Ekoloji 21, 83, 1-10 (2012)
doi: 10.5053/ekoloji.2012.831

# Road Effect on the Breeding Success and Nest Characteristics of the Eurasian Magpie (*Pica pica*)

**Elif YAMAC*, Cihangir KIRAZLI**

Anadolu University, Sciences Faculty, Biology Depertment 26470, Eskisehir- TURKEY

*Corresponding author: eerdogdu@anadolu.edu.tr

**Abstract**
It is known that roads have an ecological effect on wildlife, not only in negative but also in positive ways. Few studies provide information about the effect that roads have on bird population levels. In this study, we investigate the effect of roads on the breeding success, nest tree, and nest characteristics of the Eurasian Magpie (*Pica pica*). We compared the magpie breeding success of nesting along a paved highway with those along a dirt road. In addition, the nest and nest tree characteristics were measured for the two road types. We found that breeding success is significantly higher near highway than dirt road and that nests were wider and larger near dirt road than those near highway. According to our results, the magpie is positively affected by the highway. This may be explained by food supply and, more likely, by lower predator pressure.
**Keywords**: Breeding success, Eurasian Magpie, nest characteristics, *Pica pica*, road effect.

**Saksağanlar (*Pica pica*)'da Yolun Üreme Başarısı ve Yuva Özelliği Üzerine Etkisi**

**Özet**
Yolun doğal yaşam üzerine hem olumlu hem de olumsuz yönde etkisi olduğu bilinmektedir. Bununla birlikte kuş populasyonları üzerine yolun etkisi ile ilgili olarak az sayıda çalışma olduğu görülmektedir. Bu çalışmada yolun saksağan (*Pica pica*)'ların üreme başarısı ve yuva özelliği üzerine etkisi araştırılmıştır. Üreme başarısı üzerine yol etkisinin belirlenebilmesi için saksağan bireylerinin tali yol ile bölünmüş otoyol kenarına yaptığı yuvalardaki üreme başarıları karşılaştırılmıştır. Aynı zamanda iki yol kenarında bulunan yuvaların yuva özelliklerinin belirlenmesine yönelik ölçümler gerçekleştirilmiştir. Elde edilen verilere göre bölünmüş otoyol kenarında yuvalanan saksağan bireylerinin üreme başarılarının belirgin bir biçimde fazla olduğu tespit edilmiştir. Ayrıca yuva çapının ve yuva hacminin tali yol kenarındaki yuvalarda daha fazla olduğu belirlenmiştir. Çalışmalar sonucunda saksağan bireylerinin yol varlığından olumlu yönde etkilendiği söylenebilmektedir. Bu durum bölünmüş otoyollardaki daha fazla besin kaynağı ve düşük avcı baskısı ile açıklanabilir.
**Anahtar Kelimeler**: *Pica pica*, Saksağan, üreme başarısı, yol etkisi, yuva özelliği

Yamac E, Kirazli C (2012) Road Effect on the Breeding Success and Nest Characteristics of the Eurasian Magpie (*Pica pica*). Ekoloji 21 (83): 1-10.

## INTRODUCTION

Urbanization has increased anthropogenic impacts on wildlife. Although urban areas may have positive effects through more sources of food, water, and shelter for some species (Gaston et al. 2005, Kristan and Boarman 2007), increased urbanization has often been linked to declines of native species. The loss of natural areas, pollution, disturbance by humans, and higher densities of exotic predators have adversely impacted native species (Chandler et al. 2004, Clergeau et al. 2006, Eggers et al. 2006, Dogan et al. 2010, Demirayak et al. 2011).

One of the most common environmental impacts associated with urbanization is the effect of roads. Because of ever developing road systems, numerous studies have been conducted to reveal road effects on wildlife with implications for conservation of biodiversity (Forman and Deblinger 2000, Fahrig and Rytwinski 2009). As a result of growing interest in this field, road ecology has developed as a new ecology sub discipline (Forman et al. 2003).

Birds are one of the groups most influenced by roads and traffic (Forman et al. 2003). Mortality or injury due to vehicles (Mumme et al. 2000, Ramsden 2003, Erickson et al. 2005), decreased breeding success due to traffic noise and light (Forman and Alexander 1998, de Molenaar et al. 2006, Slabberkoorn and Ripmeester 2008), fragmentation and loss of habitat due to the profusion of paved roads (Palomino and Carrascal 2007), and a barrier effect on movement (Bélisle and Clair 2001) all have detrimental impacts on the birds. On the other hand, certain bird species are positively affected by roads (Forman 2000, Peris and Pescador 2004, Reijnen and Foppen 2006).

Although many studies have been conducted on the effects of roads on the species (Forman et al.

Received: 25.08.2011 / Accepted: 03.04.2012

2003), there have been few attempts to assess the effects at population level (Roedenbeck et al. 2007). Besides, Fahrig and Rytwinski (2009) indicated that in spite of the many studies to quantify the relationship between animal abundance and roads, due to the deficiencies in study design, it is difficult to estimate the impact on population levels from these studies.

The Eurasian Magpie (*Pica pica* Linnaeus 1758) (hereafter Magpie) has an extremely large range covering all of Europe, much of Asia, and northwest Africa. The species is common and abundant over most of its range (Del Hoyo et al. 2009). The breeding season starts early March-late April (Cramp 1998). Only the female incubates eggs for 21-22 days and produces one brood, unless disaster overtakes the first clutch. They typically build nests on many different trees and bushes and nest height can vary considerably (Antonov and Atanasova 2002, Harrison and Castell 2002). As with many other Corvids, Magpies can coexist with humans and this species has become urbanized. The highest population densities for the species are recorded in cities (Antonov and Atanasova 2002). Eurasian Magpies have adapted to using human resources (Jerzak 2001) and urban structures as nest sites (Wang et al. 2008).

Significant differences in breeding success and diet between urban and non-urban Magpie populations have been investigated (Antonov and Atanasova 2003, François et al. 2008, Wang et al. 2008, Kryštofková et al. 2011). Reijnen et al. (1995) investigated the road effects on the breeding densities. However, to the best of our knowledge, the effect of road type on Magpie breeding success has never been studied.

Here we investigated the small-scale effects urbanization has on Magpie breeding success by comparing breeding parameters between two types of roads (paved highway vs. dirt road), differing in traffic load but otherwise bordered by similar habitat. According to Kociolek et al. (2011) paved roads have greater effects than dirt, gravel or ice roads on bird species. These effects are not only direct such as habitat loss, vehicle caused mortality, pollution, and poisoning but also indirect such as noise, artificial light, barriers to movement due to wider roads, higher traffic loads, and increasing vehicle speed.

This study aimed to investigate whether the breeding success of the Magpie varies with paved highways vs. dirt roads and whether the nest tree and nest characteristics adjust with the road types.

## MATERIAL AND METHODS

### Study Site

The study was conducted in Eskisehir, a city in northwest Turkey (39º47′ N, 30º31′ E). Two nesting sites were surveyed close to two different road types. The first road is a multi-lane highway and extends from the city of Eskişehir to Bursa. The section of highway studied has four traffic lanes with a central reservation. The estimated traffic load in 2009 was 17.302 vehicles / 24 h (Anonymous 2010). The traffic is quite heavy, with cars and trucks all year round. The second nest site is located near a dirt road constructed from the natural material of the land surface. This road connects Eskişehir with Karagözler village. The road ends in an agricultural area and is mostly used by farmers and villagers. The traffic density was approximately 100 vehicles / 24 h in 2009 (Anonymous 2010).

Except for road type, the two nest sites share a similar habitat. The study site is under the effects of terrestrial climate with average monthly temperatures of 20.7ºC in the summer and 1ºC in the winter with an annual average precipitation of 378.9 kg/m$^3$. Both the highway and the dirt road consist of plains and run across open agricultural fields. Trees are occasionaly near the road and with an open area at both of the nest sites. The Black Locust (*Robinia pseudoacacia*) is the most widespread tree near the highway along with the Black Pine (*Pinus nigra*) which also grows near the highway. The Black Locusts (*Robinia pseudoacacia*), The Black Pines (*Pinus nigra*), Almond (*Prunus dulcis*), White Willows (*Salix alba*), and Oriental Beeches (*Fagus orentalis*) grow near the dirt road. There are a few buildings along the highway such as a gas station, restaurant, and small dwellings with farmhouses near the dirt road. Potential predators in the study area include the Common Buzzard (*Buteo buteo*), the Long-legged Buzzard (*Buteo rufinus*), the Common Kestrel (*Falco tinnunculus*), the Rook (*Corvus frugilegus*), the Hooded Crow (*Corvus cornix*), the Least Weasel (*Mustela nivalis*), and the Domestic Cat (*Felix catus*) (pers. observ.)

### Breeding Data, Nest and Nest Tree Characteristics

Magpie nests were located in April 2009 and 2010 along the highway and dirt road. The nests are conspicuous structures and were easily spotted in the trees because of the absence of foliage that time. The sample included 39 highway and 37 dirt road nests. Threshold distances to roads can change according to species (Reijnen et al. 1996, Palomino and Carrascal 2007). It is known that, road distance effects may extend thousands of meters (Forman et al. 2002). On the other hand, the negative effects of road on species richness and abundance can disappear 60 m away from the road in some species (Palaminoa and Carrascal 2007). There is no information about the road effect zone for Magpie breeding. Therefore, to avoid distance effects, only nest trees located 0-10 m. from the road were selected.

The study was performed from April to June in both 2009 and 2010 during the breeding season of the Eurasian Magpie to gather information of the breeding success of the species near the different road types. Occupied nests were determined as those having eggs and/or nestlings anytime during the observation period. Each nest was visited 5-7 times until the chicks fledged. The timing of the breeding, clutch size, nestling, and fledged number were recorded. A nest was considered as successful if at least one nestling fledged, otherwise it was termed unsuccessful.

After the nests were considered as occupied, if none were observed with eggs or nestlings, the nest was considered unsuccessful. GPS was used to mark nest locations and the locations were overlaid on maps.

After successful fledging or failure, nest and nest tree characteristics were recorded. Tree species (TS), tree type (TT) (shrub, coniferous and deciduous), number of branches (<20 and >20) (NB), tree diameter at breast height (cm) (DBH), tree height (cm) (TH), nest height above the ground (cm) (NHG), distance between nest and top of tree (cm) (DNT), dome height (cm) (DH), diameter of nest (vertical level) (cm) (DVL), diameter of nest (horizontal level) (cm) (DN), nest depth (cm) (ND), roofed nest volume (RNV), unroofed nest volume (UNV), nest position (in a main fork or on a side branch) (NP), height ratio (nest height/nest-tree height) (HR), and orientation of the nest relative to the trunk (in degrees) (ORT) were quantified to evaluate nests and nest trees. According to Soler et al. (2001) and de Neve et al. (2004), the nest volume was calculated with the formula $4/3(\pi \times a \times b^2)/1000$ (a: nest depth, b: half of the nest width). There were two different nest types (roofed and unroofed nests) in both of the study areas. To standardize for roofed and unroofed nest, nest depth was used instead of the largest radius value. It is known that nest roof presence and density prevent predation to the nest (Baeyens 1981, Quesada 2007). Therefore, roofed (RNV) and unroofed (UNV) nests volume were analyzed separately for the two road types.

In order to test whether the two study areas have different surrounding environments, except road type, 1 ha square plots were generated using Google Earth maps within the two study areas. Using Google Earth maps the wooded area coverage class, open agricultural area coverage class, and urban structured area coverage class were measured for each plot. Wooded or open area coverages were classified into 5 group (0, 1-<25%, 26-< 50%, 51-< 75%, and >75%) and coded as 0-4, respectively. Also, the urban structured area coverage was classified into 5 group (0, 1-<500 $m^2$, 500 $m^2$<1000 $m^2$, 1000$m^2$-<2000 $m^2$, and >2000$m^2$).

**Statistical Analysis**

The data on breeding success, nest, nest tree and nest site characteristics were analyzed to explore the effect of the different road types for the years 2009 and 2010. Statistica 7.0 for Windows (StatSoft Inc. 2006) was used to analyze the data. Since data was not available for every nest and nest tree, the sample sizes differ among the analyses. Normality was tested via Shapiro Wilk's test. Because the data on breeding success did not satisfy the assumptions of normality, non-parametric tests were employed. Breeding success and initiation date of breeding between years (2009-2010) and road types (highway and dirt road) were compared by using Mann-Whitney U tests. In case of normal distribution the t test was used. In the case of differences of nest and nest tree characteristics between the two roads, the Spearman correlation test was performed to figure out the effects of characteristics on breeding success. The differences were considered significant at <0.05 and data was presented as a mean ± standard deviation (SD).

## RESULTS

Egg laying dates, clutch size, brood size, and the number of fledglings per breeding attempt did not differ significantly between 2009 and 2010 and the data was pooled (Table 1). The earliest egg laying dates were 4 April (highway) and 6 April (dirt road) in 2009, and 30 March (highway) and 1 April (dirt road) in 2010. The majority of Magpies laid eggs during the third week of April in 2009 and the second week of April in 2010. The laying activities for both road types were mostly finished by the fourth week of April (Fig. 1).

Although no statistical differences in egg laying date, clutch size or brood size were found, the number of fledglings per nest was significantly higher along the highway site than along the dirt road. In addition, significant differences in the percentage of fledglings per successful attempt were found (Table 2). The mean values for clutch size, nestling number, fledgling, and the percentage of fledglings per breeding attempt according to road type are presented in Table 2.

There were no significant differences between highway and dirt road sites for either proportion of wooded (Z=-1, p=0.31), open (Z=1, p=0.27), or urban structured area (Z=0.8, p=0.38).

*Robinia pseudoacacia* is commonly used as a nest tree by the species in both study areas (Table 3). The nest and nest tree characteristics did not differ statistically between the two road types except for nest diameter and roofed nest volume (Fig. 2-5, Table 4), being significantly larger along the dirt road nests. To figure out the nest diameter and nest volume effects on the breeding success, the Spearman correlation test was performed for the two road types. There was no correlation observed between the nest diameter and breeding success for either highway (n=31, $r_S$=0.17, and p=0.36) or dirt road (n=26, $r_S$=-0.01, and p=0.99). Also, no significant correlation was found between nest volume and breeding success for the two road types (highway roofed nests, n=22, $r_S$=-0.14, and p=0.51, highway unroofed nests, n=8, $r_S$=-0.47, and p=0.23, dirt road roofed nests, n=17, $r_S$=0.04, and p=0.72, and dirt road unroofed nests, n=8, $r_S$=0.41, and p=0.30).

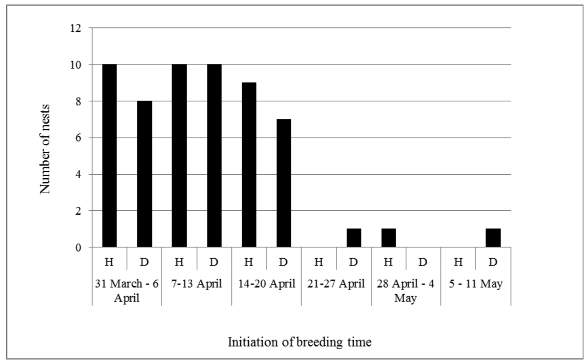


**Fig. 1.** Initiation of breeding time according to road type. H: Highway, D: Dirt road.

**Table 1.** Breeding success and initiation date of breeding time between years (2009-2010) To compare differences between years the nonparametric Mann Whitney U test was performed.

| | Highway Road | | | | Dirt Road | | | |
|---|---|---|---|---|---|---|---|---|
| Breeding Data | n 2009 | n 2010 | Z | *p* value | n 2009 | n 2010 | Z | *p* value |
| Initiation of breeding time | 21 | 6 | 1.06 | 0.28 | 17 | 9 | 0.56 | 0.57 |
| Clutch size | 25 | 13 | 1.40 | 0.16 | 20 | 14 | -0.92 | 0.35 |
| Nestling number | 25 | 14 | 1.17 | 0.24 | 23 | 14 | 0.67 | 0.50 |
| Fledgling | 25 | 14 | 1.03 | 0.29 | 23 | 14 | 0.95 | 0.33 |

**Table 2.** Basic descriptive statistics of the breeding data. To compare differences between characteristics a parametric t test was performed, otherwise the Mann Whitney U test was used to analyze data.

| | Highway Road | | | | Dirt Road | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Breeding Data | n | Min. | Max. | Mean ± SD | n | Min. | Max. | Mean ± SD | Z | *p* value |
| Initiation of breeding time | 27 | | | | 26 | | | | -0.11 | 0.91 |
| Clutch size | 38 | 2 | 8 | 6.42±1.2 | 34 | 2 | 9 | 6.44±1.8 | -0.79 | 0.42 |
| Nestling number | 39 | 0 | 7 | 3.76±2.4 | 37 | 0 | 6 | 3.59±2.2 | 0.62 | 0.53 |
| Fledgling | 39 | 0 | 6 | 2.64±2.3 | 37 | 0 | 5 | 1.52±1.9 | 2.11 | 0.03* |
| Fledgling per breeding attempt (%) | 38 | 0 | 100 | 41.00±3.0 | 34 | 0 | 100 | 24.00±0.3 | 2.08 | 0.03* |

* Significant result (p<0.05) marked in bold.

**Table 3.** Nest tree species for highway and dirt road.

| | Highway | | Dirt road | |
|---|---|---|---|---|
| Nest Tree Species | n | % | n | % |
| *Robinia pseudoacacia* | 27 | 77.14 | 14 | 43.75 |
| *Pinus nigra* | 7 | 20 | 2 | 6.25 |
| *Prunus dulcis* | 1 | 2.85 | 8 | 25 |
| *Salix alba* | 0 | 0 | 4 | 12.5 |
| Unidentified shrub | 0 | 0 | 4 | 12.5 |
| Total | 35 | 100 | 32 | 100 |

## DISCUSSION

Although aspects of Magpie breeding ecology have been shown to differ between urban and rural populations (Antonov and Atanasova 2003, Chamberlain et al. 2009), there are no studies to document how road types, differing in traffic load, affect the breeding success of this species. As far as we know, our study is the first report in this respect.

The most pronounces trait of urban breeding birds in general, and Magpies in particular, is the earlier start of breeding compared to rural populations (Jerzak, 2001, Schoech and Bowman 2001, Antonov and Atanasova 2003). The species utilize the available microclimate conditions in urban areas. Also, a higher anthropogenic food supply meets the requirements in the breeding season (Jerzak 2001, Partecke et al. 2006). Because the only difference between the two study sites is

**Table 4.** Basic descriptive statistics of the nest and nest tree characteristics according to road type are shown. To compare differences between characteristics a parametric t test was performed, otherwise the Mann-Whitney U test was used to analyze data.

| | Highway Road | | | | Dirt Road | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Nest and Nest Tree Characteristics | n | Min. | Max. | Mean ± SD | n | Min. | Max. | Mean ± SD | *p* value |
| DBH | 34 | 4.7 | 60.10 | 24.3±15.0 | 26 | 6 | 56 | 24.5±15.2 | 0.81 |
| TH | 35 | 290 | 1306.00 | 695.0±242.0 | 32 | 246 | 1346 | 695.0±260.0 | 0.92 |
| NHG (cm) | 35 | 160 | 980.00 | 436.9±207.0 | 32 | 144 | 1005 | 397.4±205.0 | 0.38 |
| DNT (cm) | 34 | 65 | 480.00 | 225.0±98.2 | 29 | 20 | 660 | 256.4±166.9 | 0.35 |
| DH (cm) | 24 | 16 | 45.00 | 27.7±7.4 | 15 | 13 | 40 | 25.6±8.1 | 0.41 |
| DVL (cm) | 32 | 18 | 68.00 | 44.8±13.8 | 28 | 14 | 62 | 41.1±15.2 | 0.32 |
| ND (cm) | 31 | 5 | 16.00 | 9.0±2.2 | 28 | 2.5 | 17 | 9.4±3.3 | 0.58 |
| DN | 32 | 12 | 27.00 | 19.6±3.5 | 28 | 11 | 33 | 22.3±4.7 | 0.01* |
| RNV | 23 | 2.37 | 7.63 | 4.04±1.3 | 19 | 1.26 | 12.53 | 5.88±2.8 | 0,02* |
| UNV | 8 | 1.13 | 6.58 | 2.75±1.82 | 8 | 1.04 | 4.91 | 3.14±1.3 | 0.87 |
| HR | 35 | 0.38 | 0.82 | 0.61±0.1 | 32 | 0.2 | 0.89 | 0.56 ±0.1 | 0.16 |

* Significant result ($p<0.05$) marked in bold.

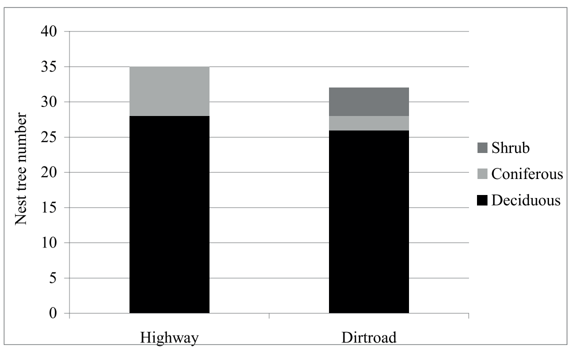


**Fig. 2.** Nest tree type (Shrub, Coniferous or Deciduous) near the two different road types (Mann-Whitney test, Z= 0.175, p= 0.86).

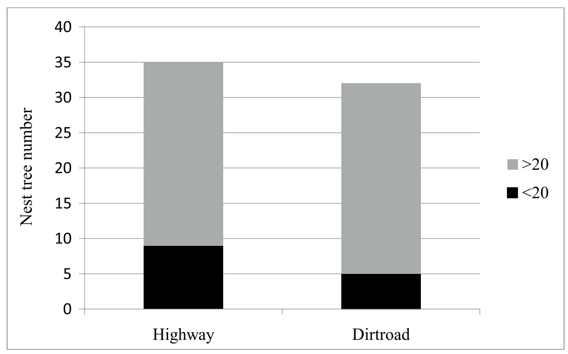


**Fig. 3.** Branches number of nest tree (<20 and >20) near two different road types (Mann-Whitney test, Z= -0.7, p= 0.47).

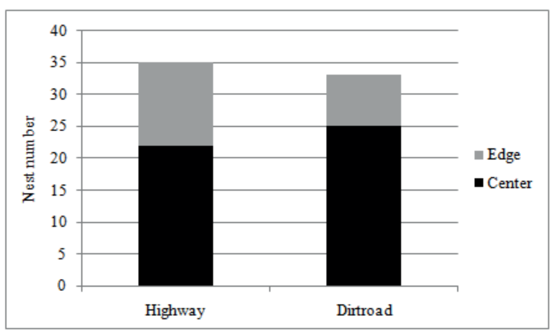


**Fig. 4.** Nest position according to tree (center or edge) near the two different road types (Mann-Whitney test, Z= 1.07, p= 0.28).

road type, the microclimate effects on the initial time of breeding should not be expected. The availability of food such as road killed animals and discarded waste may lead to the start of breeding earlier near the highway. On the other hand, food abundance effect could not be seen in this study because of the larger foraging distance of individuals in the beginning of the breeding season. Thus, we did not find an effect of road type on egg laying dates.

Clutch sizes were also very similar in the two groups of nests, but this trait has not been shown to vary among urban and rural magpie populations in general (Eden 1985, Antonov and Atanasova 2003). On the other hand, Magpies produced more fledglings near the highway than the dirt road. Despite the negative effects of roads on the birds, some species can possitively be affected. Roads provide heat surfaces to rest, nesting and resting sites by poles and bridges, artificial light to increase foraging time, food from road killed animals, and lower predation pressure (Hill 1990, Dean and Milton 2003, Fahrig and Rytwinski 2009, Lambertucci et al. 2009).

Predation is the most likely possible explanation for the positive road effect on the ultimate breeding success in Magpies. There are several studies indicating that certain animals such as foxes,

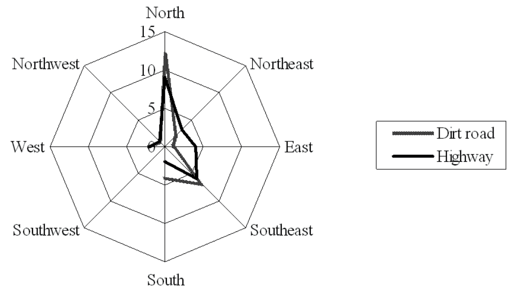


**Fig. 5.** Orientation of the nest relative to the trunk (in degrees) near the two different road types (Mann-Whitney test, Z= 0.21, p=0.83).

badgers, and snakes avoid roads due to traffic disturbance and the existence of these species is lower than expected near roads (Ford and Fahrig 2008, McGregor et al. 2008, Fahrig and Rytwinski 2009). The potential terrestrial predators for the nest of the Eurasian Magpies are the least weasel and the domestic cat in our study areas. As a result, predation rate should be higher near dirt roads, especially after hatching, when nestlings are much more conspicuous to predators. Rodewald et al. (2011) showed a strong negative correlation between predator abundance and nest survival in rural areas, but not in urban areas. There is lower predation pressure due to the abundance of food sources in terms of human waste in urban landscapes (Chamberlain et al. 2009, Rodewald et al. 2011). Likewise, there could be a lower rate of predator pressure near the highway in our study area because of the availability of food such as road killed animals and discarded waste. There are also potential aerial predators in our study area, such as the Common Buzzard, the Long-legged Buzzard, the Rook, and the Hooded Crow. Magpies often build large nests on trees with dense domes. Such a roof and a small nest entrance can protect nest contents from attacks by aerial predators by increasing the Magpie's ability to block access to their nests. These predators are not only found near roads but also away from roads, thus, their effect on Magpie breeding success between the different road types should not be significantly different.

Another potential explanation for the positive road effect on Magpie breeding success could be higher food availability. Anthropogenic food supply has led to population increases in some species, especially corvids (Chamberlain et al. 2009). Substantial amounts of food can be found on roads as road killed animals and discarded waste (Kristan et al. 2004, Ditchkoff et al. 2006). In particular, because of the energetic demands of egg production, incubation, and chick rearing, birds need a greater quantity of nutrition during the breeding season (Ward 1996). So we can expect road killed animals and discarded waste not only from vehicles but also from restaurant and gas stations to boost the food supply for Magpies breeding along highways. According to the above suggestion, differences in clutch size and chick numbers should be expected between the different road types due to the greater food supply, which is contrary to our results. But, this situation can be explained by the forage distance during different phases of the breeding season.

Increased food supply can also enhance breeding success indirectly by interacting with the begging intensity of nestlings. Due to the noise of chicks' begging, nests might attract many more predators and hungry chicks produce more begging noise. Several studies have documented that increased food availability leads to fewer feeding visit rates and higher nest attentiveness (Eggers et al. 2005, Chalfoun and Martin 2007, Eggers et al. 2008). In this way, individuals can spend more time on antipredator behavior such as nest guarding and defense (Lima 1998, Rastogi et al. 2006). It has been shown food availability can influence predation rates in song sparrows (Zanette et al. 2006). Although there is little evidence for the effects of begging on predation risk (Moreno-Rueda 2007), increased parental presence at the nest while also feeding their nestlings may reduce the risk that predators discover the nest (Redondo and Castro 1992, Leech and Leonard 1997). Yet, if there is less food near the dirt road, individuals would have low nest attentiveness because of the limited food supply and thus run a higher risk of nest predation. On the other hand, individuals at both study sites can forage over distant areas in the egg producing and laying stages. Thus, they may have a similar clutch size.

Several studies have indicated that urban nesting birds can be very flexible in their choice of nest substrates and adjust the properties of their nests in these evolutionarily novel environments (Reale and Blair 2005, Wang et al. 2008, Wang et al. 2009). On the other hand, these characteristics are similar in the two areas except for nest volume and nest diameter according to our findings.

Nest size has been considered to be a signal of parental quality in many bird species including the Magpie (Soler et al. 1995, Soler et al. 2001, Fargallo et al. 2001, de Neve et al. 2004). It could be expected that, investment in reproduction should be higher in the Magpie's nest near the dirt road than near the highway in this study. On the other hand, fledglings per successful attempt were higher along the highway site.

The results of the present study indicated that there were no significant differences found in unroofed nest volume between the highway and dirt road. But, roofed nests have a larger volume near the dirt road than the highway. According to Baeyens (1981), Magpie roofed nests are more protected than unroofed nest. The important part of the magpie's nest volume is the nest roof. A possible explanation for the roofed nest volume differences could be predation pressure. Besides, nest diameter was also wider near the dirt road than near the highway. Wide nest may provide better insulation (de Heij 2007) and also offer protection for eggs and nestlings from predators (Quader 2006). On the other hand, before a powerful conclusion about the road effects on the nest volume, more detail studies should be conducted.

To conclude, our findings indicate that highways roads positively affect Magpie breeding success perhaps due to relaxed predation pressures and/or higher food availability. Magpies were using for nesting, hedgerow trees along roads in both of the study areas. Although hedgerows supply refuge, nesting, and resting sites for some species (Evans et al. 2003), it is indicated that this area along roads with denser traffic negatively affect bird species because of collisions with vehicles (Orlowski 2008, Holm and Laursen 2011). On the other hand, findings about the higher fledglings per successful attempt of Magpies near the highway suggest that hedgerow trees were not affected negatively in the study area. According to Orlowski (2008), the road killed number was lower for Magpie than other bird species. But, mortality among juveniles and inexperienced young birds may be higher due to collisions with vehicles (Fetisov 1990, Mumme et al. 2000, Reijnen and Foppen 2006). Also, mortality rate can be affected by road surroundings (Erritzoe et al. 2003). Although many bird species, especially in the Corvid family have the cognitive ability to avoid vehicles and can learn to use roads without being killed (Mumme et al. 2000, Erritzoe et al. 2003), future field studies should be conducted to estimate mortality rates of juveniles and their effects on Magpie populations.

## ACKNOWLEDGEMENT

The authors wish to thank Associate Professor Dr. Berna Yazıcı for helping in data analysis. We would also like to thank Edward McQuaid (Anadolu University, Turkey) for his valuable contrubition to the language editing of the manuscript.

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