KFRI Research Report

WILD ANIMAL KILLS AND CAUSATIVE FACTORS IN SELECTED FOREST ROADS OF KERALA

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KERALA FOREST RESEARCH INSTITUTE
(An Institution under Kerala State Council for Science, Technology and Environment)
PEECHI, THRISSUR

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(Final Report of the Research Project - KFRI 643/2012)

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Wildlife Department
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Project Proposal

Project No.	KFRI 643/2012
Title	Wild Animal Kills and Causative Factors in Selected Forest Roads of Kerala
Investigator	Dr. P. S. Easa
Research Fellow	M. Gnana Kumar
Objectives	To record the road kills along the selected highways in relation to the probable causes like changes in the road side vegetation population and biology of the species
Duration	May 2012 – June 2014
Funding Agency	KFRI Plan Grants

Acknowledgement

The author is grateful to the Director, Kerala Forest Research Institute for the support throughout. The Chief Wildlife Warden, the Field Director (Kottayam), Conservator of Forests (Central Circle), the Divisional Forest Officer of Vazhachal Division and the Wildlife Warden (Munnr Wildlife Division) extended full support with permission and field logistics. The assistance provided by the Asst. Wildlife Warden of Chinnar Wildlife Sanctuary and the Forest Range Officers of Vazhachal Division and the field the staff of the area is remembered with gratitude.

The work would not have been possible without Mr. M. Gnana Kumar, the Research Fellow who spent most of his time in the field collecting information. He was helped by Mr. Sandeep Das and also Mr. K. P. Rajkumar, the Fellows in Wildlife Department of KFRI. Mr. Rajkumar also helped in compiling the information and preparing the text of the Report. My colleagues in KFRI Dr. Sreekumar and Dr. Jose reported the kills observed during their field trips. The colleagues in the Institute provided valuable input during discussions of the progress of the project.

C O N T E N T S

Summary

A study was conducted on wild animal kills along the road connecting Vazhachal and Malakkapara and Chinnar and Marayur in Udumalpet – Munnar road. The 16 km long stretch of the road pass through the dry deciduous forests and scrub jungle in Chinnar Wildlife Sanctuary The 50 km distance in Vazhachal Malakkapara road is through the tropical wet evergreen and moist deciduous forests and reed patches. The observations during 2013-14 were made by covering the distance on a bike at a slow pace. During the trip, the kills were recorded along with the details including the species name, GPS reading and the surrounding habitat.

A total of seventy five wild animal kills were recorded from the road passing through Chinnar Wildlife Sanctuary. These included a number of animals included in Schedule IV of Wildlife Protection Act, mostly reptiles and birds. Indian garden lizard and the three striped palm squirrel were the highest in term of number of kills. Gray slender loris and black naped hare and lesser bandicoot rat were the mammals recorded as vehicle hit in Chinnar. The birds included the rare yellow throated bulbul.

The observations in Vazhachal-Malakkapara road recorded about 315 road kills, which included almost uniformly the reptiles, amphibians and mammals. A number of Western Ghats endemics included under Schedule I and Schedule IV were seen hit by vehicles. These included Nilgiri langur, Indian crested porcupine and small Indian civet. The highest number of kills were that of bi-coloured frog with about 197 numbers followed by 52 numbers of Indian bullfrog. Indian rock python (under schedule I), checkered keelback and spectacled cobra (both Schedule II) were also observed to be killed.

The observations indicate the vulnerability of wildlife to vehicular traffic in both the areas. It is suggested to establish speed breakers in most of the areas in Chinnar to regulate the speed of the vehicles thereby helping the drivers stop the vehicles in case of sighting animals on the road. The canopy connectivity could be maintained by planting suitable tree species in identified areas and go for artificial canopy bridges as a temporary relief. Highway patrolling as suggested by National Tiger Conservation Authority could be arranged in Vazhachal road. Awareness among the drivers is considered crucial in both the areas.

Introduction

Impact on habitat and wildlife due to transport infrastructure is one of the most important topics of debate among conservationists (Van der Zande *et al.*, 1980; Ellenberg *et al.*, 1981; Bernard *et al.*, 1987; Andrews, 1990; Bennett, 1991; Reck and Kaule, 1993; Forman, 1995; Seiler, 2001; Evink *et al.*, 1996; Canters *et al.*, 1997; Jalkotzky *et al.*, 1997; Prillevitz, 1997; Evink *et al.*, 1998; Spellerberg, 1998; Forman and Alexander, 1998; Clevenger, 1998; Pierre-LePense and Carsignol, 1999; Evink *et al.*, 1999; Glitzner *et al.*, 1999; Trombulak and Frissell, 2000; Holzang *et al.*, 2000). Possible consequences to wildlife have been recognised and evidences brought in on the effects on both the species and ecosystems at different spatial scales (Canters *et al.*, 1997).

The natural environment is affected by infrastructure in both direct and indirect ways. The physical presence of roads and railroads in the landscape creates new habitat edges, alters hydrological dynamics, and disrupts natural processes and habitats often leading to degradation of the habitat. Road maintenance and traffic contaminate the surrounding environment with a variety of chemical pollutants and noise. In addition, infrastructure and traffic impose dispersal barriers to most non-flying terrestrial animals and vehicle traffic causes the death of millions of individual animals per year. The various biotic and abiotic factors operate in a synergetic way across several scales and cause not only an overall loss and isolation of wildlife habitat but also splits up the landscape in a literal sense.

There are primary and secondary effects of roads on nature and wildlife. The primary effects include habitat loss, disturbance, mortality and as a barrier (Van der Zande *et al.*, 1980; Bonnet *et al.*, 1999; Forman, 1995). These are graphically given in Figure 1. The construction of roads and railroads always implies a net loss of wildlife habitat. The physical encroachment on the land gives rise to disturbance and barrier effects that contribute to the overall habitat fragmentation due to infrastructure. The roads, railroads and traffic disturb and pollute the physical, chemical and biological environment and consequently alter habitat suitability for many plant and animal species for a much wider zone than the width of the road or railroad itself. Road verges and roadsides can however provide refuges, new habitats or serve as movement corridors for wildlife. These beneficial effects of infrastructure are a major challenge to planners and biologists as management and design must be adapted to a wider landscape context. Heavy or even moderate traffic could lead to the mortality of many animals that utilize verge habitats or while trying to cross the linear infrastructure. In addition, collisions between vehicles and wildlife are also an important traffic safety issue. The infrastructure could also be a movement barrier restricting the range of the animals or make the habitat inaccessible and can even lead to fragmentation of habitat and even isolation of the populations.

Secondary effects include changes in land use, human settlement or industrial development, or resource exploitation, which may be induced by the construction of new roads or railroads, etc.

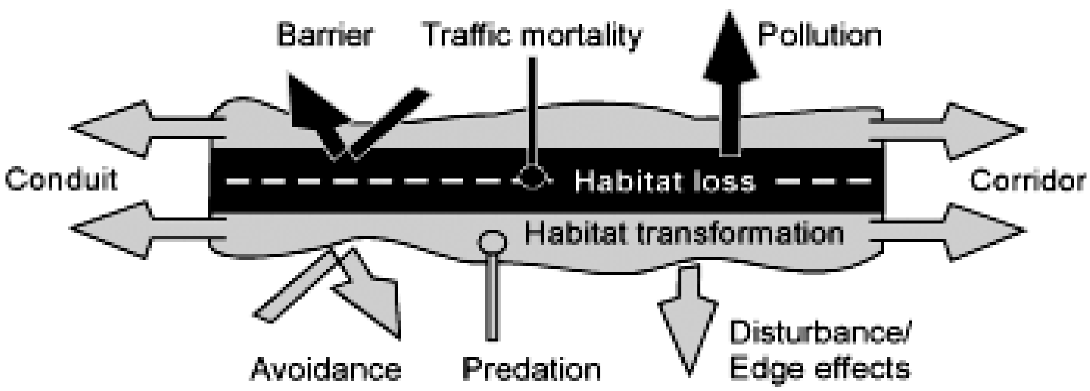

Figure 1: Schematic representation of the five primary ecological effects of infrastructure: Habitat loss and transformation, disturbance due to pollution and edge effects, barrier and avoidance, mortality due to traffic and predation, and the conduit or corridor effect. Together, the various primary effects lead to a fragmentation of habitat. Modified after Van der Zande *et al.* (1980).

Studies have indicated the complex nature of the impact of the rail lines and roads on wildlife and landscapes and even on the ecological processes (Seiler, 2001; Van der Zande *et al.*, 1980; Bennett, 1991; Forman and Alexander, 1998). A number of studies abroad have shown the impact of road infrastructure on the wildlife in the surrounding areas (Hodson, 1966; Van den Tempel, 1993; Rodts *et al.*, 1998; Shepard *et al.*, 2008). Amphibians have been considered as one of the most affected due to transport infrastructure (Vestjens, 1973; Blaustein and Wake, 1990; Reh and Seitz, 1990; Fahrig *et al.*, 1995). Since the roads could kill a constant proportion of a population, these can have a significant impact on rare species. In general, species that occur in small isolated populations, require large extensive areas for their home ranges, or exert long migratory movements, are especially sensitive to road mortality.

The larger their home range, the more often individuals will encounter roads. The smaller the populations, the higher the relative importance of each individual. This could be the case of elephants in its ranges, where elephants are often confined to several fragments of natural areas and finding difficulties to roam freely in the range. Naturally, collisions with wildlife can only occur where a road or railroad dissects a species' habitat, but local factors can alter the relationship considerably. Road kills seem to increase with traffic intensity, but very high traffic volumes, noise and vehicle movement seem to repel many animals and mortality rates may not further increase with traffic.

Unfortunately, there is no clear understanding on the impact of roads on any of the ecological aspects including ecological quality of the areas in India. A number of factors such as road characteristics, landscape topography and hydrology, wind and slope and vegetation influence the impacts. The impact on wildlife is also a factor of the sensitivity of the species. Road construction in an area amounts mostly to clearing of vegetation leading to opening up of closed canopy thereby with a direct impact on the vegetation especially at the edges. This could also affect the arboreal animals in the area. The possible changes in soil density, landscape relief, surface and ground water flows will affect ecosystems, vegetation and fauna in the wider landscape. There would be a definite change in the micro-climatic conditions and wind and light intensity, which would ultimately change the species composition favouring the light demanding ones. The microclimate alterations will have a direct impact on the species such as lichens or mosses. Effects on vegetation and fauna due to edge effects have been reported up to several tens of meters away from the road (Ferris, 1979; Ellenberg *et al.*, 1981; Mader, 1987).

Road maintenance and traffic aggravate edge effects on the surrounding environment by noise and chemical pollution. Most of the pollutants accumulate in close vicinity to the road, but there are possibilities of long distance spread of these pollutants and dust. Traffic mobilises dust from the road surface that deposits along verges and in the nearby vegetation. A number of impacts due to various pollutants have been recorded from elsewhere (Scanlon, 1991; Reck and Kaule, 1993; Bauske and Goetz, 1993; Auerbach *et al.*, 1997; Blomqvist, 1998). Traffic exhaust contains polycyclic aromatic hydrocarbons, dioxins, ozone and many fertilizing chemicals, which in high concentrations can cause physiological distress to animals and plants (Reck and Kaule, 1993; Scanlon, 1991). Changes in plant growth and plant species diversity induced by traffic exhausts have been observed as in lakes (Gjessing *et al.*, 1984) and in heath land more than 200 m distant from the road (Angold, 1997).

Traffic noise is yet another disturbance factor that spreads far into the environment. Disturbance effects by noise are comparatively less understood. Traffic noise is reported to be annoying to most humans with long term exposure inducing psychological stress and eventually lead to physiological disorder (Stansfeld *et al.*, 1993; Job, 1996; Babisch *et al.*, 1999). Though there had been questions on stress among animals, timid species might consider traffic noise as a token for the human presence and consequently avoid noisy areas. Birds are especially sensitive to traffic noise as it directly interferes with their vocal communication and thereby affects their territorial behaviour and mating success (Reijnen and Foppen, 1994). Reduced densities of birds breeding near trafficked roads have also been reported (Veen, 1973; Räty, 1979; Van der Zande *et al.*, 1980; Ellenberg *et al.*, 1981; Illner, 1992; Reijnen and Foppen, 1994). Reijnen *et al.* (1995) observed that bird densities in open grasslands declined where the traffic noise burden exceeded 50 dbA. The structure of road side vegetation, the type of adjoining habitat and the relief of the landscape and the traffic volume influence both noise spread and bird densities and thus alter the amplitude of the noise impact (Reijnen *et al.*, 1995; Kuitunen *et al.*, 1998; Meunier *et al.*, 1999). There are also possibilities of mammalian vocal and chemical communication getting affected due to the roads and the related factors. Though empirical studies are scarce, the National Tiger Conservation Authorities' guideline on inviolate area for tiger conservation is also based on disturbances of all types which are detrimental to wildlife in all respects.

The small roads with little traffic may be used as pathways by larger mammals. Vehicles and humans may serve as vectors for plants, seeds or small, less mobile animals (Bennett, 1991) and these observations offer an explanation for the high proportion of exotics and weed species found along roadsides (Mader *et al.*, 1983; Tyser and Worley, 1992; Ernst, 1998). The spread of weeds and alien plant species along roads is considered as a severe threat to the native flora in many nature reserves (Usher, 1988; Spellerberg, 1998). For larger animals, roads and railroads hardly comprise any physical barrier. Most mammals, however, are sensitive to disturbances by humans. Smell, noise and vehicle movement as well as experiences with human encounters may repel the animals from approaching the road corridor.

The mortality of wild animals is the major impact of roads passing through Protected Areas (Coffin, 2007). Animals with slow moving ability such as amphibians, reptiles are the major victims. Amphibians have been considered as one of the most affected taxa due to transport infrastructure (Vestjens, 1973; Blaustein and Wake, 1990; Reh and Seitz, 1990; Fahrig *et al.*, 1995).

There are several studies outside India on the impact of road infrastructure on wildlife (Hodson, 1966; Van den Tempel, 1993; Rodts *et al.,* 1998). The number of road kills is alarming as per the available information. Hodson (1966) assessed an annual road kill of about 4 million birds in the UK in 1960. In the Netherlands, Van den Tempel (1993) estimated at least 2 million birds per year. In Belgium, a loss of about 4 million larger vertebrates per year due to road traffic have been recorded (Rodts *et al*., 1998). Hansen (1982) estimated a yearly road kill of 1.5 million mammals, 3.7 million birds and more than 3.1 million amphibians in Denmark. Göransson et al. (1978) estimated an annual loss of up to 1.0 million birds and 0.5 million medium sized mammals in Sweden during the mid 1970s. However, another estimate suggest as much as 8.5 million bird kills on Swedish roads (Svensson, 1998). For the USA, assessments made by the Human Society during the 1960s estimated a minimum of one million animal deaths per day (Lalo,1987). Studies on turtles, by Shepard *et al*. (2008), fitted with radio transmitters, in south-central Illinois, USA indicated strong road avoidance. The results of studies by Rachelle *et al.* (2008) suggested that small mammals avoid the road itself, and not emissions such as noise from the traffic on the roads.

Amphibians have been considered as one of the most affected due to transport infrastructure (Vestjens, 1973; Blaustein and Wake, 1990; Reh and Seitz, 1990; Fahrig *et al*., 1995). Amphibians are especially sensitive to road mortality, as their seasonal migration from and to breeding locations often leads them across roads. Van Gelder (1973) found that roads with a traffic volume as low as 10 vehicles per hour could cause a 30% mortality in female toads (*Bufo bufo*). Roads with more than 60 vehicles per hour comprised an almost complete barrier. Vos and Chardon (1998) calculated that breeding ponds near motorways had a significantly reduced probability to be inhabited by frogs than undisturbed ponds farther away. Sjögren -

Gulve (1994) found that trafficked roads in the suburbs of Stockholm isolated amphibian populations. The numbers of collisions generally increase with traffic intensity, animal activity and density. Temporal variations in road kills indicate different biological periods that influence the species' activity, such as the daily rhythm of foraging and resting, mating and breeding season, dispersal of the young, or seasonal migration between winter and summer habitats (Van Gelder, 1973; Bergmann, 1974; Göransson *et a*l., 1978; Aaris-Sorensen, 1995; GrootBruinderink and Hazebroek, 1996). The change in weather pattern could also influence the occurrence and timing of accidents (Jaren *et al*., 1991; Gundersen and Andreassen, 1998). The presence of a road may modify an animal's behaviour by shift in home range, altered movement pattern, altered reproductive success, altered escape response and changed physiological state (Trombulak and Frissell, 2000).

In India, there had been very few observations on the impact of roads on landscape and the behavior of animals in terms of changes in activity, feeding habits, breeding and other aspects. Presence of road and their impact on elephants have been described by Desai and Baskaran (1996), Leimgruber *et al.* (2003), Menon *et al.* (2005) and Vidya and Thuppil (2010). There are a number of studies in India on the road kills along the highways. Sharma (1988) reported animal deaths on NH 11 in Bharathpur. Based on one year long observations, he recorded 439 casualties, which included amphibians, reptiles, birds and mammals. Gokula (1997) reported mortality in snakes due to highway traffic in the dry deciduous forests of Mudumalai Wildlife Sanctuary, Tamil Nadu. Kumara *et al.* (2000) reported road kills in Indira Gandhi Wildlife Sanctuary. A month long study by Vijayakumar *et al.* (2001) reported mortality of herpetofauna along the highway segments passing through rainforest fragments and tea gardens in the Anamalai hills, where more amphibians were killed. Only 73 reptiles were seen killed against 311 amphibians. Chhangani (2004) recorded mortality of 228 birds of 32 species in the highways passing through Kumbhalgarh Wildlife Sanctuary in Rajasthan. Parasharya and Tere (2007) reported their observations of road kill in the Anand – Ahmedabad road. Das *et al.* (2007) reported the reptile mortality along the NH 37 passing adjacent to Kaziranga National Park. The five month long study recorded 68 instances of road kills. The four day survey of amphibian mortality on roads in the Sharavathi river basin recorded 144 individuals of 13 species (Seshadri *et al.*, 2009). About 50 kills, mostly of herpetofauna and also birds and mammals were recorded in a one month long observations along the NH 220 in Cumbum - Kumily road (Selvan, 2011).

But for Dhanesh Bhaskar (2013) and Easa (2014), there was no attempt to record mortality of animals on the highways in Kerala especially those passing through the forests. The present Report is based on the observations on roads between Chinnar Check post and Marayur on the Udumalpet –Munnar road and the Vazhachal – Malakkapara stretch of Chalakudy – Anamalai (Pollachi) road.

Study Area

The road between forest Check post at Chinnar and Meladi

The road passing through the Chinnar wildlife sanctuary(10° 15' N, 77° 16' E) connects Munnar of Kerala and Udumalpet of Tamil nadu (Fig. 2). The area falls in the Marayur and Kanthalloor Panchayat of Devikulam Taluk in Idukki district and is regarded as one of the important Protected Areas in the Western Ghats due to its ecological, floral and geomorphological significance. This road has heavy traffic throughout the year. About 16 km road pass through dry thorny scrub jungle and dry deciduous forest with high faunal and floral wealth. The unique vegetation and animal diversity makes Chinnar a special place among the sanctuaries in the State. As per the Management Plan of the Sanctuary, about 963 plant species have been recorded from the area.Twenty eight mammals reported from the area include several endemic and endangered ones including grizzled giant squirrel and slender loris. About 225 bird species are observed. The reptiles and amphibians are not well explored. The surveys in the area recorded 52 species of reptiles and 15 species of amphibians. The streams and rivers in Chinnar support about 14 species. The butterflies, one of the least inventoried group have been surveyed documenting 156 species. The Management Plan for Chinnar has indicated widening of PWD road resulting in restriction to animal movement as an issue of concern.

The road between forest check posts at Vazhachal and Malakkapara

This road is part of the Chalakudy-Pollachi road passing through Valparai of Anamalai Tiger Reserve (Fig.3). The stretch of the road between the two check posts is about 50 km and pass through moist deciduous and evergreen forests and reed patches, majority of which fall under the buffer zone of Parambikulam Tiger Reserve. There is a short stretch of coffee plantations nearer to Malakkapara. The stretch of the road is at an elevation between 150 m and 1200 m. The area is very rich and diverse in faunistic and floristic wealth. There is frequent vehicular traffic during day time and night traffic is regulated to some extent.

Methods

The road stretches were covered on a motor bike (a type of road transects) at very low speed searching for animal kills on the road or road sides. On sighting a road kill, the road side habitat and state of the road kill were recorded and the kill photographed separately and with the surrounding habitat. The location of the road kill was recorded using GPS. Specimens were examined, collected and preserved for further identification, if necessary. In addition, information from secondary sources were collected, verified and recorded. All the information were entered in a format. The records with the check posts were copied and analysed for time periods of heavy traffic. This information is utilized for selecting the period of time for surveying the road stretch. But searches were invariably made between 06.00 h and 09.00 h in all the selected roads and also during the evening time especially in Chinnar. Further, the stretch of the roads of interest was covered during day and night time at random for observations of animals near the road.

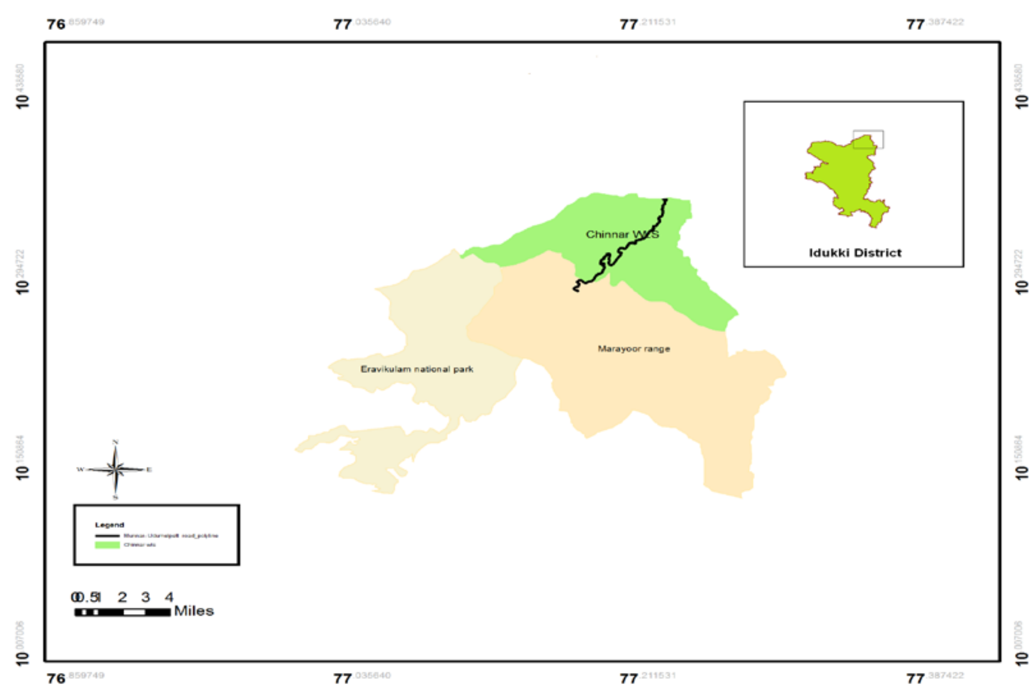

Fig. 2 Chinnar Wildlife Sanctuary showing the location of the road

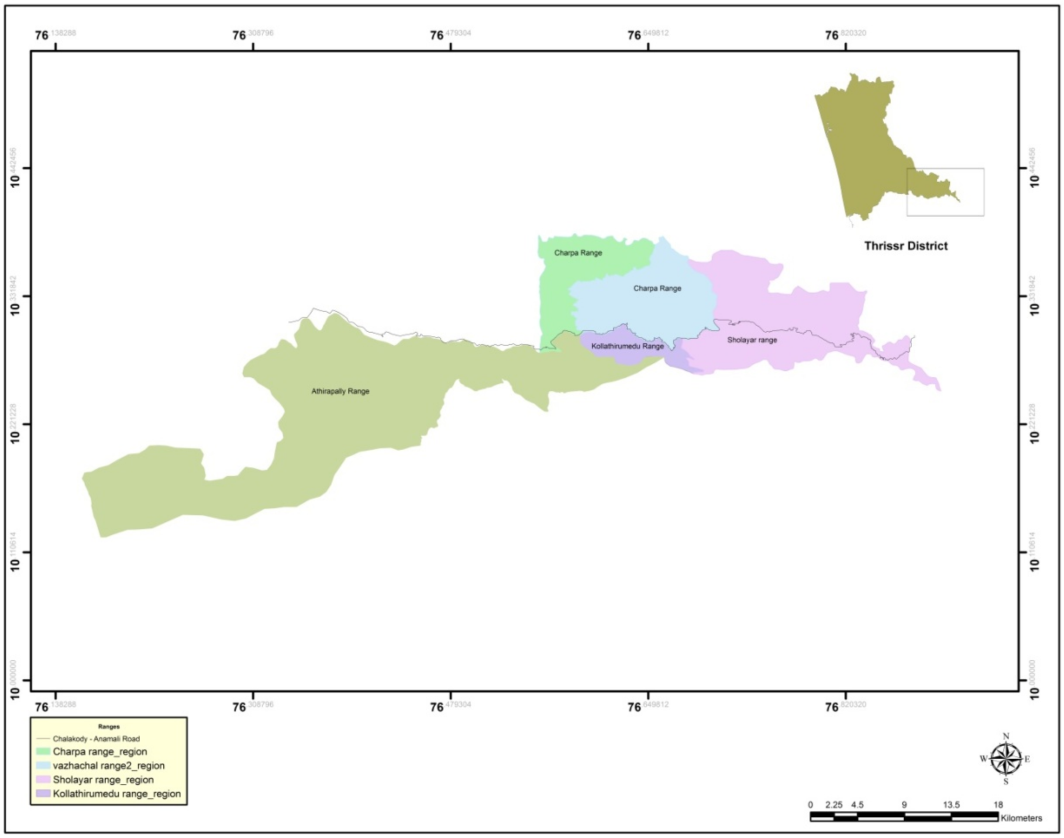

Fig. 3 Vazhachal –Malakkapara Road location

Results

The road kills in Chinnar

The number of days spent for observation in the field in Chinnar is given in Fig. 3. Seventy five road kills were recorded during January 2013 to June-2014. Birds formed 16 of the kills followed by 27 Reptiles, 29 Mammals and 3 Amphibians (Fig.5). Mammals formed about 41%, Reptiles 35%, Birds 18% and amphibians 6% (Fig.6). Most of the animals fall under Schedule IV of Wildlife Protection Act (Table 1). The Gray slender loris is one of the endangered species under Schedule I of the Act. The monthly distribution of animal kills observed during the period is given in Fig. 7, which indicate the peak in February, 2014.

Among the Mammal kills recorded, the highest number was that of three striped squirrel *Funambulus palmarum* (20 numbers), 12 kills of *Calotes versicolor* were recorded during the study. Nine species of bird kills were recorded from Chinnar. A list of animal species killed on the Munnar-Udumalpet road is given in Table 1 and the locations of animal kills are plotted in Figures 8. The photographs of the vegetation along the road and a few of the animal kills recorded from Chinnar are given in Figures 9 – 37.

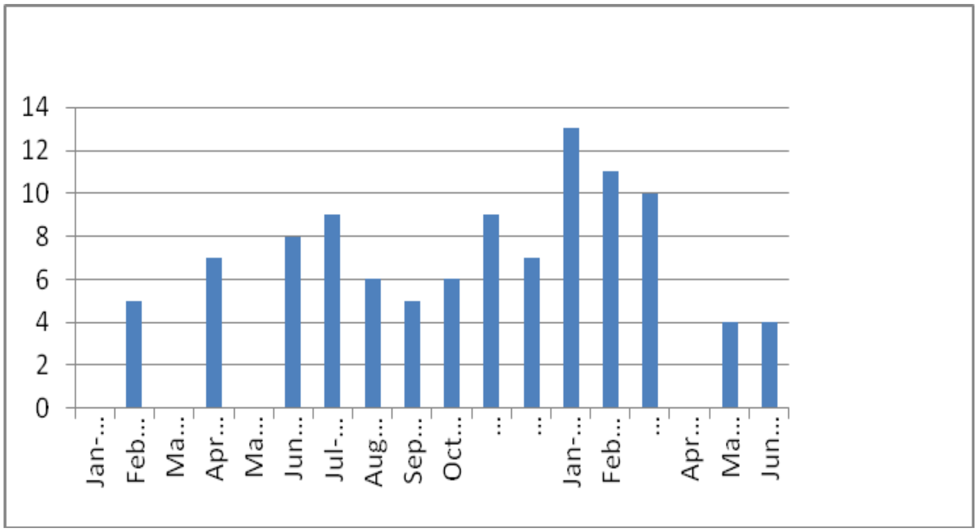

Fig. 4 The number of days spent in Chinnar

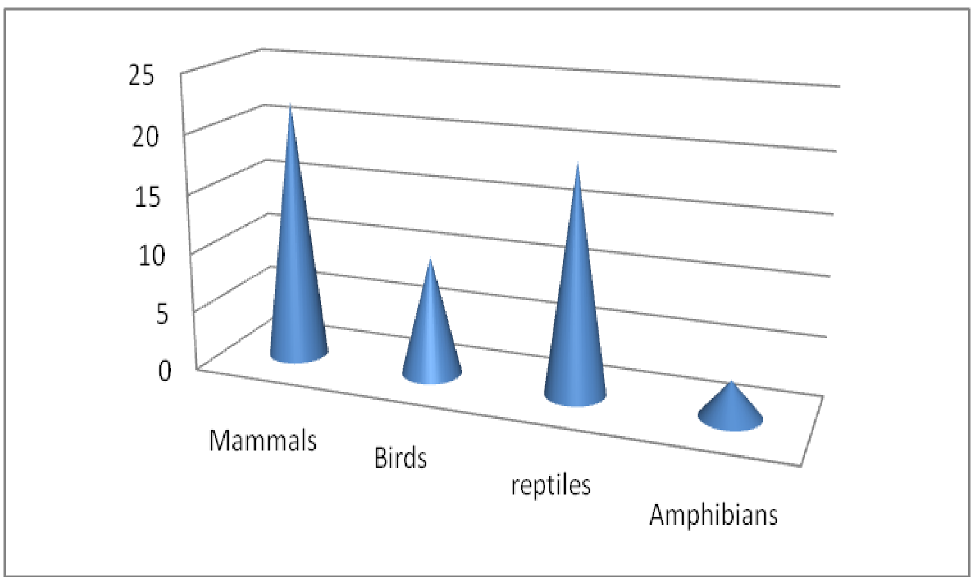

Fig. 5 Number of animal kills in different groups recorded in the Munnar-Udumalpet road

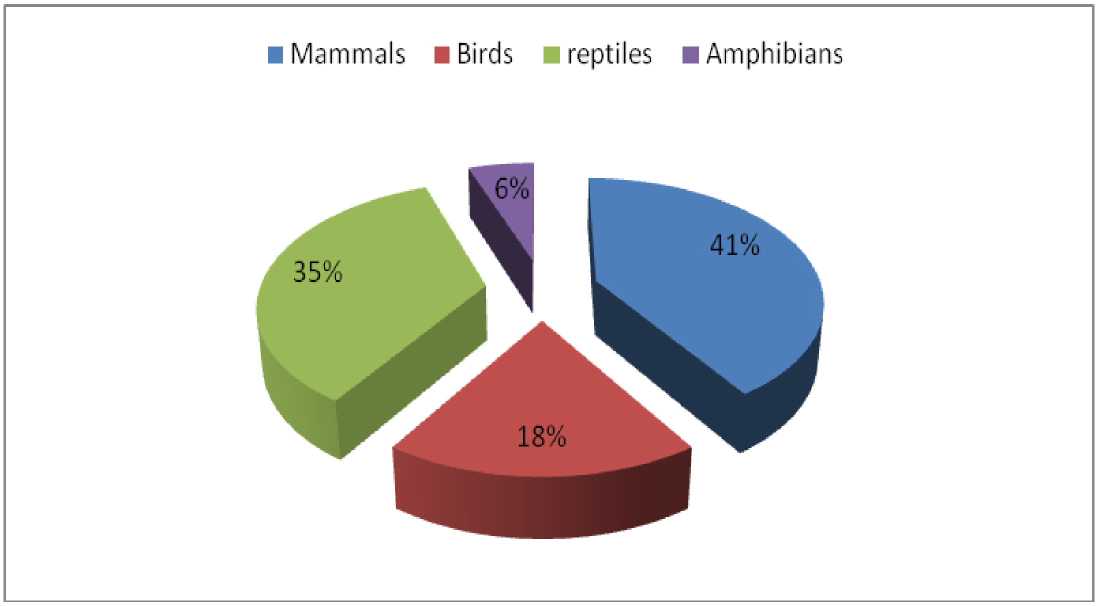

Fig. 6 Percentage of different animal kills recorded in the Munnar-Udumelpet road

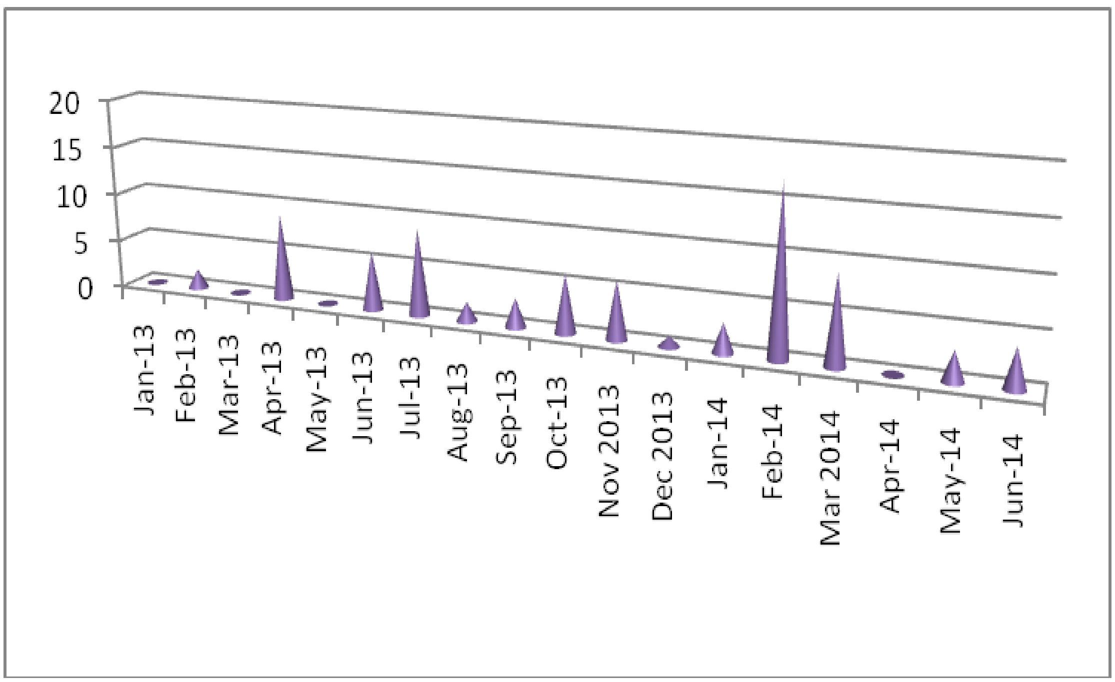

Fig. 7 The monthly distribution of animal kills in the Munnar-Udumelpet road

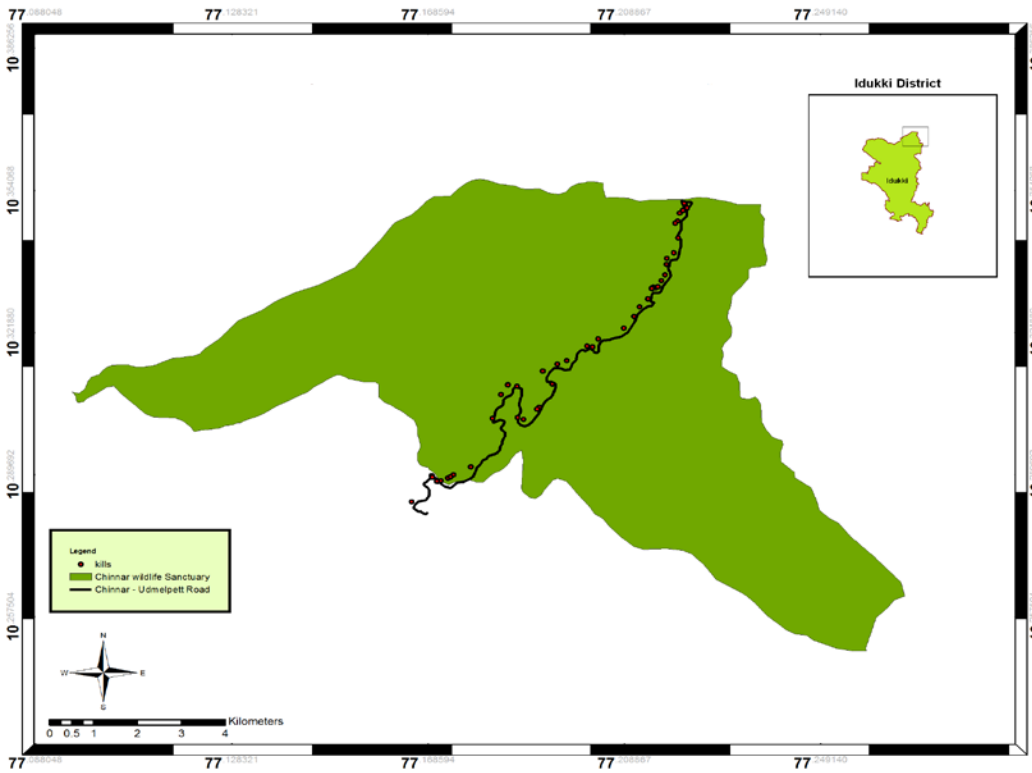

Fig. 8. The locations of animal kills observed in the Munnar-Udumalpet road

Table: 1 The Details of animal kills in Munnar-Udumelpet road observed during the period January 2013 to June 2014.

Common Name	Scientific Name	IUCN Status	WPA	Endemicity	Number of road kills
Amphibians					
Common Indian Toad	*Duttaphrynus melanostictus*	LC			3
Reptiles					
Indian Garden Lizard	*Calotes versicolor*	NE			12
Common Green Forest Lizard	*Calotes calotes*	NE			1
Common Sand Boa	*Eryx conicus*	NE	Sch. IV		5
Travancore Wolf Snake	*Lycodon travancoricus*	LC	Sch. IV		1
Common Wolf	*Lycodon aulicus*	NE	Sch. IV		2

Snake					
Common Vine Snake	*Ahaetulla nasuta*	NE	Sch. IV		1
Forsten's Cat Snake	*Boiga forsteni*	LC	Sch. IV		1
Dumeril's Black-headed Snake	*Sibynophis subpunctatus*	NE	Sch. IV		2
Green Keelback	*Macropisthodon plumbicolor*	NE	Sch. IV		1
Common Indian Krait	*Bungarus caeruleus*	NE	Sch. IV		1
Mammals					
Three-striped Palm Squirrel	*Funambulus palmarum*	LC			20
Rat	Unidentified				3
Black-naped Hare	*Lepus nigricollis*	LC	Sch. IV		1
Gray Slender Loris	*Loris lydekkerianus*	LC	Sch. I		1
Lesser Bandicoot-rat	*Bandicota bengalensis*	LC	Sch. V		4
Birds					
Red-whiskered Bulbul	*Pycnonotus jocosus*	LC	Sch. IV		1
Blue-faced Malkoha	*Phaenicophaeus viridirostris*	LC	Sch. IV		2
Yellow-throated Bulbul	*Pycnonotus xantholaemus*	VU	Sch. IV		1
Yellow billed Babbler	*Turdoides affinis*	LC	Sch. IV		4
Indian Robin	*Saxicoloides fulicatus*	LC	Sch. IV		3
Ashy Drongo	*Dicrurus leucophaeus*	LC	Sch. IV		1
Common Golden-backed Woodpecker	*Dinopium javanense*	LC	Sch. IV		1
Brown Fish Owl	*Ketupa zeylonensis*	LC	Sch. IV		1
Nightjar	*Caprimulgus* sp.				2
Total					75

Fig.9. Munnar-Udumalpet road

Fig. 10. A Raptor with catch

Fig. 11. **Indian Peafowl (*Pavo cristatus*) on road**

Fig. 12. **Tufted Gray Langur (*Semnopithecus priam*) on road**

Fig. 13. Common Indian Toad (*Duttaphrynus melanostictus*)

Fig. 14. Indian Garden Lizard (*Calotes versicolor*)

Fig. 15. Common Green Forest Lizard (*Calotes calotes*)

Fig. 16. Common Sand Boa (*Eryx conicus*)

Fig. 17. **Common Wolf Snake (*Lycodon aulicus*)**

Fig. 18. **Forsten's Cat Snake (*Boiga forsteni*)**

Fig. 19. Dumeril's Black-headed Snake (*Sibynophis subpunctatus*)

Fig. 20. Green Keelback (*Macropisthodon plumbicolor*)

Fig. 21. Common Vine Snake (*Ahaetulla nasuta*)

Fig. 22. Common Indian Krait (*Bungarus caeruleus*)

Fig. 23. Red-whiskered Bulbul (*Pycnonotus jocosus*)

Fig. 24. Yellow billed Babbler (*Turdoides affinis*)

Fig. 25. Yellow-throated bulbul (*Pycnonotus xantholaemus*)

Fig. 26. Indian Robin (*Saxicoloides fulicatus*)

Fig. 27. **Ashy Drongo (*Dicrurus leucophaeus*)**

Fig. 28. **Common Golden-backed Woodpecker (*Dinopium javanense*)**

Fig. 29. Brown Fish Owl (*Ketupa zeylonensis*)

Fig. 30. Nightjar (*Caprimulgus* sp.)

Fig. 31. Three-striped Palm Squirrel (*Funambulus palmarum*) – a long shot

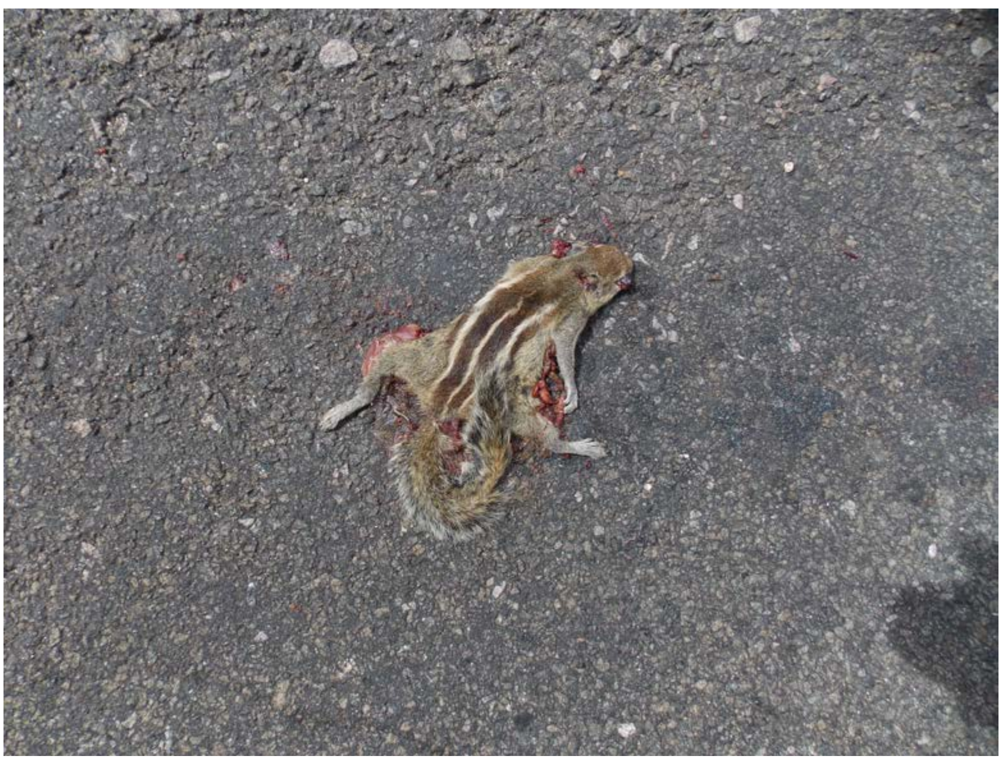

Fig. 32. Three-striped Palm Squirrel (*Funambulus palmarum*)

Fig. 33. Black-naped Hare (*Lepus nigricollis*) – a long shot

Fig. 34. Black-naped Hare (*Lepus nigricollis*)

Fig. 35. **Gray Slender Loris (*Loris lydekkerianus*) – a long shot**

Fig. 36. **Gray Slender Loris (*Loris lydekkerianus*)**

Fig. 37. Lesser Bandicoot-rat (*Bandicota bengalensis*)

The road kills in Vazhachal

About 98 days were spent in Vazhachal-Malakkapara road (Fig.38). A total of 321 road kills were recorded during January 2013 - June-2014 (Table 2). Of these, 257 kills belong to amphibians, 54 to reptiles and 10 to mammals (Fig. 39). On the numbers recorded as road kills, amphibians formed about 83%, mammals 1% and Reptiles 16% (Fig. 40). The details of amphibian kills observed during the period is given in Fig. 41, which indicates the peak in April-2014. Except six species, all are under one of the Schedules of Wildlife Protection Act. Of these, Indian rock python and Nilgiri langur are included in Schedule I and Small Indian civet, Spectacled cobra and checkered keelback are under Schedule II of the Act. Eight species observed as kills during the study are endemic to Western Ghats (Table 2).

Among the amphibian kills recorded during the study, the highest number was that of Bi-colored Frog, *Clinotarsus curtipes* (197 numbers) followed by Indian bull Frog, *Hoplobatrachus tigerinus* (52 numbers). Other amphibian kills are Indian common toad (*Duttaphrynus melanostictus*), Malabar gliding Frog (*Rachophorus malabaricus*) and Charpa Tree frog

(*Polypedates occidentalis*). Location of animal kills in Vazhachal - Malakkapara road is plotted on the map (Fig. 42). The vegetation along the road and a few of the animal kills are given in Figures 43 – 76.

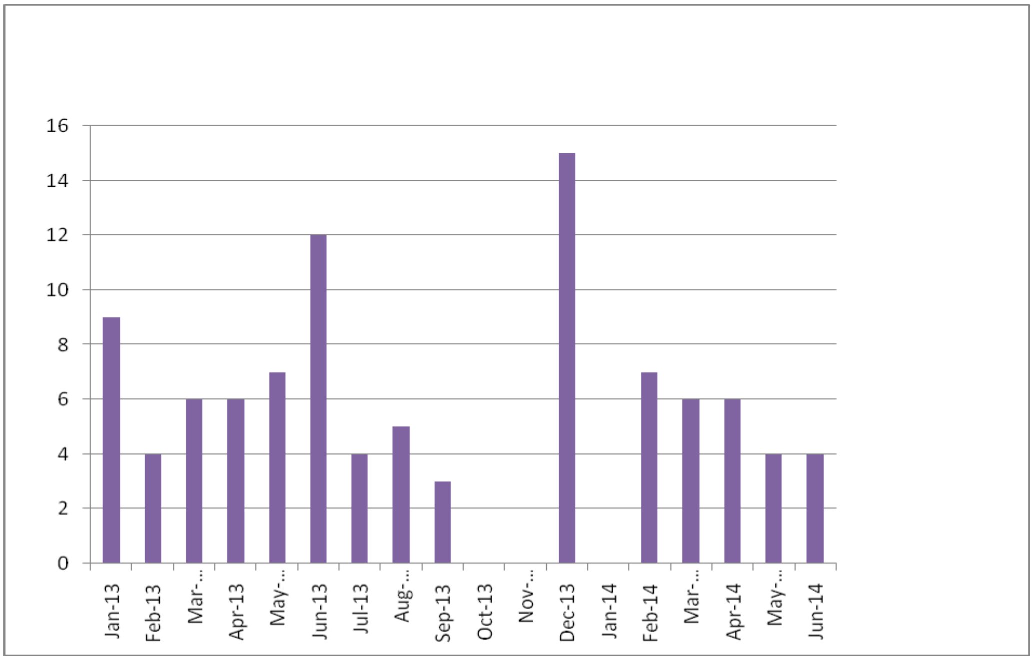

Fig. 38. The number of days spent in the Vazhachal – Malakkapara road

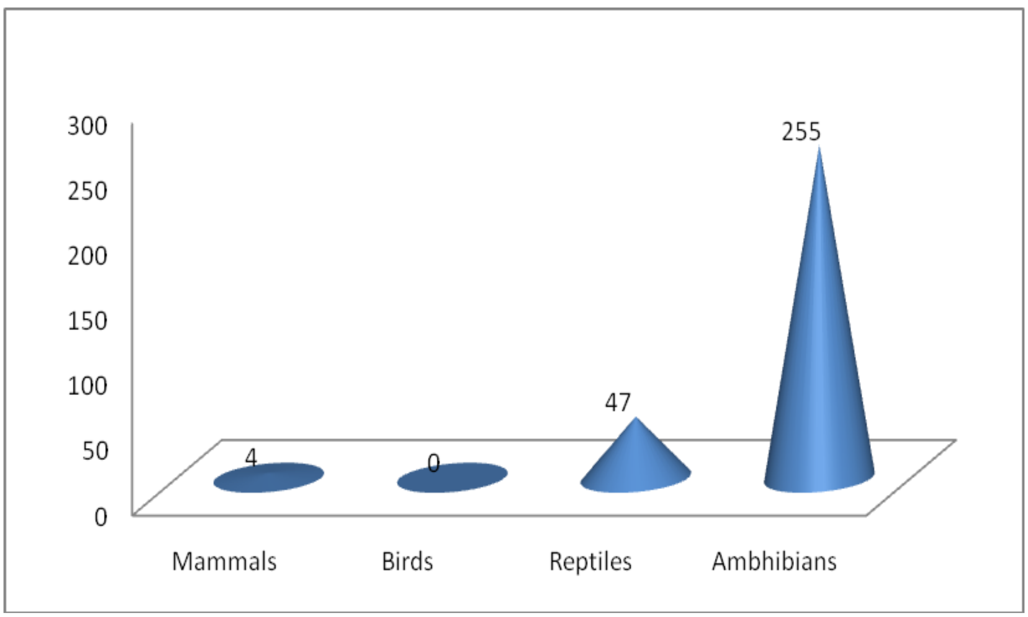

Fig. 39. Number of animal kills in different groups in the Vazhachal-Malakkapara road

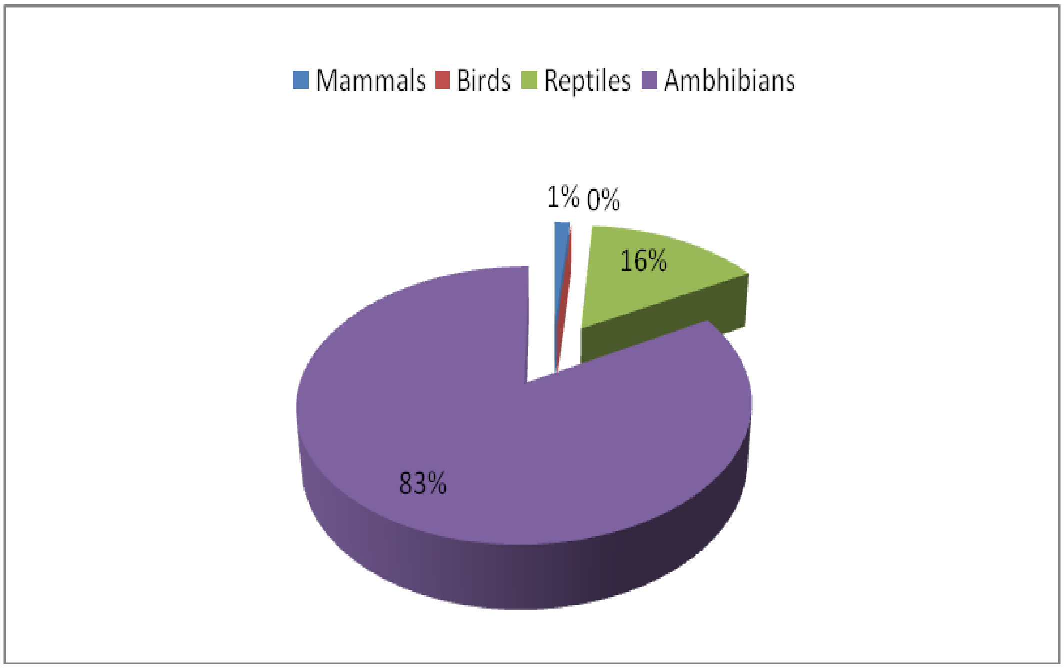

Fig. 40. Percentage of different groups of animal kills in the Vazhachal-Malakkapara road

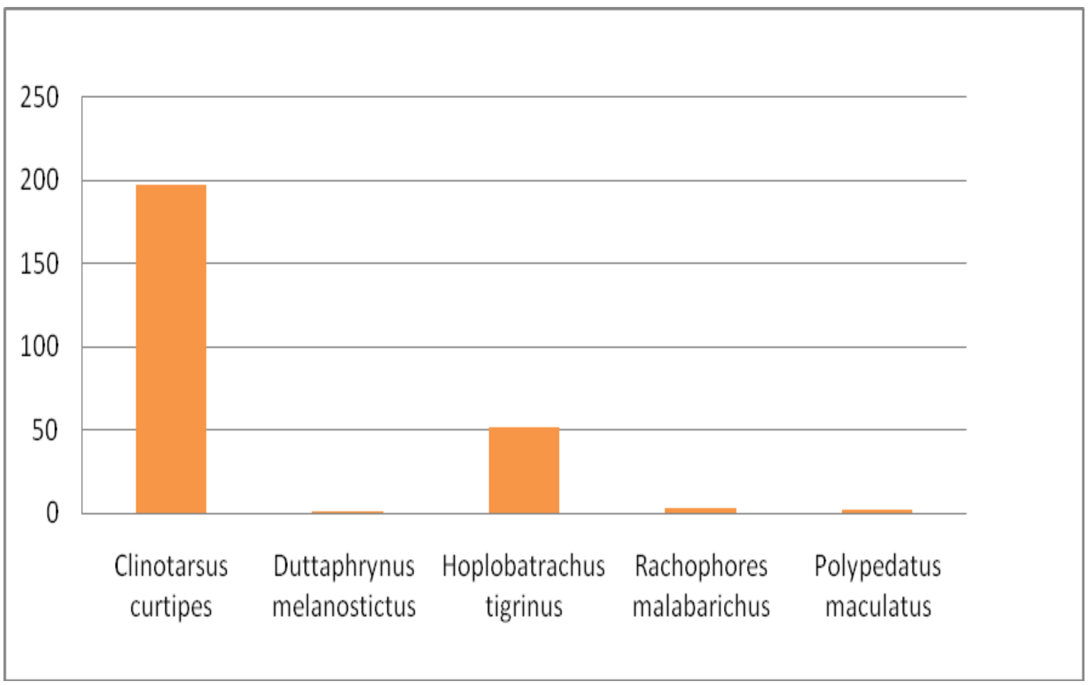

Fig. 41. Amphibian Kills Recorded during the year 2013 – 2014

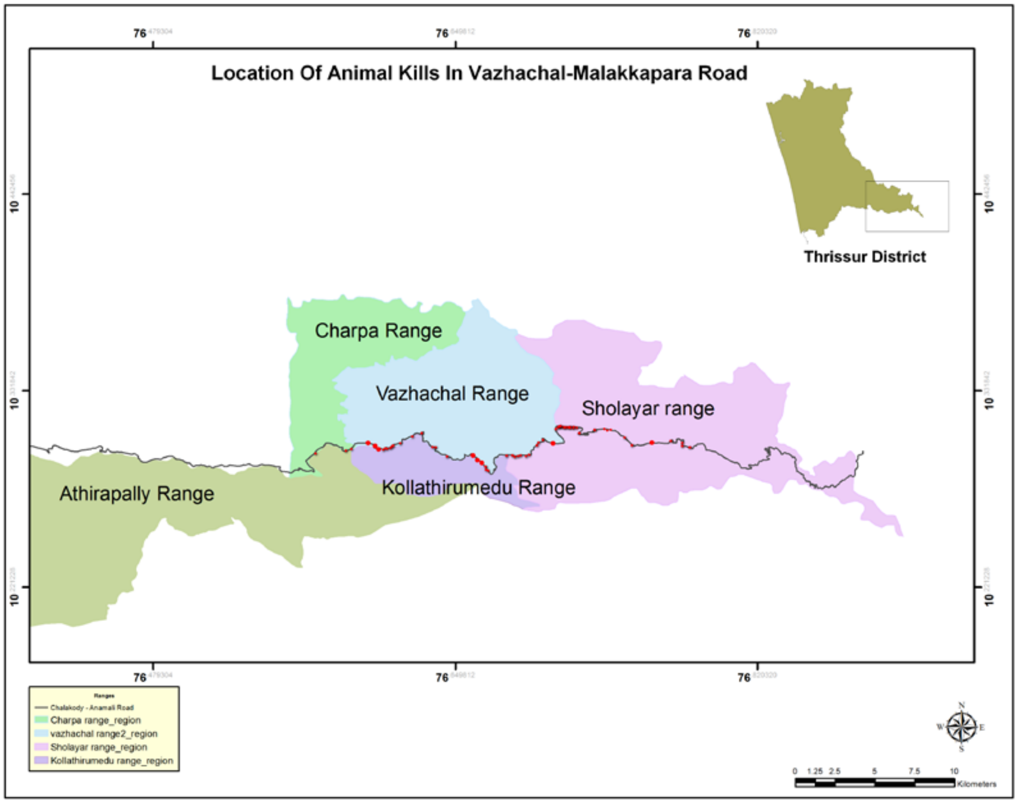

Fig. 42. Locations of animal kills in Vazhachal-Malakapara road

Table 2. The Details of animal kills in the Vazhachal-Malakkapara Road

Common Name	Scientific Name	IUCN Status	WPA	Endemicity	Number of road kills
Amphibians					
Bicoloured Frog	*Clinotarsus curtipes*	NT	Sch. IV	WG	197
Common Indian Toad	*Duttaphrynus melanostictus*	LC			1
Indian Bullfrog	*Hoplobatrachus tigerinus*	LC	Sch. IV		52
Malabar Gliding Frog	*Rhacophorus malabaricus*	LC		WG	3
Charpa Tree frog	*Polypedates occidentalis*	DD		WG	2
Three-colored	*Ichthyophis tricolor*	LC		KL	1

Caecilian					
Caecilian	*Ichthyophis* sp.				1
Reptiles					
Indian Garden Lizard	*Calotes versicolor*	NE			6
Dussumier's Litter Skink	*Sphenomorphus dussumieri*	LC		WG	4
Common Keeled Skink	*Eutropis carinata*	LC			1
Beaked Worm Snake	*Grypotyphlops acutus*	LC	Sch. IV		1
Bronze Grass Skink	*Eutropis macularis*	NE			2
Indian Rock Python	*Python molurus*	LC	Sch. I		2
Beddome's Keelback	*Hebius beddomei*	LC	Sch. IV	WG	1
Checkered Keelback	*Xenochrophis piscator*	NE	Sch. II		4
Striped Keelback	*Amphiesma stolatum*	NE	Sch. IV		1
Hill Keelback	*Hebius monticola*	LC	Sch. IV	WG	2
Common Bronzeback Tree Snake	*Dendrelaphis tristis*	NE	Sch. IV		2
Travancore Wolf Snake	*Lycodon travancoricus*	LC	Sch. IV		5
Common Vine Snake	*Ahaetulla nasuta*	NE	Sch. IV		8
Cat Snake	*Boiga* spp.				2
Spectacled Cobra	*Naja naja*	NE	Sch. II		1
Common Indian Krait	*Bungarus caeruleus*	NE	Sch. IV		1
Malabar Pit Viper	*Trimeresurus malabaricus*	LC	Sch. IV	WG	7
Common Hump-nosed Pit Viper	*Hypnale hypnale*	NE	Sch. IV		4
Mammals					
Nilgiri Langur	*Semnopithecus johnii*	VU	Sch. I	WG	1

Three-striped Palm Squirrel	*Funambulus palmarum*	LC			2
Indian Crested Porcupine	*Hystrix indica*	LC	Sch. IV		2
Small Indian civet	*Viverricula indica*	LC	Sch. II		1
Rat	Unidentified				4
Total					**321**

Fig. 43. Vazhachal-Malakkapara road

Fig. 44. Lion-tailed Macaque (*Macaca silenus*) on road

Fig. 45. Lion-tailed Macaque (*Macaca silenus*) on road

Fig. 46. Bonnet Macaque (*Macaca radiata*) on road

Fig. 47. **Gaur (*Bos gaurus*) resting near the road**

Fig. 48. **Gaur (*Bos gaurus*) on road**

Fig.49. Live Malabar Pit Viper (*Trimeresurus malabaricus*) on road

Fig. 50. Bicoloured Frog (*Clinotarsus curtipes*)

Fig. 51. Common Indian Toad (*Duttaphrynus melanostictus*)

Fig. 52. Malabar Gliding Frog (*Rhacophorus malabaricus*)

Fig. 53. Charpa Tree frog (*Polypedates occidentalis*)

Fig. 54. Three-colored Caecilian (*Ichthyophis tricolor*)

Fig. 55. Bronze Grass Skink (*Eutropis macularis*)

Fig. 56. Common Keeled Skink (*Eutropis carinata*)

Fig. 57. Indian Garden Lizard (*Calotes versicolor*)

Fig. 58. Indian Garden Lizard (*Calotes versicolor*)

Fig. 59. Beaked Worm Snake (*Grypotyphlops acutus*)

Fig. 60. Indian Rock Python (*Python molurus*)

Fig. 61. **Beddome's Keelback (*Hebius beddomei*)**

Fig. 62. **Checkered Keelback (*Xenochrophis piscator*) and *Ichthyophis* sp.**

Fig. 63. Common Bronzeback Tree Snake (*Dendrelaphis tristis*)

Fig. 64. Common Vine Snake (*Ahaetulla nasuta*)

Fig. 65. Spectacled Cobra (*Naja naja*)

Fig. 66. Common Indian Krait (*Bungarus caeruleus*)

Fig. 67. Malabar Pit Viper (*Trimeresurus malabaricus*)

Fig. 68. Common Hump-nosed Pit Viper (*Hypnale hypnale*)

Fig. 69. Nilgiri Langur (*Semnopithecus johnii*)

Fig. 70. Unidentified Rat

Fig. 71. Unidentified Rat

Fig. 72. Unidentified Rat

Fig. 73. Three-striped Palm Squirrel (*Funambulus palmarum*)

Fig. 74. Three-striped Palm Squirrel (*Funambulus palmarum*)

Fig. 75. Indian Crested Porcupine (*Hystrix indica*)

Fig. 76. Small Indian civet (*Viverricula indica*)

Discussion

Habitat fragmentation due to transport infrastructure is one of the most debated topics among wildlife managers. Modification of landscapes has adverse effect on the plant and animal diversity in the area. The linear infrastructural developments like roads and rail lines fragment the habitat thereby isolating some of the animal groups sometimes leading to extinction (Mader, 1984). It has also been reported to affect the seasonally or annually migrating species forcing them to take the risk of getting killed during the movement process (Smith and Dodd, 2003). There had been observations indicating that the nocturnal ones are not susceptible to mortality in places where the traffic is less at night (Enge and Wood, 2002).

The slow moving animals like amphibians (Hels and Buchwald, 2001), turtle (Gibbs and Shriver, 2002) and snakes (Andrews, 2004) are probably the groups which will be most affected because of the roads. However, the fast moving snakes could probably escape from the speeding vehicles. However, because of the clearing of the vegetation on the road side, the animals are in danger of getting exposed and predated (Fig. 10). The present observations indicate that the animals hit by speeding vehicles include seven Western Ghats endemics such as Nilgiri langur, Malabar pit viper, hill keelback, Beddome's keelback, Dussumier's litter skink, Malabar gliding frog and bi-coloured frog. Though some of the species are of internationally least concern, they are of important status in the geographical areas at national level. A number of species recorded fall under one of the Schedules of Wildlife Protection Act, which also indicate the important status of the species.

The road bisecting Chinnar Wildlife Sanctuary is heavily used because of the traffic of both goods vehicle and the travel carriages including buses, cars and jeeps. The vegetation on the sides of the road is not as diverse as Vazhachal - Malakkapara area. Most of the observed kills in Vazhachal are that of reptiles and amphibians.

The number of kills in Vazhachal area is more due to the observed kills of Bi-colored frog, which was moving in large numbers during breeding season. The breeding season of Bi-colored Frog is reported to be from June to July and that of Common Indian Toad normally coincides with monsoon rains (Daniels, 2005). The time taken by the tadpoles of Common Indian Toad to metamorphose varies according to places and reported to vary from 45 to 90 days. The Bi-colored Frogs gather around small tanks during breeding season (Daniels, 2005) and are susceptible to road kills while migrating to breeding habitats (Stuart *et al.,* 2008). Juveniles of Common Indian Toad tend to stay in large groups, slow moving and hop after small insects. The Indian Bull Frog, *Hoplobatrachus tigerinus,* a slow moving frog turns lemon yellow during breeding season, which coincides with rains. The baby frogs are brightly coloured with extensive patches of green on the head and sides (Daniels, 2005). Warty Frogs reportedly congregate around small rain water puddles on road sides. The road kills observed in the study area were both lemon yellow and the colour of the baby frogs. These were mostly near the Vazhachal area and must be because of the marshy swamps on both sides of the road.

The species getting killed on the road in both Chinnar and Vazhachal are of great concern because of their status and also behavior. A former Researcher of KFRI had informed the sighting of a good number of Caecilian (limbless amphibian) kills near the Athirappilly water fall area indicating that the areas even before the check post are having good animal movements attempting to cross the road. It is also possible that the amphibian kills were washed out in the gushing water during the heavy rains leaving no chance of seeing it even on the edge of the road. So the number of amphibian kills must be much more than observed.

Though few in numbers, the observations of Nilgiri langur, small Indian civet and Indian porcupine kills in Vazhachal road, with regulations for night traffic definitely indicate that the animals are not safe during day and night time and are prone to vehicle hit even with low traffic volume. This is mostly because of the carelessness of the drivers especially at turnings. The kills of Nilgiri langur in Vazhachal and that of loris in Chinnar also indicate the problem with canopy connectivity forcing the animals to come down for crossing the road to access the vegetation on the other side. The bisecting of the road in Chinnar must have even fragmented the population of loris, a slow moving animal. Though kills not observed, there is every possibility of the endemic and endangered lion-tailed macaque getting hit by speeding vehicle in Vazhchal road as seen in the Figs.44 and 45.

In addition to fragmentation of the habitat, the uncontrolled vehicular traffic on roads also contributes to disturbances in the form of noise and dust pollution. The National Tiger Conservation Authority, while mentioning about inviolate areas have suggested to reduce human interventions and disturbances in wildlife areas. Observations in Vazhachal indicate that at least a few of the vehicles crossing Malakkapara towards Vazhachal are not to Chalakudy or

Vazhachal. They are not under the scanner of the staff until they reach the next check post. They spend their time in the areas in between, have a bath in the water bodies and return via Malakkapara itself after all possible illegal activities. There is no mechanism in the area to see that the vehicles are not stopping in between and passengers getting down. The regulations are important for the safety of the passengers also. This is true in Chinnar area also, where vehicles stop in between for wildlife observations and even step down. Observations in both the places indicate that the turnings in Vazhachal with carelessness and least concern for the animals lead to the animal kills where as it is mostly the speed that is responsible for most of the kills in Chinnar.

It is unfortunate that there is not much attention given to the lower so called least charismatic species of reptiles and amphibians. Though not completely understood, the complex ecosystem functions and the ecological processes call for conservation of the species irrespective of the size, status and the charisma. It is also important to ensure free movement of the animals for maintaining at least a near natural situation allowing them to interact with their conspecifics and meeting their 'home range' requirement. It is true that these small animals are sighted only while coming closer to the animals on the road.

Recommendations

The study indicates the vulnerability of the smaller and nocturnal animals. Though the distribution of animal kill locations is almost clubbed to certain locations in Vazhachal, the entire stretch of the road in Chinnar is prone to such kills. This is especially true of the amphibians and reptiles. Even with the traffic regulations at night in Vazhachal, the diurnal ones like Nilgiri langur do not escape from the threat of getting hit. The findings have management implications especially in the wake of the threatened status of some of the species. Though complete night traffic ban is the best option to reduce the number of kills, this would be inconvenient to the general public especially to those using Munnar – Udumalpet road. Considering all the aspects and based on the observations, the following suggestions are given for mitigating the problem.

- It is evident that the drivers do not give much importance to the lower groups of animals. This may be because of the lack of sighting of these on the road. It will be good if a briefing is done for the information of the drivers before they enter the stretch of the road passing through the forest areas.

- Traffic regulations along the road have been suggested in the Management Plan of Chinnar Wildlife Sanctuary. These include restriction of night traffic, speed regulations and warning signages. Unfortunately, these were not implemented. It is recommended to establish speed breakers in all vulnerable locations including areas with sharp turnings. This would reduce the speed of the vehicles in the Sanctuary areas and stop the vehicle on sightings of animals on the road. Such a regulation in a short stretch will not be a problem for the passengers and will be better than total ban of traffic during night hours.
- It is important to provide underground passages in marshy swamp locations in Vazhachal. This will act as an amphibian corridor.
- Quick field verification will help identify the locations where canopy connectivity is lost. Actions may be taken to establish the connectivity through planting of appropriate species along the road sides, wherever it is required. Artificial canopy bridges may help till such permanent solutions are in place. The future developments should take care of such possibilities of canopy getting disconnected and should avoid activities that will hinder the movement of arboreal animals.
- The Tiger Conservation Plan of Parambikulam Tiger Reserve and the Guidelines of National Tiger Conservation Authority suggests Highway patrolling to regulate vehicular movement in Tiger Reserves and deter the people from illegal activities. This suggestion may be implemented in the Vazhachal – Malakkapara road.

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