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# Road Mortality in the Hazel Dormouse *Muscardinus avellanarius* (L., 1758) (Rodentia: Gliridae): First Evidence for this Species and Implications for Road Mortality Research

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**Abstract:** Roads are considered major movement barriers for the hazel dormouse *Muscardinus avellanarius*, which is generally regarded as a strictly arboreal mammal. Recent evidence has shown that they inhabit roadside habitats and can safely cross roads but no evidence of road mortality has been documented. In this study, we investigate the occurrence of road crossings and roadkills using direct observation in Romania. The study transect crossed a representative landscape physiognomy with forests, pastures, cultivated land and small villages. We encountered hazel dormice on roads on 21 occasions, out of which 10 were roadkill, eight were safe crossings and three were individuals on the ground beside the road. Our study gave a direct evidence that safe crossings do occur but also documents road mortality in this species for the first time. We found that woody and shrubby vegetation elements near the roads are important, especially in arable-dominated landscapes. Factors influencing road crossing behaviour and the way mortality impact on dormouse population are still largely unknown. Understanding these could improve future mitigation actions.

**Key words:** protected species, small mammal, road ecology, mortality factors, Central Europe

## Introduction

The destruction and fragmentation of natural habitats are major threats for the conservation of mammals (Schipper et al. 2008) and roads greatly contribute to both (Oxley et al. 2008, De Redon et al. 2015). Roads generally have detrimental effects on populations and communities of small mammals by destroying natural vegetation, blocking or hindering the movement and dispersal of individuals and causing direct mortality by vehicle collision (Coffin 2007, Ruiz-Capillas et al. 2015). Roads inhibit movement by small forest mammals (Oxley et al. 2008) and have negative effects on several arboreal rodent species (Laurance et al. 2008).

Among other rodent species, roads seem

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to have no effect at all, or they can even have a beneficial effect like assisting population increase (Rytwinski & Fahring 2015). The negative effect of habitat loss and fragmentation seems to be partially compensated by the presence of suitable roadside habitats. Shrubs, trees and herbaceous roadside vegetation can constitute important habitats and corridors for small mammals (Ascensão et al. 2012, Redon (de) et al. 2015). This includes arboreal species (Encarnação & Becker 2015) and may even provide permanent habitat for populations of hazel dormouse *Muscardinus avellanarius* (Schulz et al. 2012). Animal populations can be negatively affected by increased mortality due to vehicle collision (Coffin 2007) but the detrimental effect on small mammals varies greatly among species (Ascensão et al. 2015) and also depends on their conservation status (Rytwinski & Fahring 2015).

The hazel dormouse is considered a vulnerable species in Romania (Murariu 2005) and it is strictly protected in Europe (Habitat Directive, Bern Convention). It is regarded as a strictly arboreal species that avoids crossing open areas (Bright 1998). Nevertheless, individuals still need to move across the landscape, and there is evidence of crossing open habitat (Büchner 2008, Mortelliti et al. 2013, Juškaitis 2014) and roads (Chanin & Gubert 2012), even repeatedly (Kelm et al. 2015). Roads seem not to be a barrier for the movement of this species but little is known about road mortality (‘roadkill’), its impact on populations or the motivation for crossing roads.

The aim of this study was to investigate the occurrence of hazel dormice roadkill and safe road crossings. This was achieved by direct nocturnal observations on a road transect in a complex landscape matrix. We also tried to identify the habitat features that best predict the presence of this species along the roads.

# Materials and Methods

### Study area

The study area was in the western part of Romania, Timiș County (Fig. 1). The research site was located at low altitude (average 150 m a.s.l., max 220 m a.s.l., min 113 m a.s.l.), in a complex landscape matrix classified according to CORINE Land Cover classes (CLC 2018). It consisted of six small villages (Pișchia, Fibiș, Mașloc, Remetea Mică, Charlottenburg and Buzad). The land cover included (Fig. 2):

- discontinuous urban fabric (CLC 1.1.2);
- broad-leaved forests (CLC 3.1.1) dominated by *Quercus* spp.;
- transitional woodland/shrub (CLC 3.2.4);
- land principally occupied by agriculture with significant areas of natural vegetation (CLC 2.4.3);
- complex cultivation pattern (CLC 2.4.2);
- pastures (CLC 2.3.1);
- fruit tree and berry plantations (CLC 2.2.2);
- vineyards (CLC 2.2.1);
- non-irrigated arable land (CLC 2.1.1);
- inland marshes (CLC 4.1.1);
- water bodies (CLC 5.1.2).

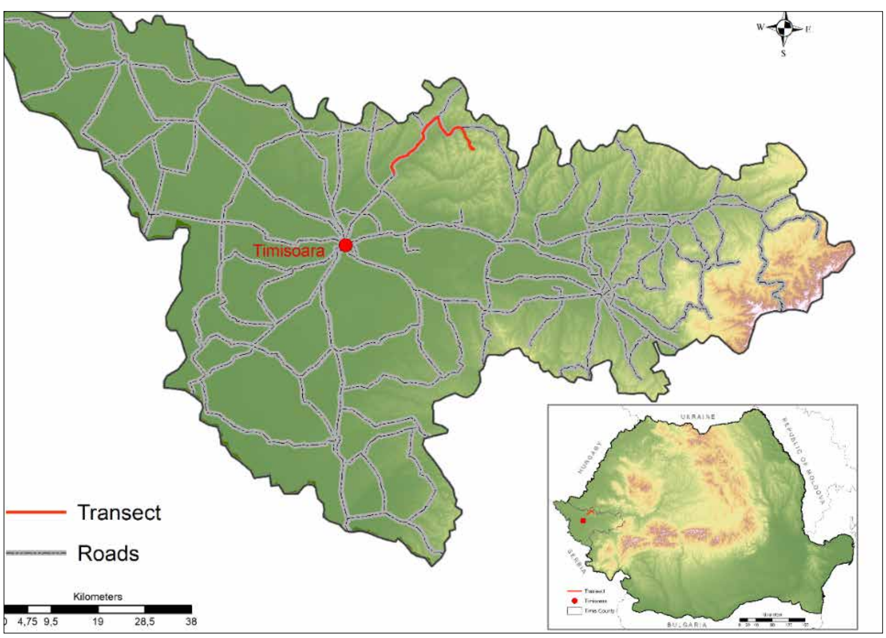


**Fig. 1**. Transect position in Timiș County, Romania.

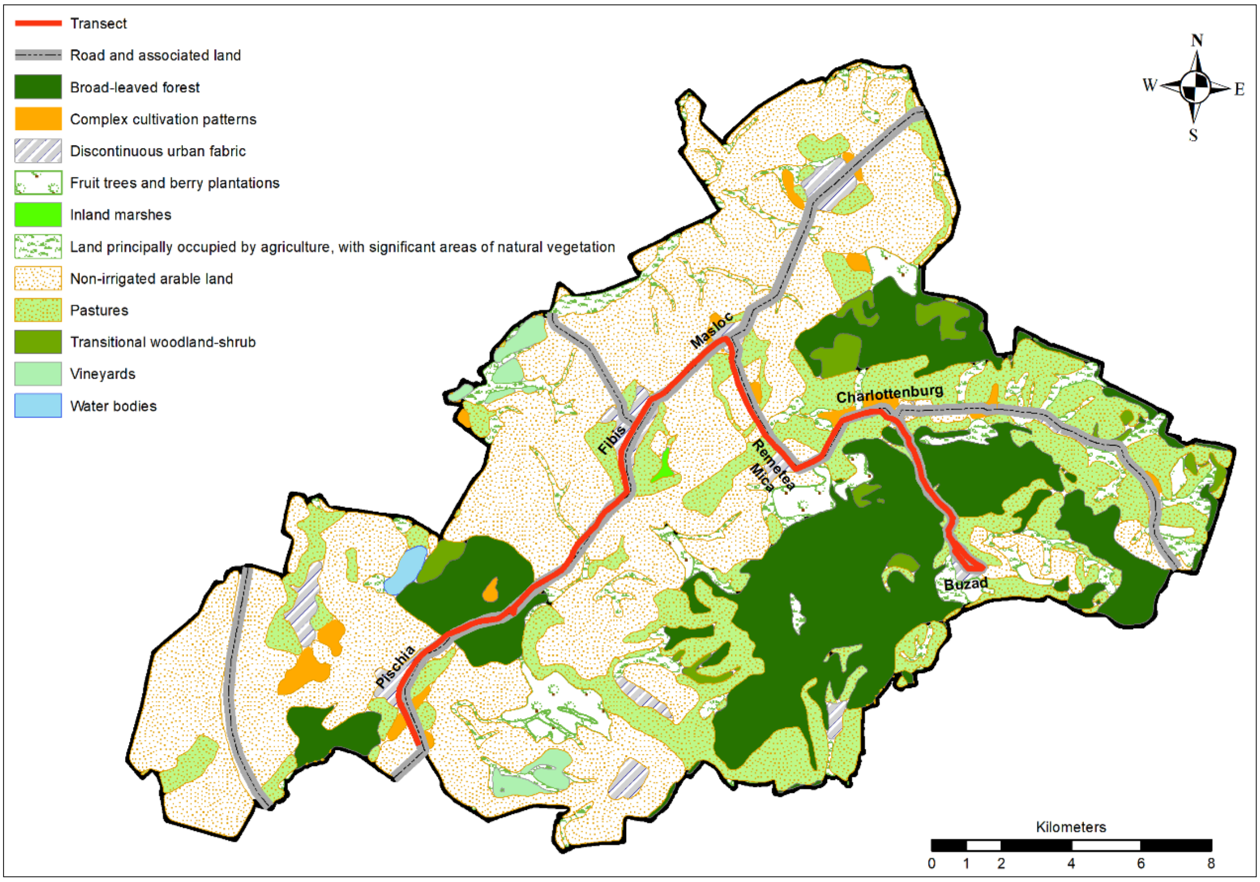


**Fig. 2.** CORINE Land Cover classes © European Union, Copernicus Land Monitoring Service 2018. European Environment Agency (EEA).

**Field surveys**

Road crossing and mortality were evaluated by direct observations on a 31 km road transect surveyed by car, after sunset, at a speed of 25–30 km/h. The transect started at the outskirts of one of the major cities in Romania, Timișoara, following a general north-eastern direction (start N45.889155, E21.348834; end N45.947965, E21.542223) using public roads classified as county and local roads based on their importance and traffic. The survey was carried out by two observers every fortnight for 3 to 7 hours during the active period of dormice (April-November 2018). This resulted into 18 transect surveys. While the transect traversing, we determined the exact position and condition of each mammal and whether it belonged to the family Gliridae*,* in which case we carried out the identification to species level. Otherwise, the identification was done at a higher taxonomic level, except for large species. We evaluated the freshness of carcasses in two categories: recent (less than 8 hours) and old (more than 8 hours). The effective survey length was considered the product of the length of roadside stretch sampled and the total number of surveys performed. The roadkill rate was calculated as the number of dead individuals per effective survey length.

The presence of suitable dormouse habitat (forest and shrubs) within 10 m on both sides of the transect was evaluated during fieldwork. Traffic density was recorded by direct counting of vehicles. Based on the results, we classified the transects into three traffic categories: 0–10, 10–50 and 50–100 vehicles/hour, respectively.

# Results

**Species composition of road-killed mammals**

We observed 130 mammals on the road, both alive and road-killed (Table 1). The only domestic species was the domestic cat. One hundred and twenty five sightings of wild mammals were recorded on the road, comprising 93 carcasses and 32 live ones. The majority were small mammals (89.6%), out of which 18.75% were hazel dormice. No other dormouse species was observed. The freshness of carcasses of small mammals was evaluated as recently killed (in the past 8 hours) in 78.5% of the cases. When considering

**Table 1.** Number of road-killed mammals on the 31 km transect surveyed 18 times in 2018.

| Species | Total number of individuals (alive and road-killed) | Roadkill | Proportion % of all wild road-killed mammals | Roadkill rate/km |
|---|---|---|---|---|
| Eulipothyphla (Erinaceomorpha – Erinaceidae): *Erinaceus roumanicus* | 7 | 6 | 6.45 | 0.011 |
| Eulipothyphla (Soricomorpha – Soricidae) | 2 | 2 | 2.15 | 0.004 |
| Rodentia (Muridae: Arvicolinae and Murinae) | 82 | 69 | 74.19 | 0.124 |
| Rodentia (Gliridae): *Muscardinus avellanarius* | 21 | 10 | 10.75 | 0.018 |
| Total small mammals (Eulipothyphla & Rodentia) | 112 | 87 | 93.55 | 0.156 |
| Chiroptera | 1 | 1 | 1.08 | 0.002 |
| Lagomorpha (Leporidae): *Lepus europaeus* | 1 | 1 | 1.08 | 0.002 |
| Carnivora (Felidae): *Felis catus* | 5 | 5 | 5.38 | 0.009 |
| Carnivora (Felidae): *Felis silvestris* | 1 | 0 | 0.00 | 0.000 |
| Carnivora (Canidae): *Vulpes vulpes* | 7 | 3 | 3.23 | 0.005 |
| Carnivora (Canidae): unidentified | 1 | 1 | 1.08 | 0.002 |
| Artiodactyla (Cervidae): *Capreolus capreolus* | 2 | 0 | 0.00 | 0.000 |
| Total – mammals | 130 | 98 | | |
| Total – Wild mammals | 125 | 93 | | |

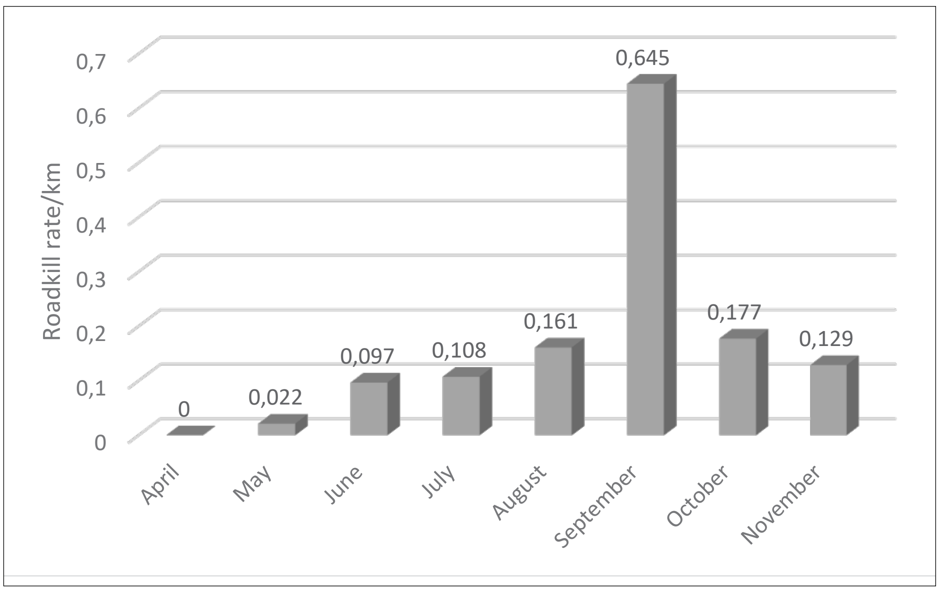


**Fig. 3.** Monthly variation of roadkill rate of small mammals per km.

only carcasses, 11.49% of all small mammals killed on the road were hazel dormice. The effective survey length was 558 km. The roadkill rate for small mammals was 0.156/km and 0.018/km for *M. avellanarius* (Table 1). The observed mean roadkill frequency for the species was 0.55 individuals/survey night.

**Mortality rate of small mammals' monthly variation**

The highest mortality rate for small mammals due to traffic was registered in September (Fig. 3), with a mean maximum number of 20 roadkill individuals. The lowest mortality rate was registered in early spring.

**Dormouse species (Gliridae) presence on the road**

The only dormouse species detected on the road during our study was the hazel dormouse. The first observation was made at the beginning of June and the last – in mid-November. In total, 21 observations were made on the transect: 11 live individuals and 10 roadkill.

Safe crossing was directly observed for eight individuals. Other three animals were waiting by the side of the road and their later fate was unknown. In total, six juveniles were observed – five dead and one crossing safely; 14 animals were adults (5 dead and 9 alive). The age of one alive animal was not determined.

There was ruderal vegetation within 2 m on either side of the road in the area where the dormice were recorded. Eighteen observations (85.71%) were made in areas with suitable dormouse roadside habitat on both sides of the road, with forest or shrubs within 10 m from the road edge. There were two observations in areas with shrubs only on one side of the road as well as one observation in a completely open area, with arable land on one side and grassland on the other. There were no sightings within villages.

## Discussion

In our study area, the mammals most affected by road traffic mortality were the small species, particularly rodents. Comparable results were obtained in other European countries (Hell et al. 2005, Gryz & Krauze 2008, Orłowski & Nowak 2006), including the Balkans, with quite similar small mammal communities, types of habitats and land use (Kambourova-Ivanova et al. 2012). The highest road mortality for small mammals was detected during the autumn, a similar result to a study in Bulgaria (Kambourova-Ivanova et al. 2012), or the end of summer and autumn in Poland (Orłowski & Nowak 2006). The roadkill rate of small mammals during our research was very similar to the mean values derived from multiple studies reviewed by Ruiz-Capillas et al. (2015). However, it is important to consider that the actual roadkill rate might have been higher due to methodological issues (Ruiz-Capillas et al. 2015). Furthermore, we observed scavenging activity among several mammal and bird species (feral cats *Felis catus*, feral dogs *Canis familiaris*, wild cats *Felis silvestris*, foxes *Vulpes vulpes*, magpies *Pica pica*, tawny owls *Strix aluco* and Ural owls *Strix uralensis*) which could have resulted in the removal of some carcasses. In an experiment with camera traps baited with chicken heads as simulated 'roadkill corpses', Schwartz et al. (2018) observed that 76% of the corpses were removed within 12 h by predator species, which is in concordance with our observations that most carcasses found (78.5%) were fresh.

Road crossing is well documented in various species of small mammals (Oxley et al. 2008), not only terrestrial, but also arboreal, like *Sciurus* species that are known to have significant activity on the ground (Fey et al. 2016, Magris & Gurnell 2002). The hazel dormouse, on the other hand, was previously believed to be a strictly arboreal species. However, several studies have revealed that this species also spends some time on the ground (for review, see Juškaitis & Büchner 2013) and that it is capable of crossing open habitats (Büchner 2008, Mortelliti et al. 2013). This behaviour was mostly linked to the dispersal of juveniles, with conflicting results regarding adults (Juškaitis 2014). Provided that suitable habitat is present, hazel dormouse populations are abundant in road verges (Chanin & Gubert 2012, Schulz et al. 2012) and safe road crossing can be inferred by the presence of the species in isolated traffic islands (Schultz et al. 2012). Genetic studies also show that hazel dormice inhabiting roadside habitats are closely related to individuals living on the other side of motorways (Friebe et al. 2018). Road crossing was indirectly demonstrated by recaptures and telemetry but with very different frequencies: eighth crossings by six individuals in four years (Chanin & Gubert 2012), 30 crossings by 19 individuals (by using mark-recapture) in one season and 27 road crossings by six individuals in 20 days revealed by telemetry of both adults and subadults (Kelm et al. 2015). During our study, we directly witnessed 11 attempts and successful road crossings during 13 survey nights. We found a larger proportion of adults crossing roads and a greater rate of successful crossing than in juveniles. However, the difference was not statistically significant, perhaps due to the limited data available.

Road mortality for the hazel dormouse was previously inferred based on the small recapture rate and the rapid loss of some radio-marked individuals during a study by Kelm et al. (2015). However, as far as we know, road mortality has not been reported in any published research on the hazel dormouse or any other dormouse species except the garden dormouse (*Eliomys quercinus*) in Spain (D'Amico et al. 2015). During the present study, we documented road mortality for the hazel dormouse, even at very low traffic densities (0–10 vehicles/hour), at a rate that is almost 10 times lower than that of all small mammals (mean observed roadkill < 1 ind./survey night). Genetic studies proved that not even major roads are a barrier for gene flow (Friebe et al. 2018), but factors influencing road-crossing behaviour and mortality are still largely unknown. During our study, we were able to document danger avoidance as one motivation for crossing roads, as we witnessed three hazel dormice trying to escape a vegetation fire (two successful, one roadkill). Further investigation is needed to understand how mortality affects hazel dormouse populations at both local and landscape levels as well as how habitat features influence the crossing behaviour. Even though most of our observations were made in areas with habitats suitable for hazel dormouse on both sides of the road, we still need to explain why crossings occur when there is suitable habitat only on one side or even none at all. By gaining a deeper understanding of the factors influencing this arboreal species' interaction with roads, conservation actions might be more effectively designed and implemented to mitigate the potential negative impacts on hazel dormouse populations.

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## References

Ascensão F., Lapoint S. & Ree (Van Der) R. 2015. Roads, Traffic and Verges: Big Problems and Big Opportunities for Small Mammals. In Ree (van der) R., Smith D. J. & Grilo C. (Eds.): Handbook of Road Ecology. Wiley Blackwell, pp. 325–333. doi:10.1002/9781118568170.ch39

Ascensão F., Clevenger A. P., Grilo C., Filipe J. & Santos-Reis M. 2012. Highway Verges as Habitat Providers for Small Mammals in Agrosilvopastoral Environments. Biodiversity and Conservation 21 (14): 3681–3697. https://doi.org/10.1007/s10531-012-0390-3.

Bright P. 1998. Behaviour of specialist species in habitat corridors: arboreal dormice avoid corridor gaps. Animal Behaviour 56: 1485–1490.

Büchner S. 2008. Dispersal of common dormice *Muscardinus avellanarius* in a habitat mosaic. Acta Theriologica 53(3): 259–262. doi:10.1007/BF03193122

Chanin P. & Gubert L. 2012. Hazel Dormouse (*Muscardinus avellanarius*) movements in a landscape fragmented by roads. Lutra 55(1): 3–15.

Coffin A.W. 2007. From Roadkill to Road Ecology: A Review of the Ecological Effects of Roads. Journal of Transport Geography 15(5): 396–406. https://doi.org/10.1016/j.jtrangeo.2006.11.006.

D'Amico M., Román J., de los Reyes L., Revilla E. 2015. Vertebrate road-kill patterns in Mediterranean habitats: Who, when and where. Biological Conservation 191: 234–242. doi: 0.1016/j.biocon.2015.06.010

Encarnação J.A. & Becker N.I. 2015. Stealthy at the roadside: Connecting role of roadside hedges and copse for silvicolous, small mammal populations. Journal for Nature Conservation 27: 37–43. doi:10.1016/j.jnc.2015.06.003

Fey K., Hämäläinen S. & Selonen V. 2016. Roads are no barrier for dispersing red squirrels in an urban environment. Behavioral Ecology 27(3): 741–747. doi:10.1093/beheco/arv215

Friebe K., Steffens T., Schulz B., Valqui J., Reck H. & Hartl G. 2018. The significance of major roads as barriers and their roadside habitats as potential corridors for Hazel Dormouse migration - a population genetic study. Folia Zoologica 67(2): 98–109. doi:10.25225/fozo.v67.i2.a10.2018

Gryz J. & Krauze D. 2008. Mortality of vertebrates on a road crossing the Bierbrza Valley (NE Poland). European Journal of Wildlife Research 54: 709–714.

Hell P, Plavy R., Slamecka J. & Gasparik J. 2005. Losses of mammals (Mammalia) and bird (Aves) on roads in the Slovak part of the Danube Basin. European Journal of Wildlife Research 51: 35–40.

Juškaitis R. 2014. The common dormouse *Muscardinus avellanarius*: ecology, population structure and dynamics, 2nd ed. Nature Research Centre, Vilnius. 195 p.

Juškaitis R. & Büchner S. 2013. The Hazel Dormouse. NBB English Edition, Westarp Wissenschaften, Hohenwarsleben. 173 p.

Kambourova-Ivanova N., Koshev Y., Popgeorgiev G., Ragyov D., Pavlova M., Mollov I. & Nedialkov N. 2012. Effect of traffic on mortality of amphibians, reptiles, birds and mammals on two types of roads between Pazardzhik and Plovdiv region (Bulgaria) – Preliminary Results. Acta Zoologica Bulgarica 64(1): 57–67.

Kelm J., Lange A., Schulz B., Göttsche M., Steffens T. & Reck H. 2015. How often does a strictly arboreal mammal voluntarily cross roads? New insights into the behaviour of the hazel dormouse in roadside habitats. Folia Zoologica 64(4): 342–348. doi:10.25225/fozo.v64.i4.a9.2015

Laurance W.F., Croes B.M., Guissouegou N., Buij R. Dethier M. & Alonso A. 2008. Impacts of roads, hunting, and habitat alteration on nocturnal mammals in African rainforests. Conservation Biology 22(3): 721–732. doi:10.1111/j.1523-1739.2008.00917.x

Magris L. & Gurnell J. 2002. Population ecology of the red squirrel (*Sciurus vulgaris*) in a fragmented woodland ecosystem on the Island of Jersey, Channel Islands. Journal of Zoology 256(1): 99–112. doi:10.1017/s0952836902000134

Mortelliti A., Santarelli L., Sozio G., Fagiani S. & Boitani L. 2013. Long distance field crossings by hazel dormice (*Muscardinus avellanarius*) in fragmented landscapes. Mammalian Biology 78(4): 309–312. doi:10.1016/j.mambio.2012.09.006

Murariu D. 2005. Mammalia. In Botnariuc N. & Tatole V. (Eds.): The red book of vertebrates of Romania (in Romanian). București. Muzeul Național de Istorie Naturală "Grigore Antipa". 11–84.

Oxley D. J., Fenton M. B., Carmody G. R., Journal T. & Apr N. 2008. The Effects of Roads on Populations of Small Mammals. Journal of Applied Ecology 11(1): 51–59.

Redon (de) L., Le Viol I., Jiguet F., Machon N., Scher O. & Kerbiriou C. 2015. Road network in an agrarian landscape: Potential habitat, corridor or barrier for small mammals? Acta Oecologica 62: 58–65. doi:10.1016/j.actao.2014.12.003

Ruiz-Capillas P., Mata C. & Malo J. E. 2015. How many rodents die on the road? Biological and methodological implications from a small mammals' roadkill assessment on a Spanish motorway. Ecological Research 30(3): 417–427. doi:10.1007/s11284-014-1235-1

Rytwinski T. & Fahrig L. 2015. The impacts of roads and traffic on terrestrial animal populations. In: Ree (van der) R., Smith D. J. & Grilo C. (Eds.): Handbook of Road Ecology. Wiley Blackwell, 237–246.

Schipper J., Chanson J. S., Chiozza F., Cox N. A., Hoffmann

M., Katariya V., Lamoreux J., Rodrigues A. S., Stuart S. N., Temple H. J., Baillie J., Boitani L., Lacher T. E., Jr., Mittermeier R. A., Smith A. T., Absolon D., Aguiar J. M., Amori G., Bakkour N., Baldi R., Berridge R. J., Bielby J., Black P. A., Blanc J. J., Brooks T. M., Burton J. A., Butynski T. M., Catullo G., Chapman R., Cokeliss Z., Collen B., Conroy J., Cooke J. G., Da Fonseca G. A., Derocher A. E., Dublin H. T., Duckworth J. W., Emmons L., Emslie R. H., Festa–Bianchet M., Foster M., Foster S., Garshelis D. L., Gates C., Gimenez–Dixon M., Gonzalez S., Gonzalez–Maya J. F., Good T. C., Hammerson G., Hammond P. S., Happold D., Happold M., Hare J., Harris R. B., Hawkins C. E., Haywood M., Heaney L. R., Hedges S., Helgen K. M., Hilton–Taylor C., Hussain S. A., Ishii N., Jefferson T. A., Jenkins R. K., Johnston C. H., Keith M., Kingdon J., Knox, D. H., Kovacs K. M., Langhammer P., Leus K., Lewison R., Lichtenstein G., Lowry L. F., Macavoy Z., Mace G. M., Mallon D. P., Masi M., Mcknight M. W., Medellin R. A., Medici P., Mills G., Moehlman P. D., Molur S., Mora A., Nowell K., Oates J. F., Olech W., Oliver W. R., Oprea M., Patterson B. D., Perrin W. F., Polidoro B. A., Pollock C., Powel A., Protas Y., Racey P., Ragle J., Ramani P., Rathbun G., Reeves R. R., Reilly S. B., Reynolds J. E., 3rd, Rondinini C., Rosell–Ambal R. G., Rulli M., Rylands A. B., Savini S., Schank C. J., Sechrest W., Self–Sullivan C., Shoemaker A., Sillero–Zubiri, C., De Silva N., Smith D. E., Srinivasulu C., Stephenson P. J., Van Strien N., Talukdar B. K., Taylor B. L., Timmins R., Tirira D. G., Tognelli M. F., Tsytsulina K., Veiga L. M., Vie J. C., Williamson E. A., Wyatt S. A., Xie Y. & Young B. E. 2008. The status of the world's land and marine mammals: diversity, threat and knowledge. Science 322: 225–230.

Schulz B., Ehlers S., Lang J. & Büchner S. 2012. Hazel dormice in roadside habitats. Peckiana (8): 49–55.

Schwartz A. L. W., Williams H. F., Chadwick E., Thomas R. J. & Perkins S. E. 2018. Roadkill scavenging behaviour in an urban environment. Journal of Urban Ecology 4(1): 1–7. doi: 10.1093/jue/juy006