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Assessment of Avian Road Kill Mortality in the State Highway Passing Through Agricultural Landscape

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ABSTRACT

Roads are becoming one of the greater threats to avian fauna. In India, very few studies have been carried out to assess the mortality of avian fauna and other vertebrates. The data on the road kill survey was collected from Jan 2015 to Dec 2017. For the survey of a road-killed avian fauna, the road passing through the agricultural landscape (from Amravati to Paratwada) was selected based on geographical location and availability of vegetation diversity. The survey found a total of 694 carcasses of 38 different species belonging to 25 families that were killed on Amravati to Paratwada Highway. The highest mortality of Greater Coucal (*Centropus sinensis*) was recorded on Amravati to Paratwada state highway. While studying the seasonal variations, it was observed that the maximum mortality was found from June to September and the minimum from February to May.

KEY WORDS: AVIAN MORTALITY, AGRICULTURAL LANDSCAPE, ROAD VEHICLE COLLISION, STATE HIGHWAY.

INTRODUCTION

In this era of industrialization and modernization, the activities of humans affect the population of avian fauna. There are approximately 80 million birds are killed due to collisions with road vehicles every year in the United States alone (Erickson et al. 2005). Highways through wildlife reservoirs affect the fauna seriously and the effects range from habitat loss and fragmentation, direct mortality through collision with vehicles (Foster and Humphrey 1995; Das et al. 2007; Row et al. 2007; Baskaran and Boominathan 2010).

For birds and other vertebrate groups, a direct threat of roads is death due to collisions with vehicles (Erritzoe et al. 2003). Increasing traffic speed and volume have been found to also increase mortality and the mortality rates are generally highest during summer and Spring (Case 1978; Loss et al. 2014b). Mortality rates have been found to increase with the increasing width of the road corridor (Oxley et al. 1974; Pintoa et al. 2020). Pintoa et al. (2020) studied the temporal patterns of bird mortality due to road traffic collisions in the Mediterranean region. This study provides evidence that bird mortality due to road vehicle collisions may change between years and be highest during the breeding season (Pintoa et al. 2020).

Migratory species travel long distances and they may be even more at risk because they are presumably exposed to more road crossing events than non-migratory species (Harris and Scheck 1991). Higher mortality of adult and juvenile birds having roadside habitats can create sink populations that can only persist through immigration (Mumme et al. 2000; Bishop and Brogan 2013). Betleja et al. (2020) studied how high birds fly above roads, and how they use the road infrastructure such as bridges, lampposts, etc. This study found that species differed significantly in the height at which they crossed over roads, and 30 % of the birds crossing were at heights below 12 m, which is a potential collision height (Betleja et al. 2020). Roads are becoming one of the greater threats to animal and plant populations. In India, the highways are going through many protected areas and cause a severe impact on wildlife and their habitat (Vijayakumar et al. 2001). In India, very few studies have been carried out to assess the mortality of avian fauna and other vertebrates on the roads passing through reserve forests (Chhangani 2004; Das et al. 2007; Baskaran and Boominathan 2010; Selvan et. al. 2012; Rawankar and Wagh 2018; Betleja et al. 2020).

These studies provide the data on various casualties due to the vehicular collision in birds and other vertebrate fauna

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in the different parts of India and also suggest the urgent need to undertake such a survey to estimate the magnitude of this threat in different parts of India.

Figure 1: Map showing Amravati to Paratwada State Highway passing through agricultural land (Satellite image).

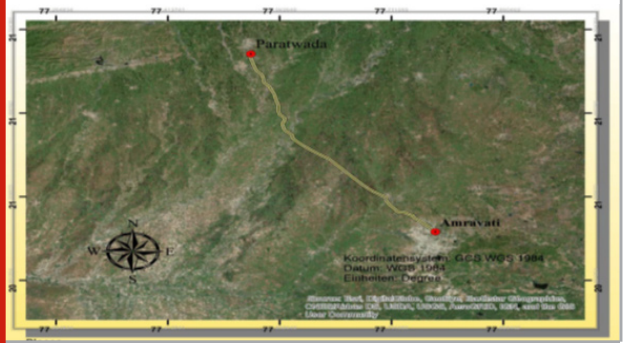


Figure 2: State Highway from Amravati to Paratwada passing through agricultural land (Actual Photograph)

MATERIAL AND METHODS

The Amravati to Paratwada State Highway Number – 6 is passing through the agricultural landscape and large numbers of vehicles are passing through this highway at very high speed every day. Hence this study was carried out to estimate the avian mortality due to road vehicle collisions on this state highway.

Road Vehicle collision Study: The data of the roadkill survey was collected from Jan 2015 to Dec 2017. For the survey of avian roadkill, Amravati to Paratwada, 50-kilometer state Highway Number – 6 was selected which is passing through the agricultural landscape. The survey was performed using a motorcycle. The motorcycle was ride at a speed of 10- 20 km/hour on the roads. The survey was performed in the morning hours from 7.00 to 9.00 am. The road, as well as 5 feet, fix area along the side of the road, was screened out for avian carcasses. When the dead bird was encountered, a photograph of the bird was taken. The survey was performed twice a week on this road. This survey method was followed by various researchers and found satisfactory in evaluating the road kills. (Das 2007; Baskaran 2010; Selvan 2012; Betleja et al. 2020).

Once the roadkill was encountered and photographed then it was removed from the road to prevent the double counting. Taxonomic keys were used to identify the road kills. Up to genus and species level identification was done. The road kills reported by locals, birders, and the author's occasional visits and road kills data were also recorded (Grimmat et al. 2009; Rasmussen and Anderton 2012; Wadatkar et al. 2016; Betleja et al. 2020).

The mortality estimation is subject to multiple biases and hence to calculate the annual mortality estimate accurately, the biases such as observer bias (probability of detection) and scavenging activity (persistence time) are considered. To calculate the mortality estimate, the formula provided by Gerow et al. was used (Tajera et al. 2018; Betleja et al. 2020).

$$M = (C / nS)* (I / Tp)$$

Where M is the estimated mortality; C is the number of carcasses found; nS is the number of surveys conducted (nS = 104), I is the number of days between surveys (I = 03); T is the persistence time of each taxon (T= 2.2 days), and p is the probability of detection (p= 67 %). While calculating the mortality per km (with or without bias), an average of three years was taken into consideration. Standard deviation was calculated for each road-killed bird species on Amravati to Paratwada State highway during the year 2015 to 2017 (Betleja et al. 2020).

RESULTS AND DISCUSSION

The survey found a total of 694 carcasses of 37 different avian species belonging to 25 families that were killed by road vehicles collision on the Amravati to Paratwada Highway. The highest mortality of Greater Coucal (*Centropus sinensis*) was encountered, and followed by Red - vented Bulbul (*Pycnonotus cafer*), Spotted Owlet (Athene brama), Common Myna (*Acridotheres tristis*), House Crow (*Acridotheres tristis*), Indian Nightjar (*Caprimulgus asiaticus*), Ashy Prinia (*Prinia socialis*), Indian Roller (*Coracias benghalensis*), Yellow-eyed Babbler (*Chrysomma sinense*), Laughing Dove (*Spilopelia senegalensis*), Jungle Babbler (*Turdoides striata*), Asian Koel (*Eudynamys scolopaceus*), Common Stonechat (*Saxicola torquatus*), Jungle Prinia (*Prinia sylvatica*), Indian Pond Heron (Ardeola grayii), Red-wattled Lapwing (*Vanellus indicus*), Barred buttonquail (*Turnix suscitator*), Indian Robin (*Copsychus fulicatus*) , Baya Weaver (*Ploceus philippinus*), Indian Thick-knee (*Burhinus indicus*), Common Tailor Bird (*Orthotomus sutorius*), Pied Cuckoo (*Clamator jacobinus*), Rufous Treepie (*Dendrocitta vagabunda*), Coppersmith Barbet (*Psilopogon haemacephalus*), Barn Owl (Tyto alba), Large Grey Babbler (*Turdoides malcolmi*), Indian Scops Owl (*Otus bakkamoena*), Yellow Wagtail (*Motacilla flava*), Scaly-breasted Munia (*Lonchura punctulata*), Silver bill Munia (*Euodice malabarica*), Wire - tailed Swallow (*Hirundo smithii*), Red - rumped Swallow (*Hirundo daurica*), Common House Martin (*Delichon urbicum*), Long-Tailed Shrike *(Lanius schach*) and Tawny bellied Babbler (*Dumetia hyperythra*).

Table 1. Showing the species-wise mortality and its percentage to the total carcasses killed due to a road vehicle collision and standard deviation for each species, on Amravati to Paratwada State highway during the year 2015-2017

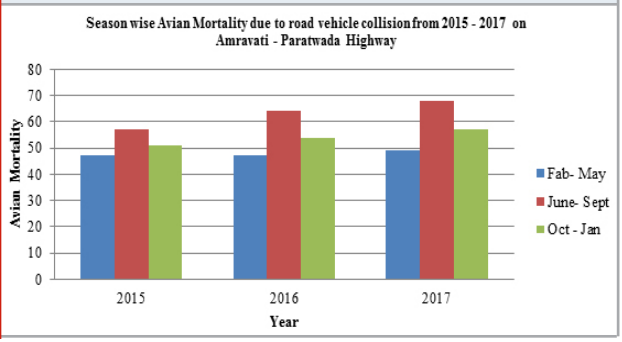
Scientific Name	Common Name	2015	2016	2017	Total (%)	SD
Centropus sinensis	Greater Coucal	29	65	79	173 (24.93)	25.79
Athene brama	Spotted Owlet	16	16	24	56 (8.07)	4.62
Pycnonotus cafer	Red-vented Bulbul	16	18	20	54 (7.78)	2.00
Acridotheres tristis	Common Myna	11	13	14	38(5.48)	1.53
Corvus splendens	House Crow	11	9	8	28(4.03)	1.53
Caprimulgus asiaticus	Indian Nightjar	12	9	6	27 (3.89)	3.00
Coracias benghalensis	Indian Roller	9	3	10	22 (3.17)	3.79
Spilopelia senegalensis	Laughing Dove	8	6	8	22 (3.17)	1.15
Prinia socialis	Ashy Prinia	10	4	7	21 (3.03)	3.00
Chrysomma sinense	Yellow-eyed Babbler	9	7	3	19 (2.74)	3.06
Prinia sylvatica	Jungle Prinia	6	6	4	16 (2.31)	1.15
Turdoides striata	Jungle Babbler	7	2	6	15 (2.16)	2.65
Ardeola grayii	Indian Pond Heron	6	4	5	15 (2.16)	1.00
Burhinus indicus	Indian Thick-knee	6	5	4	15 (2.16)	1.00
Vanellus indicus	Red-wattled Lapwing	6	4	2	12 (1.73)	2.00
Psilopogon haemacephalus	Coppersmith Barbet	5	5	2	12 (1.73)	1.73
Tyto alba	Barn Owl	4	2	6	12 (1.73)	2.00
Eudynamys scolopaceus	Asian Koel	7	2	2	11 (1.59)	2.89
Saxicola torquatus	Common Stonechat	7	4		11 (1.59)	2.12
Orthotomus sutorius	Common Tailor Bird	5	5	1	11 (1.59)	2.31
Turdoides malcolmi	Large Grey Babbler	4	5	1	10 (1.44)	2.08
Copsychus fulicatus	Indian Robin	6	0	3	9 (1.3)	3.00
Clamator jacobinus	Pied Cuckoo	5	3	1	9 (1.3)	2.00
Otus bakkamoena	Indian Scops Owl	2	5	1	8 (1.15)	2.08
Ploceus philippinus	Baya Weaver	6	0	1	7 (1.01)	3.21
Turnix suscitator	Barred buttonquail	6	0	0	6 (0.86)	3.46
Dendrocitta vagabunda	Rufous Treepie	5	0	0	5 (0.72)	2.89
Bubulcus ibis	Cattle Egret	0	5	0	5 (0.72)	2.89
Lonchura punctulata	Scaly-breasted Munia	0	2	0	2 (0.29)	1.15
Merops orientalis	Green Bee-eater	0	2	0	2 (0.29)	1.15
Euodice malabarica	Silver bill Munia	0	1	0	1 (0.14)	0.58
Motacilla flava	Yellow Wagtail	0	0	1	1 (0.14)	0.58
Hirundo smithii	Wire-tailed Swallow	0	0	1	1 (0.14)	0.58
Hirundo daurica	Red-rumped Swallow	0	0	1	1 (0.14)	0.58
Delichon urbicum	Common House Martin	0	0	1	1 (0.14)	0.58
Lanius schach	Long Tailed Shrike	0	0	1	1 (0.14)	0.58
Dumetia hyperythra	Tawny-bellied Babbler	0	0	1	1 (0.14)	0.58
	Unidentified Birds	7	17	10	34(4.9)	5.13
	Total	231	229	234	694	

The Family wise mortality of avian species was also calculated. Highest mortality was encountered in the Centropodidae and then followed by Pycnonotidae, Strigidae, Sturnidae, Corvidae, Caprimulgidae, Cisticolidae, Coraciidae, Sylviidae, Columbidae, Leiotrichidae, Cuculidae, Muscicapidae, Ardeidae, Charadriidae, Turnicidae, Ploceidae, Burhinidae, Megalaimidae, Tytonidae, Estrildidae, Motacillidae, Hirundinidae, Laniidae, and Timaliidae. The year wise mortality of the birds due to road vehicular collisions are shown in Table No. 1 and season wise details in Fig. 3.

Carcasses of Greater Coucal were found more frequently than other reported bird carcasses on the studied highway and perhaps the most dominant species on all the roads of Vidarbha and Maharashtra. This bird species cannot make pace with the speed of the vehicle because of its large size, low-level flight pattern, and ground-dwelling habit

and hence gets killed in collision with the vehicle. Indian Roller and Common Myna are the tree cavity-nesting birds. These birds prefer the holes of the Neem plant (*Azadirachta indica*) and Babul plant (*Acacia nilotica*) along the roadside. The frequency of road vehicle collisions of Indian Roller and Common Myna was observed maximum in summer because these birds' activities get increased near the nest site. This observation correlates with a previously published study (Erritzoe et al. 2003; Betleja et al. 2020).

Figure 3: Season wise Avian Mortality due to road vehicle collision from 2015 - 2017 on Amravati - Paratwada Highway



Owls, owlets (Spotted Owlet), and Nightjars are the nocturnal bird species. As Owls and Owlets feed on mice, rats, and other small animals, they used roadside trees for roosting. These birds are also tree cavity-nesting birds and they become active during the night, but due to high-intensity LED flashlights of vehicles they cannot make pace with the speed of the vehicle and get killed. Spotted Owlet and nightjars are the most frequently killed species of birds among the nocturnal birds (Betleja et al. 2020).

While studying the seasonal variations, it is observed that the maximum mortality was found during the months of June to September and the minimum in the months of Feb to May. The majority of the bird species have a breeding season during the rainy months from June to September. During the breeding season, the movements of the bird's increase, and hence the chances of collision also increase. Pintoa et al. (2020) studied the temporal patterns of bird mortality due to road traffic collisions in the Mediterranean region and their study also found that bird mortality due to road vehicle collisions was highest during the breeding season. Betleja et al. (2020) studied how high birds fly above roads, and how they use road infrastructure such as bridges, lampposts, etc. This study found that species differed significantly in the height at which they crossed over roads, and 30 % of the birds crossing were at heights below 12 m, which is a potential collision height (Betleja et al. 2020).

Due to rain, the wings of the birds get wetted, and hence the weight of the wings increases, and birds require more energy to fly. Due to this reason, birds find difficulty in flying due to wet body feathers. Again during monsoon, the frogs, toads, snakes, lizards, and small mammals come on roads in more number, and the birds which feed on these animals also come on roads frequently to catch these animals. Due to this reason, the mortality of nocturnal raptors (Owls and Owlets) get increased during the monsoon season. On Amravati to Paratwada State Highway, the estimated mean annual mortality was found 4.62 birds/km/year, and when recalculated by considering the biases such as observer bias and scavenging activity it is found 12.44 birds/km/year (Betleja et al. 2020).

Photo Plate No 1: Photographs of Carcasses of the birds Killed Due to Road vehicle Collision

Various study results show that the most dominant species found dead due to road vehicle collision belong to the family passerines, Columbidae, nocturnal birds such as owlets and nightjars. On the contrary, the present study recorded the observations that the Greater Coucal was the most dominant species belonging to the family Centropodidae found dead on the roads due to the vehicular collision. This scientific report presents that the Greater Coucal is the most dominant species found dead due to the road vehicle collision on State highways passing through agricultural landscape (Dhindsa et al. 1988; Chhangani 2004; Erickson et al. 2005; Selvan et al. 2012; Betleja et al. 2020).

Photo Plate No2: Photographs of Carcasses of the birds Killed Due to Road vehicle Collision

Erritzoe et al. (2003) and Boves and Belthoff (2012) reported that the passerines and Owls are the most dominant among the road-killed species. The present study also recorded the significant mortality of Passerines and Owls due to road vehicle collisions. When the data of road vehicle collision was evaluated based on feeding habitat (Table No. 2), it is found that the maximum number of species were insectivorous (21 species) followed by Omnivorous (06 species), Carnivorous (4 species), Granivorous (3 Species), Frugivorous (2 Species) and Piscivorous (1 species). The insectivorous and omnivorous birds do come on the roads to feed on the small insects and other animals such as amphibians, snakes, crabs, etc., and hence the chance of their collision with vehicles increases. The granivorous birds come on the roads to feed on the grains dispersed on the roads. Frugivorous birds such as Red Vented Bulbul, Brahmany Starling, and Coppersmith Barbet feed on the fruits of the roadside trees and collide with vehicles when trying to cross the roads. In the Piscivorous bird category, the study found only one species which is the Indian Pond Heron. This bird mainly feeds on fishes, frogs, aquatic insects, etc. The record of these species as roadkill may be a matter of chance only (Betleja et al. 2020).

When a comparison was made between diurnal and nocturnal birds (Table No.2), it is found that the majority of the species which got killed due to road vehicle collisions are diurnal (33 species) and only 4 species were nocturnal. The nocturnal bird species include the Owls (Barn Owl, Scops Owl), Owlet (Spotted Owlet), and Indian Nightjar. The mortality in diurnal birds occurred during the early hours of the day when the diurnal birds are more active and the speed of the vehicle is very high. The mortality in nocturnal birds such as Owls, owlets, and Nightjar occurred during the night-time (Betleja et al. 2020).

Following recommendations will be useful to minimize road vehicle collision and avian species conservation.

1. It is recommended that limiting the speed of the vehicle on the highways passing through the critical areas to 40 to 50 km/hour (Orlowski and Nowak, 2006), further speed breakers and signposts at the roadsides should be introduced in Wildlife conservation policies.
2. Structural elements can encourage birds to fly above traffic or below the road through bridges or culverts. Flight diversion works best for species with direct, rapid flight. Poles that produce an illusion of a solid barrier were effective in reducing bird road kills.
3. Vehicle LED lighting appears to blind Owls and increases the chances of collision with vehicles hence light pollution could be addressed as a part of the strategy.
4. The combined efforts and continuous monitoring of Foresters, Non-Government Organisations (NGO), and Birders are needed for the conservation of the Avian Diversity.

This study provides baseline data on the magnitude of avian mortality due to road vehicle collisions on the Amravati to Paratwada state highway in the Amravati District. Due to such loss of these species, the total avian population becomes severely affected. The number of mortality due to road vehicle collisions may be quite large because the avian carcasses get cleared immediately by scavengers after death and remain unnoticed; sometimes the collided birds have dashed far away from the road and cannot be noticed. Further, this was the first attempt to estimate the mortality of avian fauna due to road vehicle collision on State highway no.6 Amravati to Paratwada (50Km) in the Amravati district. The better estimation and evaluation of avian carcasses need long-term study (Betleja et al. 2020).

Table 2. Showing feeding habits and diurnal/ Nocturnal habit of birds killed by road vehicle collision Amravati - Paratwada State Highway

Sr. No	Scientific Name	Insectivorous	Granivores	Frugivorous	Carnivorous	Omnivorous	Piscivores	Diurnal	Nocturnal
1	*Prinia socialis*	+						+	
2	*Eudynamys scolopaceus*	+						+	
3	*Turnix suscitator*					+		+	
4	*Ploceus philippinus*		+					+	
5	*Bubulcus ibis*	+						+	
6	*Tyto alba*				+				+
7	*Delichon urbicum*	+						+	
8	*Acridotheres tristis*					+		+	
9	*Saxicola torquatus*	+						+	
10	*Orthotomus sutorius*	+						+	
11	*Psilopogon haemacephalus*			+				+	
12	*Centropus sinensis*	+						+	
13	*Merops orientalis*	+						+	
14	*Corvus splendens*					+		+	
15	*Caprimulgus asiaticus*	+							+
16	*Ardeola grayii*						+	+	
17	*Copsychus fulicatus*	+						+	
18	*Coracias benghalensis*	+						+	
19	*Otus bakkamoena*				+				+
20	*Burhinus indicus*				+			+	
21	*Turdoides striata*	+						+	
22	*Prinia sylvatica*	+						+	
23	*Turdoides malcolmi*	+						+	
24	*Spilopelia senegalensis*					+		+	
25	*Lanius schach*					+		+	
26	*Clamator jacobinus*	+						+	
27	*Pycnonotus cafer*			+				+	
28	*Cecropis daurica*	+						+	
29	*Vanellus indicus*	+						+	
30	*Dendrocitta vagabunda*					+		+	
31	*Lonchura punctulata*		+					+	
32	*Euodice malabarica*		+					+	
33	*Athene brama*				+				+
34	*Dumetia hyperythra*	+						+	
35	*Hirundo smithii*	+						+	
36	*Chrysomma sinense*	+						+	
37	*Motacilla flava*	+						+	

+ = Present

CONCLUSION

The findings of the present study recorded the avian mortality of 37 bird species due to road vehicle collision on Amravati to Paratwada state highway, which is passing through the agricultural landscape. Greater Coucal, Red-vented Bulbul, Spotted Owlet, Common Myna, Nightjars, Indian Roller, Dove, and Babblers were found the most affected agricultural habitats dependent bird species. But Greater Coucal was reported the most dominant species affected due to this road vehicle collision threat. The maximum mortality of bird species was recorded during the rainy seasons and the minimum during the summer season. This report presents the first-ever detailed quantitative study on avian mortality due to road vehicle collisions on state highways passing through agricultural landscapes.

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Data availability Statement: All data / results / information is available with the authors and can be shared on a reasonable request made to the corresponding author when required.

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