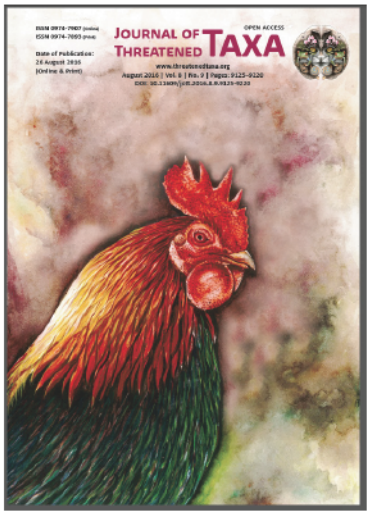

Journal of Threatened Taxa

The international journal of conservation and taxonomy

www.threatenedtaxa.org

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

SHORT COMMUNICATION

EFFECT OF VEHICULAR TRAFFIC ON WILD ANIMALS IN SIGUR PLATEAU, TAMIL NADU, INDIA

A. Samson, B. Ramakrishnan, A. Veeramani, P. Santhoshkumar, S. Karthick, G. Sivasubramanian, M. Ilakkia, A. Chitheena, J. Leona Princy & P. Ravi

26 August 2016 | Vol. 8 | No. 9 | Pp. 9182–9189
10.11609/jott.1962.8.9.9182-9189

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 August 2016 | 8(9): 9182–9189

Effect of vehicular traffic on wild animals in Sigur Plateau, Tamil Nadu, India

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Abstract: The construction of a road, directly and indirectly, impacts on the ecosystems where the road is built. Highways passing through national reserves/wildlife sanctuaries have an adverse impact on wild animals. The present survey was conducted to estimate the road kills on the state highways passing through the Nilgiri north territorial forest division (19km) and Mudumalai Tiger Reserve (15km) in Sigur Plateau, Tamil Nadu, India. The road kills were monitored three times a month between July 2013 and December 2013 (six months) and a total of 176 road kills belonging to 30 species were recorded. Reptiles were the most affected taxa (39%), followed by mammals (33%) and birds (21%). Amphibians were least affected by vehicular traffic and comprised 7% of the total kills. According to road stretch category, the overall road kill was N=135 in the forested area and N=41 in human habitations. A total of 812 food materials were encounterd 612km with average of 1.32 food materials / km. Conservation and management implications are essential to prevent the local extinction of wildlife.

Keywords: Road kill, Sigur Plateau, Tamil Nadu, vehicular traffic.

The construction of a road, directly and indirectly, impacts on the ecosystems where the road is built (Matsue 2009). The environmental impact of roads is of increasing national and international interest and concern (Bennett 1991; Forman & Alexander 1998; Spellerberg 1998; Tromubulak & Frissell 1999; Forman & Deblinger 2000). Roads can impose major barriers to faunal movement, the intensity of the barrier being dependent on the intrinsic nature of the highway and verge (Mader 1984; Bennett 1991; Bright 1993; Vermeulen 1994; Slater 1995). The effects range from habitat loss and fragmentation (Burnett 1992; Richardson et al. 1997) to affecting the wild animal distribution pattern (Newmark et al. 1996), movement (Desai & Baskaran 1998), breeding density (Reijnen et al. 1995), heterozygosity, genetic polymorphism (Reh & Seitz 1990) and directly by mortality through collisions with vehicles (Oldham &

DOI: http://dx.doi.org/10.11609/jott.1962.8.9.9182-9189

Editor: Raju Vyas, Vadodara, Gujarat, India. **Date of publication:** 26 August 2016 (online & print)

Manuscript details: Ms # 1962 | Received 01 June 2016 | Final received 03 August 2016 | Finally accepted 09 August 2016

Citation: Samson, A., B. Ramakrishnan, A. Veeramani, P. Santhoshkumar, S. Karthick, G. Sivasubramanian, M. Ilakkia, A. Chitheena, J.L. Princy & P. Ravi (2016). Effect of vehicular traffic on wild animals in Sigur Plateau, Tamil Nadu, India. *Journal of Threatened Taxa* 8(9): 9182–9189; http://dx.doi.org/10.11609/jott.1962.8.9.9182-9189

Funding: The project was funded by The Nature Trust , Chennai.

Conflict of Interest: The authors declare no competing interests.

Acknowledgements: The authors thank Mr. K.V.R.K. Thirunaranan, Founder, The Nature Trust, Chennai for providing funding support for this project. Our wholehearted thanks to the Principal Chief Conservator of Forests and Chief Wildlife Warden of Tamil Nadu state for giving us the necessary permission to carry out the field work. Our special thanks are due to the Chief Conservator of Forests & Field Director, Deputy Director of Mudumalai Tiger Reserve and the District Forest officer of the Nilgiri north forest division for providing permission and all logistic support to carry out the field work. We thank our field assistants Mr. Manigandan and R. Bomman and B. Vishnu for taking pain to collect field data in the forest amidst elephants.

Swan 1991; Foster & Humphrey 1995; Das et al. 2007; Row et al. 2007; Shwiff et al. 2007; Seshadri et al. 2009). The taxa affected ranges from mammals (Drews 1995; Newmark et al. 1996; Richardson et al. 1997; Samson et al. 2014a), birds (Newmark 1992; Reijnen et al. 1995; Drews 1995), reptiles (Rosen & Lowe 1994; Drews 1995; Gokula 1997; Das et al. 2007; Samson et al. 2014b) and amphibians (Reh & Seitz 1990; Fahrig et al. 1995; Vijayakumar et al. 2001; Seshadri et al. 2009).

The impact of roads on wildlife was extensively studied in other countries rather than India. In India, highways bisect many protected areas, reserve forests, and private forests. It has been realized in recent years that highways cause severe impact on wildlife and their habitats (Gokula 1997; Vijayakumar et al. 2001; Sunder 2004; Das et al. 2007; Rao & Girish 2007; Boominathan et al. 2008; Seshadri et al. 2009; Baskaran & Boominathan 2010; Selvan 2011; Samson et al. 2014b). Therefore, the forest department and many non-governmental organizations protest against the construction of new highways and also the upgrading or widening of the existing roads especially in the protected areas in India. These roads have been identified as the source of disturbance to wildlife both directly (road kills including that of endangered species) (Gokula 1997) and indirectly (noise and disturbance) (Daniel et al. 1995; Boominathan et al. 2008). And also direct or indirect impact of these roads on wild fauna has received very little attention in the country (Sunder 2004). Most of these observations are very subjective in nature, though undoubtedly, these roads have an adverse impact on wild animals (Daniel et al. 1995; Gokula 1997; Desai & Baskaran 1998). However, the actual impact was quantified in the year from 1998 to 1999 (Baskaran & Boominathan 2010) in the protected areas of Mudumalai Tiger Reserve. Therefore, the present study investigates the roads' impact on wildlife fauna in the the state highways inside the Nilgiri north territorial forest division as well as protected areas of Mudumalai Tiger Reserve after 15 years of the previous studies in Sigur Plateau.

Study Area

The Sigur Plateau is the connective junction of the Western Ghats and the Eastern Ghats. It harbors a diverse range of wildlife including the Asian Elephant *Elephas maximus*, Tiger *Panthera tigris*, Leopard *Panthera pardus*, Gaur *Bos gaurus*, Chital *Axis axis*, Sambar *Rusa unicolor* and numerous other important mammal and bird species (Gokula & Vijayan 1996; Ramakrishnan & Saravanamuthu 2012). The Sigur Plateau is an excellent habitat that supports several endangered species and Critically Endangered Gyps vultures such as Long-billed *Gyps indicus* and White-rumped *Gyps bengalensis*, Egyptian *Neophran percnopterus* and Red-headed Vulture *Sacrogyps calvus* (Ramakrishnan et al. 2014; Samson et al. 2014c; Samson et al. 2015). The villages within the Sigur Plateau are home not only to local communities but also, more recently, to a number of tourist facilities. These facilities subsist mainly on the attractions of the diverse wildlife in the area surrounding

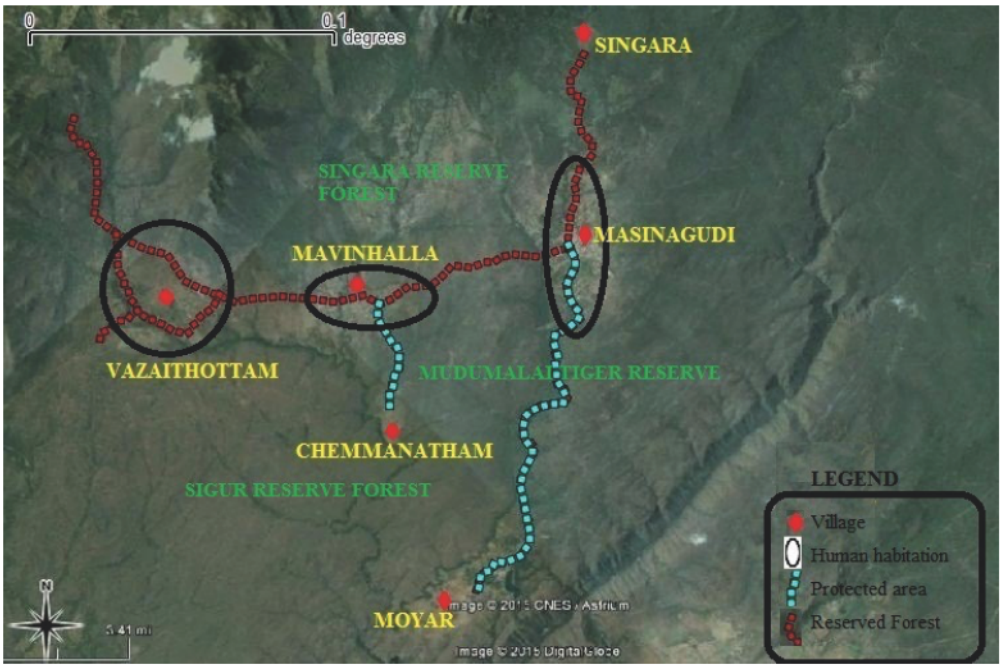

Image 1. Map showing the location of the road networks in the Sigur Plateau

the Mudumalai Tiger Reserve. The study targeted the state highway passing through the Nilgiri north forest division and Mudumalai Tiger Reserve in the Sigur Plateau. In total, a 34km stretch of intensively used local road was selected to quantify the road kills. Of which 19km passes through the Nilgiri North territorial forest division and 15km passes through the protected areas of Mudumalai Tiger Reserve (Image 1).

Methods

Road kills were recorded in a state 'Udhagamandalam to Masinagudi Highway' passing through Nilgiri north territorial forest division (19km) and Mudumalai Tiger Reserve (15km) (Image 1). The vegetation type of the adjacent forest habitat classified as dry thorn forest (Gokula & Vijayan 1996; Ramakrishnan & Saravanamuthu 2012). Observations were made for six months from July to December 2013. The study was restricted to amphibians, reptiles, birds and mammals as major taxa. This stretch of road was traversed three times in a month (at 10-day interval) on a motor bike (an observer and driver using a motorbike at a maximum speed of 10–15 km/hr). Once during the morning (06:00–08:00 hr) and evening (16:00–18:00 hr) time alternatively during the survey period. The road was categorized into two types of road stretches, viz., road stretch across forested areas (28km) and road stretch across a human habitation (6km). At each sighting of a road kill information such as the location, type of road stretch, state of the road kill and the climatic condition was recorded. The dead animals were identified up to species level, wherever possible, and removed from the road to avoid recounting and if unidentified, it was preserved in 10% formalin for later identification based on the field guides (Whitaker & Captain 2004; Daniels 2005; Grimmett et al. 2011; Menon 2014). In addition to counting the food materials thrown by the tourists along the roadside areas, were also estimated along the 34km stretch throughout the survey.

Results

Totally 176 road kills belonging to four classes, of which birds (13 species), reptiles (8 species) mammals (7 species) and amphibians (2 species) with a total of 30 species were recorded from a total of 612km of the survey within the 34km stretch (Table 1). Among the 176 road kills, reptiles were the most affected accounting for 39% (n=69; 11.5±1.87) followed by mammals 33% (n=58; 9.67±2.87) and birds 21% (n=36; 5.67±2.87). Amphibians were least affected by vehicular traffic and comprised 7% (n=13; 0.5±0.84) of the total kills (Table 2). The encounter rate of reptiles mortality rate was 0.019 individual/km/month, mammals 0.016 individual/km/month and birds 0.010 individual/km/month and amphibians were least affected with 0.003 individual / km/ month.

Table 1. Details of vertebrate fauna killed by vehicular traffic

	Animal groups	No. of Species	Total no of kills (Mean and SD)	Percentage of road kills
1	Reptiles	8	69 (11.5±1.87)	39%
2	Mammals	7	58 (9.67±2.87)	33%
3	Birds	13	36 (5.67±2.87)	21%
4	Amphibians	2	13 (0.5±0.84)	7%
	Total	28	176	

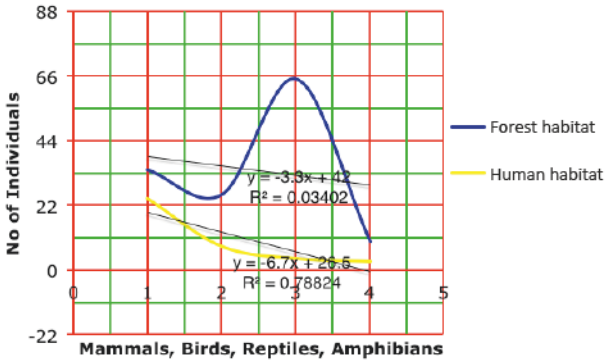

Figure 1. Road kills status in two habitats

The Garden lizard (N=43) was the major victim among eight species of reptiles. In mammals the most killed species was the Bandicoot Rat (N=19) and in the case of birds the House Sparrow (N=6) was found to be high. For amphibians the Common Indian toad was the common kill (N=10).

The encounter rate shows that 0.050 individuals/km/month was observed on the territorial division (N=105) Nilgiri north forest division. On the other hand, 0.043 individuals/km/month was observed on the protected areas (N=71) Mudumalai Tiger Reserve. As well as the encounter rate of road stretch category kill shows that 0.044 individual/km/month in forested areas (R^2=0.034) (N=135) and 0.034 individuals/km/month was observed in human habitation (R^2= 0.788) (N=41) respectively (Fig. 1). Totally 812 food materials were encountered 612km with 1.32 food materials/km in the study area.

Discussion

The present study recorded a total of 176 incidences of road kills of vertebrate fauna (Images 2–20). Of which, reptiles were the most affected followed by mammals,

Table 2. Species killed by vehicles in the study areas

	Name of the species	Scientific Name	Individuals (N)
I	**Mammals**		
1	Black-napped Hare	*Lepus nigricollis*	4
2	Domestic Dog	*Canis lupus familiaris*	2
3	Field Rat	*Rattus rattus*	17
4	Bonnet Macaque	*Macaca radiata*	1
5	Bandicoot Rat	*Bandicota indica*	19
6	Sambar Deer	*Rusa unicolour*	1
7	Three-striped Palm Squirrel	*Funambulus palmarum*	14
II	**Birds**		
1	House Crow	*Corvus splendens*	2
2	Common Myna	*Acridotheres tristis*	5
3	Laughing Dove	*Spilopelia senegalensis*	3
4	Eurasian Collar Dove	*Streptopelia decaocto*	4
5	Grey Francolin	*Francolinus pondicerianus*	3
6	Indian Robin	*Saxicoloides fulicatus*	1
7	Jungle Babbler	*Turdoides striata*	4
8	Red-vented Bulbul	*Pycnonotus cafer*	4
9	House Sparrow	*Passer domesticus*	6
10	Domestic Turkey	*Meleagris gallopavo*	1
11	Tailor Bird	*Orthotomus sutorius*	1
12	Asian Koel	*Eudynamys scolopaceus*	1
13	Hoopoe	*Upupa epops*	1
III	**Reptile**		
1	Bronze back snake	*Dendrelaphis tristis*	3
2	Chameleon	*Chamaeleo zeylanicus*	5
3	Garden Lizard	*Calotes versicolor*	43
4	Green Vine Snake	*Ahaetulla nasuta*	4
5	Bengal Monitor	*Varanus bengalensis*	7
6	Indian Rat Snake	*Ptyas mucosa*	4
7	Keeled Grass Skink	*Eutropis carinata*	1
8	Russell's Viper	*Daboia russelli*	2
IV	**Amphibians**		
1	Common Indian Toad	*Duttaphrynus melanostictus*	10
2	Unidentified		3
	Total		176

birds, and amphibians. Baskaran & Boominathan (2010) attempted similar work within the protected area (Mudumalai Tiger Reserve) in the same region. According to their survey totally, 180 incidents of road kills were reported in a four month period between December 1998 and March 1999. Then, amphibians were most affected followed by reptiles, mammals, and birds.

In this study reptiles were affected more by percentage - totally eight species of reptiles were killed by vehicles in this study. The Garden Lizard was most affected by road kill. Commonly Lizards are cold-blooded species and thermoregulation is a unique character for reptiles (Das et al. 2007). The roads reflect the sunlight so the road surface is always warmer than the soil surface or any other surface. Reptiles use the road surface for thermoregulation, and that seems to be the reason for the high death rate of reptiles by road kill (Rosen & Lowe 1994; Vijayakumar et al. 2001). The Monitor lizard and Chameleon are reported as the next most affected species in this study. This is mainly because of their slow mobility, not reacting quickly to vehicles and the fact that drivers are less likely to notice these animals because of ignorance (Bennett 1991; Row et al. 2007). Among snakes, the Rat snake, Green vine snake, Bronze back snake and Russell's viper were the most affected due to road kill. This study found that among the reptile road kills, snakes alone were accounted for four out of eight species. A similar kind of finding has been made by Baskaran & Boominathan (2010) at Mudumalai Tiger Reserve, southern India. Rosen & Lowe (1994) estimated ten to a hundred millions of snakes have been killed by automobiles in the United States and reasoned that resting or coiling of snakes on the road surface especially during the spring season for warmth is a contributing factor to the high road mortality of snakes.

The most affected mammalian species were the Bandicoot rat and field rat. Since both of them are nocturnal in habit their movement would be during late evening and night hours. The head lights of the vehicles blind the vision of nocturnal animals whereby resulting in more deaths during night hours (Baskaran & Boominathan 2010). Even though a lot of nocturnal species are present in this landscape these two species were especially a victim of roadkills because they were smaller in size and less noticed on the road by drivers. Apart from nocturnal mammalian species, the Three-striped Palm squirrel was observed in a considerable number of kills. Mendez-Carvajal et al. (2016) reported that sunbathing is the key activity for striped squirrels during early morning and late evening times. In our study most of the kills were freshly observed during early morning and late evening times. The Three-striped Palm Squirrel used the road surface for sunbathing which seemed to be the reason for the high death rate of Three-striped Palm Squirrel by road kill, and also our field observation revealed that they are attracted by food materials that were thrown out by tourists which is

also the reason for the road kill.

Totally 11 species of birds were recorded killed by collision with vehicles in this study. In the past studies, only eight species of birds were a victim of roadkills reported in this area (Baskaran & Bominathan 2010). The House sparrow was found to be the most affected species than others. The road kills of House sparrow were collected mostly on the road passing through human settlement areas. Because in general the House sparrows depend on human habitations to fulfill their needs (Balmori 2002). Other birds such as Eurasian collard dove, Jungle babbler, Common myna, Red-vented bulbul, Francolin, Laughing dove were also accounted for a sizeable number of road kills. Similar findings were also recorded in Kumbhalgarh Wildlife Sanctuary, Rajasthan. According to this study, the most affected avian species were the Eurasian-collared Dove, Laughing dove, House sparrow, Jungle babbler and Francolin (Chhangani 2004). The present study corroborates with earlier studies in Rajasthan. These birds are graminivours and insect feeders in the habit (Ali & Ripley 1987). Seibert & Conover (1991) and Potvin & Bishop (2010) reported that low altitude flying is key for more victim of roadkills in birds. Vestjens (1972) and Brown et al. (1986) reported that the roadside trees are selected as nesting trees as a key factor for road kill accident of some birds. In some cases the scavenging birds are attracted by the carcasses on the road side also lead to road kills (Chhangani 2004). Birds are attracted to roads as a location of concentrated resources, especially food (Erritzoe et al. 2003; Rytwinski & Fahrig 2012). Such evidence is proved that (a direct observation on the field) they are attracted to the food materials that were left behind by tourists.

Among the amphibian community, the present investigation recorded that the Common Indian Toad *Duttaphrynus melanostictus* was the most affected species by road kill. This finding corroborates with Baskaran & Boominathan (2010) in Mudumalai Tiger Reserve as well as Vijayakumar et al. (2001) in Anamalai Hills. The foraging nature of these toads, which are very fond of gathering near street lamps and vehicle head lights to feast on insects (Daniels 2005) coupled with their highly eurytopic and human commensally traits (Daniel 2002; Daniels 2005) could also be the possible reasons for their higher susceptibility of becoming road kill victims. The speed of the traffic, the size of the species and its dispersal behavior are also cited as important factors when assessing the barrier effect of a road (van Langevelde & Jaarsma, 1995). Wide roads with high traffic densities restrict animal movement most effectively.

In the present study recorded that a number of road kills were recorded in the territorial division of Nilgiri North Forest Division compare to the protected areas of Mudumalai Tiger Reserve. The reason for this variation in road kills is due to vehicular traffic intensities between the two areas. The state highway passing through the Nilgiri North Forest Division at one end is connected to the Interstate highway NH 67 at Theppakadu followed by the other end which is connected to the "Queen of Hills" Ooty that is a reason for high vehicular traffic intensity in the Nilgiri North Forest Division thus resulting in the high number of road kills. The present study is preliminary in nature as it was a short term study and has some caveats like the actual rate of mortality per day and seasonal variability in the rate of road kill which could not be worked out. A more detailed year-round study is needed to understand better the impact of vehicular traffic on wildlife. Nevertheless, the present study showed that the state highway that passes through the Nilgiri north reserve forest division and protected area of Mudumalai Tiger Reserve in the Sigur Plateau is a serious impediment to wild animals.

Management recommendations

The present study showed that highways have an adverse impact on wildlife. The present study was attempted for six months from July to December 2013. It is advisable that long-term studies are important to suggest various impact highways have on wild animals.

The following recommendations are explicated to minimize the threat for the road mortalities of wild animals:

- To construct road humps at every 300 or 400 m interval in the wild animals affected roads.
- Signage's and hoardings need to be fixed at critical wild animal affected points to regulate the speed and caution the vehicles.
- Bushes should be removed along the verges and roadsides to sight animal crossings as well as enable animals to see the vehicles and avoid accidents.

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Image 2. Asian Koel

Image 3. Bandicoot Rat

Image 4. Bengal Monitor

Image 5. Bonnet Macaque

Image 6. Bronze-back Snake

Image 7. Chameleon

Image 8. Common Indian Toad

Image 9. Common Myna

Image 10. Eurasian Collar Dove

Image 11. Field Rat

Image 12. Garden Lizard

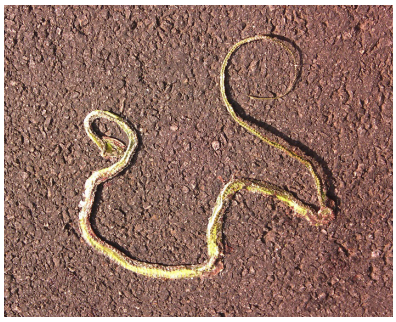

Image 13. Green Vine Snake

Photo courtesy: A.Samson & P. Santhoshkumar

Image 14. House Sparrow

Image 15. Indian Rat Snake

Image 16. Indian Robin

Image 17. Jungle Babbler

Image 18. Red-vented Bulbul

Image 19. Russell's Viper

Image 20. Three-striped Palm Squirrel

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Journal of Threatened Taxa

OPEN ACCESS

ISSN 0974-7907 (Online); ISSN 0974-7893 (Print)

August 2016 | Vol. 8 | No. 9 | Pages: 9125–9220
Date of Publication: 26 August 2016 (Online & Print)
DOI: 10.11609/jott.2016.8.9.9125-9220
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