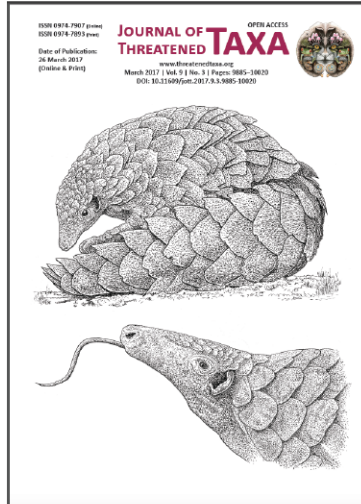


OPEN ACCESS



The Journal of Threatened Taxa is dedicated to building evidence for conservation globally by publishing peer-reviewed articles online every month at a reasonably rapid rate at www.threatenedtaxa.org. All articles published in JoTT are registered under [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/) unless otherwise mentioned. JoTT allows unrestricted use of articles in any medium, reproduction, and distribution by providing adequate credit to the authors and the source of publication.



Journal of Threatened Taxa

Building evidence for conservation globally

www.threatenedtaxa.org

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

COMMUNICATION

IMPACT OF VEHICULAR TRAFFIC ON VERTEBRATE FAUNA IN HORTON PLAINS AND YALA NATIONAL PARKS OF SRI LANKA: SOME IMPLICATIONS FOR CONSERVATION AND MANAGEMENT

Suranjan Karunarathna, Sudheera Ranwala, Thilina Surasinghe & Majintha Madawala

26 March 2017 | Vol. 9 | No. 3 | Pp. 9928–9939

10.11609/jott.2715.9.3.9928-9939



For Focus, Scope, Aims, Policies and Guidelines visit http://threatenedtaxa.org/About_JoTT.asp

For Article Submission Guidelines visit http://threatenedtaxa.org/Submission_Guidelines.asp

For Policies against Scientific Misconduct visit http://threatenedtaxa.org/JoTT_Policy_against_Scientific_Misconduct.asp

For reprints contact <info@threatenedtaxa.org>

Partner



Publisher/Host





ISSN 0974-7907 (Online)
ISSN 0974-7893 (Print)

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 March 2017 | 9(3): 9928–9939

IMPACT OF VEHICULAR TRAFFIC ON VERTEBRATE FAUNA IN HORTON PLAINS AND YALA NATIONAL PARKS OF SRI LANKA: SOME IMPLICATIONS FOR CONSERVATION AND MANAGEMENT

Suranjan Karunarathna¹, Sudheera Ranwala², Thilina Surasinghe³ & Majintha Madawala⁴

OPEN ACCESS



¹ Faculty of Graduate Studies, University of Colombo, Colombo 03, Sri Lanka

² Department of Plant Sciences, University of Colombo, Colombo 03, Sri Lanka

³ Department of Biological Sciences, Bridgewater State University, Bridgewater, MA 02325, USA

⁴ South Australian Herpetology Group, South Australian Museum, North Terrace, Adelaide, SA 5000, Australia

¹ dmsameera@gmail.com (corresponding author), ² sudheeraranwala@gmail.com, ³ tsurasinghe@bridgew.edu,

⁴ majintham@yahoo.com

Abstract: Impacts of roadkills are extensively documented in developed nations. Only a handful of studies on road mortality has emerged from developing nations where tourism and rural development have led to an expansion of transportation networks. To fill such gaps, we conducted a survey to document roadkills in and around two tourism-heavy national parks of Sri Lanka and identified factors that contribute to road mortality. Based on a questionnaire, we interviewed 68 local villagers, 56 local and 59 foreign visitors, and 57 safari drivers to document their opportunistic observations on roadkills, their awareness about roadkills, and to understand potential causes of roadkills. We found 47 roadkilled vertebrate species at both parks; among these, 19 are threatened and 20 are endemic. Our research revealed that herpetofauna were killed the most. We concluded that increased visitation, high-speed driving, lack of awareness, and poor law enforcement as the likely causes of roadkills at both parks. As mitigatory actions, we proposed posting speed limits, increasing awareness of the tourists and safari drivers, limiting vehicle access to the parks, seasonal or night-time access restrictions, and strict enforcement of the speed limits inside national parks.

Keywords: Conservation, lowland forests, management, montane forests, over-visitation, roadkills, speed limits, tourism.

DOI: <http://doi.org/10.11609/jott.2715.9.3.9928-9939> | ZooBank: urn:lsid:zoobank.org:pub:BF5F4DED-9E5B-48DC-B0BD-CE36F8AA4BBE

Editor: P.O. Nameer, Kerala Agricultural University, Thrissur, India.

Date of publication: 26 March 2017 (online & print)

Manuscript details: Ms # 2715 | Received 23 April 2016 | Final received 02 March 2017 | Finally accepted 04 March 2017

Citation: Karunarathna, S., S. Ranwala, T. Surasinghe & M. Madawala (2017). Impact of vehicular traffic on vertebrate fauna in Horton Plains and Yala national parks of Sri Lanka: some implications for conservation and management. *Journal of Threatened Taxa* 9(3): 9928–9939; <http://doi.org/10.11609/jott.2715.9.3.9928-9939>

Copyright: © Karunarathna et al. 2017. Creative Commons Attribution 4.0 International License. JoTT allows unrestricted use of this article in any medium, reproduction and distribution by providing adequate credit to the authors and the source of publication.

Funding: Self funded

Conflict of interest: The authors declare no competing interests.

Author Details: SURANJAN KARUNARATHNA is a field biologist, and conducts research on herpetofaunal taxonomy, behavior and ecology, also promotes conservation awareness among the Sri Lankan public. He is an active member of many IUCN/SSC Specialist Groups; SUDHEERA RANWALA is a senior lecturer in University of Colombo, and studies plant life, controlling invasive species and conducts biodiversity assessments; THILINA SURASINGHE is a conservation biologist who currently works as an assistant professor in Biological Sciences (Bridgewater State University). He is an ecologist; his academic training encompasses different aspects of biology, ecology, and environmental sciences and natural resources management; MAJINTHA MADAWALA is a conservationist engaged in numerous habitat restoration and snake rescue programs. He is an active member of Crocodile Specialist Group in the IUCN/SSC.

Author Contribution: SK and MM conceived the concept, ideas, plan of work and did field work; SK and TS preparing the manuscript; SR supervised the project and did the final editing; TS prepared the map, figures and improved the manuscript; All authors equally contributed to the manuscript.

Acknowledgements: The authors wish to thank Gayan Karunarathna, Chamara Amarasinghe, Nayanaka Ranwella, Dinesh Gabadage, Asanka Udayakumara, Thasun Amarasinghe, Madhava Botejue, Mendis Wickramasinghe, Tharaka Kusuminda, village officers (Grama Niladhari) for the study sites, director generals, park wardens and the National Parks officers of the Department of Wildlife Conservation for their support and encouragement during the field surveys. We would like to give our special thanks to Spencer Manuelpillai, Tharaka Priyadarshan, Ishan Seneviratne, Sanjaya Atapattu, Tharaka Kusuminda, Supun Lahiru Prakash for useful photographs; Dr. Maringa Sumanadasa and the staff of Faculty of Graduate Studies in University of Colombo for various help; Sanuja Kasthuriarachchi, Dr. Nanda Wickramasinghe, Dr. Manori Nandasena, Chandrika Munasinghe and Rasika Dasanayake (National Museum Sri Lanka) for assistance during examining collections under their care; members of the Young Zoologists' Association of Sri Lanka for various help. Finally, we thank the anonymous reviewers for constructive comments on the manuscript.



INTRODUCTION

Roads impose multiple ecological impacts on local biodiversity including habitat fragmentation, altered microclimates with edge effects, nonpoint-source pollution, increased anthropogenic disturbances, high rates of pest infestations and non-native invasions, altered animal behavior, impeded dispersal and migration, and altered hydrology (Trombulak & Frissell 2001; Laurance et al. 2009). Being barriers against movements, roads can isolate populations, reduce metapopulation dynamics, lower genetic heterozygosity, and cause mortality due to vehicular collision (Forman & Alexander 1998). Such incidental mortality leads to reduced abundance and diversity of local wildlife (Gibbs & Shriver 2002; Laurance et al 2008). Continuous expansion of the land-based transport networks, their linear nature, and increasing traffic volume can amplify negative impacts of roadkills on population persistence (Carr & Fahrig 2001; Gibbs & Shriver 2002; Karunarathna et al. 2013).

Impacts of road mortality have been mostly studied in developed nations where both multi-lane highways and volume of motor traffic are growing rapidly (Taylor & Goldingay 2004). Twenty percent of the US landscapes are affected by public road systems, which include the total spatial coverage of roads, roadsides, and the “road-effect zone” which extends 100m beyond the roadside (Forman 2000). In New South Wales of Australia, one roadkill occurred per week for every 4-km stretch along a 100-km road circuit where victims were mostly endemic arboreal and ground-dwelling mammals (Taylor & Goldingay 2004). Road networks are expanding in the developing nations with a concurrent rise in the traffic flow (Vijayakumar et al. 2001; Das et al. 2007). Protected areas of the developing countries have extensive road networks, which facilitates tourism, especially safaris (Laurance et al. 2008; Karunarathna et al. 2013). These conditions could be highly pertinent to Sri Lanka, a biodiversity-rich Indian Oceanic tropical island where a number of protected areas attract both local and international tourists (Buultjens et al. 2005). The road development schemes of Sri Lanka have largely neglected the importance of landscape connectivity or mitigation of wildlife road mortality, which may aggravate negative impacts of roads on local and regional biodiversity.

There is a paucity of studies documenting roadkills in Sri Lanka (Karunarathna et al. 2013). Among the few existing research, many are biased towards herpetofauna (de Silva 1999; Maduwage et al 2003; Amarakoon et al.

2010; Karunarathna et al 2012). De Silva (1999) reported a brief account on road mortality of reptiles in Horton Plains National Park - a popular tourist destination in Sri Lanka. In addition, Karunarathna et al. (2012) highlighted the severity of roadkills of land monitors, in and around multiple national parks of Sri Lanka that entertain high volumes of tourists. These studies emphasized that roadkills in and around protected areas of Sri Lanka are of a critical conservation concern, especially national parks that entertain mass tourism. Given the potential impact of motor traffic on local wildlife, we investigated wildlife road mortality in two Sri Lankan national parks—Horton Plains National Park (HNP) and Yala National Park (YNP)—that experience high volume of tourists (Fig. 1). Our main objectives in this study were to (i) document species that suffer road mortality in and around the two national parks, and (ii) identify factors that contribute to roadkills.

Study Areas

Both HNP and YNP are managed by the Department of Wildlife Conservation under the jurisdiction of the Ministry of Environment and Natural Resources. Both national parks are home for unique assemblages of native biodiversity including charismatic megafauna, and possess picturesque landscapes that are characteristic of their respective geographies (DWC 2004).

YNP (06°21'42.49"N & 81°28'45.13"E) is located in the lowland dry zone (annual average precipitation ~640mm, annual average temperature ~29.5°C) of southeastern Sri Lanka and covers ~97,800ha (Buultjens et al 2005). YNP hosts a variety of ecosystems including moist monsoon forests, dry monsoon forests, semi-deciduous forests (Image 1a,b), scrub forests, thorn forests, and grasslands (de Silva & de Silva 2004). The Inland aquatic habitats of YNP are seasonal rivers, waterholes, tanks, and rock pools; these are seasonal water bodies and are heavily dependent on monsoons (IUCN & CEA 2006). YNP experiences a prolonged hot and dry climate from June to October; and receives rain mostly via northeast monsoons during November–January period (DWC 2004). Since the park is located in the coastal peneplain, saltwater habitats such as coastal marshes, mangrove-associated lagoons, seasonal rivers, and sandy beaches are also found there (IUCN & CEA 2006). The vertebrate fauna of YNP includes 45 species of mammals, 230 species of birds, 46 species of reptiles, 18 species of amphibians, and 25 species of fish (DWC 2004).

HNP (06°48'35.55"N & 80°48'21.27"E) is located in the wet zone (annual average precipitation >2000mm,

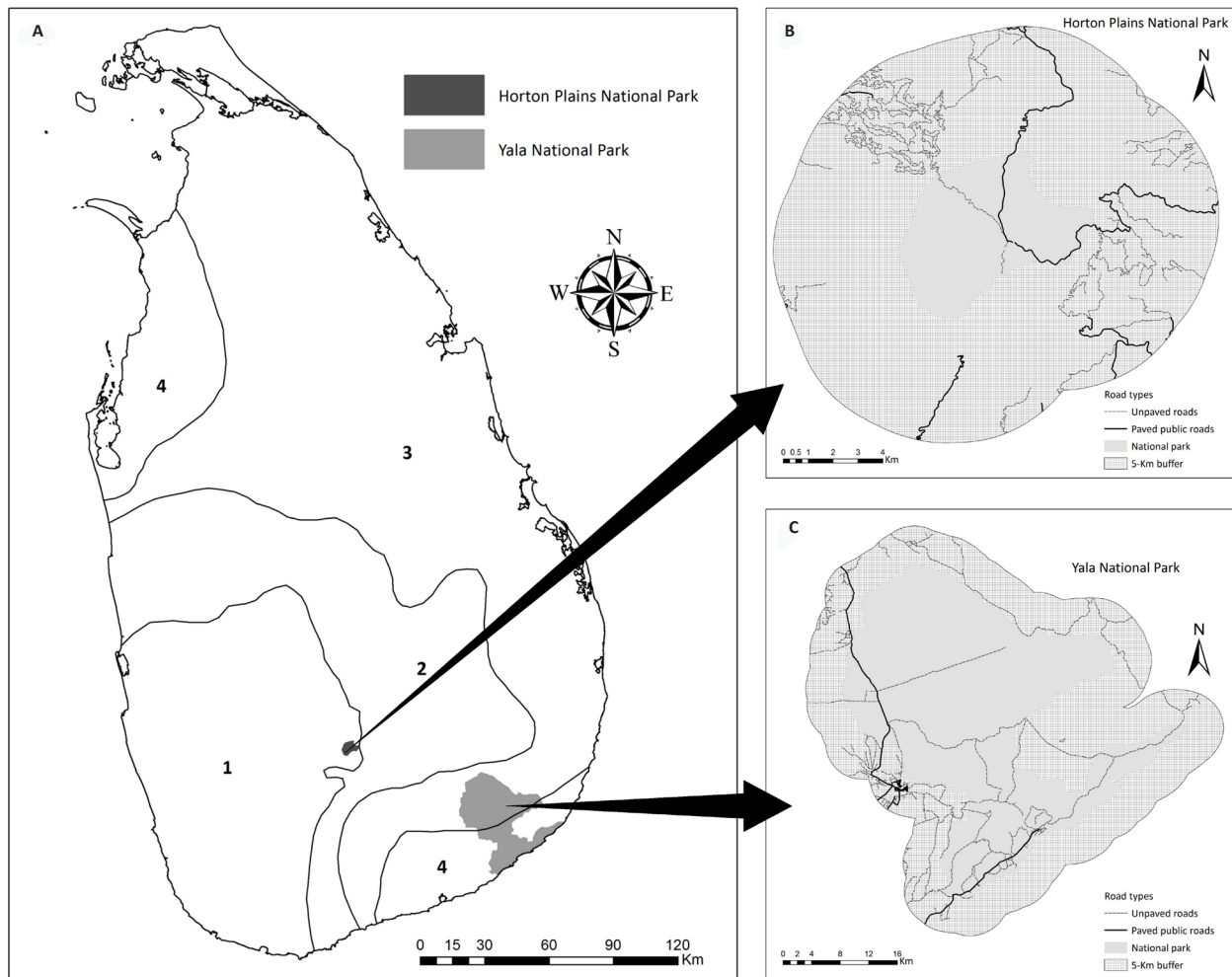


Figure 1. Study areas for the survey of roadkills: (A) the location of Horton Plains National Park (HNP) and Yala National Park (YNP) in Sri Lanka. Bioclimatic zones: 1 - wet zone, 2 - intermediate zone, 3 - dry zone, and 4 - arid zone in Sri Lanka. (B) Horton plains National Park and (C) Yala National Park with the associated road network. The 5-km-buffer is the 5-Km-wide area adjoining the park that was surveyed for roadkills.

annual average temperature $\sim 20^{\circ}\text{C}$) central highlands (2,100–2,300 m) of Sri Lanka and spans $\sim 3,160\text{ha}$ (Pethiyagoda 2012). Moist evergreen upper montane forests and montane grasslands (Image 1e,f) comprise the dominant vegetation types (de Silva 2007). Diverse arrays of aquatic habitats are found throughout the park, including forested pools, low-order streams, and waterfalls (Gunawardana et al 1998). Southwestern monsoons bring heavy rain to the park for a major part of the year (May–October). The vertebrate fauna of the park includes 25 species of mammals, 90 species of birds, 10 species of reptiles, 15 species of amphibians and locally rare fish species; the point endemism within the park of the park is highly remarkable for both fauna and flora (DWC 2004; IUCN & CEA 2006).

MATERIALS AND METHODS

Documentation of species composition of roadkills

We recorded the presence of roadkills from 2009 to 2014 on motor-traffic accessible roads inside and immediately around (all roads located within a distance of 500m from the park boundary) both national parks. All surveyed roads were unpaved gravel roads with the exception of the public transportation roads; the latter were paved. None of the surveyed roads had any restrictions on vehicular access. In each year, we surveyed $\sim 160\text{km}$ and $\sim 50\text{km}$ stretches of roads at YNP and HNP, respectively. The same stretches were revisited in the following years. Our field survey team consisted three trained vertebrate field biologists. Our sampling efforts were even between both dry and wet



Image 1. (a) & (b) - Dryzone forest and wetland habitat on the roadside in YNP; (c) & (d) - vehicular pressure and braking regulations inside the YNP; (e) & (f) - Montane forest and wet grassland habitat on the roadside in HNP; (g) & (h) - vehicular pressure and offroad parking in HNP. (© Ishan Seneviratne, Majintha Madawala & Sanjaya Atapattu).

seasons at both parks. On each sampling day, we recorded roadkills while walking (YNP: 2km; HNP: 10km) or riding on motor vehicles at an average speed of 25kmh^{-1} (YNP: 60km; HNP: 15km). Throughout the survey, both road surface and the road verges (50cm on either side of the road) were scanned for carcasses. All observations were

made during the mornings (approximately 07:00–11:00 hr) and early evenings (approximately 14:00–17:00 hr) on a given day (average sunrise time: 06:10hr, sunset: 17:50hr). We used standard field guides and keys to identify roadkilled specimens. All specimens were photographed and identifications were verified through

expert zoologists.

Identification of causes of road mortality

We interviewed local villagers (68), both Sri Lankan and foreign visitors (115), and vehicle drivers of safari tours (57) using a questionnaire at both national parks. Safari tours are only limited to YNP. Through these in-person interviews, we asked the following questions to gather information on people's opportunistic observations on and attention to roadkills, their attitudes and perceptions about roadkills, driving speed, specific causes of roadkills as observed or speculated, and people's view on prevention of roadkills. We also inquired about the purpose of visit from all tourists. Questions and available responses (in parenthesis) in the questionnaire included: what is your purpose of visit? (wildlife observations, recreation and relaxation, other); have you ever seen roadkills? (yes, no); do you like to see roadkills? (yes, no); what are the major sources of roadkills?; what do you feel about roadkills? (very sad, sad, indifferent); do you drive faster than 30km/h, the maximum speed limit allowed? (yes, no); and what are your suggestions on mitigating roadkills? We also obtained information on annual vehicle entry at both parks from the Department of Wildlife Conservation for the 6-year duration of our study to calculate the trends in visitation rates. We ran a Wilcoxon sign-rank test to identify significant differences between the two parks for the total number of vehicles entered and the rate of increase in vehicle entry.

RESULTS

Species composition of roadkills

Our roadkill survey comprised 47 vertebrate species (16 amphibians, 16 reptiles, 8 mammals, and 7 birds) in both national parks (Fig. 2a). Among these fatalities, 20 species (11 amphibians, 6 reptiles, 2 mammals and 1 bird) are endemic while 24 species (10 amphibians, 7 reptiles, 5 mammals and 2 birds) are listed threatened in Sri Lanka's National Red List of Threatened Species (Table 1). According to the IUCN Global Red List, 12 roadkilled species are considered threatened.

We noted remarkable differences in species composition of roadkills between the two national parks. We recorded a total of 26 vertebrate species (11 reptiles, 7 amphibians, 5 mammals and 3 birds) in YNP among which three species are endemic, and another two (1 reptile and 1 mammal) are threatened. At HNP, we documented 22 roadkilled vertebrate species (10

amphibians, 5 reptiles, 4 birds and 3 mammals). Among these fatalities, 17 species (9 amphibians, 5 reptiles, 2 mammals and 1 bird) are endemic; another 17 species (8 amphibians, 5 reptiles, 2 mammals and 2 birds) are threatened. The vertebrate species most vulnerable to road mortality differed between the two parks. Reptiles were the most prevalent roadkill (40% of all species) in YNP whereas amphibians (~46%) suffered the greatest road fatalities at HNP. More than one-third (~77%) of roadkills found in HNP are endemic whereas only a one-tenth (~12%) of YNP roadkills are endemic. A similar pattern was observed among Red Listed species that suffered road fatalities; only ~8% of the roadkilled species in YNP are listed threatened whereas the equivalent figure for HNP was ~77%. In YNP, more than one-fifth of roadkilled threatened species belonged to four vertebrate families—Bufonidae, Boidae, Testudinidae and Felidae—all but the last are herpetofauna. Among the roadkilled threatened species in HNP, nearly half (~45%) was accounted by three herpetofaunal families: Agamidae, Microhylidae, and Rhacophoridae.

Visitation rate

We noted marked distinctions between the two parks in terms of the average visitation rates, the total number of motor vehicles admitted, and rate of increase in visitations. In all metrics, YNP figures exceeded those of HNP by multiple folds. For the 6-year period, a total of 2,94,435 motor vehicles entered YNP with an average entry rate of ~49,072 vehicles per year (Fig. 2b). The visitation rate (based on vehicle entrance) increased consistently from year to year throughout our study for both parks; however, the rate of increment varied between consecutive years. The smallest increase (~2.9%) was observed in the 2012–2013 period while the greatest increase (~124.9%) was recorded from 2009–2010 periods. The visitation rate of YNP has more than doubled (~222.5%) from 2009 to 2014. Compared with YNP, the visitation rate was lower at HNP where only a total of 1,43,010 vehicles entered the park with an average rate of ~23,835 vehicles per year—approximately, half the number recorded at YNP (Table 2). The rate of increase in traffic throughout the study period was comparatively lower in HNP which had ~40% less vehicular entries per year than that of YNP. The smallest raise (~3.1%) in vehicular traffic was observed in 2012–2013 period while that of the greatest increment (~22.9%) was recorded in 2011–2012. The overall growth of visitations for HNP was ~83.4% for the six-year period. There was a significant difference between the two parks in the total number of vehicles

Table 1. Roadkills recorded from two national parks in 2009–2014 (E - endemic; LC - Least Concern; NT - Near Threatened; VU - Vulnerable; EN - Endangered; CR - Critically Endangered; HNP - Horton Plains National Park; YNP - Yala National Park); * indicates the percent species composition per each vertebrate class = (Number of roadkilled species of a certain vertebrate class in a given park ÷ total number of roadkilled species in all vertebrate classes) x 100; Red List criteria use according to MOE 2012.

Taxa	% Sp. comp.*		Species	Roadkilled site	IUCN status	Endemicity
	HNP	YNP				
Amphibians - 16	48	24	<i>Duttaphrynus atukoralei</i>	YNP	NT	E
			<i>Duttaphrynus melanostictus</i>	Both	LC	-
			<i>Fejervarya greenii</i>	HNP	EN	E
			<i>Hoplobatrachus crassus</i>	YNP	LC	-
			<i>Hylarana gracilis</i>	YNP	LC	E
			<i>Hylarana temporalis</i>	HNP	NT	E
			<i>Microhyla ornata</i>	YNP	LC	-
			<i>Microhyla zeylanica</i>	HNP	CR	E
			<i>Polypedates maculatus</i>	HNP	LC	-
			<i>Pseudophilautus alto</i>	HNP	EN	E
			<i>Pseudophilautus femoralis</i>	HNP	CR	E
			<i>Pseudophilautus schmarida</i>	HNP	CR	E
			<i>Pseudophilautus silus</i>	HNP	EN	E
			<i>Ramanella palmata</i>	HNP	CR	E
			<i>Taruga eques</i>	HNP	EN	E
			<i>Uperodon systema</i>	YNP	LC	-
Reptiles - 16	22	44	<i>Amphisma stolatum</i>	YNP	LC	-
			<i>Aspidura trachyprocta</i>	HNP	EN	E
			<i>Calotes versicolor</i>	YNP	LC	-
			<i>Calotes nigrilabris</i>	HNP	EN	E
			<i>Ceratophora stoddartii</i>	HNP	EN	E
			<i>Cophotis ceylanica</i>	HNP	EN	E
			<i>Dendrelaphis tristis</i>	YNP	LC	-
			<i>Eutropis carinata</i>	YNP	LC	-
			<i>Geochelone elegans</i>	YNP	NT	-
			<i>Gongylophis conica</i>	YNP	VU	-
			<i>Hemidactylus leschenaultii</i>	YNP	LC	-
			<i>Lankascincus taprobanensis</i>	HNP	EN	E
			<i>Melanochelys trijuga</i>	YNP	LC	-
			<i>Oligodon taeniolata</i>	YNP	LC	-
			<i>Oligodon sublineatus</i>	YNP	LC	E
			<i>Varanus bengalensis</i>	YNP	LC	-
Birds - 7	17	12	<i>Caprimulgus atripennis</i>	YNP	LC	-
			<i>Clamator coromandus</i>	HNP	LC	-
			<i>Gallus lafayetii</i>	HNP	LC	E
			<i>Saxicola caprata</i>	HNP	EN	-
			<i>Saxicoloides fulvicatus</i>	YNP	LC	-
			<i>Pycnonotus cafer</i>	YNP	LC	-
			<i>Turdus merula</i>	HNP	EN	-
Mammals - 8	13	20	<i>Felis chaus</i>	YNP	NT	-
			<i>Funambulus palmarum</i>	YNP	LC	-
			<i>Lepus nigricollis</i>	YNP	LC	-
			<i>Muntiacus muntjak</i>	HNP	NT	-
			<i>Panthera pardus</i>	YNP	EN	-
			<i>Sus scrofa</i>	YNP	LC	-
			<i>Srilankamys ohiensis</i>	HNP	EN	E
			<i>Suncus montanus</i>	HNP	EN	E

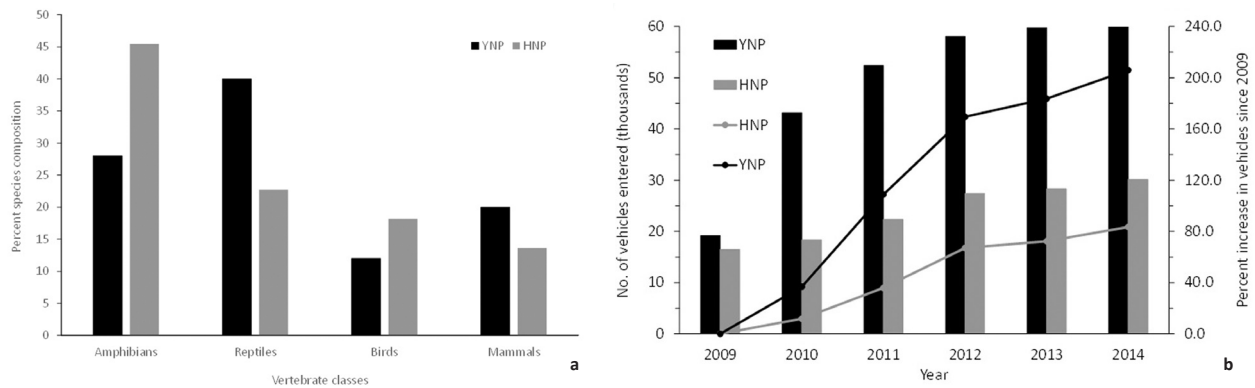


Figure 2. (a) Percent species composition of road mortality in both YNP (Yala National Park, black) and HNP (Horton Plains National Park, grey). Species composition = (Number of roadkilled species per each vertebrate class at each national park ÷ total number of roadkilled species of all classes found at each national park) × 100%; **(b)** Entrance of tourist vehicles into the Yala National Park (YNP) and Horton Plains National Park (HNP) from 2009 to 2014. The bars indicate total number of vehicles entered each park in each year. The lines indicate the percent increase in number of vehicles in each year at each park as a fraction of number of vehicles entered in 2009. Percent increase in vehicles since 2009 = (Number of vehicles entered each park each year ÷ Number of vehicles entered each park in 2009) × 100%.

Table 2. Trends in entry of tourist vehicles into Horton Plains National Park (HNP) and Yala National Park (YNP) from 2009 to 2014 (abbreviations: NVE - Number of vehicles entered; DAV - Daily average number of vehicles entered; NVP - Number of vehicles as a percentage of total; IVS - Increment in number of vehicles between successive years; PBS - Percent increase between successive years).

Year	HNP					YNP				
	NVE	DAV	NVP	IVS	PBS	NVE	DAV	NVP	IVS	PBS
2009	16427	45.0	11.5	-	-	19194	52.6	6.5	-	-
2010	18374	50.3	12.8	1947	11.9	43175	118.3	14.7	23981	124.9
2011	22333	61.2	15.6	3959	21.5	52362	143.5	17.8	9187	21.3
2012	27443	75.2	19.2	5110	22.9	58048	159.0	19.7	5686	10.9
2013	28306	77.6	19.8	863	3.1	59754	163.7	20.3	1706	2.9
2014	30127	82.5	21.1	1821	6.4	61902	169.6	21.0	2148	3.6
Total	143010					294435				

entered in each year ($w=4, p<0.05$); the rate of increase in vehicle entry did not differ significantly between the two parks ($w=15.4, p>0.05$).

Questionnaire survey

Our questionnaire survey revealed that all respondents, in general, are distressed by seeing roadkills and aware of the problem. Over 80% of the local inhabitants interviewed at both national parks said that they have seen roadkills. In contrast, >50% of both local and foreign visitors as well as safari jeep drivers had not seen any roadkills in any of the national parks with the exception of foreign visitors at HNP where 68% of visitors claimed to have seen roadkills (Table 3). All the interviewees claimed that they would rather not see any roadkills. In addition, ~90% of all tourists and jeep drivers were pitiful towards roadkills. Among local inhabitants of HNP, only 10% were indifferent towards

roadkills whereas <40% of local villagers of YNP were unmoved. The majority (>65%) of local inhabitants and local tourists ruled high-speed driving as the most detrimental source of road mortality. Foreign tourists at both national parks as well as the safari drivers (≥50%) considered carelessness as the main cause of road mortality. All respondents at both national parks ranked carelessness or high-speed driving as the top two causes of roadkills. The majority (>70%) of all visitors at both parks did not consider fast-driving as a necessity except local visitors to HNP where >60% wanted to drive beyond speed limits. Similarly, the majority (~55%) of safari drivers deemed fast-driving as a necessity. In general, at least 50% of all respondents at both parks agreed on reduced vehicular speed via enforced speed limits, speed bumps, and monitoring to mitigate roadkills.

Table 3. The questionnaire survey results based on in-person interviews with the local inhabitants, tourists (local visitors and foreign visitors) and safari jeep drivers. Yala National Park (YNP) and the Horton Plains National Park (HNP) in 2014; * Safari tours are only available at YNP.

Questions	YNP				HNP		
	Local villagers	Local visitors	Foreign visitors	Safari jeep*	Local villagers	Local visitor	Foreign visitors
What is your purpose of visit?							
<i>To see wildlife</i>	N/A	12	27	N/A	N/A	9	11
<i>Just a fun or a rest and relax</i>	N/A	15	8	N/A	N/A	14	7
<i>Other</i>	N/A	5	2	N/A	N/A	1	4
Have ever seen any roadkills?							
<i>Yes</i>	35	8	13	9	21	11	15
<i>No</i>	7	24	24	48	5	13	7
Do you want or like to see roadkills?							
<i>Yes</i>	0	0	0	0	0	0	0
<i>No</i>	17	5	2	32	14	8	5
<i>Never</i>	25	27	35	25	12	16	17
What is the major cause of roadkills?							
<i>Speeding</i>	32	22	12	9	17	16	5
<i>Use of cell phones</i>	0	4	3	17	0	0	0
<i>Careless driving</i>	10	6	17	24	9	5	11
<i>Poor knowledge about wildlife</i>	0	0	5	7	0	3	6
What are your perceptions about roadkills?							
<i>Very sad</i>	21	7	29	23	16	3	16
<i>Sad</i>	5	23	8	28	7	17	8
<i>None</i>	16	2	0	6	3	4	0
Do you need to drive faster than 30km/h							
<i>Yes</i>	N/A	9	2	31	N/A	15	5
<i>No</i>	N/A	23	35	26	N/A	9	17
What are your suggestions regarding mitigation of roadkills?							
<i>Speed limitation</i>	36	17	14	37	11	5	10
<i>Road barriers</i>	6	5	9	7	15	7	2
<i>Monitoring</i>	0	2	3	2	0	0	5
<i>Limitation of vehicles and visitors</i>	0	8	11	11	0	12	5
Total number of respondents	42 people	32 people	37 people	57 people	26 people	24 people	22 people

DISCUSSION

Species susceptibility to roadkills

Our study revealed that herpetofauna are the most susceptible to road fatality among the vertebrate group in Sri Lanka, at least within the two bioclimatic zones our study sites represented, the lowland dry zone and upper montane wet zone. Our observations are in agreement with a few other studies conducted in tropical, subtropical, and temperate zones (Fahrig et al. 1995; Forman & Alexander 1998; Trombulak & Frissell 2001). Taxa with high vagility (inherent power of movements, including both the distance and

frequency of movements for dispersion, or migration) are mostly susceptible to roadkills (Carr & Fahrig 2001; Laurance et al. 2009). Besides, taxa with larger home ranges, including large mammals, top carnivores, and chelonians are also considered vulnerable to roadkills (Gibbs & Shriver 2002; Laurance et al. 2009).

Among amphibian roadkills in our study, 12 of 17 species are aquatic breeders. Among amphibians, pond-breeding species have the highest probability of road mortalities given their seasonal mass migrations and post-natal dispersal among multiple aquatic habitats (Hels & Buchwald 2001; Karunaratna et al. 2008). Sri Lanka's anurans are largely arboreal and undergo direct

development (Bahir et al. 2005) hence considered relatively independent of standing water, which supposedly negate the necessity for movements among multiple aquatic habitats. Yet, we recorded four direct-developing amphibian species in our roadkill survey, which indicated that even arboreal species may disperse across the landscapes and can suffer road mortality. More than 90% of roadkilled herpetofauna in our study were ground-dwelling species with a slow-moving habit; such natural histories predispose them to road mortality (Laurance et al. 2009). During our survey, we noted that more amphibians crossed the roads during the rainy season in both national parks suggesting that rain triggered increased amphibian activities, such as foraging and mating. Increased activities of amphibians coinciding with rainfall have been reported in other parts of Sri Lanka (Weerawardhena et al. 2004). Roadside ditches created by tire ruts may function as ecological traps for many pond-breeding anurans (DiMauro & Hunter 2002).

The differential species composition of roadkills we noted between the two national parks can be attributed to differences in regional species pools and sampling effects (Zobel et al. 1998). The moist, wet climate of HNP favors amphibians that are dependent on high humidity and ample water availability whereas the dry, arid climate of YNP is much suitable for reptiles. Therefore, the most abundant taxa in each park appeared to suffer the most from roadkills. Although only recorded in a handful of instances, roadkills of Leopards and Jungle Cats at YNP were noteworthy (Image 2). One of the roadkilled Leopards was pregnant with three cubs. These carnivores tend to have large home ranges and actively roam and defend large territories (Spellerberg 1998); such requirements may predispose these large cats to road fatalities while crossing access roads. The population sizes of these carnivores are small and declining in Sri Lanka owing to habitat destruction, fragmentation, and vengeful killing (Miththapala 2006). For instance, in the block I of YNP, the population size of Leopards is estimated to be ~25 (Kittle & Watson 2005). Therefore, even the demise of a few individuals of a small and declining population can have deleterious effects through inbreeding depression, reduced genetic heterozygosity, and genetic drift (Ellstrand & Elam 1993).

Driving forces of roadkills

YNP is among the most visited tourist destinations in Sri Lanka, and the park attracts both local and foreign tourists for wildlife watching and scenic beauty (Buultjens et al. 2005). In 2014, approximately 245,120

people visited the park, and these numbers have kept rising during the past decades. In addition to access roads, two more major public roads bisect YNP; the traffic in these roads increases substantially during the Buddhist pilgrimage season (personal observations). The Department of Wildlife Conservation has imposed a maximum speed limit of 30km h⁻¹. Yet, we found faded speed limit posts inside the park or on public roads that bisect the park. There were no strict enforcements of traffic laws inside or around the parks, leading to rampant over speeding (>80km h⁻¹). Further, our interview survey also revealed prevalence of high-speed driving.

Tourism accounts for a greater proportion of national income of Sri Lanka; international tourism in particular is considered the fourth largest source of foreign exchange (Weerasinghe et al. 2003). Travel and tourism made a total contribution of US\$ six billion to the gross domestic production of Sri Lanka in 2013 (9.4% of the gross domestic production), while generating many employment opportunities (WTTC 2014). The current status of tourism in both parks is not sustainably managed and has led to many other environmental concerns such as solid waste and garbage disposal, noise pollution, air pollution, deteriorating water quality and scenic beauty, changes in wildlife behavior that accompany fitness costs, erosion and others means of pollution from vehicles and roads, overcrowding, and wildlife harassment (Weerasinghe et al. 2003; Buultjens et al. 2005). We contend that lack of awareness among tour operators, absence of strict law enforcement, and poor communication between parks authorities and tour operators are the most detrimental factors that have contributed to roadkills in these national parks (Buultjens et al. 2005). Incidence of road mortality has substantially increased in many parts of the world following increased mass tourism and high traffic volume (Green & Higginbottom 2000; Seshadri & Ganesh 2011).

Our questionnaire-based interviews revealed that the local villagers have seen more roadkills than the tourists, and hence we can infer that the local communities are at least aware of the problem. Nearly 60% of all tourists have not seen any roadkill at either of the national parks. Since local inhabitants spend more time in the region than tourists, the latter may not encounter many roadkilled wildlife; therefore may be less aware of the situation. Safari drivers appeared to be surprisingly unaware of the issue. Both tourists and safari drivers are important stakeholders of tourism, and therefore making them aware of roadkills as a critical conservation concern is paramount. None of the



Image 2. Roadkilled photos in the study areas in both National Parks: (a) Endangered - Sri Lankan Leopard *Panthera pardus*; (b) Common Squirrel *Funambulus palmarum*; (c) Land Monitor *Varanus bengalensis*; (d) Bronze-backed Snake *Dendrelaphis tristis* in YNP; (e) Endangered - Black-cheek Lizard *Calotes nigrilabris*; (f) Endangered - Eurasian Blackbird *Turdus merula*; (g) Endangered - Sri Lankan Pigmy Lizard *Cophotis ceylanica*; (h) Endangered - Common Rough-side *Aspidura trachyrocta* in HNP. (© Spencer Manuelpillai, Tharaka Kusuminda, Majintha Madawala, Dushantha Kandambi & Tharaka Priyadarshana).

respondents seemed to take any pleasure in seeing or committing roadkills and over 80% claimed that they would be emotionally distressed by seeing roadkills. This indicated that roadkills were a deterrent for the

tourists and emphasized the necessity to take mitigatory actions. In stark contrast to our findings, recent studies done in North America and Australia indicated that, drivers intentionally ran over amphibians and reptiles or

intend to do so (Ashley et al. 2007; Beckmann & Shine 2012).

Recommendations to mitigate roadkills

The Fauna and Flora Protection (Amendment) Act provides the Department of Wildlife Conservation with authorization to implement and enforce regulations to set lower speed limits and to prosecute violators (PDSRSL 2009). We strongly recommend that the government authorities immediately enforce posted speed limits in and around the parks and employ law enforcement officers to monitor violations. Creating speed-limit bumpers will force the safari drivers and commuters to slow down. Increasing the awareness among the safari drivers, tour business owners, and the tourists is of great importance. These stakeholders should be made aware of speed limits, impacts of roadkills on local wildlife, and importance of following regulations to ensure the sustainability of the tourism industry. The maximum number of vehicles permitted into the parks needs to be controlled. We strongly advise against construction of new access roads or public roads across either of the parks as such actions will exacerbate the problem.

We also suggest that public roads with high wildlife occupancy be closed for traffic during the nights since most wildlife activities peak nocturnally. Seasonal closure of certain roads, especially during the rainy season may mitigate amphibian road mortality. In addition, identification of roadkill hotspots (areas where wildlife are mostly susceptible to vehicular collision) is crucial. In 2013, both national parks earned 30 million Sri Lankan Rupees (US\$ 240,000) through tourism. We urge that the conservation authorities invest some of this revenue into tourist awareness and law enforcement. A transition from mass tourism (where a large number of tourists are entertained with little opportunity for education and awareness) to ecotourism (where a fewer number of tourists are entertained with a greater opportunity of education, awareness, and recreation) is a much-needed endeavor for both parks (Weerasinghe et al 2003).

Many developing nations such as Costa Rica have successfully reformed their regulations in state protected areas with the introduction of ecotourism-driven approaches (Stem et al. 2003). Since ecotourism charges a higher bill per head, transition from mass tourism to ecotourism is financially beneficial for both the government and private-sector service providers as well as the local inhabitants. A conceptual change in the tourism industry may most likely warrant many other benefits to the environment (Weerasinghe et

al 2003; Buultjens et al. 2005). Although building up green bridges, wildlife overpasses, and underpasses can establish unimpeded connectivity, such endeavors are costly. Further, such major constructions may accentuate disturbances and temporarily increase incidental mortality. Therefore, such major changes in the road network should be proceeded with caution. Construction of culverts or underground tunnels with minimal disturbances or use of low-cost underpasses that can be retrofitted into the existing access roads, however, can be a potential solution if carried out based on feasibility studies and environmental impact assessments, based on sound science and principles of ecology (Dodd et al. 2004).

Future directions for research

We acknowledge that our study design may have a few shortcomings. Removal of roadkilled carcasses by scavengers and postmortem destruction and displacement of the carcasses by traffic may have compromised our observations (Santos et al. 2011; Beckmann & Shine 2015). To account for these biases, surveys need to be conducted in higher frequencies, particularly focusing on times of peak animal movements, highest traffic density, and peak feeding time of scavengers. Use of multiple survey methods (walking vs motor vehicles) may have biased our observations towards larger, conspicuous roadkills. Impacts on seasonality of rain and droughts as well as differential road mortality between days and nights need to be investigated.

REFERENCES

- Amarakoon, A.M.R.K., E.S. Nathanael & A. de Silva (2010). The pattern of reptiles killed by road traffic on the Anuradhapura-Mihintale Road, Sri Lanka. *Lyriocephalus* 7: 81–88.
- Ashley, E.P., A. Kosloski & S.A. Petrie (2007). Incidence of intentional vehicle–reptile collisions. *Human Dimensions of Wildlife* 12: 137–143; <http://doi.org/10.1080/10871200701322423>
- Beckmann, C. & R. Shine (2012). Do drivers intentionally target wildlife on roads?. *Austral Ecology* 37: 629–632; <http://doi.org/10.1111/j.1442-9993.2011.02329.x>
- Bahir, M.M., M. Meegaskumbura, K. Manamendra-Arachchi, C.J. Schneider & R. Pethiyagoda (2005). Reproduction and terrestrial direct development in Sri Lankan shrub frogs. *The Raffles Bulletin of Zoology* 12: 339–350.
- Buultjens, J., I. Ratnayake, A. Gnanapala & M. Aslam (2005). Tourism and its implications for management in Ruhuna National Park (Yala), Sri Lanka. *Tourism Management* 26: 733–742; <http://doi.org/10.1016/j.tourman.2004.03.014>
- Carr, L.W. & L. Fahrig (2001). Effect of road traffic on two amphibian species of differing vagility. *Conservation Biology* 15: 1071–1078; <http://doi.org/10.1046/j.1523-1739.2001.0150041071.x>
- Das, A., M.F. Ahmed, B.P. Lahkar & P. Sharma (2007). A preliminary report of reptilian mortality on road due to vehicular movements

- near Kaziranga National Park, Assam, India. *Zoos' Print Journal* 22(7): 2742–2744; <http://doi.org/10.11609/JoTT.ZPJ.1541.2742-4>
- DiMauro, D. & M.L. Hunter (2002)**. Reproduction of amphibians in natural and anthropogenic temporary pools in managed forests. *Forest Science* 48: 397–406.
- de Silva, A. (1999)**. *The Habitat Preferences and the Status of Amphibians and Reptiles at Horton Plains National Park*. Zoological Survey of Sri Lanka. NSF, Sri Lanka, 68pp.
- de Silva, M. & P.K. de Silva (2004)**. *The Yala Wildlife Reserves: Biodiversity and Ecology*. Wildlife Heritage Trust Publication, Colombo: Sri Lanka, 212pp.
- de Silva, A. (2007)**. *The Diversity of Horton Plains National Park: With Special Reference to its Herpetofauna and Including A Bibliography on the Literature on Horton Plains*. Vijitha Yapa Publications, 127pp.
- Dodd, C.K., W.J. Barichivich & L.L. Smith (2004)**. Effectiveness of a barrier wall and culverts in reducing wildlife mortality on a heavily traveled highway in Florida. *Biological Conservation* 118: 619–631; <http://doi.org/10.1016/j.biocon.2003.10.011>
- DWC (Department of Wildlife Conservation) (2004)**. *A Guide to National Parks of Sri Lanka*. Second Edition, Department of Wildlife Conservation, Sri Lanka, 98pp.
- Elstrand, N.C. & D.R. Elam (1993)**. Population genetic consequences of small population size: implications for plant conservation. *Annual Review of Ecology and Systematics* 24: 217–242; <http://doi.org/10.1146/annurev.es.24.110193.001245>
- Fahrig, L., J.H. Pedlar, S.E. Pope, P.D. Taylor & J.F. Wegner (1995)**. Effect of road traffic on amphibian density. *Biological Conservation* 73: 177–182; [http://doi.org/10.1016/0006-3207\(94\)00102-V](http://doi.org/10.1016/0006-3207(94)00102-V)
- Forman, R.T. (2000)**. Estimate of the area affected ecologically by the road system in the United States. *Conservation Biology* 14: 31–35; <http://doi.org/10.1046/j.1523-1739.2000.99299.x>
- Forman, T.T.R. & L.E. Alexandra (1998)**. Roads and their major ecological effects. *Annual Review of Ecological System* 29: 207–231; <http://doi.org/10.1146/annurev.ecolsys.29.1.207>
- Gibbs, J.P. & W.G. Shriver (2002)**. Estimating the effects of road mortality on turtle populations. *Conservation Biology* 16: 1647–1652; <http://doi.org/10.1046/j.1523-1739.2002.01215.x>
- Green, R.J. & K. Higginbottom (2000)**. The effects of non-consumptive wildlife tourism on free-ranging wildlife: a review. *Pacific conservation biology* 6: 183–197; <http://doi.org/10.1071/PC000183>
- Gunawardana, E.R.N., I.R. Calder, P.T.W. Rosier & N. Chandrasiri (1998)**. Hydrological importance of Horton Plains National Park, pp. 45–63. In: Gunasena, H.D.M. (ed.). *Proceedings of the University of Peradeniya and Oxford Forestry Institute link project*. University of Peradeniya, 236pp.
- Hels, T. & E. Buchwald (2001)**. The effect of roadkills on amphibian populations. *Biological Conservation* 99: 331–340; [http://doi.org/10.1016/S0006-3207\(00\)00215-9](http://doi.org/10.1016/S0006-3207(00)00215-9)
- IUCN and CEA (International Union for Conservation of Nature and Central Environment Authority) (2006)**. *National Wetland Directory of Sri Lanka*. IUCN Sri Lanka country office, Sri Lanka, 234pp.
- Karunaratna, D.M.S.S., U.T.I. Abeywardena, M.D.C. Asela & L.D.C.B. Kekulandala (2008)**. A preliminary survey of Amphibian fauna in Nilgala Forest area and its vicinity, Sri Lanka. *Herpetological Conservation and Biology* 3: 264–272.
- Karunaratna, D.M.S.S., A.A.T. Amarasinghe, M.B. Madawala & H.K.D. Kandambi (2012)**. Population status of two *Varanus* species (Reptilia: Sauria: Varanidae) in Sri Lanka's Puttalam Lagoon system, with notes on their diet and Conservation status. *Biawak* 6: 22–33.
- Karunaratna, D.M.S.S., S.M. Henkanaththegedara, A.A.T. Amarasinghe & A. de Silva (2013)**. Impact of vehicular traffic on Herpetofaunal mortality in a Savannah forest, Eastern Sri Lanka. *Taprobanica* 5: 111–119.
- Kittle, A. & A. Watson (2005)**. *Distribution and Status of the Sri Lankan leopard (Panthera pardus kotiya)*. Ministry of environmental, Colombo, Sri Lanka, 43pp.
- Laurance, W.F., M. Goosem & S.G.W. Laurance (2009)**. Impacts of roads and linear clearings on tropical forests. *Trends in Ecology and Evolution* 24: 659–669; <http://doi.org/10.1016/j.tree.2009.06.009>
- Laurance, W.F., B.M. Croes, N. Guissouegou, R. BUIJ M. DETHIER & A. ALONSO (2008)**. Impacts of roads, hunting, and habitat alteration on nocturnal mammals in African rainforests. *Conservation Biology* 22: 721–732; <http://doi.org/10.1111/j.1523-1739.2008.00917.x>
- Maduwage, K.P., A. Silva & S. Batuwita (2003)**. Snakes killed on the roads of the gardens of the University of Peradeniya. *Loris* 23: 22–24.
- Miththapala, S. (2006)**. The ecology of the wild cats of Sri Lanka, pp. 235–236. In: Bambaradeniya, C.N.B. (ed.). *Fauna of Sri Lanka: Status of Taxonomy, Research, and Conservation*. IUCN Sri Lanka Country Office: Sri Lanka. 308pp.
- MOE-SL (Ministry of Environment, Sri Lanka) (2012)**. *The National Red List 2012 of Sri Lanka: Conservation status of the Fauna and Flora*. Ministry of Environment, Colombo, Sri Lanka. 127pp.
- PDSRSL (Parliament of the Democratic Socialist Republic of Sri Lanka) (2009)**. *Fauna and Flora Protection (Amendment) Act, No. 22 of 2009*. Published as a Supplement to Part II of the Gazette of the Democratic Socialist Republic of Sri Lanka, Department of Government Printing, Sri Lanka.
- Pethiyagoda, R. (ed.) (2012)**. *Horton Plains: Sri Lanka's Cloud-forest National Park*. Wildlife Heritage Trust of Sri Lanka, Colombo, Sri Lanka, 432pp.
- Seshadri, K. & T. Ganesh (2011)**. Faunal mortality on roads due to religious tourism across time and space in protected areas: A case study from south India. *Forest Ecology and Management* 262: 1713–1721; <http://doi.org/10.1016/j.foreco.2011.07.017>
- Spellerberg, I.F. (1998)**. Ecological effects of roads and traffic, a literature review. *Global Ecological and Biogeography Letter* 7: 317–333; <http://doi.org/10.1046/j.1466-822x.1998.00308.x>
- Stem, C.J., J.P. Lassoie, D.R. Lee & D.J. Deshler (2003)**. How 'eco' is ecotourism? A comparative case study of ecotourism in Costa Rica. *Journal of Sustainable Tourism* 11: 322–347; <http://doi.org/10.1080/09669580308667210>
- Taylor, B.D. & R.L. Goldingay (2004)**. Wildlife roadkills on three major roads in northeastern New South Wales. *Wildlife Research* 31: 83–91; <http://doi.org/10.1071/WR01110>
- Trombulak, S.C. & C.A. Frissell (2001)**. Review of ecological effects of roads on terrestrial and aquatic communities. *Conservation Biology* 14: 18–30; <http://doi.org/10.1046/j.1523-1739.2000.99084.x>
- Vijayakumar, S.P., K. Vasudevan & N.M. Ishwar (2001)**. Herpetofaunal Mortality on Roads in the Anamalai Hills, Southern Western Ghats. *Hamadryad* 26: 253–260.
- Weerawardhena, S., U. Amarasinghe & S. Kotagama (2004)**. Activity Pattern and Environmental Variation of Micro Habitats of Six-Toed Green Frog *Euphlyctis hexadactylus* Lesson 1834 (Anura: Ranidae) in Sri Lanka. *Lyriocephalus* 5: 111–129.
- Weerasinghe, U.M.I.R.K., D. Kariyawasm & M. De Zoysa (2003)**. Ruhuna (Yala) National Park in Sri Lanka: Visitors, Visitation and ecotourism. *World Forestry Congress, Quebec City, Canada* A1: 0116.
- WTTC (World Travel & Tourism Council) (2014)**. *Travel and tourism: Economic impact 2014 Sri Lanka*. World Travel and Tourism Council, London, UK, 89pp.
- Zobel, M., E. Maarel & C. Dupré (1998)**. Species pool: the concept, its determination and significance for community restoration. *Applied Vegetation Science* 1: 55–66; <http://doi.org/10.2307/1479085>





OPEN ACCESS



The Journal of Threatened Taxa is dedicated to building evidence for conservation globally by publishing peer-reviewed articles online every month at a reasonably rapid rate at www.threatenedtaxa.org. All articles published in JoTT are registered under [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/) unless otherwise mentioned. JoTT allows unrestricted use of articles in any medium, reproduction, and distribution by providing adequate credit to the authors and the source of publication.

ISSN 0974-7907 (Online); ISSN 0974-7893 (Print)

March 2017 | Vol. 9 | No. 3 | Pages: 9885–10020

Date of Publication: 26 March 2017 (Online & Print)

DOI: 10.11609/jott.2017.9.3.9885-10020

www.threatenedtaxa.org

Articles

An updated report on the distribution and conservation status of the endangered Cat's Head Rockrose *Helianthemum caput-felis* (Magnoliopsida: Violales: Cistaceae) in Algeria
-- Jonás C. Agulló, Ana Juan, Manuel B. Crespo, María Ángele Alonso & Alejandro Terrones, Pp. 9885–9891

A comparative study of the diet of the Indian Eagle Owl *Bubo bengalensis* (Franklin, 1831) from two distinct habitats in the Tamil Nadu - Puducherry area, southern India
-- M. Eric Ramanujam & Tushita Singh, Pp. 9892–9902

Review

Status, distribution and threats of kraits (Squamata: Elapidae: *Bungarus*) in Bangladesh
-- M.F. Ahsan & M.M. Rahman, Pp. 9903–9910

Communications

Ecology of marine macro algal flora of Visakhapatnam coastal areas, Bay of Bengal, India
-- I. Vishnupriya Sowjanya & P.S. Raja Sekhar, Pp. 9911–9919

Distribution pattern, population estimation and threats to the Indian Pangolin *Manis crassicaudata* (Mammalia: Pholidota: Manidae) in and around Pir Lasura National Park, Azad Jammu & Kashmir, Pakistan
-- Faraz Akrim, Tariq Mahmood, Riaz Hussain, Siddiq Qasim & Imad-ul-din Zangi, Pp. 9920–9927

Impact of vehicular traffic on vertebrate fauna in Horton plains and Yala national parks of Sri Lanka: some implications for conservation and management
-- Suranjan Karunaratna, Sudheera Ranwala, Thilina Surasinghe & Majintha Madawala, Pp. 9928–9939

Forest ghost moth fauna of northeastern India (Lepidoptera: Hepialidae: *Endoclitia*, *Palpifer*, and *Hepialiscus*)
-- John R. Grehan & Vijay Anand Ismavel, Pp. 9940–9955

First record of tapeworm *Moniezia* (Cestoda: Anoplocephalidae) infections in Leopards: Coprological survey of gastrointestinal parasites of wild and captive cats in Sri Lanka
-- Vishvapali Kobbekaduwa, Caroline Fillieux, Ashan Thudugala, R.P.V. Jayantha Rajapakse & Rupika S. Rajakaruna, Pp. 9956–9961

Short Communications

Macrofungi in two botanical gardens in southwestern India
-- Mundamoole Pavithra, Kandikere R. Sridhar & Ammatanda A. Greeshma, Pp. 9962–9970

A report on some butterflies (Lepidoptera) from Ladakh in Jammu & Kashmir and Lahaul in Himachal Pradesh, India
-- Sanjay Sondhi, Balakrishnan Valappil, Yash Sondhi & Anchal Sondhi, Pp. 9971–9987

Status, abundance and habitat preference of butterflies (Insecta: Lepidoptera) in Chittagong University Campus, Chittagong, Bangladesh

-- Ibrahim Khalil Al Haidar, M. Mizanur Rahman, M. Farid Ahsan & M. Ariful Islam, Pp. 9988–10003

A preliminary report on the impact of road kills on the herpetofauna species in Nilgiris, Tamil Nadu, India
-- P. Santhoshkumar, P. Kannan, A. Veeramani, A. Samson, S. Karthick & J. Leonaprinicy, Pp. 10004–10010

Notes

Lifecycle and fecula measurements of *Cheritra freja* (Lepidoptera: Lycaenidae), as relevant to the different larval stages
-- Tharaka Sudesh Priyadarshana & Ishara Harshajith Wijewardhane, Pp. 10011–10013

New distribution record of Nagarjunasagar Racer *Platyceps bholanathi* (Reptilia: Squamata: Colubridae) in Sigur, Nilgiris landscape, India
-- Arockianathan Samson, Palanisamy Santhoshkumar, Balasundaram Ramakrishnan, Sivaraj Karthick & Chandrashekaruni Gnaneswar, Pp. 10014–10017

A first report of the presence of the Indian Wild Pig *Sus scrofa cristatus* from Kajinag Range, Kashmir, India
-- Riyaz Ahmad, Intesar Suhail & Yash Veer Bhatnagar, Pp. 10018–10020