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Letter to the editor

A century documenting roads' toll on global biodiversity

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ABSTRACT

The 100th anniversary of the first scientific account of roadkill recognizes the growing awareness of roads' ecological impacts. Since the first scientific record of roadkill in 1925, global road networks have expanded to over 21.6 million km. Roads result in the mortality of millions of animals annually, threatening biodiversity by reducing populations, fragmenting habitats, and raising extinction risks. Although it was not until the early 2000s that road ecology became formally established as a discipline, research has since advanced substantially. A recent global roadkill dataset spanning 2283 species in 54 countries is an example of this advancement, and it highlights the urgency of this issue. As road expansion accelerates, especially into intact habitats, it is essential to align infrastructure development with both ecological sustainability and economic objectives. We need to build better roads that meet human needs while safeguarding biodiversity, promoting conservation, and preventing another century of major ecological harm.

Globally, roads provide significant benefits to society by facilitating the transportation of people and goods. However, wildlife mortality resulting from collisions with vehicles is one of the main causes of the decline in biodiversity throughout the world. A century ago, *Science* published what is widely regarded as the first scientific account of roadkill, in which Dayton and Lillian Stoner reported 225 dead animals observed during a 1,017-km drive across Iowa (Stoner, 1925). The Stoners' pioneering research revealed that the impacts of roads and traffic extend beyond human safety, laying the groundwork for a growing field of ecological research. This initial report hinted at the profound impacts that would unfold with the rise of expansive road networks. The current road network is over 21.6 million km (Meijer et al., 2018), and the vehicles using these roads result in the mortality of millions of animals annually (Schwartz et al., 2020). This threatens biodiversity through reducing populations, fragmenting habitats, and increasing extinction risks (Grilo et al., 2021; Van Der Ree et al., 2015). However, it was only in the late 20th century that conservation concerns began to translate into more substantial and more systematic research on how roads affect wildlife (Forman and Alexander, 1998). By 2003, Road Ecology had become established as a discipline (Forman et al., 2003), providing a conceptual framework that unifies a broad spectrum of studies.

In 2025, a century after the first publication, an open-access global roadkill dataset documented 208,570 roadkill records of 2283 species and subspecies in 54 countries (Grilo et al., 2025). This is an illustration of the significant progress made to understand this threat. The database informs our understanding of which species experience the highest mortality, spatial and temporal patterns of mortality, impacts on population abundance, and potential extinction risk. Advancing road ecology is extremely timely as the biodiversity crisis grows and a tsunami of infrastructure development is projected globally (Laurance, 2018). An estimated 25 million additional kilometers of roads are expected to be built between 2010 and 2050 (Dulac, 2013). The majority of these roads will likely be in the world's remaining intact habitats (Alamgir et al., 2017). As wildlife populations are affected by collisions, the ripple effect on ecosystems can be devastating.

Roadkill can also have an impact on public safety, resulting in substantial human injury and economic loss (Huijser et al., 2009, Abra et al., 2019). For example, São Paulo state in Brazil spends US\$25 million of its public budget annually on wildlife-vehicle collisions (WVCs) (Abra et al., 2019). In the United States, WVCs are estimated to cause over 200 human deaths and 29,000 injuries annually, with associated costs estimated to be between \$6 and \$12 billion (Huijser et al., 2009). However, even with significant advances, the death of wild animals due to vehicle collisions is a vastly underestimated threat that is still absent from many political and environmental agendas.

The mortality numbers and the growing threat of extinction for several species reveal the urgent need to implement solutions.

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Fig. 1. A roadkilled tayra (*Eira barbara*), along the BR-174 Brazilian Federal Highway, illustrates the growing threat of vehicle collisions to wildlife conservation. Photo: Fernanda D. Abra.

Thanks to a growing body of scientific research over the past decades, it has become possible to predict, avoid, mitigate, and even compensate for at least some of the ecological impacts of roads. To avoid repeating a century of costly oversight, road expansion must align with the Sustainable Development Goals, not only to limit biodiversity loss but also to achieve net gains through proactive conservation planning.

Collaboration among governments, researchers, and civil society can be a cornerstone in defining effective solutions to conserve biodiversity and ecosystem services and guarantee the safety of human populations (e.g., Huijser et al., 2009). An effective and well-enforced policy that integrates infrastructure expansion requirements and human safety with wildlife movement and habitat needs is crucial to a sustainable future.

A century after the first scientific article on wildlife road mortality and decades since the term road ecology was introduced, the field has evolved from its theoretical and academic roots into a new phase of widespread and large-scale application. The emerging global focus on sustainable infrastructure reframes road ecology not just as a science, but as a vital component of infrastructure planning and policy. This emerging paradigm calls for the integration of decades of accumulated ecological knowledge into practical solutions, ensuring that roads are not only efficient and resilient but also compatible with the agenda of biodiversity conservation.

Fig. 1

CRediT authorship contribution statement

Abra Fernanda: Conceptualization, Writing – original draft, Writing – review & editing. **Goebel Luan:** Writing – original draft, Writing – review & editing, Conceptualization. **Tremaine Gregory:** Writing – review & editing. **Alfonso Alonso:** Writing – review & editing. **Clara Grilo:** Writing – review & editing. **Huijser Marcel:** Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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