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AMBIENT APPRAISAL

Avian Mortality in Mount Abu Wildlife Sanctuary and its Vicinity Areas due to Electrocution and Road Vehicles Collision

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Study Area: Mount Abu Wildlife Sanctuary (Sirohi district), Rajasthan, India
Coordinates: $72^0$38'-$72^0$53'E

Keywords: Speed limit, Avian conservation

Abstract

Electrocutions and road-vehicle collisions significantly affect birds' survival. During the present study, we observed that 24 individuals who died due to electrocutions belonged to 8 bird species, while 303 individuals who died in road-vehicle collisions belonged to 30 bird species. The Accipitridae family had the most electrocuted birds individuals, followed by Corvidae and so on. During the study we found that most road-killed species were from the Columbidae family followed by two families containing three species each; Sturnidae and Turdidae. Two-two species of road kill were from five families Cuculidae, Hirundinidae, Corvidae, Motacillidae, Pycnonotidae and the remaining family Dicruridae, Accipitridae, Meropidae, Passeridae, Phasianidae, Leiothrichidae, Timaliidae, Charadriidae and Strigidae contained only one species of road-killed in the study area. Columbidae family had the highest number of road-killed individuals 57 whereas the minimum road-killed individuals belonged to Strigidae family. Undergrounding medium and low voltage cables might be reduced the risk of bird electrocution.

Introduction:

Anthropogenic-induced mortality of birds has been widespread for a long time and is a major source of bird mortality due to road vehicle collisions and electrocution (Jacobson, 2005; Reijnen & Foppen, 2006; Rioux *et al.*, 2013; Loss *et al.*, 2015). Power line structures cause both collisions and electrocution of birds in several countries and have also become a large conservation issue in South Africa, North America, Asia, Oceania and Europe for many years (Avery, 1978; Bevanger, 1994; Salvador & Ibanez, 2006; Lehman et al., 2007; Loss *et al.*, 2014; Mojica *et al.*, 2018). Increased bird mortality due to electrocution and collisions has been also observed and studied in the parts of Asia, Africa and Latin America due to increasing global energy demand (Bernardino *et al.*, 2018). Birds mortality due to power lines has been widely studied in several regions of North America (APLIC, 2006), Europe (Prinsen *et al.*, 2011), Africa (Boshoff *et al.*, 2011; Angelov *et al.*, 2013), central Asia and India (Dixon *et al.*, 2013; Harness *et al.*, 2013). Several studies have also been conducted on the reduction in collisions and electrocutions of avian species with electric power lines (Lehman, 2001; Manville, 2005; Jenkins *et al.*, 2010). Since 1970, several authorities, researchers, managers and conservationists have also started research work to understand various factors that were responsible for bird electrocutions, including bird behaviour and size, pylon material and designs and surrounding ecological habitat characteristics (Lehman *et al.*, 2007; Dwyer *et al.*, 2014). While well-planned electric power lines can prevent electrocution, power line-marking also reduces the bird's possible collision threat and risk (Lehman *et al.*, 2007; Barrientos *et al.*, 2011). As a result, electric power line collision mortality is a worldwide avian conservation problem and it, along with other threats like habitat loss and hunting, may be contributing to the decline in species numbers and populations (Bevanger & Brseth, 2004; Drewitt & Langston, 2008; Jenkins *et al.*, 2010). Electrocution due to power lines has been identified as one of the major leading avian conservation issues and which causes mortality of several rare and threatened birds, especially raptors (Bevanger & Overskaug, 1998; Real *et al.*, 2001). Electrocution and collision death rates are lower in some species at the population level, but they can cause a serious impact on threatened and rare species (Faanes,

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1987; Brown & Drewien, 1995). Raptors, waterfowl, herons, cranes, shorebirds, owls, corvids, tetraonids and passerine birds were the most common examples of power line collisions, which have affected up to 245 avian species (Negro, 1999; Moleon *et al*., 2007; Lasch *et al*., 2010). Large-sized birds have more risk of electrocutions and collisions with power lines (e.g., Eagle-owl, Sergio *et al*., 2004; Vultures, Angelov *et al*., 2013; Cranes, Shaw *et al*., 2010; Condors, Rideout *et al*., 2012) and electrocutions can also cause significant changes in the local population of birds (Sergio *et al*., 2004). Several studies have been also documented on the Spanish imperial eagle (Aquila adalberti) (Ferrer & Hiraldo, 1992; Gonzalez *et al*., 2007), Golden Eagle (*Aquila chrysaetos*) (Manville, 2005; Lasch et al., 2010), Eagle Owl (*Bubo bubo*) (Bevanger & Overskaug, 1998; Rubolini *et al*., 2005), Saker Falcon (*Falco cherrug*) (Harness *et al*., 2008) and Bonelli's eagle (*Aquila fasciata*) (Real *et al*., 2001) to have a significant adverse effect on the population at the regional level.

Roads play an important role in human life by providing social, cultural and economic benefits to the society. The development of roads and highways are directly associated with habitat fragmentation and mortality of wild vertebrates (Prado *et al*., 2006). Roads and railroads are listed as threats to certain birds and other wildlife by the International Union for Conservation of Nature (IUCN; http://www.iucnredlist.org). Expansion and establishment of roads cause adverse and significant effects on biodiversity at local, regional and landscape levels with the greater impact not being identified at the present time (Findlay & Bourges, 2000; Burton *et al*., 2002). Road proximity and density cause an adverse impact on the breeding success ranging from small birds like- warblers to larger birds like- vultures (Catchpole & Phillips, 1992; Donazar *et al*., 1993; Reijnen & Foppen, 1994). The main effect and threats of roads to individual avian mortality or injury from vehicle collisions and some other impacts such as behavioural modification, reduction in species abundance, population and breeding success (Reijnen & Foppen, 1994; Ashley & Robinson, 1996; Jacobson, 2005; Reijnen & Foppen, 2006). The presence of roads around a bird's habitat has a significant impact on its eco-biology. Vehicle noise also enhances stress levels among birds (van der Zande *et al*., 1980; Reijnen *et al*., 1987; Reijnen & Foppen, 1994; Reijnen *et al*., 1995; Ramsden, 2003). Road killing of birds is influenced in several ways, including species composition, abundance, mobility, seasonal and spatial patterns and also affected by the landscape patterns of particular geographical areas (Miller & Cale, 2000; Erritzoe *et al*., 2003). Several studies have been conducted in India to assess problems related to vertebrate animal mortality on roads and highways (Chhangani, 2004; Baskaran & Boominathan, 2010).

The aim of the present study was to analyse avian mortality due to electrocutions and road-vehicle collisions of birds in Mount Abu wildlife sanctuary and its peripheral surrounding areas of Sirohi district, Rajasthan.

Methodology:

The present study was carried out from January 2020 to December 2021 in the Mount Abu Wildlife Sanctuary and its peripheral surrounding areas of Sirohi district, Rajasthan. Regular observations were conducted using road transect, point count and direct visual methods along the electric power lines, major roads and other associated roads. The study was carried out with the help of a bike and photographs of electrocuted and road-killed birds were taken by camera model Nikon P1000.

Results and Discussion

Electric power line networks enhance mortality of birds due to strike with electric power lines and wires (Loss et al., 2014;Bernardino et al., 2018). But electric power line networks can also have some significant positive impacts on some bird species while utilizing, pylons as habitat, perching and nesting sites (Infante & Peris, 2003; Hollmen *et al*., 2008; Tryjanowski *et al*., 2014). On the other hand, electricity networks causes worldwide avian mortality due to electrocutions and collisions (APLIC, 2006; Prinsen *et al*., 2011; Loss *et al*., 2015). Threatened species, particularly raptors are more vulnerable to electrocution (Gonzalez *et al*., 2007; Lehman *et al*., 2007; Hernandez Matas *et al*., 2015; Mc Clure *et al*., 2018).

During present study, eight species of birds died due to electrocution and another 30 species died due to road vehicle collisions (Table-1). A total of 24 bird individuals died due to electrocutions and 303 bird individuals died due to road vehicle collisions. Electrocuted birds belong to six families and eight species. These birds belong to families, namely the Accipitridae (*Milvus migrans govinda, Spilornis cheela* and *Accipiter badius*), Corvidae (*Corvus splendens splendes*), Phasianidae (*Pavo cristatus*), Columbidae (*Columba livia intermedia*), Strigidae (*Athenebrama indica*) and Sturnidae (*Acridotheres tristis*). Individuals from the Accipitridae family were electrocuted the most (9) followed by Corvidae (6), Columbidae (4), Sturnidae (3), and Phasianidae (1) and Strigidae (1) (Fig.-1).

Bird abundance was also reduced up to 1–3.5 kilometres away from highways and roads (Forman *et al*., 2002; Benitez-Lopez *et al*., 2010). Habitat fragmentation, pollution, poisoning, noise and collisions with vehicles were significant negative impacts of roads on wildlife communities (Fahrig & Rytwinski, 2009; Francis *et al*., 2009; Goodwin & Shriver, 2011; Kociolek *et al*., 2011; Summers *et al*., 2011; Mc Laughlin & Kunc, 2013). Scavenging raptors like crows and insectivore birds like white wagtails (*Motacilla alba*) and red-backed shrike (*Lanius collurio*) also share roadside habitats for foraging and feeding time (Ceresa *et al*., 2012; Morelli, 2013; Husby

Ambient Science, 2022: Vol. 09(2); 37-42
DOI:10.21276/ambi.2022.09.2.aa03

Table-1: List of Birds observed and recorded as electrocuted and killed in road accidents and collisions in study area

#	Common name	Zoological name	Family	IUCN STATUS
1	Asian Koel	*Eudynamys scolopaceus scolopaceus*	Cuculidae	LC
2	Asian Pied Starling	*Gracupica contracontra*	Sturnidae	LC
3	Black Drogue	*Dicrurus macrocercus minor*	Dicruridae	LC
4	Black Kite	*Milvus migrans govinda*	Accipitridae	LC
5	Brahmin Starling	*Sturnus pagodarum*	Sturnidae	LC
6	Brown Rock Chat	*Cercomela fusca*	Turdidae	LC
7	Common Myna	*Acridotheres tristis*	Sturnidae	LC
8	Common Swallow	*Hirundo rustica*	Hirundinidae	LC
9	Created Serpent Eagle	*Spilornis cheela*	Accipitridae	LC
10	Eurasian Collared Dove	*Streptopelia decaocto decaocto*	Columbidae	LC
11	Greater Coucal	*Centropus sinensis sinensis*	Cuculidae	LC
12	Green Bee Eater	*Merops orientalis*	Meropidae	LC
13	House Crow	*Corvus splendens splendens*	Corvidae	LC
14	House Sparrow	*Passer domesticus indicus*	Passeridae	LC
15	Indian Grey Francolin	*Francolinus pondicerianus*	Phasianidae	LC
16	Indian Peafowl	*Pavo cristatus*	Phasianidae	LC
17	Indian Robin	*Saxicoloides fulicatus cambaiensis*	Turdidae	LC
18	Jungle Babbler	*Turdoides striata*	Leiothrichidae	LC
19	Large Grey Babbler	*Turdoides malcolmi*	Timaliidae	LC
20	Large Pied Wagtail	*Motacilla maderaspatensis*	Motacillidae	LC
21	Laughing Dove	*Streptopelia senegalensis cambayensis*	Columbidae	LC
22	Oriental Magpie-Robin	*Copsychus saularis saularis*	Turdidae	LC
23	Red Collared Dove	*Streptopelia tranquebarica*	Columbidae	LC
24	Red Vented Bulbul	*Pycnonotus cafer*	Pycnonotidae	LC
25	Red Wattled Lapwing	*Vanellus indicus indicus*	Charadriidae	LC
26	Rock Pigeon	*Columba livia intermedia*	Columbidae	LC
27	Rufous Treepie	*Dendrocitta vagabunda*	Corvidae	LC
28	Shikra	*Accipiter badius*	Accipitridae	LC
29	Spotted Dove	*Streptopelia chinensis chinensis*	Columbidae	LC
30	Spotted Owlet	*Athenebrama indica*	Strigidae	LC
31	White Eared Bulbul	*Pycnonotus leucotis*	Pycnonotidae	LC
32	White Wagtail	*Motacilla alba*	Motacillidae	LC
33	Wire Tailed Swallow	*Hirundo smithii*	Hirundinidae	LC

& Husby, 2014).

During the study period maximum road-killed species (5) were observed from family Columbidae (*Streptopelia decaocto decaocto, Streptopelia senegalensis cambayensis, Streptopelia tranquebarica, Columba livia intermedia* and *Streptopelia chinensis chinensis*) followed by three avian species each from two avian families Sturnidae (*Gracupica contra contra, Sturnus pagodarum* and *Acridotheres tristis*), and Turdidae (*Cercomela fusca, Saxicoloides fulicatus cambaiensis and Copsychus saularis saularis*). Five avian families consist each two avian species killed in road accidents and collisions which were as Cuculidae (*Eudynamys scolopaceus scolopaceus* and *Centropus sinensis sinensis*), Hirundinidae (*Hirundo rustica* and *Hirundo smithii*), Corvidae (*Corvus splendens splendens* and *Dendrocitta vagabunda*), Motacillidae (*Motacilla maderaspatensis* and *Motacilla alba*), Pycnonotidae (*Pycnonotus cafer* and *Pycnonotus leucotis*).

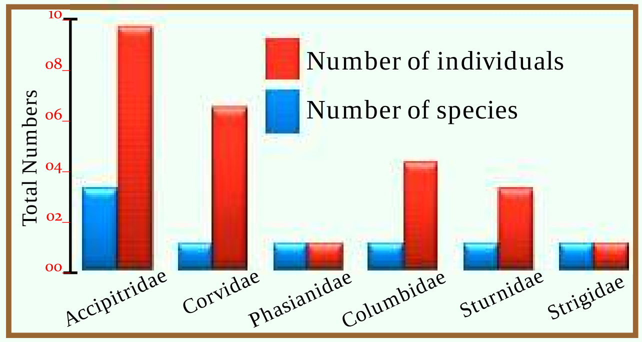

Figure-1: Family wise representation of number of species and individuals died due to electrocutions in study area

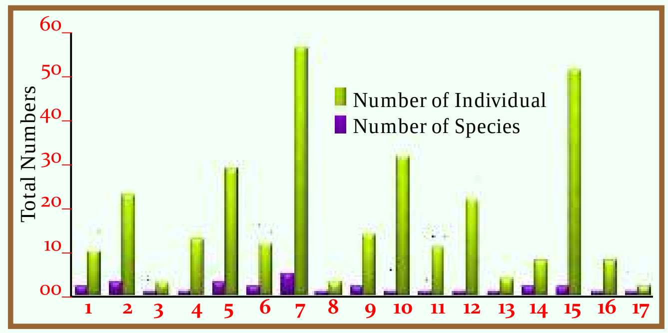

Figure-2: Family-wise representation of the number of species and individuals recorded in the study area. 1-Cuculidae; 2-Sturnidae; 3-Dicruridae; 4-Accipitridae; 5-Turdidae; 6-Hirundinidae; 7-Columbidae; 8-Meropidae; 9-Corvidae; 10-Passeridae; 11-Phasianidae; 12-Leiothrichidae; 13-Timaliidae; 14-Motacillidae; 15-Pycnonotidae; 16-Charadriidae; 17-Strigidae

Avian families Dicruridae, Accipitridae, Meropidae, Passeridae, Phasianidae, Leiothrichidae, Timaliidae, Charadriidae and Strigidae contained only one species of killed due to vehicle collision and road traumas in the study area (Table-1 & Fig.- 2). Maximum road killed individuals were belonging to the family Columbidae (57) followed by Pycnonotidae (52), Passeridae (32), Turdidae (29), Sturnidae (23), Leiothrichidae (22), Corvidae (14), Accipitridae (13), Hirundinidae (12), Phasianidae (11), Cuculidae (10), Motacillidae (8) and Charadriidae (8), Timaliidae (4), Dicruridae (3) and Meropidae (3) with minimum road-killed individuals belonging to Strigidae

(2) (Fig.-2). During the study, three species of birds (*Milvus migrans govinda*, *Spilornis cheela* and *Pavo cristatus*) were observed to be only electrocuted and were without a single case of a road accident and collision mortality.

Conclusion

Underground cables are one of the ways to mitigate avian mortality due to electrocution and collision with related structures. Underground medium and low voltage cables might be helpful for the conservation of avian species which also reduces the risk of electrocution among avian taxa. In order to achieve avian conservation and reduction in avian death due to electrocution, underground moderate voltage electric power lines had been successfully installed in various countries including United site, Norway, Netherland, Belgium and Germany (Haas *et al*., 2005; Prinsen *et al*., 2012). Regular field visits and monitoring of avian behavioural responses aided by several technologies such as thermal imaging, camera traps, video and radar might be helpful for determining the rate of crossing electric power lines by birds. Long-term studies to assess population trends in local and regional areas were also beneficial for determining the rate of mortality due to electrocution and road vehicle collisions of birds and other wildlife. Types of species, species abundance, morphological characteristics of species (e.g., body size, wing size, age, gender and behaviour), prey availability and seasonal and climatic factors were also responsible for bird's electrocution in particular areas (Manosa, 2001; Janss & Ferrer, 2001; APLIC, 2006). However, significant efforts and investigations have been made to decrease the bird collisions rate with electric power lines (Negro, 1999). Several methods were also developed for the decline in birds' collisions rate with electrocutions, but their efficiency has yet to be proven (APLIC, 2006; Lehman *et al*., 2007).In the United States, different studies were conducted on the non-conductive woods pole used as perching guards for birds, but even then they did not reduce the risk of avian electrocutions (Garret 1993; Harness & Garret, 1999; Harness, 2000). The use of insulating materials and modification of electric pylons seems to be effective and has significantly reduced bird mortality in several areas (Garret, 1993; Dwyer, 2004). The speed limit of vehicles particularly on the roads adjoining the natural avian habitat or forest plays a significant role in the number of birds that die on the highways and roads due to collisions (Chambers *et al*., 2010). During present study, we observed that speedy vehicles created confusion amongst the birds during their initial flight and low-level aerial movements from one place to another place were significant causal factors for avian mortality as compared to vehicles with controlled and slow speeds. It has been observed that birds more frequently collided with vehicles in open areas as compared to forests and protected areas. Large-sized birds such as peacocks, kites, eagles and other raptors were more vulnerable to electrocutions than small birds such as robins, wagtails and sparrows. Food material thrown by locals and tourists on roads has also been observed to possible enhancement of road-vehicle collisions of birds. The establishment of speed limits sign boards and alert boards for wildlife areas birds rescue centres and awareness towards avian conservation can significantly reduce future avian mortality due to road-vehicles collisions

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Ambient Science, 2022: Vol. 09(2); 37-42
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