ARE ROADS A DEATH TRAP FOR ANIMALS? A CASE STUDY OF BHIMASHANKAR WILDLIFE SANCTUARY

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Abstract : Bhimashankar Wildlife Sanctuary, home to endangered fauna such as Leopard Cat (Felis bengalensis), Red Giant Squirrel (Ratufa indica indica), Mouse Deer (Tragulus meminna), Leopard (Panthera pardus) etc. is also popular as Jyotirlinga or Jyotirlingam and lacs of devotees visit the Shiva temple each year situated in the core area of the Sanctuary. This results in heavy traffic load in the entire landscape reaching up to 1528 vehicles per day in the month of Shravan or Sawan (July-August) and 2600 vehicles per day on Mahashivratri (religious festival). This study tries to document the effect of this ongoing traffic on wildlife crossing the roads by quantifying the traffic load coming in Bhimashankar Wildlife Sanctuary on an hourly basis, documenting the number of animal movement on the road, along the road and crossing the road successfully at different hours of the day and across the seasons and estimating the mortality of animals getting killed due vehicular collisions.

IndexTerms **- Bhimashankar Wildlife Sanctuary, road-kills, vehicle collisions**

I. INTRODUCTION

Animal-vehicle collisions on roads have probably occurred since the arrival of the automobiles. Wildlife mortality associated with roadways has been on the rise during the 20th century as vehicle speed and traffic volumes have increased (Puglisi et al. 1974). Traffic may be destructive to animal populations in two ways: directly, resulting in animal mortalities and indirectly, leading to fragmentation of habitats (Mader 1984; Groot Bruinderink and Hazebroek 1996; Reed et al. 1996). Fragmentation, in turn, may result in isolating the populations, which again may result in affecting population size and an increased stochastic risk of extinction (Bennett 1990). There has been limited research to study the effects of roads on the movement of animals. According to Noss 2001, road-kill is a classic death-trap phenomenon. Animals are attracted to roads for a variety of reasons, often resulting in their mortality. Snakes and other ectotherms use roads for basking, birds like doves use roadside gravel to aid their digestion of seeds or to dust-bathe, mammals use roads to eat de-icing salts, deer and other browsing herbivores are attracted to the dense vegetation of roadside edge, rodents proliferate in the artificial grasslands of road verges, and many large mammals find roads to be efficient travel ways. Scavengers like owls, crows, jackals etc. seek out road-kills, often to become road-kills themselves.

In India, there was about an eight-fold increase in the total length of roads (from 0.399 to 3.38 million km) and 100-fold increase in the number of motorized vehicles (from 0.3 to 30 million, with a growth of ~ 12% per annum) between 1951–2004 (Rao et al. 2007). These major roads, more commonly highways and heavy traffic pass through almost every national park and protected area – the last remains of fragile wild habitats (Gubbi 2004) and their impact in the form of road kills are virtually unknown.

We decided to study the impact of roads and ongoing traffic at Bhimashankar Wildlife Sanctuary situated in the Ambegaon and Khed talukas of Pune District, as the study site is much popular as Jyotirlinga or Jyotirlingam- one of the twelve devotional sites considered to be a residing place and manifestation of Shiva attracting lacs of devotees each year. There has always been heavy traffic load in this area reaching up to 1528 vehicles per day in the month of Shravan or Sawan (July-August) and 2600 vehicles per day on Mahashivratri. However, the Shiva temple situated in the core area of the Bhimashankar Wildlife Sanctuary is home to a variety of rare and endangered fauna such as the Leopard Cat (Felis bengalensis), Red Giant Squirrel (Ratufa indica indica), Mouse deer (Tragulus meminna), Leopard (Panthera pardus), Jackal (Canis aureus), Barking deer (Muntiacus muntjac), Sambar (Cervus unicolor) and other animals.

Hence in order to know and document the effect of this ongoing traffic on wildlife crossing the roads, this study was carried out to a) To quantify the traffic load coming in Bhimashankar Wildlife Sanctuary on an hourly basis, b) To document the number of animal movements on the road, along the road and crossing the road successfully at different hours of the day and across the seasons and c) To estimate the mortality of animals getting killed in vehicular collisions.

II. METHODOLOGY

A) Details of the Study Site- Tar (Metaled) Roads

There are two tar (metaled) roads within the sanctuary; the main arterial road which is also our sample having a length of approximately 5 km. enters the sanctuary from the gate at Mhatarbachi Wadi village and ends at the temple. The other being the control starts from halfway of the main arterial road (2.5 km. from Mhatarbachi Wadi) and ends 5 km. away, at village Kondhwal. The roads are about 4-7 meters wide and pass through distinct habitats such as naturally open patches, dense forests, small water bodies, and agricultural fields. Control road has the average width of 4 meters while the sample road is 7 meters wide; thus being wider out of the two. There is heavy traffic on the sample road mostly during the day, when the pilgrims come in large numbers for worshipping. Daytime traffic mainly comprises of cars tourist buses and transport tempos. The sample road is metalled and in excellent condition from Mhatarbachi Wadi village till Kondhwal Phata, that is just ahead of Nigdale village, so the average speed of vehicles here is as high as 90 Km/Hr. However, the road after Kondhwal Phata (turn) till the temple is not in good condition with the number of potholes on the road. Here the average speed of the vehicle in this patch is around 40 Km/Hr. The habitat along the sample road from Mhatarbachi Wadi village to the temple varies in terms of vegetation with alternate thick forested areas and open patches. Similarly, the road from Kondhwal Phata (turn) to Kondhwal village also has a lot of habitat variations with agricultural fields, forested areas as well as open patches. The vehicular traffic on control road, in comparison to the main arterial road, is very less with few local vehicles plying to Kondhwal village.

B) Sampling

The sampling was carried out five times, once during the month of December 2006 and once during the month of February 2007 to generate data for the winter season while one transect was taken in March 2007 and one in May 2007 to generate data for the summer season while the final transect was taken in July 2007 to capture data for monsoon season. A total of 76 transects of 10 km each were taken in the winter season, 55 transects of 10 km each were taken in summer season while 19 transects of 10 km each were taken in monsoon. As it pours very heavily and continuously throughout the monsoon season with foggy conditions, it is challenging to continue fieldwork thus resulting in a limited number of transects.

The sample and control roads were surveyed on a bike at a slow and steady speed of 10-15 km per hour. The road transects were taken after a gap of every hour both on sample road and control road to document number of animals crossing the road, their behavioral responses and to look for road kills, if there are any.

Primary information like starting point, end point, total distance, starting time, end time, season and weather conditions, quality of road were noted down before every transect. In case of a sighting, information about the exact time of observation, the type of specimen sighted right till its genus level, its exact distance from the vehicle, whether it was seen on sample road or control road was noted down. In case of behavioral observations when an animal was sighted different parameters like habitat around it, the straightness or curviness of the road and other specific behavioral responses if any were recorded. In case of a road kill, other than above parameters the length of the animal was measured. Traffic load was quantified by taking hourly counts from morning 8 a.m. to evening 7 p.m during the days of road transect and the numbers of vehicles coming into the sanctuary were estimated. Statistical analyses were restricted to ascertaining if the frequency of sightings of individual taxa were different across the sample and control road, across seasons using $\chi 2$ tests.

III. RESULT

Frequency of sightings

The sample and control roads were monitored with 150 transects of 10 km each in the year 2006-07 covering a total of 1,500 km. A total of 105 sightings were encountered in 55 transects out of 150 on sample road (rate of sighting = 0.07 per km) while 66 sightings were encountered in 41 transects out of 150 on control road (rate of sighting = 0.044 per km).

A total of 73 mammals belonging 6 families, (rate of sighting = 0.048 per km); 21 birds belonging to 2 families (0.014 sightings per km); 10 reptiles belonging to a single family (0.006 sightings per km) and single amphibian species (0.0006 per km) were recorded on sample road. Family Viverridae was represented the most in the overall sightings with Palm Civet (Paradoxurus hermaphroditus) seen most frequently with 34 sightings (0.022 sightings per km). Among the rodents, Indian Gerbille (Tatera indica) was sighted the most with 16 sightings (0.01sightings per km) followed by the Indian field mice (Mus booduga) with 14 sightings (0.009 sightings per km). Black napped hare (Lepus nigricollis) was sighted twice in our survey transect with a frequency of (0.0013 sightings per km).

Similarly, a total of 47 mammals belonging to 9 families (rate of sightings= 0.031 sightings per km); 18 birds belonging to 5 families (0.012 sightings per km) and single amphibian species (0.0006 per km) were recorded on control road. Palm civet (Paradoxurus hermaphroditus) was seen most frequently with 18 sightings (0.012 sightings per km) followed by the Indian field mice (Mus booduga) with 8 sightings (0.005 sightings per km), Black napped hare (Lepus nigricollis) with 6 sightings (0.004 sightings per km) and Indian Gerbille (Tatera indica) with 4 sightings (0.005 sightings per km). Amongst the birds, the most frequently seen species was the Turtle Dove (Streptopelia turtur) with 20 sightings (0.013 sightings per km) on sample road and 5 sightings (0.003 sightings per km) on control road. Rest of the species sighted appeared to be in very low numbers.

A simple $\chi 2$ test was performed and it was found that season has no change on the movement of animals. The chi-square analysis shows that there is a significant difference in the number of sightings between individual species at Bhimashankar (sample road) and the number of sightings between individual species at Kondhwal (control road) at 0.1% probability. Also, the chi-square analysis shows that there is no significant difference between the numbers of transects with & without sightings from sample and control road.

The frequency of road kills

In order to ascertain the impact of vehicular traffic on the fauna of Bhimashankar Wildlife Sanctuary along roads and to estimate the probability of road kills we used the following formula:-

The probability of an animal coming onto the road getting killed = (number of kills× mean sighting distance× total minutes spend on transects) / (total km× minutes × time of kill visibility× total sightings).

The parameters are as follows:

Number of Kills= 9, Mean sighting distance=12 m, Total minutes spend on transect= 4360, Total km= 1500, Minutes= 1 (60 sec), Time of Kill visibility= 24 hours, Total sightings= 171,

Thus we have, $\frac{(9\times12\times4360)}{(1500\times24\times60\times171)}$ = 0.00127 probability of an animal crossing the road being overrun by vehicle on sample road.

For the winter season, by using the same formula, we get the probability for an animal coming onto the sample road getting killed as- (2×15.5×2361)/ (760×24×60×95) = 0.0007 probability of an animal being overrun by the vehicle.

And for the summer season, by using the same formula, we get the probability for an animal coming onto the sample road getting killed as:- (2×7×1434)/ (550×24×60×71) = 0.0003 probability of an animal being overrun by the vehicle

No road-kills were observed and reported on the control road.

IV. DISCUSSION

Assessing the frequency of sightings

Callaghan, 2002 found that the frequency of traffic affects road-crossing success because animals need sufficient time between successive automobiles moving on a road to successfully cross the road. Our study estimated the average traffic load on sample road leading to the temple to be 434 vehicles/day (n=18) and 36 vehicles/hour (n=12) while on control road it was only 12 vehicles/day and 1 vehicle/ hour. However, these figures include high footfall days like *Shravani Somvar*, 15th August that happens to be a public holiday and *Mahashivratri* day. After excluding these three days the average traffic load on the sample road comes down to 134 vehicles/day and 13 vehicles/ hour. Despite the vehicular traffic, the number of animal sightings on the sample road was more than the control road with the most frequently encountered animal being the Palm Civet (*Paradoxurus hermaphrodites).* This is because they get attracted to plastic bags with leftover food and chips packets thrown by the tourists on the sample road. We observed the Palm Civet (*Paradoxurus hermaphrodites)* to be licking the salt and oil from the thrown-away packets. The next group of mammals which were sighted frequently after Civets were the rodents, first being the Indian Gerbille (*Tatera indica*) belonging to family Murridae. There were more sightings on sample road than on control road, the reason being the possible presence of better habitat conditions along the sample road. According to S.H. Prater, Gerbille's build their burrows near hedges and thickets or under bushes and prefer a more open type of habitat. Thus the natural open patches along the sample road favor the Gerbille population. Also, the grass growing on these open patches is an important food source for the Gerbille's. Just like Indian Gerbille (*Tatera indica*), the Indian field Mice (*Mus booduga*) was also sighted mostly on the sample road than on control road. We observed that other than better habitat for these rodent species along the sample road, the ready availability of food may also be another important factor. This is because these rodents relish on the leftover food thrown by the tourists. We have also observed that many insects get attracted to the vehicular lights and die on the road in this process (Rao et al. 2007). These insects automatically become food for the rodents attracting them to the roads. Amongst the birds, Turtle Dove's *(Streptopelia turtur)* were seen in more numbers (n=20) on sample road only between 6 p.m and 7 p.m. This is the time when these birds come onto the road for eating small pebbles lying on the road. These pebbles have a sort of grinding effect within the stomach of these birds.

We observed that there was a significant difference in the number of sightings in respective hours on the two roads. Out of 105 sightings on sample road, 51 sightings (almost 50%) were noted down between hours 7 p.m to 9 p.m. This coincides with the time when tourist vehicular flow goes down gradually as most of them prefer to return by or before 6 p.m owing to the bad conditions of the road, the visibility factor, and absence of reflectors that usually guides the vehicles at night.

We also observed that there is no change in the movement of animals based on the seasons (winter and summer). These results are similar to what Kumara et al. (2000) and K.S. Gopi Sundar (2004) have concluded in their studies. There were no animal sightings during monsoon season on either sample road or control road. This may be because rainfall in Bhimashankar is as high as 5000 mm,

humidity is almost 100% and it's very foggy during the whole of the monsoon (Jagdale, 1994). The harsh monsoon weather lasts for 4 months (June-September). Thus for the remaining eight months and two season's animals become opportunistic feeders and show no significant difference in their movement patterns.

Assessing the frequency of Road-kills

Michael Starr, 2004 in his study concluded that the frequency of road-kills along a highway was about 0.29 animals/km, while the frequency of road-kills along the rural road was about 0.13 animals/km. The frequency of road kills was greater for the sample road than for the control road, which supports our results. As per our study results, the probability of an animal coming on to the sample road and getting killed due to a vehicle collision is as low as 0.00127 in Bhimashankar Wildlife Sanctuary while no road-kills were observed and reported on the control road.

The quality of the road plays a very important role in determining the probability of animals getting killed on road (Trombulak and Frissell 2000). At our field site, it was observed that the road from Kondhwal Phata (turn) to Bhimsahankar temple, a major portion of the sample road (almost 3 km out of 5 km) is in bad condition. Though the road is metaled there are many potholes and cracks on this road. Naturally while driving on this road the speed of vehicles decreases and comes down to almost 30-40 km/hr. Callaghan, 2002 found that the speed of the vehicle affects an animal's ability to cross the road because animals need sufficient time between successive automobiles moving on a road to successfully cross the road. Hence this may be one of the reasons to find fewer animals getting killed on the sample road despite heavy traffic. The probability of an animal coming on to the road getting killed due to a vehicle collision in winter season is 0.0007 and that in summer season is 0.0003. Both these values are extremely low suggesting that the issue of road kills in Bhimashankar Wildlife Sanctuary is definitely not a big one.

V. Conclusion

Our study suggests that animal mortality rate due to vehicular traffic is quite low and that populations of most species may not be significantly affected by road kills due to ongoing traffic in Bhimashankar. Though Bhimashankar Wildlife Sanctuary harbors many red data species, no species of conservation concern were reported to be killed by vehicle collisions during this study. Thus the results of this study are in contrast with those obtained from other regions in the country. Though the sample size of our transects was limited, we believe much more research is required to ascertain the actual magnitude of road-kills in relation to the population of particular species in this area. Studies elsewhere have documented that roads perform as physical barriers to the movements of animals often changing their behavior (Daveley and Stouffer 2001) but our results are in contrast to these studies. However, the overall disturbance effects of roads on wildlife would be underrepresented by road-kills and animals are possibly affected much more by other effects of roads such as habitat fragmentation, stress due to the noise of traffic etc. (Van der Zande et.al 1980, Goosem 1997, Forman and Alexander 1998). Considering that the State Government of Maharashtra is undertaking several large-scale expansions of the road network within the State, many more studies are required before we can hope to better understand the impact of roads on wildlife.

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