Impact of land use on wildlife-vehicle collisions in Romania

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Abstract

Wildlife-vehicle collisions (WVC) are an increasing concern in Romania due to the intended strategic direction of the country to expand its road network, especially through the construction of new motorways. However, the absence of a centralized WVC database hampers the assessment of ecological impacts and the implementation of effective mitigation measures. This study explores correlations between land use types and WVC patterns using citizen science data, online platforms, and published reports. A total of 3,037 WVC records involving 143 species were geolocated and linked to land cover types within a 30-meter buffer using the ESA 2021 dataset. Normalized data were analyzed to identify mortality trends across habitats. Results indicate that cropland is the most collision-prone land use, particularly affecting generalist mammals like the red fox. Reptiles were disproportionately impacted in semi-natural mosaic areas. These findings highlight the value of habitat-specific mitigation in environmental impact assessments (EIAs) and suggest priority zones for intervention. Despite methodological limitations, this study demonstrates the potential of citizen science to inform data-poor contexts and guide biodiversity-sensitive infrastructure planning.

1. Introduction

Romania is actively expanding its national road network, particularly through the construction of new motorways. While this development supports economic growth and improves human mobility, it also intensifies the environmental footprint of linear infrastructure in the country. Among the most significant ecological impacts of transport infrastructure are wildlife-vehicle collisions (WVC), which result in fauna mortality and have the potential to increase the pressure on sensitive and already threatened species and to contribute to increasing fragmentation (Seiler et al, 2023). This category of impact should be a subject to be analyzed in Environmental Impact Assessment Reports elaborated for transport infrastructure projects, in accordance to the requirements of Directive 2011/92/EU, as amended by Directive 2014/52/EU (the EIA Directive) (European Parliament and Council, 2011, European Parliament and Council, 2014).

Currently, Romania lacks a centralized and systematic approach to WVC data collection. In the absence of an official monitoring system, environmental consultants and researchers rely on citizen science platforms and online community reports to understand the spatial and ecological patterns of roadkill. These datasets have important limitations, being

observed incidentally and collected non-systematically, but provide a critical resource in a data-deficient context.

Given the legal requirement for biodiversity assessments in Environmental Impact Assessments (EIA), Strategic Environmental Assessments (SEA) and Appropriate Assessment (AA), integrating WVC information into infrastructure planning and project development is essential. However, to develop effective mitigation strategies and ensure the proposal of adequate impact avoidance and mitigation measures, it is crucial to understand roadkill patterns, including in regards to land use types that provide the highest risk of mortality for certain species. This study aims to explore correlations between land use categories and WVC occurrences in Romania, in order to provide indications regarding certain species, that could inform future mitigation planning.

2. Methods

The objective of this study was to analyze the relationship between land use and wildlife mortality across Romanian roads. The data was collected from different citizen science sources: a dedicated citizen science portal and professionally curated Facebook groups. Additionally, in certain geographically limited areas, published data was available, which was used to supplement the citizen science data (Grilo et al., 2025).

After data collection from the various sources, WVC records were represented spatially and aggregated into a dataset of 3,037 valid records, spanning more than 10 years. Of the 3,037 records 696 were collected from Facebook ("WVC România / Wildlife-Vehicle Collisions," n.d., ("RoadKill (animale moarte pe sosea)", n.d.), 664 from the ROad.kill portal (CDV & GreenWeb, 2019) and 1,677 from Grilo et al., 2025. Records with insufficient, erroneous information or uncertain data (unclear species identification or incorrect coordinates) were removed. Invertebrate records were also removed, due to the very small number of entries, totaling 3 entries in the entire dataset.

Each collision point was associated with the dominant land use type within a 30-meter radius. The land use types were based on the European Space Agency (ESA) 2021 land cover data at 10-meter resolution (Zanaga et al., 2022). The data were then categorized by species and land use, normalized, and organized into a matrix. A correlation analysis was conducted on the normalized matrix, to examine whether specific species are disproportionately affected by certain land use types.

3. Results

From the 3,037 validated records, 143 species were identified. The data were strongly dominated by mammals, followed by birds and reptiles. The species most frequently found in the records were: *Vulpes vulpes* (red fox), with 29% of all mammal records, *Dolichophis*

caspius (Caspian whipsnake), with 30% of herpetofauna collisions and *Tyto alba* (barn owl), with 19% of the bird record collisions.

Cropland was identified as the land use type with the highest mortality rate, accounting for 877 individual roadkill records, especially among generalist species (species that are not closely associated with a type of habitat). Mammals were identified as the most frequently affected group.

The results of the correlation analysis suggest moderate and low negative correlation between land use types. The highest degree of correlation was observed between cropland and built-up areas (-0.32544108), with all the other combinations having lower values.

Table 1. Correlation of species mortality patterns between land use types

Land use type	Bare/sparse vegetation	Built-up	Cropland	Grassland	Herbaceous wetland	Permanent water bodies	Tree cover
Bare/sparse vegetation	1	-0,01935523	-0,09467502	-0,03531412	-0,019986	-0,00619372	0,158797882
Built-up		1	**-0,32544108**	-0,28482417	0,056915192	-0,10858078	**-0,29137784**
Cropland			1	**-0,29240424**	-0,14170344	-0,19595216	-0,44793839
Grassland				1	-0,09862723	-0,02347072	-0,19974347
Herbaceous wetland					1	-0,03904921	-0,12257461
Permanent water bodies						1	0,111050128
Tree cover							1

This result suggests a species-specific vulnerability for different types of habitats. It also indicates that urban and agricultural edges can represent high-risk areas. These areas had the highest incidence of mortality for *Erinaceus roumanicus* (Northern white-breasted hedgehog) and *Meles meles* (European badger).

In the case of birds, the highest incidence of mortality was identified in cropland (43%) and grassland (28%). These open habitats likely intersect with foraging and flight corridors, making farmland–road interfaces critical zones for avian collisions.

For herpetofauna, mortality was associated mainly with cropland (32%), grassland (31%) and tree-covered areas (15%). These patterns point to semi-natural landscapes as key mortality hotspots, especially where roads fragment sun-exposed or edge habitats.

4. Discussion

The findings suggest that land use plays a significant role in shaping wildlife mortality patterns on roads in Romania. Croplands, due to their openness and proximity to road networks, present the highest collision risk, particularly for mobile generalist mammals. The presence of weak correlations between land use types supports the hypothesis that

species respond differently to road risks based on their habitat preferences and that mitigation measures should be adapted to habitat type and should be species-specific.

The current analysis is based on citizen science, which is a method that presents a series of limitations, of which it is important to be aware.

There is likely a strong sampling bias towards larger, more conspicuous species, which are easier to see from a moving car. This is indicated by the almost complete absence of invertebrates from the roadkill records.

Given the nature of citizen science data, the process of data collection lacks a standardized protocol and uniform spatial distribution, which makes it difficult to draw firm conclusions. There is a lack of temporal resolution as well in the data record, limiting any attempt to analyze seasonal or diurnal patters of mortality.

The analysis does not include traffic intensity data, due to this information being non-existent in Romania. Without this data, it cannot be assessed how traffic pressure influences roadkill patterns.

Nonetheless, the analysis highlights the potential for land use-based risk mapping for fauna mortality. In practice, this could be integrated into EIAs, with the aim of targeting mitigation efforts more precisely. Road infrastructure traversing croplands and urban fringes should be prioritized for mitigation measures aimed at reducing mortality risk, such as special fencing, wildlife crossings and signage (Rosell et al, 2023). Semi-natural landscapes, often undervalued in planning, also require attention due to their impact on less visible taxa like reptiles.

5. Conclusion

This study underscores the relevance of land use in shaping wildlife-vehicle collision patterns in Romania. It shows that the majority of roadkill incidents occur in land use types that align with each species' ecological niche. This suggests that road mortality strongly reflects habitat use and movement patterns. For the majority of land use types, species mortality profiles show weak correlation, indicating that roadkill composition varies with habitat — highlighting the need for habitat-specific mitigation measures

While the findings are constrained by data limitations, they offer valuable guidance for more ecologically informed infrastructure planning and support the case for incorporating citizen science into impact assessments.

6. References

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