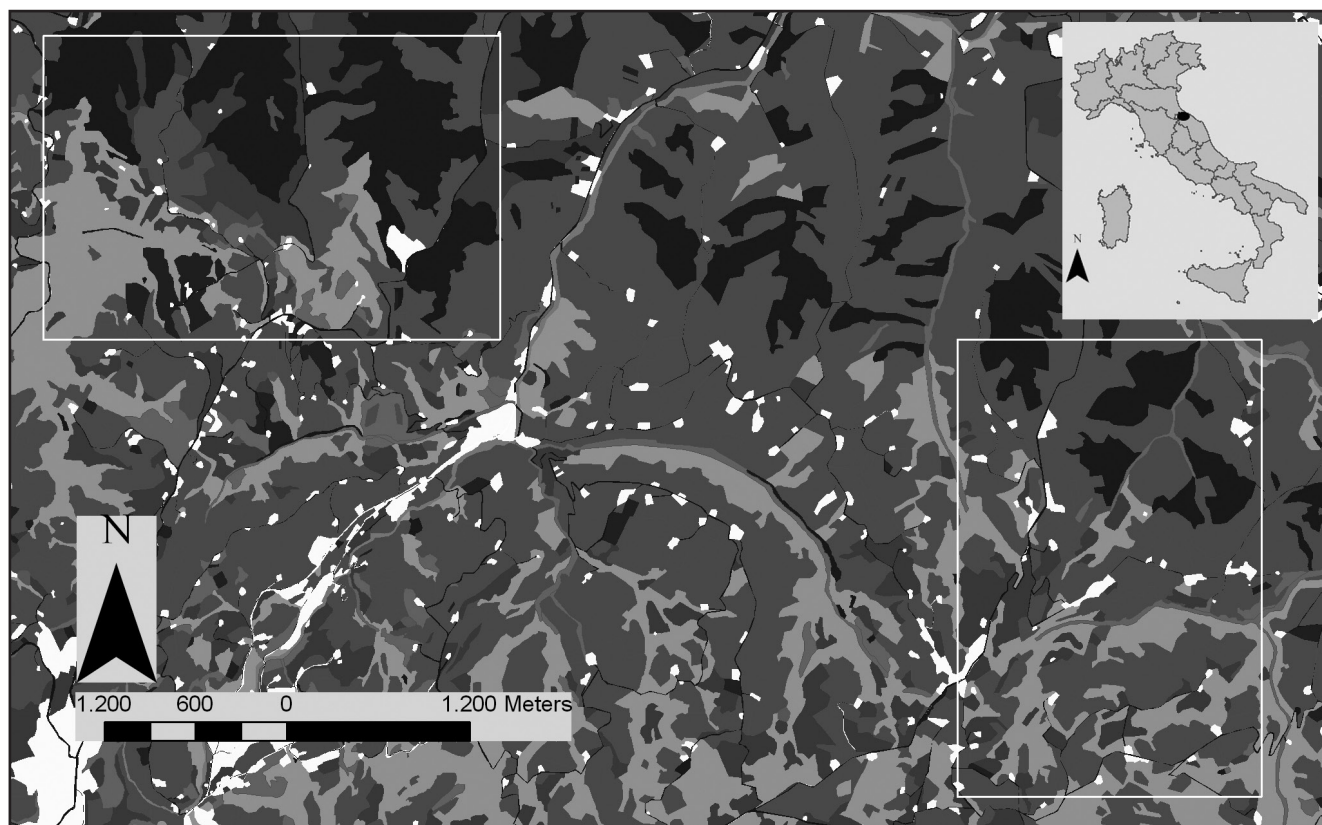


Figure 1 Study area and land-use map

Table 1. Density of shrubs in the 100 m buffer around selected and “not selected” suitable shrubs.

	Suitable shrub selected (with nest)	Random suitable shrub not selected
Density (in 100 m buffer)	7,41 (SD = 2.8; N: 41)	7,86 (SD = 3.2; N: 43)

considered the shrubs with dense foliage and a strong branch structure) (Morelli & Pandolfi 2009; Guerriere & Castaldi 2006; Tryjanowski *et al.* 2000; Farkas *et al.* 1997; Tucker *et al.* 1994, Lefranc 1993; Glutz von Blotzheim 1962).

As recommended by Tryjanowski & Kuzniak (1999), in several cases the shrubs were measured at the end of the breeding season, after the young's fledgling period, to reduce the effect of human disturbance.

Finally, the suitable shrubs were classified as either “selected” (when the nest of a Red-backed Shrike was found inside them), or “not selected” (when they were not so occupied).

Landscape variables and GIS

Shrubs, buildings and road networks were digitized at a scale of 1:250 with the ESRITM ArcGIS 9.3 software using: photo-interpretation, the vegetation physiognomies map (Catorci *et al.* 2007), the land-use regional map, and the Marche CTR maps.

Paved and unpaved roads were regarded as equivalents because they experienced similar, low levels of traffic and would therefore have the same impact on habitat selection. Terrain elevation (above sea level),

distance from the nearest road, distance from the nearest building, and shrub projection at the soil surface level were also measured for every suitable shrub.

Spatial distribution and density of suitable shrubs

Three buffer zones (0 to 25 m; 26 to 100 m and 101 to more than 250 m) were created to establish if the suitable shrubs were homogeneously spaced in relation to road density. The number and density of these shrubs in each buffer zone was then calculated. When a shrub was in the middle of two buffer zones, we assigned it to the most prevalent one.

Furthermore, the number and density of shrubs located around the “selected” and random “not selected” foliage were compared inside a 100 m buffer to determine if there was a correlation between nesting site and the density of these shrubs.

Statistical analysis

The data collected on Red-backed Shrike nests follow a normal distribution pattern and were compared using a T-test. The Chi-square test was also used to compare the discrete variables, while in order to determine their influence on the selection of shrubs as a

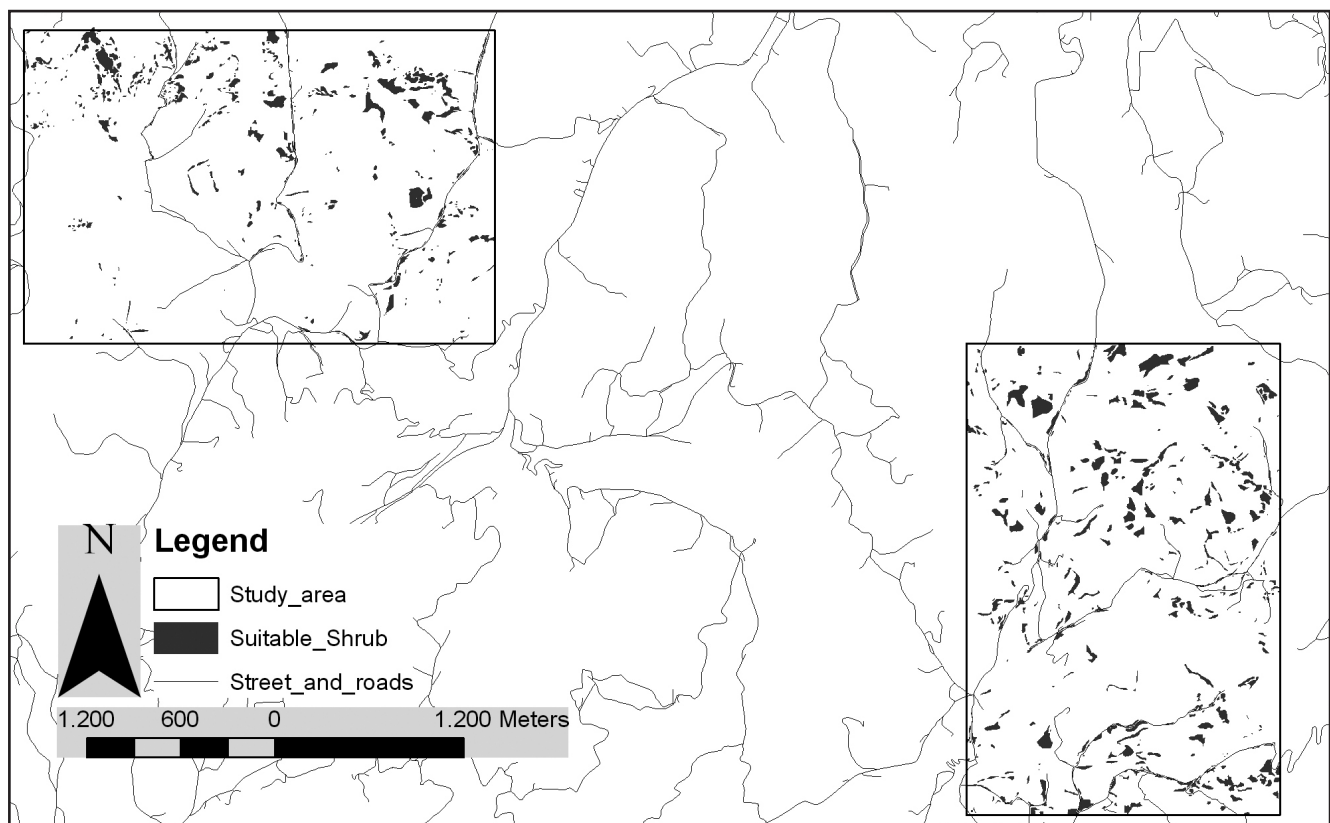


Figure 2 Suitable shrubs and road network

Table 2. Suitable shrubs and environmental variables

Shrub type	N	Road_distance	Elevation	Build_distance	Shrub_projection
Suitable shrub selected	42	17.11 ± 20.05	252.09 ± 47.83	159.85 ± 81.07	12.35 ± 7.30
Suitable shrub not selected	697	117.52 ± 121.48	257.10 ± 68.61	161.41 ± 79.01	12.84 ± 9.18

nesting place, a logistic regression analysis was applied to the variables of distance from road and building, elevation, shrub projection at the soil surface and density of the nearest shrubs. All of the statistical tests were carried out using the SPSS v. 15.0 program.

Results

We found 42 nests during the 2009 breeding season. These were exclusively located on shrubs, resulting in an estimated density of the presence of the Red-backed Shrike of 0.035 pairs/ha.

We also identified and mapped 739 suitable shrubs (Fig. 2), with a density of 0.62 shrubs/ha. The mean distance between the closest shrubs was 38 m, with the maximum distance being 178 m and the minimum being less than 1 m.

The total number of suitable shrubs studied in every buffer zone category was similar ($\chi^2_2 = 0.48$; $P > 0.05$, Fig. 2), although the shrub density was slightly higher

with proximity to the road (Fig. 3a and 3b). We have not, however, identified any differences between shrub density around the “selected” and “not selected” suitable shrubs ($F = 0.418$; $P > 0.05$).

The variables of shrub size, elevation, and distance to buildings (Tab. 2) did not differ between the “selected” and “not selected” suitable shrubs (Tab. 4), but there was a significant difference in the distance from the road between those that were “selected” and those that were not (Tab. 2, Tab. 4). More than 76% of the selected shrubs were located within 25 m of the road, and we did not find any nests which were over 100 meters from such a thoroughfare (Tab. 3, Fig. 4a and Fig. 4b).

Discussion

Studies of birds' habitat preferences are of particular interest, especially when they relate to anthropised environments and areas that are subject to

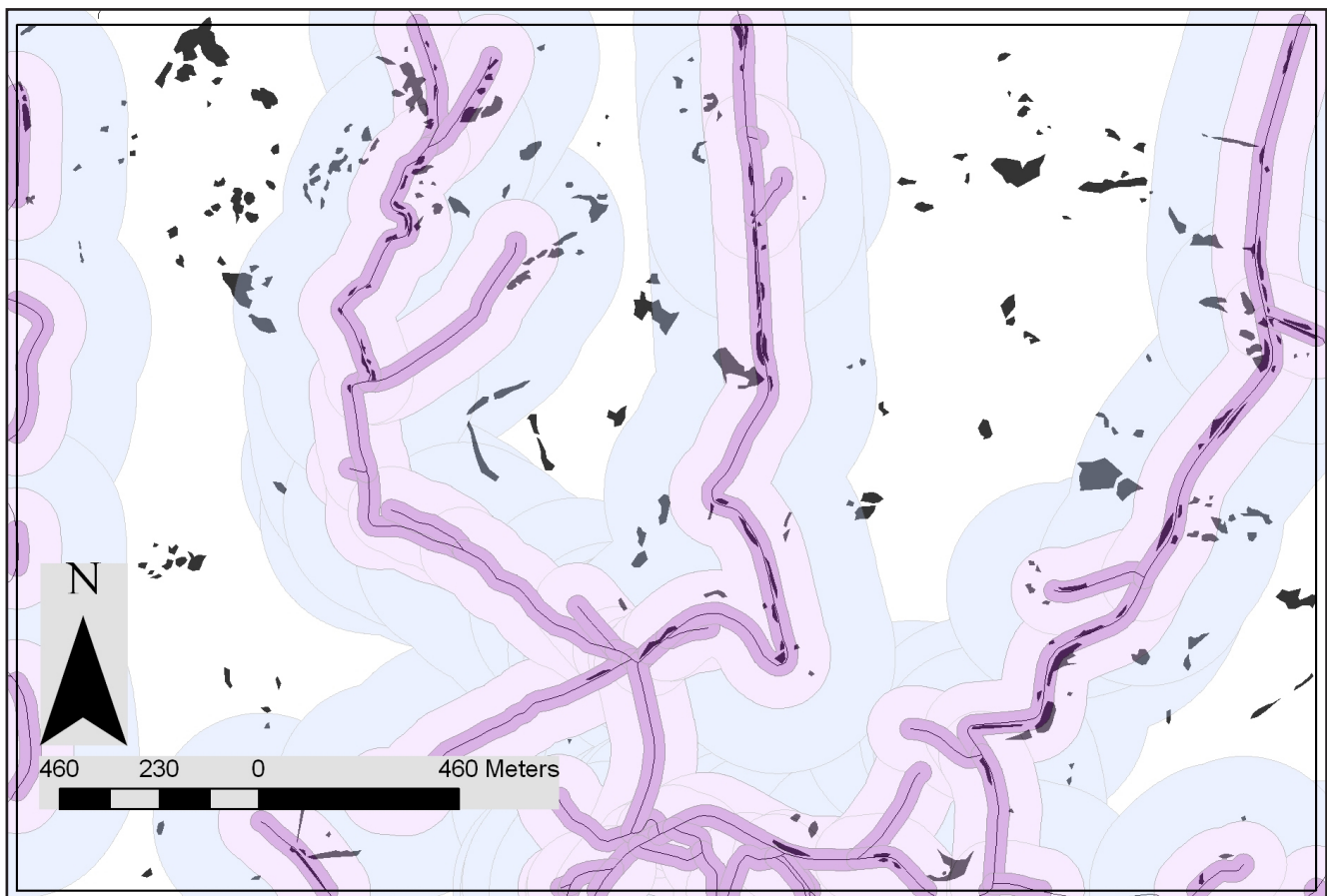


Figure 3a Example of classification of suitable shrubs about distance to the road

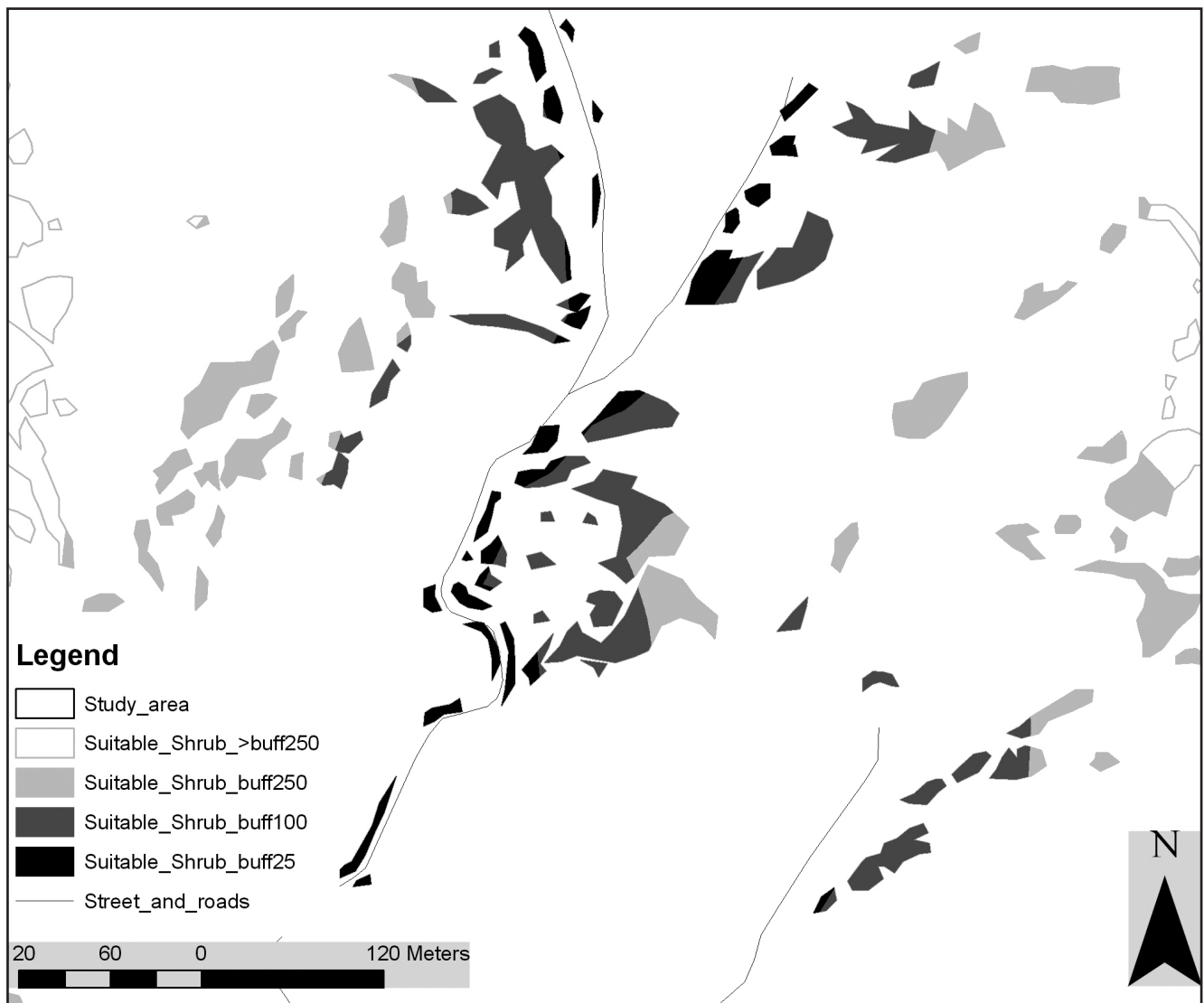


Figure 3b Example of classification of suitable shrubs about distance to the road

rapid change, such as farmland (Donald *et al.* 2006) and transitional or ecotonal zones. In our study area, the breeding habitats of the Red-backed Shrike were all fragmented by roads (both paved and unpaved), and our results have demonstrated that breeding pairs were not distributed randomly across farmland landscapes, as might be expected from a rather uniform shrub matrix, but were instead often situated along road lines. This observation highlights the preference of the Red-backed Shrike for roadside shrubs as nesting sites (Lefranc 1993, Cramp & Simmons 1980), which is a tendency that is encouraged by the long-standing local tradition of planting hedges and

verges along country lanes (in general *Crataegus sp.*, *Prunus spinosa*, *Rubus ulmifolius*, *Ligustrum vulgare*) (Pandolfi 2000; Witt 1987).

Our results suggest that the species prefers to nest close to roads, even though apparently suitable shrubs in farmland and shrubland core areas were also available.

The disturbance caused by variations in road traffic (number of cars per hour, etc.) was not considered in this study. This is because all of the roads near to the nesting sites had low levels of traffic, and there was thus a minor risk of mortality as a result of a collision with a vehicle. Indeed, in four years of surveys along

Table 3. Number and density of suitable shrubs in the road buffer zones.

	buffer road (m)		
	0-25	26-100	101-250
N° suitable shrubs	318	322	335
Mean surface of shrubs projection (m ²)	14,79 ± 6,87	12,00 ± 6,16	11,87 ± 11,99
N° suitable shrubs selected	34	8	0

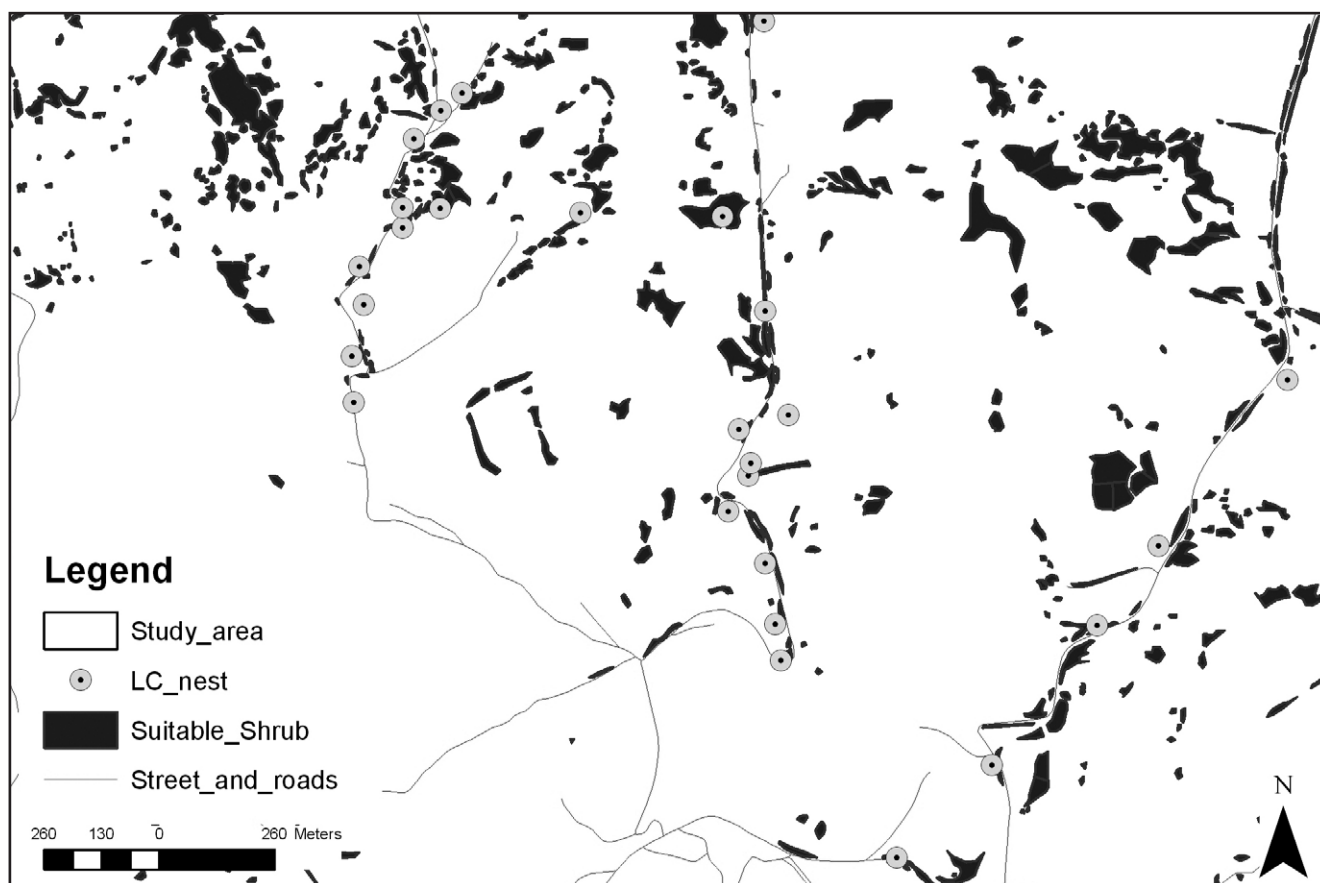


Figure 4a Nest site, suitable shrubs and road in the study area.

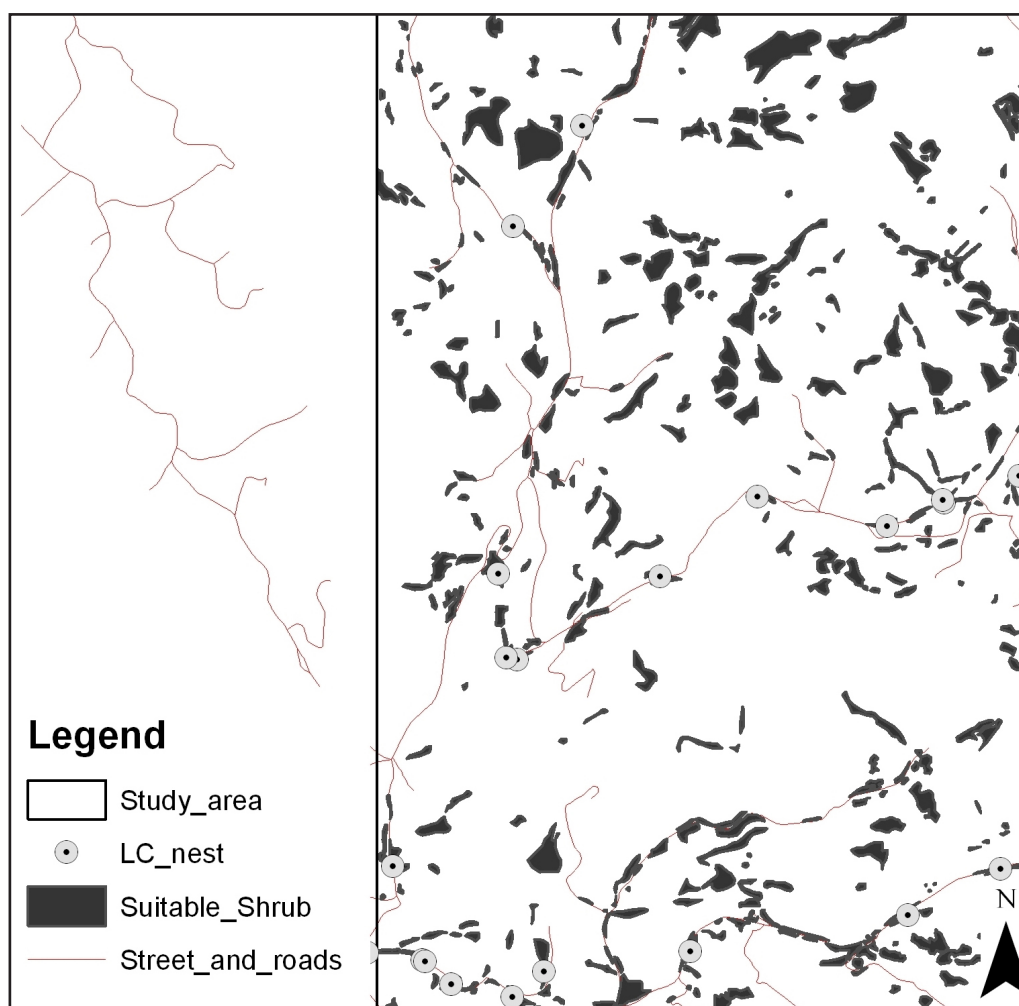


Figure 4b
Nest site, suitable shrubs
and road in the study area.

Table 4. Logistic regression on suitable shrubs (occupied and not) and distance from road, elevation, distance from building and shrub size.

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1(a)	Road_distance	-0,033	0,007	20,649	1	0,000	0,967
	Elevation	-0,002	0,003	0,539	1	0,463	0,998
	Build_distance	-0,001	0,002	0,124	1	0,724	0,999
	Shrub_projection	-0,054	0,026	4,288	1	0,038	0,947
	Constant	-0,179	0,863	0,043	1	0,836	0,836

283 km of paved roads and 522 km of unpaved roads, there was only one case of a male Red-backed Shrike being found dead on the road, probably having been killed by car.

Suitable habitat and anthropisation benefits

In recent years, the Red-backed Shrike has been intensively studied across its European range (Latus *et al.* 2004; Tryjanowski *et al.* 2000; Farkas *et al.* 1997; Leugger 1993; Lefranc 1993; Luise 1991). When it comes to this species, it is important to reject the common assumptions that anthropisation, and roads as an agent of fragmentation, have produced “only negative effects”. Indeed, in some cases, a low level of fragmentation can be regarded as a positive factor, primarily for some ecotonal species like the Red-backed Shrike; it produces suitable nesting sites and offers an additional benefit to a bird which feeds mainly on insects and micro-mammals (Lefranc 1993).

In fact, since roads are characterized by bare and exposed surfaces, they could be regarded as rich hunting territory. This is because recent studies have revealed that road verges are corridors for the various insects (carabids, butterfly, etc) that are the potential prey of the Red-backed Shrike (Hobbs 1992; Vermeulen 1994; Vermeulen & Opdam 1995). Preferably taking their prey on the ground, some Lanidae can thus use an exposed patch of road within its territory as an attractive place for easily catching insects. Moreover, roads are often linked to the electric posts and wires that are frequently used by birds as surveying and hunting posts (Bechet *et al.* 1998). The characteristics of the environment (e.g. tall grass or ground inclination) affect the amount and quality of visual information that is accessible to a predator during seeker activities (Fernandez-Juricic *et al.* 2004). Accordingly, the open spaces near roads could maximize the visual field of

a sit-and-wait predator like the Shrike, which is positioned above the shrubs at the roadside.

In conclusion, it seems that some birds choose to nest close to roads because there are very few open areas which satisfy their hunting habits. The nests of the Red-backed Shrike are mainly located in the shrubs that are nearest to roads, and we speculate that the species prefers this proximity for various reasons: the shrubs along the roadside are smaller and fragmented and are generally set out in rows. This provides an open and monochrome space which represents an excellent environment for hunting.

However, we believe that our results are also affected by local environmental characteristics such as: non-intensive agriculture with uncultivated land, shrublands, tree rows, and hedgerows. In other environments, like in grasslands and mountain pastures, or along high-traffic-roads, this assumption could not be made consistently. Nevertheless, our results may contribute to a better understanding of the irregular distribution of the Red-backed Shrike in agricultural environments. It may also provide useful indications for the conservation of the quality of habitats for breeding and feeding, helping to define more precisely the attributes of this bird's optimal, suitable habitat.

It seems reasonable to support the thesis that roads must, in some cases, be regarded as positive elements of the environmental mosaic, increasing nesting habitat availability for shrikes and other ecotonal species.

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