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Impact of Road Traffic on Mysore Slender Loris *Loris lydekkerianus lydekkerianus* in Keelaveliyur, Tamil Nadu, India

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Authors' contributions

This work was carried out in collaboration between both authors. Author RL collected the data, analyzed the data and wrote the first draft. Author VG designed the study and did the final draft. Both the authors read and approved the final draft.

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ABSTRACT

Roads directly affect the wildlife by mortality through collisions with vehicles. Mysore slender loris *Loris lydekkerianus lydekkerianus* is distributed in drier regions of southern India. The present paper deals with the impact of road traffic on Mysore slender loris in Keelaveliyur, Tamil Nadu, India. Road kills were recorded from four roads varied in distance from 8 km to 11 km: Keelaveliyur to Thogaimalai, Keelaveliyur to Melapatti, Keelaveliyur to Othakadai, and Keelaveliyur to Pathiripatti. In total, 41 lorises, consisting of 21 adult females, 12 adult males, three subadult females, and five subadult males, were found killed on road by the road traffic from January 2017 to

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December 2021. Of the four roads differed in traffic volume, more number of roadkills was found on Keelaveliyur to Othakadai road, followed by Keelaveliyur to Pathiripatti, Keelaveliyur to Melapatti, and Keelaveliyur to Thogaimali. Keelaveliyur to Pathiripatty, though with lesser vehicular traffic, was found with more number of roadkills and can be attributed to the availability of more number of trees not only along the roadside but also perpendicular to the road. Besides, abundance of loris was more along this roadside. Extensive removal of trees along the roadside for developmental activities not only reduced the availability of trees but also the population of loris in and around Keelaveliyur in recent years.

Keywords: nocturnal primates; vehicles; abundance; canopy contiguity; developmental activities.

1. INTRODUCTION

Roads are an intrusion to wildlife [1] as they indirectly affect the distribution pattern of animal [2], breeding [3], heterozygosity, genetic polymorphism [4] and directly by mortality through collisions with vehicles [5]. Several studies documented that from amphibians to mammals are affected by road traffics [6-9]. However, such studies are more common in the western countries than in Asia. It has recently been realized in India that highways cause severe impact to wildlife and their habitats [10,11,12,8]. The slender loris *Loris lydekkerianus*, with two recognized subspecies (Malabar slender loris *Loris lydekkerianus malabaricus* distributed in the wet evergreen forests of the Western Ghats and the Mysore slender loris *Loris lydekkerianus lydekkerianus* distributed in drier regions of southern India), is one of the two nocturnal primates found in India. Unlike macaques and langurs, lorises are poorly studied as they are small in size and nocturnal in habit. However, slender Loris received relatively more attention in southern India during the past two decades. Here, we present the impact of road traffic on Mysore slender loris *Loris lydekkerianus lydekkerianus* in Keelaveliyur, Tamil Nadu, India.

2.1 Study Area

The present study was carried out in and around Keelaveliyur, a small village situated between 10^0 44' 39''- 10^0 44' 17'' N and 78^0 28' 44''-78^0 28' 54 E in Thogaimalai Block in Karur District of Tamil Nadu, India. The village was selected as it harbours significant number of lorises in and around the village. Temperature varied from 28˚C in January to 42˚C in the month of May. The variation of temperature exhibits hot and dry weather with low degree of humidity throughout the year. The average annual rainfall varied from 356.1mm in northeast monsoon to 270.3 mm in southwest monsoon. Nearly 490 families, largely agrarian, reside in this village. As per the census 2020, the human population is 2340 which includes 1181 male and 1159 female. Agriculture is the main occupation of the people of this village and paddy, sorghum *Sorghum bicolor (L, Moench 1794),* sunflower *Helianthus annuus (L. 1753) and* redgram *Cajanus cajan (L. Huth 1893)* are the main crops cultivated. The present study was carried out in four different roads that radiate from keelaveliyur (Fig. 1): Keelaveliyur to Thogaimalai (9 km), Keelaveliyur to T.Melapatti (8 km), Keelaveliyur to Othakadai (11 km), and Keelaveliyur to Pathiripatti (11 km). Keelaveliyur to Thogaimalai road is dominated largely by *Prosopis juliflora* (Sw. DC., 1825) followed by *Tamarindus indica* (L. 1753) and *Commiphora caudata* (Engl. 1883) on either side. Keelaveliyur to Melapatti is dominated largely by *Prosophis juliflora* followed by *Azadirachta indica* (A.Juss 1830). Keelaveliyur to Othakadai is dominated largely by *Tamarindus indica* followed by *Azadirachta indica*, *Wrightia tinctoria* (R.Br.1810). Keelaveliyur to Pathiripatti is dominated largely by *Tamarindus indica* followed by *Azadirachta indica*, *Prosopis juliflora*, and *Tectona grandis* (L 1782). Othakadai to Thogaimalai road is the main road that connects Tiruchirappalli, a city and thus traffic is heavy in this road. The other two roads lead to small hamlets and thus road traffic is considerably less.

Fig. 1. Map showing the study area

2. METHODS

Roadkills were recorded from four roads: Keelaveliyur to Thogaimalai (9 km), Keelaveliyur to Melapatti (8 km), Keelaveliyur to Othakadai (11 km), and Keelaveliyur to Pathiripatti (11 km). Observations were made from January 2017 to December 2021. All the four roads were travelled by motor bike with 10-15km speed/hr during the morning hrs (06:00-08:00 hr) twice in a month. Once a roadkill is sighted information such as date, geographical location, age class (adult, subadult, and youngone if possible), sex (if possible), and status of the kill (fresh-assumed to be killed >5 hours ago, very fresh-assumed to be killed <5 hours ago, old – assumed to be killed a day ago, and very old-assumed to be killed more than a day ago) were recorded and the recorded roadkill is removed immediately from the road to avoid recounting. Besides, local people were also instructed to inform if any dead loris found in their vicinity.

In order to assess the population of loris along the road sides, all the four roads were visited once in a month during the night hours between 08:00 pm to 11:00 pm and number of lorises sighted was noted. Census of loris was made by flashing powerful lights on the canopies present on either side of the road. Orange reflection from the eyes of the loris when contacted by light indicated its presence. Besides, characteristic call of loris was also used to know its presence.

All the vegetation found on the either side the four roads were identified up to species level and counted once in a year. Number of vehicles (two wheelers to heavy vehicles) used the four roads during day and night hours was counted once in a year to know the intensity of vehicular traffic.

3. RESULTS

In Total, 1141 individuals belonging to nine plant species were recorded on either side of the Keelaveliyur to Thogaimali which is an 8 km stretch (Table 1,). Of the nine species, *Prosopis juliflora* dominated the entire stretch on either side followed by *Tamarindus indica*, *Azadirachta indica, Commiphora caudata, Wrightia tinctoria, Delonix regia* (Bojer 1837)*, Tectona grandis, Syzygium cumini* (L. 1912), and *Albizia amara* (Roxb 1837). A total of 1204 individuals belonging to 16 species was recorded on either side of the Keelaveliyur to Othakadai (Table 1) which is an 11 km stretch. Of the 16 species, *Prosopis juliflora* dominated the entire stretch followed by *Tamarindus indica* and *Azadirachta indica.* 1641 individuals belonging to 17 species were recorded on either side of the Keelaveliyur to Pathiripatti which is an 11 km stretch. Of the 17 species, *Prosopis juliflora* dominated the

entire stretch. In Total, 1424 individuals belonging to 16 species were recorded on either side of the Keelaveliyur to Melapatti which is an 8 km stretch. Of the 16 species, *Prosopis juliflora* dominated the entire stretch. In general, the abundance of plant species on either side the select four roads showed a declining trend over the study years (Fig. 2).

Of the four roads surveyed, more number of lorises was recorded in Keelaveliyur to Pathiripatti and Keelaveliyur to Melappati roads (Table 2). A maximum of 14 individuals of loris was sighted in 2017 in the Keelaveliyur to Melapatti road and that number gradually reduced in the subsequent years. A maximum of seven individuals of loris was sighted in 2018 in the Keelaveliyur to Othakadai road and that number reduced to two in 2020 and 2021. A maximum of 15 individuals of loris was sighted in 2018 in the Keelaveliyur to Pathiripatti road and that number gradually reduced in the subsequent years. A maximum of four individuals of loris was sighted in 2017 in the Keelaveliyur to Thogaimalai road and that number gradually reduced in the subsequent years.

Table 1. Details of plant species found on either side of the road

S. No.	Road and distance in km	Plant species and its abundance (in 2017, 2018, 2019, 2020)
1	Keelaveliyur to Thogaimalai 9 km	*Azadirachta indica* (70,55,40,40,37), *Tamarindus indica* (450, 300, 289, 289, 289), *Prosopis juliflora* (500, 500, 300, 150, 82), *Wrightia tinctoria* (10, 6, 6, 6, 4), *Commiphora caudata* (75, 75, 50, 15, 3), *Delonix regia* (25, 22, 21, 21, 21), *Tectona grandis* (1, 1,1,1,1), *Syzygium cumini* (1, 1, 1, 1, 1), *Albizia amara* (15, 8, 6, 6 ,6)
2	Keelaveliyur to Othakadai 11km	*Tamarindus indica* (140, 112, 95, 81,81), *Holoptelea integrifolia* (8, 8, 6, 6, 6,), *Azadirachta indica* (115, 95, 60,48,48), *Ziziphus nummularia* (25,18,16,16,16), *Vachellia seyal* (20,20,15,15,5), *Delonix regia* (1,1,1,1,1), *Albizia amara* (7,7,3,3,3), *Prosopis juliflora* (650,400,250,200,132), *Wrightia tinctoria* (25, 20,18,14,28), *Delonix elata* (50, 50, 45, 40, 37), *Borussus flabellifer* (1,1,1,1,1), *Commiphora caudata* (85,70,70,50,25), *Pongamia pinnata* (70,70,65,65,65), *Ficus religiosa* (3,3,3,3,3), *Ailanthus excelsa* (3,3,3,3,3), *Tectona grandis* (1,1,1,1,1,)
3	Keelaveliyur to Pathiripatti 11km	*Tamarindus indica* (214,214,214,214,214), *Holoptelea integrifolia* (6,6,6,6,6), *Wrightia tinctoria* (8,6,6,5,5), *Azadirachta indica* (50,42,35,32,28), *Ficus religiosa* (1,1,1,1,1), *Polyalthia longifolia* (4,4,4,4,2), *Pongamia pinnata* (25,25,20,14,14), *Moringa oleifera* (4,2,2,2,2,), *Prosopis juliflora* (550,400,170,170,142), Vachellia seyal (50,40,25,25,16), *Cocos nucifera* (12,12,12,12,12), *Tectona grandis* (650,650,650,647,647), *Ziziphus nummularia* (3,3,3,3,3),*Thespesia populnea* (1,1,1,1,1), *Delonix elata* (8,8,8,8,8), *Ailanthus excels* (6,6,6,6,6) *Commiphora caudate* (50,50,30,28,14)
4	Keelaveliyur to Melapatti 8 km	*Delonix regia* (2,2,2,2,2), *Tamarindus indica* (15,8,3,3,3), *Azadirachta indica* (65,50,38,35,32), *Moringa oleifere* (4,4,2,2,2), *Prosopis juliflora* (1200,850,850,613,613), *Albizia amara* (8,8,2,2,2), *Delonix elata* (15,15,15,15,8), *Ailanthus excelsa* (2,2,2,2,2), *Pongamia pinnata* (25,25,8,8,8), *Thespesia populnea* (12,12,9,9,2), *Commiphora caudata* (25,18,12,12,12), *Holoptelea integrifolia* (1,1,1,1,1), *Cocos nucifera* (8,8,8,8,8), *Borassus flabellifer* (1,1,1,1,1), *Wrightia tinctoria* (34,28,23,11,7), *Vachellia seyal* (15, 15,15,2,2)

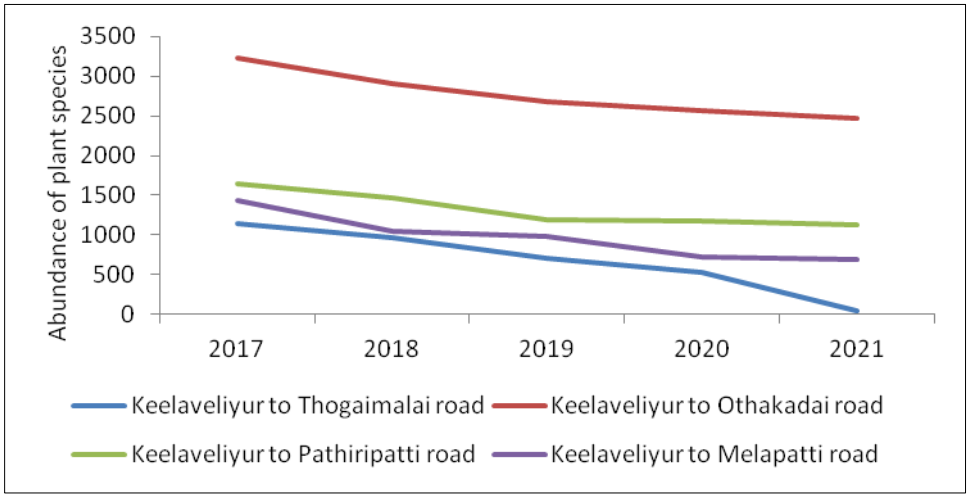

Fig. 2. Abundance of plant species on either side of the road during the study period

Table 2. Number of lorises found on either side of the road and number of vehicles used the roads during the study period

Road	Year	Distance Covered (in km) (Km)	Number of animal sighted		Number of vehicles recorded	
			Total	Per. Km	Day hours	Night hours
Keelaveliyur to Melapatti	2017	8	14	1.75	256	204
	2018	8	17	2.13	263	212
	2019	8	8	1.00	298	223
	2020	8	7	0.88	301	243
	2021	8	4	0.50	314	251
Keelaveliyur to Othakadai	2017	11	6	0.55	3980	2501
	2018	11	7	0.64	4002	2617
	2019	11	3	0.27	4056	2678
	2020	11	2	0.18	4108	2980
	2021	11	2	0.18	4222	3199
Keelaveliyur to Pathiripatti	2017	11	13	1.18	140	98
	2018	11	15	1.36	152	98
	2019	11	9	0.82	158	102
	2020	11	8	0.73	158	108
	2021	11	7	0.64	221	115
Keelaveliyur to Thogaimalai	2017	9	4	0.44	2890	1943
	2018	9	3	0.33	3021	1967
	2019	9	2	0.22	3098	2007
	2020	9	1	0.11	3678	2019
	2021	9	1	0.11	3986	2989

In total, 41 Mysore slender lorises were found killed on road by the road traffic (Table 3, Fig. 3). It includes 21 adult females, 12 adult males, three subadult females, and five subadult males. Of the 41, 30 were found on the selected four roads while 11 were found inside the rural network roads. Of the four roads, more number of roadkills were found on Keelaveliyur to Othakadai road (16: eight adult females, six adult males, one subadult males, and one subadult females), followed by Keelaveliyur to Pathiripatti with nine (five adult females, three subadult males, and one subadult female) Keelaveliyur to Melapatti with four (two adult males, one adult female, one subadult female), and Keelaveliyur to Thogaimali with one adult female.

Table 3. Details of Loris-roadkill found on roads in and around Keelaveliyur

S. No	Age class	Date	Road	kill history
1	Adult female	10.08.2017	Keelaveliyur to Othakadai	Old
2	Adult male	16.05.2017	Keelaveliyur to Othakadai	very fresh
3	Adult female	27.09.2017	Keelaveliyur to Othakadai	Old
4	Adult female	24.12.2017	Keelaveliyur to Othakadai	Fresh
5	Adult female	27.12.2017	Keelaveliyur to Pathiripatti	Fresh
6	Adult female	23.05.2017	Keelaveliyur to Pathiripatti	Old
7	Adult female	23.12.2017	Keelaveliyur to Pathiripatti	Fresh
8	Adult male	25.11.2017	Rural network roads	Fresh
9	Adult female	07.05.2017	Rural network roads	very fresh
10	Adult female	23.12.2017	Rural network roads	Fresh
11	Adult male	13.11.2018	Keelaveliyur to Metupatti	Fresh
12	Adult female	22.03.2018	Keelaveliyur to Othakadai	Old
13	Subadult male	01.05.2018	Keelaveliyur to Pathiripatti	very fresh
14	Subadult male	12.04.2018	Keelaveliyur to Pathiripatti	Fresh
15	Adult female	20.08.2018	Keelaveliyur to Pathiripatti	Fresh
16	Male	24.12.2018	Keelaveliyur to Pathiripatti	Old
17	Adult female	10.03.2018	Keelaveliyur to Thogaimalai	Old
18	Adult male	16.09.2018	Rural network roads	Old
19	Adult male	21.02.2018	Rural network roads	Old
20	Adult female	18.08.2018	Rural network roads	Fresh
21	Adult female	13.12.2018	Rural network roads	Fresh
22	Adult female	27.03.2019	Keelaveliyur to Othakadai	Fresh
23	Adult female	15.10.2019	Keelaveliyur to Othakadai	very old
24	Subadult male	01.06.2019	Keelaveliyur to Othakadai	very old
25	Subadult female	08.08.2019	Keelaveliyur to Othakadai	Old
26	Adult male	18.08.2019	Keelaveliyur to Othakadai	very fresh
27	Adult female	11.02.2019	Keelaveliyur to Othakadai	Fresh
28	Adult female	22.06.2019	Keelaveliyur to Pathiripatti	Old
29	Subadult male	22.12.2019	Rural network roads	very old
30	Adult female	28.04.2019	Rural network roads	very old
31	Adult female	23.02.2020	Keelaveliyur to Othakadai	Fresh
32	Adult male	22.04.2020	Keelaveliyur to Othakadai	very fresh
33	Adult male	18.09.2020	Keelaveliyur to Othakadai	very old
34	Subadult female	23.05.2020	Keelaveliyur to Pathiripatti	Fresh
35	Adult male	09.10.2020	Rural network roads	Fresh
36	Adult female	09.12.2020	Rural network roads	very fresh
37	Adult male	11.11.2021	Keelaveliyur to Metupatti	old
38	Subadult female	06.01.2021	Keelaveliyur to Metupatti	Fresh
39	Adult female	21.12.2021	Keelaveliyur to Metupatti	Old
40	Adult male	04.04.2021	Keelaveliyur to Othakadai	Old
41	Adult male	13.07.2021	Keelaveliyur to Othakadai	very fresh

In the rural road networks, another 11 lorises (four adult males, six adult females, and one subadult male) were found killed by the vehicles during the five year study. Besides, one loris was found electrocuted near road. Number of roadkills of lorises was found maximum from August to December followed during February to May (Fig. 4).

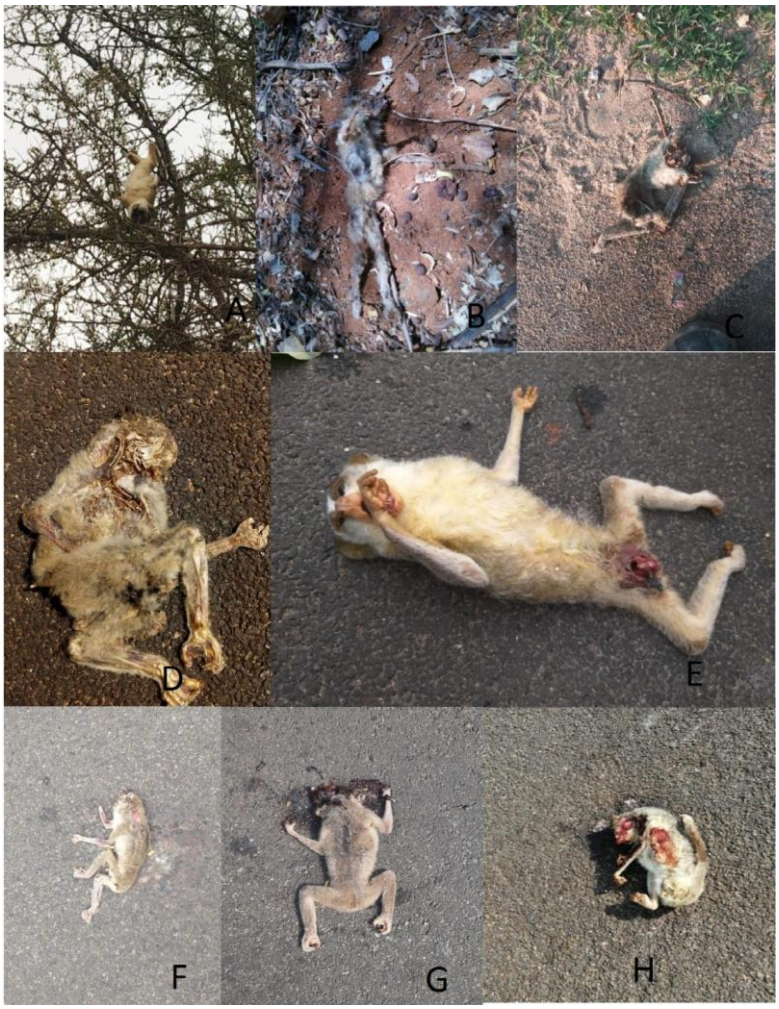

Fig. 3. Different dead lorises found in the study area

A-Electrocuted loris, B-Found dead for unknown reason, C,D,E,F,G, and H are roadkills

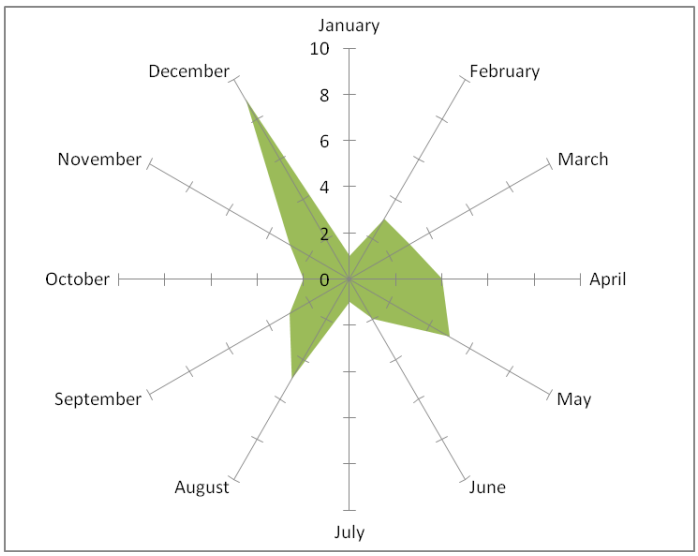

Fig. 4. Number of roadkills of lorises found in various months of the study period

4. DISCUSSION

In India, effect of roads on wildlife was done largely on road networks present inside the protected areas [eg. 10,12,13,8,14,9,15-21] while a few studies are available on outside the protected areas [22,23]. The present study was carried out in an unprotected area where the Mysore slender loris *L. lydekkerianus lydekkerianus,* endemic to India and listed as 'Near Threatened' on the IUCN Red List of Threatened Species, inhabits roadside vegetation, backyard vegetation and vegetation bordering the cultivated fields. Totally 41 Mysore slender lorises were found killed on road by the road traffic. Nocturnal primates are susceptible to the adverse effects of night-time light exposure as they have sensitive visual systems highly adapted for foraging and travelling in darkness. Hence, exposure to white light could have deleterious effects on nocturnal primates [24]. Mysore slender loris, one such a nocturnal primate, swiftly freezes its activity in response to sudden light in night. This often resulted in getting run over by vehicles when loris crosses the road. Lorises have a specialized anatomy associated with their quadrupedal life-style, their hand morphology for example [25], and thus such anatomy is more suitable for walking on the branches of plants rather than on the ground. Hence, loris on ground or road could not act quickly in response to moving vehicles. It makes them susceptible to vehicular hits. The lack of contiguity in canopies along the road side often forces the animal to prefer road to reach another tree. Roadkills of lorises were observed from many regions where they live [26]. Moreover, drivers are less likely to notice the animal because of its smaller size. Adults are more prone to road accident as they make more movement than young ones. Besides, one loris was found electrocuted. On road side trees, loris moves at a height where the live electric wire passes, and accidentally gets electrocuted when touches the live wire. Although, only one such case was noticed during the study period, locals say such electrocution are frequent. Number of roadkills of lorises was found maximum from August to December. Lorises spent much time on exploration in the wet season [27]. Females showed two oestrus peaks, one in April–June and another in October–December [28,29]. It could be assumed that during this period both male and female loris make greater movements in search of opposite sex than in other periods. It could also be the reason why roadkills are more during a particular season. Different species of acacia (*A. planifrons*, *A. sundra*, *A. latronum*, *A. pennata*), tamarinds *Tamarindus indica*, and a variety of shrubs and undergrowth (including *Zyziphus* spp., *Indigofera* spp., *Acacia intsia*, *Pterolobium* spp. and *Euphorbia* spp.), were found to be the most preferred vegetation types used by lorises [26]. In the present study, large scale removal of the above said plant species was recorded during the study period and it resulted in the decline of population of loris in greater numbers within a short spell.

5. CONCLUSIONS AND RECOMMENDATIONS

The present study concluded that the Mysore slender loris population is severely affected by the vehicular traffics. Sensitive visual system and anatomy of loris and lack of canopy contiguity are the probable causes making the loris prone to vehicular hits. Besides, they are also facing persistent threat to their survival due to severe vegetation removal in Keelaveliyur. Although lorises have no conflict with people either for habitats or for resources, a strong negative feeling about loris among public exists. Hence, public education and awareness should also be initiated. Loris crossing signs should be erected at vulnerable points to alert drivers to the potential presence of lorises on or near the road.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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