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THE COST OF CROSSING: AN INITIAL ATTEMPT TO UNCOVER WILDLIFE VEHICULAR MORTALITY IN DODDABETTA, NILGIRIS (INDIA)

CIJENA PRELASKA: POČETNI POKUŠAJ OTKRIVANJA SMRTNOSTI DIVLJIH ŽIVOTINJA OD VOZILA U DODDABETTI, NILGIRIS (INDIJA)

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Abstract

Roads pose a significant threat to wildlife, particularly in biodiversity-rich regions such as the Nilgiris (India). This preliminary study documents patterns of wildlife-vehicle collisions (WVC) in the Doddabetta region, focusing on taxonomic diversity, seasonal variation, and species-specific vulnerability. A total of 80 individuals from 19 species were recorded as roadkill across 60 randomly selected days, with reptiles especially the endemic *Salea horsfieldii* showing the highest incidence. The data suggest a strong correlation between roadkill events and seasonal activity patterns, particularly during breeding periods. Contributing factors include high vehicle speeds, roadside garbage that attracts prey species, and inadequate driver awareness. The study underscores the urgent need for mitigation measures such as wildlife crossings, dynamic signage, and impact assessments of existing and proposed roads. As the findings are based on limited, randomly timed surveys, we recommend future research with systematic seasonal monitoring during both day and night to better understand the broader ecological implications. This study provides baseline data for developing conservation strategies in high-risk zones like Doddabetta.

Key words: Breeding season, Endemic species, Herptofauna, Roadkill, Seasonal pattern, Shola habitat

1. INTRODUCTION / UVOD

The recent global assessment by Grilo et al. (2025) reports 208,570 wildlife roadkill incidents between 1971 and 2024, covering 2,283 species and subspecies across 54 countries and

six continents, in which 126 were threatened species with a total of 4,570 records. Wildlife roadkill refers to the accidental death of animals caused by vehicle collisions has escalated

with the global expansion of road networks, making roads one of the leading sources of human-induced mortality for many vertebrates and a major concern for ecological, economic, and social systems (Grilo et al., 2021; Hill et al., 2019; Medrano Vizcaíno et al., 2022; Schwartz et al., 2020; Sukhontapatipak et al., 2025). Unlike poaching or hunting, which generally target specific individuals, wildlife–vehicle collisions often involve healthy animals (Ontiveros et al., 2022; Pawgi et al., 2024). Such incidents can disrupt gene flow, contribute to population isolation and decline (Sutherland et al., 2010), and alter movement and distribution patterns (Desai & Baskaran, 1998; Sur et al., 2022). They may also increase inbreeding, lead to local extirpation (Quinn & Hastings, 1987), and even affect surrounding flora and fauna (Mazumdar & Gogoi, 2010). A high roadkill rate in any taxonomic group can directly disrupt the food chains of native wildlife species (Andersson et al., 2017; Hodson, 1966; Muñoz et al., 2015; Ray et al., 2023). India has a road network spanning over 600,000 km, making it the second largest in the world (Indian Road Industry Report, 2020; Pawgi, 2024; Sur et al., 2022; Sushanth et al., 2025) and over the past six decades, both the total road length and the number of automobiles in India have grown significantly.

Studies worldwide have revealed the massive scale of wildlife mortality caused by road traffic. In the United States, over a million vertebrates are killed daily, including between 89 and 340 million birds annually (Loss et al. 2014). Europe reports approximately 194 million bird and 29 million mammal deaths each year (Grilo et al., 2020), while Latin America sees an estimated 12.4 million birds and 5.1 million mammals

killed annually (Medrano-Vizcaíno et al., 2022). Canada records 13.8 million bird deaths annually (Bishop & Brogan, 2013), Australia reports 5 million frogs and reptiles, and the Netherlands experiences the loss of 653,000 birds and 159,000 mammals each year. In Bulgaria, an estimated 7 million birds are killed annually on roads (Forman & Alexander, 1998). Similarly, in India, numerous studies have documented the widespread impact of road traffic on wildlife across diverse ecosystems (Baskaran & Boominathan, 2010; Bhupathy et al., 2011; Chhangani, 2004a, 2004b; Chittaragi & Hosseti, 2014; Choudhury & Ghosh, 2008; Das et al., 2007; Dutta et al., 2016; Gokula, 1997; Gubbi et al., 2012; Hat & Mubeen, 2019; Husain & Mehta, 2023; Islam & Saikia, 2014; Jeganathan et al., 2018; Kumara et al., 2000; Nagar et al., 2013; Pawgi et al., 2024; Pragatheesh, 2011; Rao & Girish, 2007; Ray et al., 2023; Samson et al., 2016, 2018; Santhoshkumar et al., 2016, 2017; Santhoshkumar & Kannan, 2017; Saxena et al., 2020; Seshadri et al., 2009; Seshadri & Ganesh, 2011; Siva & Neelannarayanan, 2020; Sundar, 2004; Sur et al., 2022; Sushanth et al., 2025; Vijayakumar et al., 2001). Accurately assessing the impact of wildlife–vehicle collisions (WVCs) on population persistence requires comprehensive knowledge of local species abundance, roadkill rates, and spatiotemporal collision patterns. Such understanding is crucial for identifying high-risk areas, informing mitigation strategies, and evaluating the broader ecological and socio-economic consequences (Bartonicka et al., 2018; Grilo et al., 2025; Gunson et al., 2009; Visintin et al., 2016). This study is an approach to quantify the diversity and scale of faunal mortality caused by vehicular collisions and to assess the seasonal variation in collision patterns.

2. MATERIAL AND METHODS / MATERIJA I METOD RADA

The study was conducted along a 1.75 km road transect stretching from Doddabetta Junction to Attabettu (Nilgiris, India) (Figure1). The area is characterized by dense forests and sub-alpine vegetation, including *Rhododendron* spp,

coarse grasses, and flowering shrubs. Nilgiri district gets an average annual rainfall of 1920 mm (Samson et al., 2018). Along the transect, the left side of the road (from Doddabetta to Attabettu) is dominated by plantations and

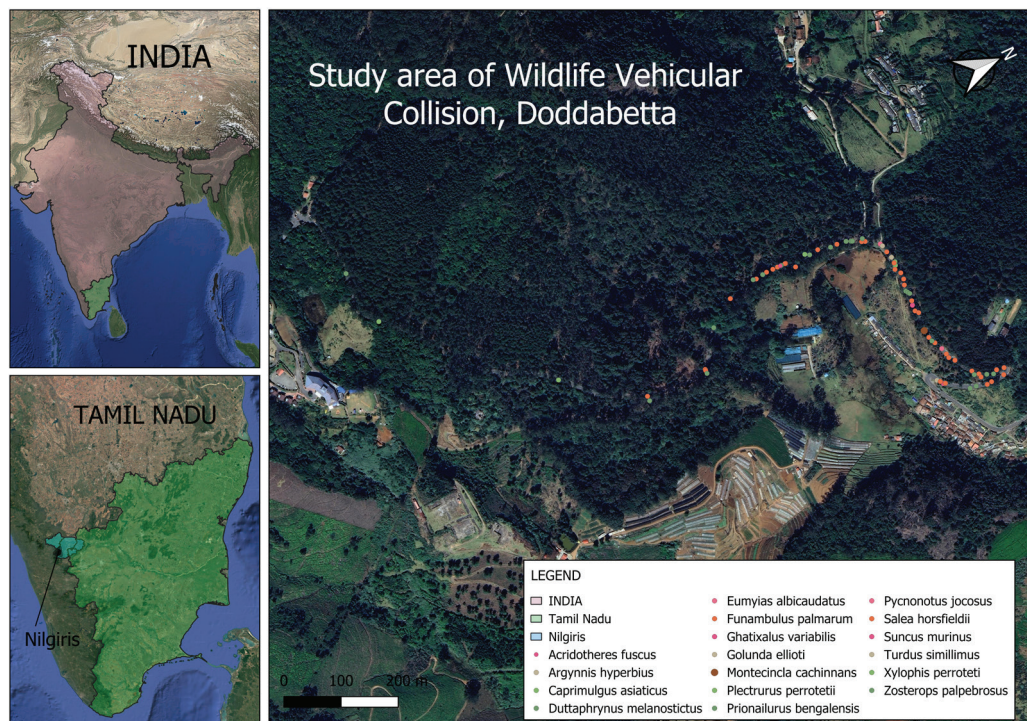


Figure 1. Map of the study area / Slika 1. Prikaz područja istraživanja

invasive species such as *Pinus sp.*, *Eucalyptus sp.*, *Cestrum aurantiacum*, *Acacia sp.*, *Cupressus corneyana*, *Acacia melanoxylon*, *Cupressus macrocarpa*, *Ageratina adenophora*, and *Lobelia leschenaultiana*. The right side of the road is bordered by Shola forest for the first 830 meters, after which the vegetation resembles that of the left side making it a de-

graded ecotone region. Data were collected opportunistically by walking along the transect on randomly selected sunny and cloudy days over a five-month period, from February to June (2025). Data were analysed using R software12.0 (2020) using ggplot2, ggtext and dplyr, and mapping was visualized using QGIS version 3.32.0.

3. RESULTS / REZULTATI

A total of 60 days were randomly selected for the study, during which roadkill were recorded on 42 days. We documented 81 individuals representing 19 species and subspecies killed due to vehicle collisions (Table 1, Figure 2). These included 2 species from the class Amphibia, 6 from Mammalia, 7 from Aves, 3 from Reptilia, and 1 from Insecta. The reptile *Salea horsfieldii* (Horsfield's Spiny Lizard) accounted for the highest number of roadkills, with 40

individuals, followed by the amphibian *Duttaphrynus melanostictus* (Asian common Toad) with 20 individuals. Other species such as *Zosterops palpebrosus* (Indian White-eye), *Suncus murinus* (Asian House Shrew), *Plectrurus perroteti* (Nilgiri Burrowing Snake), and *Xylophis perroteti* (Perrotet's Mountain Snake) were each represented by two individuals. The remaining species *Ghatixalus variabilis* (Variable Ghat Frog), *Eumyias albicaudatus* (Nilgiri Fly-

Table 1. Summary information about roadkill taxa / **Tabela 1.** Prikaz informacija o stradalim taksonima

Common name	Scientific name	Class	IUCN status	Distribution range	Total no of individuals
Indian toad	<i>Duttaphrynus melanostictus</i>	Amphibia	Least concern	South Asia and Indonesia	20
Variable ghat frog	<i>Ghatixalus variabilis</i>	Amphibia	Endangered	Endemic to southern western Ghats	1
Nilgiri flycatcher	<i>Eumyias albicaudatus</i>	Aves	Least concern	Endemic to western Ghats	1
Nilgiri Laughingthrush	<i>Montecincla cachinnans</i>	Aves	Endangered	Endemic to Nilgiris	1
Indian nightjar	<i>Caprimulgus asiaticus</i>	Aves	Least concern	Found in south Asia	1
Jungle myna	<i>Acridotheres fuscus</i>	Aves	Least concern	Found in south Asia	1
Indian white-eye	<i>Zosterops palpebrosus</i>	Aves	Least concern	Found in south Asia	2
Red-whiskered bulbul	<i>Pycnonotus jocosus</i>	Aves	Least concern	Found in South Asia and Indonesia	1
Indian blackbird	<i>Turdus simillimus</i>	Aves	Least concern	Found in India	1
Nilgiri fritillary	<i>Argynnis hyperbius hybrida</i>	Insecta	-	Endemic to Nilgiris	1
Indian palm squirrel	<i>Funambulus palmarum</i>	Mammalia	Least concern	Found in India	1
Leopard cat	<i>Prionailurus bengalensis</i>	Mammalia	Least concern	Found in Asia	1
Asian house shrew	<i>Suncus murinus</i>	Mammalia	Least concern	Found in India and other regions	2
Indian Bush Rat	<i>Golunda ellioti</i>	Mammalia	Least concern	Found in India	1
Jungle cat	<i>Felis chaus</i>	Mammalia	Least concern	Found in India and other regions	1
Indian grey mongoose	<i>Urva edwardsii</i>	Mammalia	Least concern	Found in India and other regions	1
Nilgiri spiny lizard	<i>Salea horsfieldii</i>	Reptilia	Least concern	Endemic to Nilgiris	40
Perrotet's mountain snake	<i>Xylophis perroteti</i>	Reptilia	Least concern	Endemic to Nilgiris	2
Nilgiri burrowing snake	<i>Plectrurus perroteti</i>	Reptilia	Least concern	Endemic to Nilgiris	2

catcher), *Acridotheres fuscus* (Jungle Myna), *Caprimulgus asiaticus* (Indian Nightjar), *Pycnonotus jocosus* (Red-whiskered Bulbul), *Montecincla cachinnans* (Nilgiri Laughingthrush), *Turdus simillimus* (Indian Blackbird), *Funambulus palmarum* (Indian Palm Squirrel), *Prionailurus bengalensis* (Leopard Cat), *Felis chaus* (Jungle Cat), *Urva edwardsii* (Indian Grey Mongoose), *Golunda ellioti* (Indian Bush Rat), and *Argynnis hyperbius hybrida* (Nilgiri Fritillary) were each recorded only once. Of the 19 species and subspecies, two were classified as Endangered, one lacked an official conservation status, and the remaining 16 were categorized

as Least Concern. Additionally, four species were endemic to the Nilgiris, while other two were endemic to the southern Western Ghats.

Analysis of the monthly collision data (Figure 3) showed that June recorded the highest number of incidents ($n = 24$) followed by May ($n = 23$), March ($n = 13$), April ($n = 12$), and February ($n = 9$). In June, the most affected species was *Salea horsfieldii* ($n = 10$), followed by *Duttaphrynus melanostictus* ($n = 3$). Other species recorded in June included *Plectrurus perroteti*, *Xylophis perroteti*, *Suncus murinus* ($n = 2$), and *Ghatixalus variabilis*, *Golunda el-*

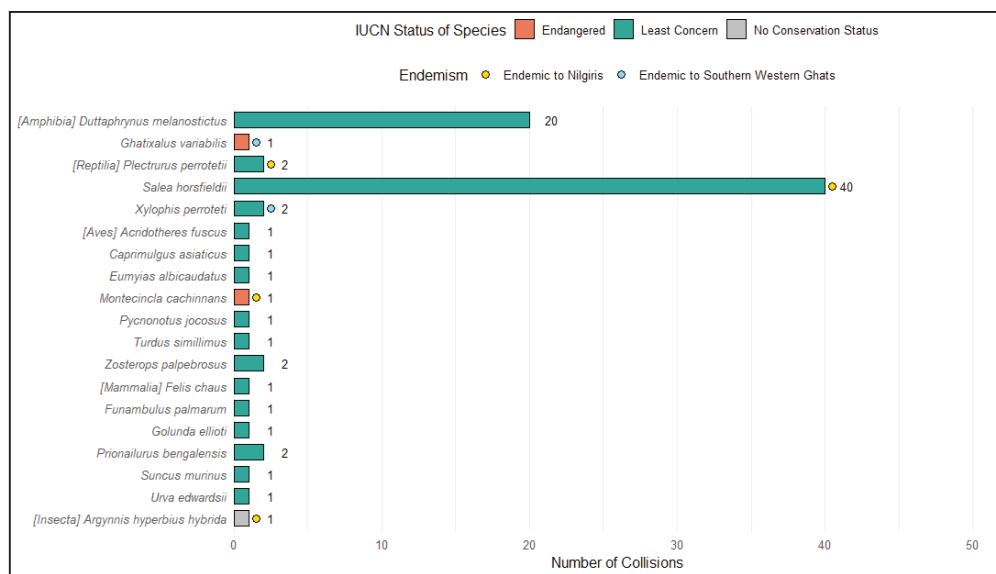


Figure 2. Trend of species WVC with their IUCN and Endemism status / **Slika 2.** Trend sudara vozila sa divljim životinjama (WVC) sa njihovim IUCN statusom ugroženosti i endemičnosti

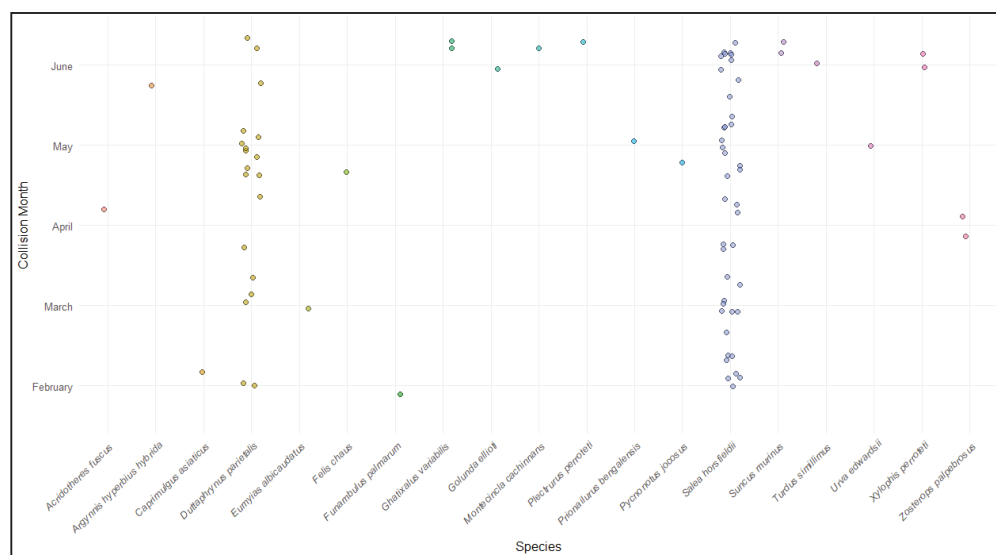


Figure 3. Month wise trend of WVC / **Slika 3.** Mjesečni trend sudara vozila sa divljim životinjama (WVC)

lioti, *Turdus simillimus*, *Montecincla cachinnans*, and an *Argynnis hyperbius* hybrid (each $n = 1$). In May, *Duttaphrynus melanostictus* had the highest number of collisions ($n = 10$), followed by *Salea horsfieldii* ($n = 9$), while *Felis chaus*, *Prionailurus bengalensis*, and *Pycnon-*

otus jocosus, *Urva edwardsii* were recorded once each ($n = 1$). In March, *Salea horsfieldii* was the most frequently recorded species ($n = 9$), followed by *Duttaphrynus melanostictus* ($n = 3$), and *Eumyias albicaudatus* ($n = 1$). April accounted for $n = 12$ collisions, with *Salea*

horsfieldii (n = 7) followed by *Duttaphrynus melanostictus* and *Zosterops palpebrosus* contributing (n = 2 each), and *Acridothores fuscus* recorded once (n = 1). February showed *Salea horsfieldii* (n = 5), followed by *Duttaphrynus melanostictus* (n = 2) while *Caprimulgus asiaticus*, *Funambulus palmarum* had one record each (n = 1).

Analysis of weather conditions (Figure 4) revealed that sunny days accounted for the majority of roadkill incidents (n = 58), followed by rainy conditions (n = 22), and cloudy weather (n = 1). Among the sunny records, may had the

highest number of incidents (n = 17), followed by June (n = 14), March (n = 13), April (n = 9), and February (n = 5). Under rainy conditions, the number of incidents was comparatively lower (n = 22), with the highest recorded in June (n = 8), followed by May (n = 7), April (n = 5), and February (n = 2) and only one incident occurred during cloudy weather (n = 1).

Analysis of canopy cover and weather conditions (Figure 5) revealed a significant influence on collision frequency. The highest number of collisions occurred under 70% canopy cover (n = 24), followed by 0% canopy cover (n = 19),

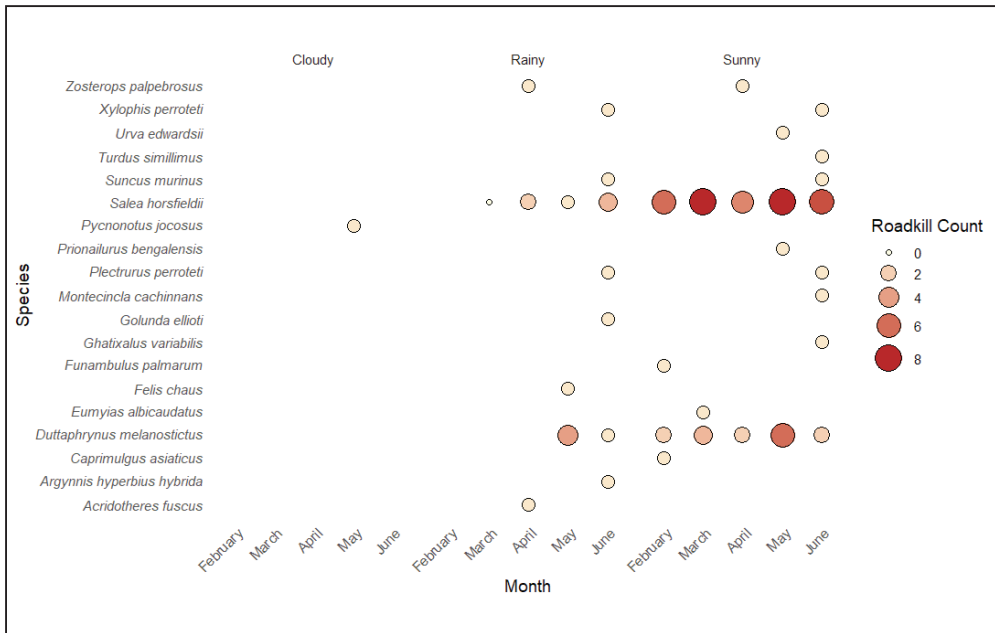


Figure 4. Month wise and season wise trend analysis of WVC / *Slika 4.* Analiza mjesečnog i sezonskog trenda sudara vozila sa divljim životinjama (WVC)

60% canopy cover (n = 11), 80% canopy cover (n = 9), 75% canopy cover (n = 7), 65% canopy cover (n = 6), and 75% canopy cover (n = 5). In terms of weather, sunny conditions accounted for the majority of incidents across canopy types (n = 55). Notably, 70% canopy recorded the highest number of sunny day collisions (n = 16), followed by 0% canopy (n = 14), 60%

canopy (n = 8), 75% canopy (n = 6), 80% canopy (n = 5), and 65% canopy (n = 3). Under rainy conditions, a total of 25 collisions were recorded: 70% canopy (n = 13), 0% canopy (n = 4), 80% canopy (n = 3), 75% canopy (n = 2), 60% canopy (n = 2), and 65% canopy (n = 1). Only one collision occurred under cloudy weather, which was recorded at 0% canopy (n = 1).

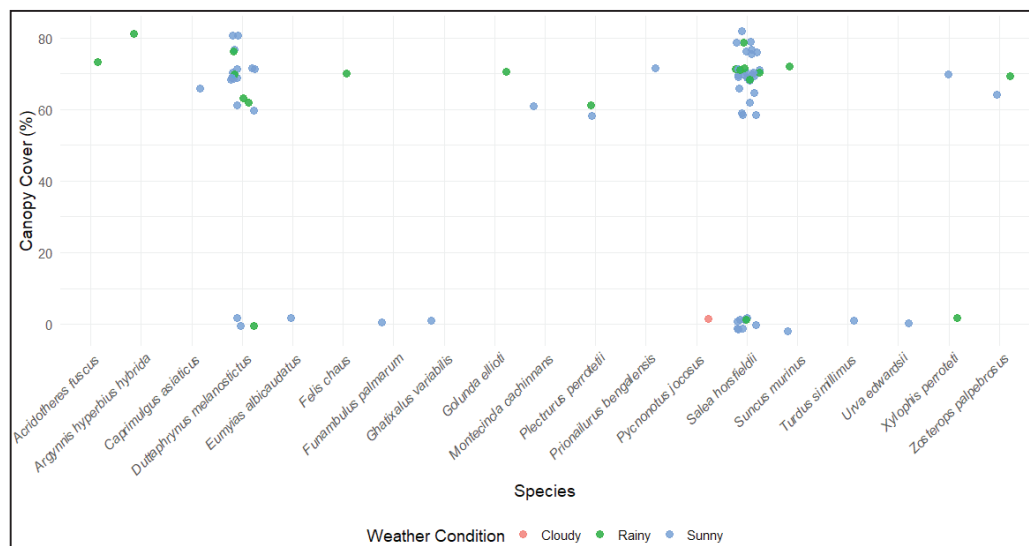


Figure 5. Relationship between species roadkill and canopy cover / **Slika 5.** Veza između vrsta i stepena sklopa kod sudara vozila sa divljim životinjama (WVC)

4. DISCUSSION / DISKUSIJA

This study highlights the significant threat vehicular traffic poses to wildlife in the Nilgiris, as demonstrated by 81 roadkill incidents involving 19 species and subspecies recorded over just 42 days. While the majority of these species are currently classified as Least Concern, the presence of one Endangered species and multiple endemics including three restricted to the Nilgiris and another three to the southern Western Ghats raises serious conservation concerns. Month wise analysis revealed that June and May recorded the highest number of collisions, likely due to increased animal movement during this period and a surge in tourist activity around Doddabetta, which sees peak visitation in these months.

Reptiles, in particular, are highly vulnerable due to their tendency to use roads for thermoregulation (Andrews & Gibbons, 2005; Sushanth et al., 2025), their slow movement, and foraging habits (Brehme et al., 2013). The highest number of roadkill incidents in this study involved *Salea horsfieldii* (Horsfield's Spiny Lizard), followed by *Duttaphrynus melanostictus*. *S. horsfieldii*, an

agamid lizard endemic to the Western Ghats, typically inhabits elevations of 1,600–2,500 m in the Nilgiri Hills (Abinash & Vishnu, 2022; Daniel, 2002; Santhosh Kumar et al., 2017). It is commonly found on low bushes, tree trunks, and rocks, particularly along the edges of shola-grassland mosaics (Deepak et al., 2022). These transitional habitats are ecologically important, especially during the dry season (October to May), which aligns with the species' breeding period (Bhupathy & Nixon, 2004). Frequent use of these edge areas during courtship and oviposition increases the species' exposure to roads. Notably, several dead females were found with extruded eggs, suggesting that collisions often occur during or shortly after laying, further highlighting their vulnerability during reproduction. The second most affected species, *Duttaphrynus melanostictus*, faces a high risk of road mortality, likely due to its extended breeding season from February to November, with peak activity during the monsoon. Our findings align with previous studies suggesting that roadkill incidents tend to increase during

seasonal migrations to breeding habitats, particularly in the rainy season, when amphibian's cross roads in large numbers, thereby increasing their risk of collisions with vehicles (Sukhon-tapatipak et al., 2025; Sur et al., 2022).

Although birds are generally less susceptible to road mortality due to their ability to fly and their visual and auditory awareness of oncoming vehicles (Husby & Husby, 2014), eight bird fatalities involving six species were recorded. High vehicle speed appears to be the primary contributing factor (Erritoe et al., 2003; Husain & Mehta, 2023; Saxena et al., 2020; Sur et al., 2022). Among them *Montecincla cachinnans* (Nilgiri Laughingthrush) and *Eumyias albicaudatus* (Nilgiri Flycatcher), were endemic species of the Nilgiris, highlighting that even avian species are not entirely insulated from road threats. Reptiles with restricted ranges and specialized habitats, such as *Plectrurus perroteti* and *Xylophis perroteti*, appear especially susceptible to road mortality. Nightjars are particularly susceptible to road mortality due to their nocturnal habits and behavior. They often feed on insects attracted to streetlights and may rest or incubate eggs on warm road surfaces during the breeding season, making them vulnerable to vehicle collisions. Sudden exposure to headlights can disorient

them, preventing escape (Erritoe et al., 2003; Hernandez, 1988; Husain & Mehta, 2023).

For instance, a single roadkill incident of *Plectrurus perroteti* was documented in June, a period closely aligned with its reproductive season. As a viviparous species known to give birth between July and August (Santhoshkumar et al., 2016; Smith, 1943; Wall, 1919), such incidents raise serious concerns that additional roadkills during this critical phase could further jeopardize population viability. Similarly, *Argynnis hybrida*, the Nilgiri Fritillary, an endemic butterfly species restricted to the Nilgiri Hills, has also been recorded as roadkill. The loss of such localized and conservation-sensitive taxa underscores the urgent need for mitigation strategies along roads intersecting biodiverse habitats.

Multiple studies across protected areas in India have reported roadkill incidents involving several mammal species of conservation concern (Rajvanshi et al., 2001). A key contributing factor is that mammals often become disoriented or temporarily blinded by the glare of vehicle headlights, making them more susceptible to collisions (Sur et al., 2022). In the present study, small mammal species such as the Indian palm squirrel (*Funambulus palmarum*),



Figure 6. Nilgiri marten (left) observed crossing the road during the study period, and Indian Bush Rat (right) feeding on discarded sweet corn along the roadside / *Slika 6.* Kuna iz Nilgirija (levo) primijećena kako prelazi put tokom perioda istraživanja i indijski žbunski pacov (desno) koji se hrani odbačenim kukuruzom šećerem pored puta

leopard cat (*Prionailurus bengalensis*), Asian house shrew (*Suncus murinus*), Indian bush rat (*Golunda ellioti*), jungle cat (*Felis chaus*), and Indian grey mongoose (*Herpestes edwardsii*) were recorded as roadkill, highlighting the widespread impact of vehicular traffic on diverse mammalian fauna.

Other observations (Figure 6) included sightings of *Martes gwatkinsii* (Nilgiri marten) crossing the road, and low-flying endemic birds such as *Sholicola major* (Nilgiri blue robin), *Ficedula nigrorufa* (Black-and-orange Flycatcher), and *Culicicapa ceylonensis* (Grey-headed Canary-fly-

catcher), all at heightened risk of vehicular collision due to their proximity to roads. We also observed *Golunda ellioti* feeding on sweet corn discarded by tourists, indicating that human food waste may be altering wildlife behaviour. Additionally, garbage dumping along roadsides especially near shola forest edges by both locals and tourists poses a significant threat to biodiversity by attracting wildlife closer to roads and degrading natural habitats. The litter provides an easy food source for rodents and other animals, increasing their presence near roads and, consequently, their risk of vehicle collisions (Samson et al., 2016).

5. CONCLUSION / ZAKLJUČAK

Despite being conducted in a relatively small area, the study revealed a considerable number of roadkill incidents, particularly among range-restricted and ecologically sensitive taxa. These findings highlight the disproportionate impact of vehicular traffic on such vulnerable species, underscoring the urgent need for species-specific mitigation measures and long-term monitoring. The collision data from Doddabetta, including spatial and temporal trends, offer valuable baseline insights for shaping future mitigation strategies. Given that the present study is based on preliminary data collected at irregular intervals, future research should focus on systematic, year-round monitoring both during the day and at night to gain a more comprehensive understanding of roadkill patterns across broad-

er spatial and temporal scales. Integrating habitat connectivity into infrastructure development is critical to reducing wildlife-vehicle collisions and preserving essential ecological corridors. Mitigation strategies for high-risk species should include the construction of wildlife overpasses and underpasses, enforcement of speed limits in sensitive zones, and targeted public awareness campaigns promoting wildlife conservation (Sushanth et al., 2025). Improvements in road infrastructure such as the use of reflective surfaces, speed bumps, and protective barriers can also help minimize collision risks. Additionally, rotating road signage locations may enhance driver attentiveness, as static signs tend to lose their effectiveness over time (Husain & Mehta, 2023; Sullivan et al., 2004).

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Sažetak

Putevi predstavljaju značajnu pretnju divljim životinjama, posebno u regionima bogatim biodiverzitetom kao što je Nilgiris (Indija). Ova preliminarna studija dokumentuje obrasce sudara vozila sa divljim životinjama (WVC) u regionu Doddabeta, fokusirajući se na taksonomski diverzitet, sezonske varijacije i ranjivost specifičnu za vrstu.

Zabeleženo je ukupno 81 jedinka iz 19 vrsta kao žrtve saobraćaja tokom 60 nasumično odabranih dana, pri čemu su gmizavci, a posebno endemska vrsta *Salea horsfieldii*, pokazali najveću učestalost.

Podaci ukazuju na jaku korelaciju između događaja stradanja na putevima i sezonskih obrazaca aktivnosti, naročito tokom perioda razmnožavanja. Faktori koji doprinose tome uključuju velike brzine vozila, smeće pored puta koje privlači vrste plena i nedovoljnu svest vozača. Studija naglašava hitnu potrebu za merama ublažavanja kao što su prelazi za divlje životinje, dinamička signalizacija i procene uticaja postojećih i predloženih puteva. Budući da su nalazi zasnovani na ograničenim, nasumično tempiranim istraživanjima, preporučujemo buduća istraživanja sa sistematskim sezonskim praćenjem tokom dana i noći, kako bi se bolje razumele šire ekološke implikacije. Ova studija pruža osnovne podatke za razvoj strategija očuvanja u zonama visokog rizika poput Doddabeta.

Ključne riječi: endemska vrsta, herpetofauna, sezona razmnožavanja, sezonski obrazac, stradanje na putu, stanište Šola

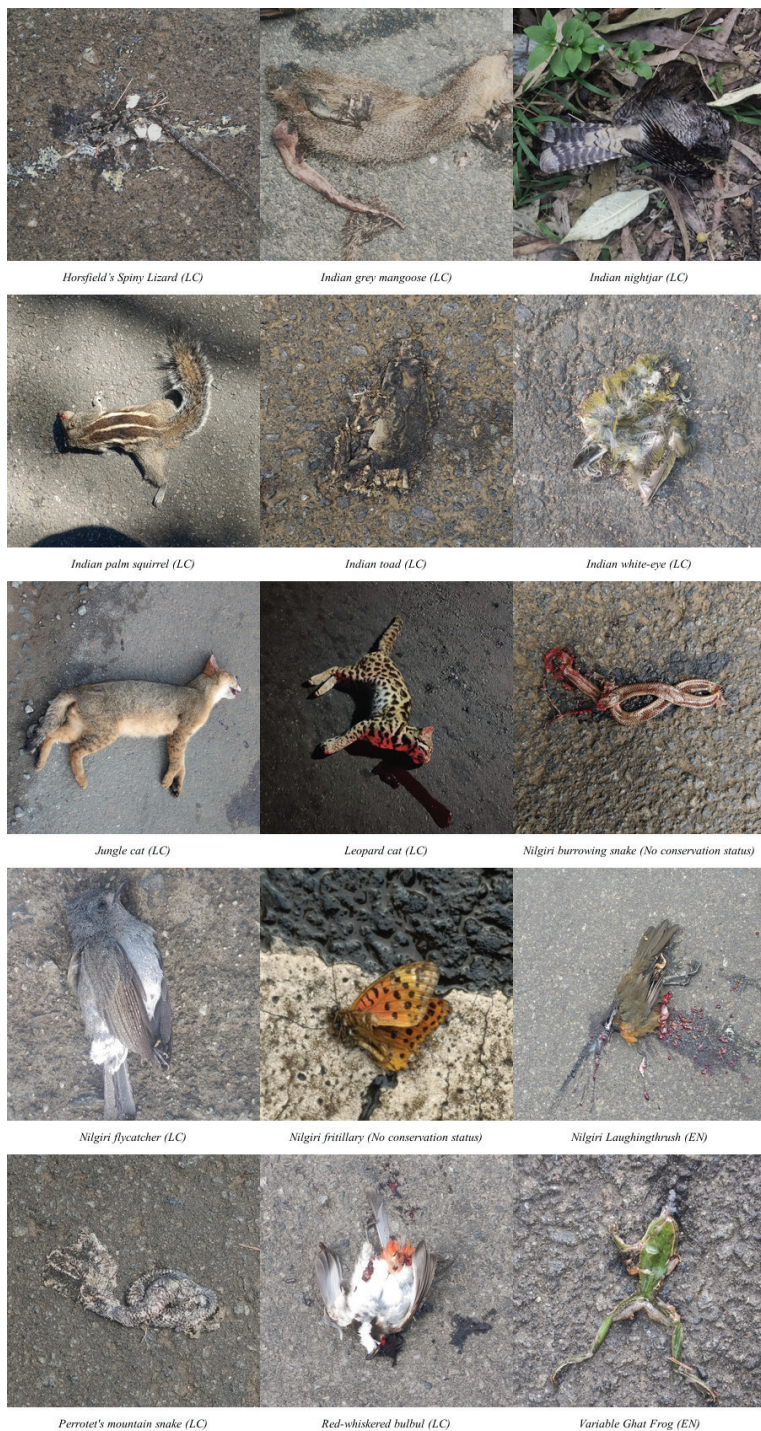


Figure 7. Some of the WVC images during the survey / **Slika 7.** Fotografije posljedica nekih sudara sa divljim životinjama tokom istraživanja