ORIGINAL RESEARCH PAPER

Ecology

HIGHWAY MORTALITY OF VERTEBRATE SPECIES IN THE ARAVALLI MOUNTAIN RANGE OF NORTH GUJARAT, INDIA

KEY WORDS: Mortality; Road-kills; Vehicles; Western India

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ABSTRACT

Vehicle induced mortality also known as a road kill of wild animals is well known in many developing countries including India but very few empirical studies describe the extent of this mortality on wildlife population. For our study, road kill was monitored in three major roads of North Gujarat between May 2005 (monsoon) to October 2006 (winter) and a total of 89 road kills were recorded. Mammals were the most effected taxa (58.42%) followed by reptiles (30.33%) and birds (11.23%). The time of observation was also noted which indicated the intensity of kill of the animal species during different times of the day. Conservation and management implications are essential to prevent the rapid loss of animal population due to road kills.

Road-kill surveys such as this are needed to identify species for which road mortality is unsustainable, to determine the influence on threatened species, and to identify important spots of roads that are important to have speed limits for the protection of the resident faunal species.

INTRODUCTION:

Anthropogenic activities continue to affect wildlife by the loss of habitat and change in the extent of habitat beyond road (Spellerberg, 1998). Habitat fragmentation remains the primary cause of decline for many species of wildlife (Soule' *et al.* 1988; Lawrance, 1990). Road incursion is one of the common forms of habitat fragmentation (Groat B. & Hazebrolk, 1996). Every year across the world millions of animals are injured or killed by vehicles. Roads may act as a barrier to animals' movement, produce edge effects or cause substantial mortality of wildlife (Andrews, 1990; Bennett, 1991). Collisions of animals with vehicles and trains are very common (Chhangani, 2004).

The research results have largely been descriptive and anecdotal reporting on surveyed or counts of animals killed by vehicles, their age, sex, characteristics of road kills and seasonal patterns. Although counts of dead animals can be useful for evaluating the magnitude of road-kills, they are inadequate for understanding the relationship between roads and wildlife (Clevenger *et al.,* 2003).

We quantified road-kill occurrence among small terrestrial vertebrates in the North Gujarat. Seasonal and geographic patterns of road-kills were identified

Study Area:

The study was conducted in North-west India with the geographic co-ordinates (23°35'13"N to 24°30'57"N and 72°10'28"E to 73°24'47"E). The area encompasses the Sabarmati river watershed comprising of mountain landscapes of North Gujarat and adjacent state of Rajasthan in India. The forest area is highly fragmented with few good patches of forests at the foothills of terminating Aravalli mountain range occurring in Banaskantha and Sabarkantha. Topography comprises of hilly mountains with an elevations ranging from 10m to over 900 m (FSI, 1997). Surveys for wildlife killed by vehicles were conducted along a major road circuit. The circuit comprised the Ambaji to Palanpur NH14 (65 km) west to east, Ambaji to Himatnagar NH76a (110 km), Ambaji to Taranga SH54 (54 km) and Ambaji to West Balaram (50 km) which made a total of 279km (Fig. 1). The region experiences a high variation in temperature with a minimum as low as 5ş C in winters to maximum of 46ş C in summers. The monsoon season experiences an average rainfall of 765mm (FSI, 1997). The study area mainly comprised of moist, dry, deciduous, thorn and open scrub forests which were dominated by *Butea monosperma*, *Wrightia* , *Accacia, Diasyprous* etc.,

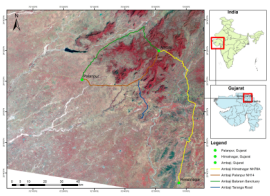

Figure 1: Map of Study area with highlighted Major Road Circuit

METHODS:

Quantitative surveys for road killed wildlife involved driving a vehicle and recording dead wildlife (road-kills) seen on the road within 3 m of edge of the road. The speed at which the survey was conducted varied throughout the circuit due to the range of speed zones present 40-60 km/ hr. When an animal was found to be killed on the road surface, an attempt was made to identify the species, approximate time of kill, % of injury, number of individuals, microhabitat were also recorded. We further recorded the animals along with its photograph.

Dead fauna were identified to species level with the assistance of field guides (Menon, 2003) and their location was recorded. Monitoring was conducted for 53 weeks over a period of 11/2 years which include all the major seasons of the year. In 2005, mainly the monsoon and winter season was included in the study whereas in the year 2006, all seasons were surveyed. Road vehicle counts were undertaken twice a month in both holidays and working days, in all the four major roads of the circuit.

RESULTS:

Road-kill surveys

In total 89 individuals were found to be road killed comprising of 52 individuals of 15 mammalian species forming 10 different families, 27 reptiles of 13 species belonging to 8 different families and 10 individuals of 6 different avian species that represent 5 different families were recorded along the road kill circuit during 53 weeks of surveys. The overall mean was calculated to be 1.68 individuals per week. Mammals accounted for 58.43%, reptiles were found to be 30.33% whereas birds accounted for 11.24% of the total road-killed fauna. Indian flying fox, five striped palm squirrel and desert cat were the most commonly observed road killed animal species.

Small-size of frogs made them difficult to detect, which may have contributed to the low number of records. Frog road-kills dismember and desiccate rapidly on the road surface, rendering them virtually undetectable from a moving vehicle (authors' personal observations).

Fewer road-kills of all wildlife groups were recorded during (n=14) summer than during winter (n=30) and monsoon (n=45).

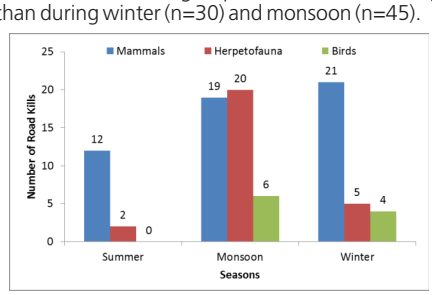

FIGURE 2 No. of Road kills recorded in different seasons.

TABLE 1 List of vertebrate species recorded during the study

S. No.	Scientific Name	Species	IUCN status
MAMMALS			
	Canidae		
1	*Canis aureus* (Linnaeus, 1758)	Golden Jackal	LR-lc
Erinaceidae			
2	*Hemiechinus auritus*	Long eared Hedgehog	Indeterminate
3	*Paraechinus micropus*	Indian Hedgehog	LC
Felidae			
4	*Felis silvestris ornate*	Desert Cat	E
5	*Felis chaus* (Schreber,1777)	Jungle Cat	LC
Herpestidae			
6	*Herpestes edwardsii (E.Geoffroy Saint-Hilaire,1818)*	Grey Mongoose	LC
Leporidae			
7	*Lepus nigricollis* (F.Cuvier,1823)	Indian Hare	LC
Muridae			
8	*Tatera indica* (Hardwicke,1807)	Indian Gerbill	LC
Viverridae			
9	*Viverricula indica* (Desmarest,1804)	Small Indian Civet	LR-lc
10	*Paradoxurus hermaphrodites*	Common palm civet	Th
Sciuridae			
11	*Funambulus pennatii*	Five stripped palm squirrel	LC
Cercopithecidae			
12	*Semnopithecus entellus*	Common langur	LC
Pteropodidae			
13	*Pteropus giganteus*	Indian flying fox	LC
14	*Cynopterus sphinx*	Greater short nose fruit bat	LC
HERPETOFAUNA			
	Testudinidae		
1	*Geochelone elegans*	Starred tortoise	LR-lc
Boidae			
2	*Eryx johni*	Russel's John Boa	LC
3	*Gongylophis conicus*	Common sand boa	LR-nt
Colubridae			
4	*Ptyas mucosa*	Dhaman common rat snake	LC
5	*Amphiesma stolata*	Buff strip keel back	LC
6	*Lucodon aulicus*	Wolf snake	LR-nt
Elapidae			
7	*Naja oxiana*	Black cobra	Data deficient
8	*Bungarus caerulens*	Krait	Not evaluated
Viperidae			
9	*Echis carinatus*	Saw scaled viper	LC
Agamidae			
10	*Calotes versicolor*	Common garden lizard	LC
Varanidae			
11	*Varanus bengalensis*	Indian monitor lizard	LC
	Chamaeleonidae		
12	*Chamaeleon zeylanicus*	Indian chameleon	LR-nt
Colubnidae			
13	*Coelgnathus helena*	Trinket snake	LR-nt
BIRDS			
	Pycnodidae		
1	*Pycnonotus cafer*	Red vented bulbul	LC
Cuculidae			
2	*Centropus sinensis*	Greater Coucal	LC
3	*Eudynamys scolopacea*	Asian Koel	LC
Columbidae			
4	*Columba livia*	Blue rock pigeon	LC
Phasianidae			
5	*Pavo cristatus*	House crow	LC
Muscicapidae			
6	*Saxicoloides fulicata*	Indian robin	LC

E=Endangered, V=Vulnerable, I=Indeterminate, T=Threatened, LR-lc= Lower risk least concerned

Road-kill frequency:

The road kill on all the four major roads was also studied and the road with maximum number of road kills was identified:

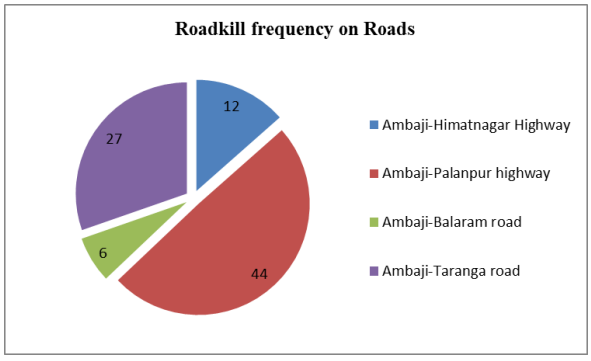

FIGURE 3: No of road kills recorded on different roads in the study area.

Out of 89 individuals recorded during the road kill study, it was observed that 44 incidents of animals being road killed were reported from the Ambaji-Palanpur highway, it was followed by Ambaji-Taranga road having observed 27 road killed animals. On Ambaji-Himatnagar road the road killed animals were found to be 12 whereas the minimum road killing of animals was seen in the Ambaji-Balaram road.

Domestic road-kills

During, our survey on wildlife road-kills, we also recorded many domestic animals in all the four roads which included dog, cat, cow, buffalo, goat, camel and domestic pig. But they were not included in the present study, as the major objective was to carry out this study for the local wildlife.

DISCUSSION:

A railway crossing near Chittrasani (Balaram-Ambaji Wildlife Sanctuary) which cross from the main town and a well known hill station, Abu road to Palanpur was present all over our study area. The morality of the wildlife is very low in this area. Most of them around the railway crossing are agricultural land. One small Indian civet (sub-adult) was recorded near the railway gate, present below the culvert of the railway line (author's personal observation). Most of our study area was crossing with culvert, bridge and ploy culvert which also helps for the wildlife population as barriers to escape from the road-kill.

Precisely (n=45) 50.56% of animals kills occurred during monsoon. There was higher kill rate of reptiles during monsoon season than in summer due to their inability to move fast (Baskaran and Boominathan, 2010) and also the reptiles are in hibernation during harsh summers and chilly winters. Hence, it becomes obvious to have less reptile mortality during summers and winters.

Within reptiles, snakes showed the highest road kill rate as they use road substrate for their thermoregulation (Vijakumar, *et. al*. 2001) majorly venomous snakes like Cobra, Krait and Viper.

The highest number of road killed animals was found in the Ambaji-Palanpur highway (n=44), the road is a national highway and the frequency of traffic on this road is more as compared to the other three roads. Another reason for high mortality of animals in this road is the temple of Ambaji, a place of pilgrim interest where approximately eight lakhs peoples come to worship Godess Amba especially in the post monsoon season. Due to this increases the number of vehicles running on this road NH 14.

During the survey it was found that the road leading from Ambaji to Balaram had the minimum of animal mortality due to road kill and the reason can be attributed to the fact that two wildlife sanctuaries lie in-between the distance from Ambaji to Balaram i.e. Balaram wildlife sanctuary and Jessore sloth bear sanctuary. Due to the presence of these two conservation areas there is less disturbance by the vehicles which has further resulted in the easy crossing of the animals from one place to another and the number of road killed animal species in the area has significantly reduced.

CONCLUSION:

The effect of road on wild animals can be majorly attributed to the anthropogenic activities which mainly include development activities. The present study outlines the impact of increasing vehicular pressure on the wildlife road kills in North Gujarat. Conservation of the wildlife and management of road traffic is necessary to insure better safety for wildlife. Some management recommendations after this study are as follows:

1. Drivers need to be made aware to drive more consciously. And expect animals to be crossing the road anytime of the day and be more alert at night.
2. The horn if used wisely can warn animals a fair distance away so that they can move away from the road before the vehicle reaches that spot. However blowing the horn when the vehicle is right on top of the animal can startle them and they may run into the car.
3. If an animal is seen on the road the driver must slow down the vehicle and do not presume that the animal will get out of the way on its own.
4. Sign boards with speed limit should be installed in the area with high road kill i.e. Ambaji to Palanpur highway.
5. Further studies leading to identify animal prone zones, time of the day and type of vehicle responsible for more accidents are required in order to address the road kill issues.

The Ambaji Palanpur highway needs urgent attention for the applying the recommendation for prevention of road kills of wildlife of the area. The need to work upon this issue for the conservation of fauna is utmost important.

ACKNOWLEDGEMENTS:

The authors would like to thank Gujarat Forest Research Institute, Gandhinagar for providing financial support to the project titled "Status, occurrence and distribution of Mammals in North Gujarat. The present survey forms a part of the research project. The authors are also grateful to the Head, department of Life sciences, HNG University, Patan and Additional Director, Gujarat Institute of Desert Ecology, Bhuj-Kachchh for providing logistic support, permission to carry out the research work and for his encouragement.

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