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RESEARCH ARTICLE

A CASE STUDY ON MONKEY TRANSCIENCE OWING TO VEHICLE COLLISIONS DURING THE SEASONAL PERIODS ON THE HILLY REGIONS OF NILGIRIS TAMIL NADU – SOUTH INDIA

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ABSTRACT

Summer seasons provide more entertainment to the people of India due to vacations of schools and colleges who seek to spend their breaks in hill stations. Crisis begins when tourists rush to hill stations, causing traffics, environmental pollution, pausing the vehicles, feeding and throwing the food and snack items on road sides paving the way to vehicle collisions in-between the humans and animals. Nilgiri ghat road and the surrounding area is a home for the three major species of primates group, (*Macaca radiata*, *Macaca silenus* and *Trachypithecus johnii).* We studied the mortality rate among these species owing to vehicle collisions during the summer vacation period. The study area was divided into various zones separated with markings and the mortality rate along with the age and sex were recorded each day for a total of 98 days till the end of the vacation. Mortality recorded for each week was combined together to rate the total mortality that occurred during each day of the week. Computation was done using the SPSS software version 20. Factors such as timings of the accidents, chief accidental zone and the species which utilizes the road to the maximum were estimated and were compared with the total mortality that had been recorded. Transience was much influenced by the accidental timings among the various zones and the major species that was much pretentious was the bonnet monkey (*Macaca radiata)* which indirectly predicted the tourists' trip to Nilgiris contributing to the vehicle collisions and transience among the primate groups. This paper predicts the impact of tourism on the primate group owing to vehicle collision. Primates have more interaction with the humans and linger along the road sides to eat the food from them. The case study addresses the need to protect the valued creatures of the nature not only the primates but also the other organisms from that PA and to generate awareness among the public regarding the issue.

INTRODUCTION

Every year in India incalculable collisions occur between motor vehicles and animals resulting in considerable loss of animal life. Being a tropical country with extreme hot climate, the hill stations serve as a good recreational place to escape from the scorching sun during the summer that falls from March till the end of May. As a developing country, with a huge population, the country has immense two wheelers when compared to four wheelers and roadways contribute to the Indian transport in a major way. Connectivity being a priority, large areas of pristine habitats has been sacrificed for laying roads resulting in several direct and indirect negative impacts on ecosystems [4]. Vehicular densities on Indian roads have increased from 0.3 to 30 million in the last 50 years and many of them pass through PA and non-PAs [10; 13].

High densities of roads passing through protected areas (PA) often result in mortality of large bodied animals. Vehicle strikes are associated with mortality and roads [12] and noises from the vehicles cause disturbances [11]. Much attention is given to understanding and mitigating the impact of roads through PAs on these animals as roads experience some form of traffic all through the year [5, 8, and 7]. Unlike in many developed countries, relatively large proportion of the traditional religious enclaves and scenic landscapes in Asia including India are located inside PAs. These areas attract millions pilgrims and tourists to the PA which brings additional seasonal traffic; the impact of which, on fauna, is not known. [14]. Pertinent questions for those seeking to conserve these populations are how species are using the road environment and what factors are contributing to wildlife being involved in collisions with vehicles. Use of the road environment is typically species specific, with many animals completely avoiding the roads and others being attracted to it [2, 3].

Nilgiri bioreserve serves as an abode for a variety of endangered species and especially the roads of the hill station are inhabited by the monkeys which are much engrossed towards the tourists for the food being provided to them. Hence the monkeys reside on the road edges and inhabit the

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trees near the roads as their home. The foot hill of Nilgiris serves as a superior place for the bonnet monkeys (*Macaca radiata*), **the LionTailed Macaque** *(Macaca silenus)* and **the Nilgiri Langur** *(Trachypithecus johnii)* which are predominantly occupying these area. Palaniappan from Hindu News Paper reported about dumping the waste from Kallar to Udhagamandalam stretch that traverses through the ecologically sensitive Nilgiris Bio-Reserve Sphere (NBR) in which he also mentioned about the monkeys which are getting run over by the vehicles and it is a common sight to see large number of monkeys on either side waiting for the feed provided by tourists. During the seasonal periods, these monkeys inhabit the roads, eating and crossing across the roads leading to accidents and deaths.

Hence the study was conducted to evaluate the fatality rate of the monkeys along the foot hills of Nilgiri Biosphere during the seasonal periods to: (a) compute the use of the roadside border by the monkeys and to identify the specific species that makes regular use of the roads; (b) to identify the major accidental prone habitat to implement the mitigation efforts; (c) to compute the accidental timings (diurnal or nocturnal) to estimate the death rate of the monkeys during the seasonal periods; (d) to identify the sexual group which are more subjected to vehicle collision on roads pertaining to the monkey groups; (e) to categorize the age group of the monkeys, that falls as a trap to vehicle collisions owing to the seasonal tourists.

METHODOLOGY

Study Area

Nilgiri Biosphere Reserve is an International Biosphere Reserve in the Western Ghats. The Nilgiris is a range of mountains with at least 24 peaks above 2,000 metres (6,600 ft), in the western most part of Tamil Nadu state at the junction of Karnataka and Kerala states in Southern India. They are part of the larger Western Ghats mountain chain making up the southwestern edge of the Deccan Plateau. Kallar, Burliyar and Katteri are situated on National Highway 67 between Mettupalayam and Coonoor on the Coonoor Ghat Road at an altitude of 800 to 830 metres above the mean sea level. It is also on the border between the Coimbatore District and The Nilgiris District. The main ghat road to Udhagamandalam starts from Kallar, which is located at 10 kms from Mettupalayam. Kallar has thick vegetation covering tall trees which serves as an abode for a large group of monkeys. The scenic beauty of Kallar attracts more number of tourists, to refresh and recharge their engines, before the climbing of the hair pin bends.

Burliyar is a village in Coonoor Taluk of The Nilgiris District. Burliar is best known as a rest stop on this Ghat Road located at 6 kms from Kallar. Most people are employed in the running of small shops and restaurants that cater to the needs of travelers [9]. The horticulture department sales here are very popular with tourists, and many buy uncommon fruits at reasonable prices. It is the place where most buses stop for the convenience of passengers taking the picturesque journey to Ooty and Coonoor.

Marapalam, is located in the next 7 kms from Burliyar to Coonoor. Wherever there is sufficient space on either side of the road for parking, tourists tend to take a small break from the up-hill journey. While stopping there, after the light eats or having their food, the tourists leave a number of plastic water bottles, packaging materials used for bringing food and paper plates along the entire stretch. A number of monkeys are getting run over by the vehicles. It is a common sight to see large number of monkeys on either side waiting for the feed provided by tourists. From Marapalam it is about 5 km to Coonoor and in between is Katteri, the next consequent place located at 3 kms from Marapalam to Coonoor. From Katteri to Coonoor, the thick vegetation gets gradually reduced as the municipality begins and human interferences are commonly observed.

Fatality survey

The surveyed area for the conflict of interest was from Kallar to the Coonoor, a total stretch of 18 kms. The hot spot areas were Kallar, Burliyar, Marapalam and Coonoor ghat road. Four teams comprising of three members in each group examined the accidents and fatality that happened during each day and night. Each area based on the kilometers was divided into many segmental zones. Each zone comprised of 1 km and the zones were separated with paint markings on the roads (Refer Table 1).

After each death, the carcasses were removed from the spot and the accident spot was numbered with a chalk to avoid recounts of the deaths. For the each 24 hours the markings was done and totaled at the end of each day and hence it was counted from March 1st to June 6th 2012 for a total of 98 days. Each day of the week was noted for 14 times and hence the seven days of the week was equalized for 98 days (7 ×14= 98) for the convince of calculations.

Accident timings

The timings during which the collision happened were noted from the place where the accident happened. Since the examination zones covers for 1 km and more for each member and the exact timings of the incident could not be calibrated, an approximate time was noted based on the carcass of the monkeys and was compiled and classified together as nocturnal and diurnal timings. The nocturnal timings were taken from evening 6 P.M till 5 A.M in the morning categorized based on the darkness prevailing in those areas before the sun light arrives and diurnal timings were taken from 5.A.M till 6.P.M.

Statistical Analysis

All statistical calculations were performed using the SPSS version 20. Pearson correlation factor was used to determine the relationship between the accident timings and mortality rate. One way ANOVA was used for testing the significance of variations across each area with the total death rate during the seasonal periods. Linear regression analysis was carried out separately for accident timings (diurnal and nocturnal) with the three monkey species documented in those areas. It was done to determine the maximum threshold of the species mortality on roads during the seasonal periods in relation to the accident timings.

RESULTS

Mortality documented

During the 98 days of observation, about 57 monkeys were documented for road killed due to accidents on the hilly roads of the Nilgiri Bioreserve and the mortality rate was noted according to the day wise and is represented in the (Table 4).

The major was the bonnet monkey, which was more in number and was frequently observed along the road sides where the human inferences were prominent. The second among the list was Nilgiri langur and followed by Lion Tailed macaque. The sexes of the monkeys were also documented along with the fairly assumed age of the monkeys. Females were more countable than males and the young siblings were often in trouble to lose their lives in road accidents (Table 2 and 3).

Table 1 Particulars of the sampling area along the Ghat road of Nilgiris

Sl.no	Accidental area	Road length(km)	No. of zones examined
1.	Kallar to Burliyar	6	6
2.	Burliyar to Marapalam	7	7
3.	Marapalam to Coonoor	5	5

Timings and days of maximum mortality

As already mentioned in the methodology part, a rough estimation of the accident timings was noted and compiled together as nocturnal and diurnal timings. The accidents were observed mostly during the day timings and the mortality rate was more during the weekends especially on Saturdays and Sundays (Table 4). Accidents during the weekends were more since the tourists, park their vehicles along the foot hills, for hill viewing, during which they feed the monkeys and have fun with their actions. This sets a major cause for the monkeys to dwell on the road sides waiting to consume the foods from the tourists.

It predicted whether the variables are dependent and indicated whether the variables increase or decrease together (Table 5). The Pearson correlation coefficient(r) in relation to day time and night time accidents with total number of deaths was 0.913(diurnal), 0.840(nocturnal) and that was statistically significant ($p < 0.005$). There was a strong, positive correlation between accidents that happen during the day time, which was statistically significant ($r = 0.913$, $p < 0.005$).

Area in relation with fatality

Fatality rate according to each area was calculated based on the total number of deaths that have been recorded in those areas and their means were compared using the one–way ANOVA to determine the area that predicts the accidental hotspot among the ghat road (Table 6). There was a statistically significant difference between groups as determined by one-way ANOVA ($F = 6.018$, $p = 0.087$) in the area of Kallar to Burliyar, ($F = 2.909$, $p = 0.166$) in the areas of Burliyar to Marapalam and ($F = 2.571$, $p = 0.191$) in the areas of Marapalam to Coonoor. The mean comparison among the areas clearly depicts that Kallar to Burliyar region has more accidents in comparison to the other two regions that has been documented.

Accident timings and species mortality rate

Species transience was greatly influenced by the timings when observed in the field area and hence species mortality rate in relation to accidental timings (Diurnal and Nocturnal) was estimated by linear regression analysis. Regression was calculated individually for nocturnal and diurnal timings to identify the relationship between the species and timings and a significant result was observed. The upshot predicted that mortality rate was much influenced by the diurnal timings (Table 7). The dependent variables were the accident timings and the independent variables taken were the three primate species. The R^2 value for the dependent variable (Diurnal timings) was 0.984 and the adjusted R^2 value was 0.964 which predicts that the species mortality rate was much influenced by the accident timings and there was a positive correlation between the two variables. The p value was 0.004 which was statistically significant and hence the assumption was correct. Similarly the R^2 and the adjusted R^2 value for Nocturnal timings was 0.968 and 0.937.

Table 2 Mortality rate among the species along with their sexes

Sl.no	Common Name	Species Name	Males	Females	Total	Total %
1.	Bonnet monkey	*Macaca radiata*	17	22	39	68.42
2.	Nilgiri Langur	*Trachypithecus johnii*	5	6	11	19.29
3.	Lion tailed Macaque	*Macaca silenus*	2	5	7	12.28
			24	33	57	99.99

Table 3 Documentation of mortality analysis among the monkeys pertaining to their ages

Sex	Younger ones 4 yrs)	Adults (4- 10 yrs)	Older ones (< 10 yrs)	Total
Males				
Macaca radiata	9	4	4	17
Trachypithecus johnii	2	1	2	5
Macaca silenus	1	1	0	2
Females				
Macaca radiata	12	4	6	22
Trachypithecus johnii	2	2	2	6
Macaca silenus	2	2	1	5

Mortality rate due to vehicle collisions in relation to accident timings was calculated using Pearson correlation factor.

Table 4 Total summary of the mortality based on accident timings and days and primate species

Day	Day Time	Night Time	B	NL	LTM	Kallar to Burliyar	Burliyar to Marapalam	Marapalam to Conoor	Total Deaths
Thursday	2	1	1	1	1	1	1	1	3
Friday	7	1	5	2	1	5	1	2	8
Saturday	7	3	8	1	1	5	4	1	10
Sunday	8	6	9	3	2	6	5	3	14
Monday	6	2	6	1	1	5	1	2	8
Tuesday	3	2	3	1	1	3	1	1	5
Wednesday	7	2	7	1	1	3	5	1	9
	40	17	39	10	8	28	18	11	57

The p value was 0.009 which was greater than 0.005 and hence the results were statistically significant.

Table 5 Correlation in relation to accident timings and total mortality rate

		Diurnal	Nocturnal	Total mortality
Diurnal	Pearson Correlation	1	.545	.913**
	Sig. (2-tailed)		.206	.004
	N	7	7	7
Nocturnal	Pearson Correlation	.545	1	.840*
	Sig. (2-tailed)	.206		.018
	N	7	7	7
Total mortality	Pearson Correlation	.913**	.840*	1
	Sig. (2-tailed)	.004	.018	
	N	7	7	7

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

DISCUSSION

Conducting surveys during the seasonal periods on the hilly regions established that variety of fauna lose their life due to vehicle collisions. The study was conducted from the pre-seasonal to the end of the season/vacation period that is for a period of three and a half months. Although some reptile and amphibian fatalities were recorded, analyses were strictly restricted to mammals and especially only monkeys. Similarly the investigation excluded the survey on vehicles as it could miscalculate the mortality rate and also the Nilgiris ghat road to Ooty is a single road without any diversions and hence the vehicles from Kallar to Coonoor would pass through the same passage and exception is the very few vehicles countable in number belonging to the small population of the people living along the road sides of the ghat road. The behavior of animals in different circumstances is often overlooked when modeling fatalities on roads in relation to traffic flow [15], although models taking animal speed into account have suggested that slow moving species are at greater risk [6]. Calculations were based on the vehicle traffic that would be observed between the weekdays and weekends. Usually there would be greater traffic during the weekends when more populations of people come to enjoy their summer holidays. However monkeys are not slow moving animals, but during the seasonal periods when there is more traffic and sound horns, although they attempt to cross the roads they get jammed in-between the small vehicles due to the horror of sound horns. Special attention was paid to the tourists' spot areas where the tourists park their vehicles along the road sides for their resting and site seeing. It was such places where the interactions occur between the monkeys and humans. People provide food items and fruits to the monkeys which consume them and mark their presence along the roadsides. The spots from Kallar to Burliyar recorded more deaths owing to the scenic beauty of the foot hills, curvature of the roads and high traffic volume. Moreover owing to the summer season, there would be scarcity for food in these regions due to the lack of rain and hence the monkeys come in search of food to the forest corridors where there are human interventions. *Macaca radiata* (Bonnet monkey) had more communications with the human population and when observing their behavior, they were not anxious about the humans. *Trachypithecus johnii* (Nilgiri Langur) and *Macaca silenus* (Lion tailed Macaque) was noted very rarely during the mid regions of the day. Lion tail Macaque is caught very hardly ever in sight, however due to habitat destruction they move from the dense forests to the corridors for food. One of the characteristic features of these macaques is that, they do not leap from tree to tree instead they climb down and walk on the ground to reach the other tree, which leads to accidents and death among those species. However their mortality rate due to vehicle collision is a rare phenomenon. Females and younger ones were more pruned to accidents due to their juvenile and unripe behavior whereas mature males and adult ones escaped owing to their vigilant nature. Future survey will be made on their behavioral nature. The presence of a vehicle will vary with traffic volume, the proximity to human habitation and temporal variation due to the season, the day of the week and the time of day [1].While the presence of both an animal and a vehicle are necessary for a collision, the likelihood of a collision occurring will be influenced by road features like curvature and driver visibility, the time of day (tiredness of the driver), and the reason for the animal being on the roadside in the first place (i.e., foraging on the verge or actually trying to cross the road). Mortality recorded were highest during the week ends and especially in Sundays (14) and in Saturday it was (10) owing to increased traffic. During the night times, the tourists' vehicles do not stop in between the journeys on the hill road and hence the monkeys have less chance to get hit from the vehicles. From observations, most of the transience in primates was due to the tourists, who throw the food items from the moving vehicles, which got scattered on the roads and that invited the primates to the roads which evidently lead to mortality.

This study for the first time documents the mortality among the primates and interestingly striking results were obtained when compared with the accident prone zones, timings and the primate species. Moreover the country like India treats primates as a servant of God according to the Hindu mythology; hence the monkeys are grown in temples and in some religious pilgrimages where the people offer food to them. This has become a ritual practice for the people of India to offer their food to the monkeys, which makes them to intermingle with the humans and dwell in human habitats. The same phenomenon was observed on the hilly region which makes to lose their life due to the vehicle collisions at some stage in the summer holiday seasons of India.

MITIGATION IMPLICATIONS

There is greater loss of fauna during the tourist seasonal periods on the hill stations owing to the vehicle collisions. Like in many Asian countries, the PA management has ignored the issue of roads being potential drivers for the loss of biodiversity [14]. The endangered and threatened species are paid more attention, but when coming to the transience of monkeys, there is meager consideration. When analyzing in depths, the normal feeding habits of the monkeys has distorted and they play a very important role in the seed dispersal in the

forests and this would be conversed in the future communications.

We recommend few strategies to avoid the transience of the primates like not to pause the vehicles where the monkeys are present, avoiding sound horns and strictly not to throw the food along the road and road sides. The government along with the co-operation of the non governmental agencies and public should create more awareness regarding the transience of monkeys and must alert the tourists' vehicles through pamphlets and banners during the seasonal phases. Night travel along the hill regions could be reduced. Unnecessary pausing of the vehicle should be penalized. Further, it is advisable to have more public transport vehicles like buses than allowing private cars to reduce vehicular density well below threshold [14]. Thus maintaining the natural resource is not only the role of the government but also of the public to save the existence of the fauna by not intervening in their habitat, for each species life is much valued in ecological management.

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