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Preliminary report of bird road kills in the Changbai Mountain Nature Reserve in China

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Abstract. Bird road kills and roadside bird abundances were investigated along 3 roads around the Changbai Mountain Nature Reserve area, using sample line transects which were conducted from 2007 to 2013. A total of 462 birds, belonging to 41 species, were killed by cars, which accounted for 56.94% of roadside species richness. Road kills where mostly recorded from April to October, while a decreasing tendency in road kill occurrences was observed over the timeframe of this study. The highest mortalities attributed to road kills were observed for shrub birds, followed by forest birds. Bird road kills was significantly correlated with bird roadside abundance, the perpendicular distance to the highway, and the frequency of birds crossing the highway. Results from this study will contribute to recommendations and management policies for protective countermeasures to reduce bird road kills in the future.

Key words: roadside bird abundance, road kills, bird community, road ecology.

Road kills present one of the most obvious forms of the impact of roads on wildlife. A large number of studies have been conducted world-wide on this issue, most of which focus on vertebrate road kills in general (Seshadri & Ganesh 2011, Selvan et al. 2012, Wang et al. 2013, D'Amico et al. 2015), some researches especially focus on amphibians (Orlowski et al. 2008, Hartel et al. 2009, Gu et al. 2011), and reptiles (MacKinnon et al. 2005, Ciesiolkiewicz et al. 2006, Pragatheesh & Rajvanshi 2013). In addition, bird road kills also attract attention in many countries (Erritzoe et al. 2003, Morelli et al. 2014, Jack et al. 2015), and roads are one of the most important factors for explaining declining bird population trends (Kociolek et al. 2011). However, in China, systematic reports of bird road kills have been nonexistent until the conductance of this study.

Changbai Mountain Nature Reserve is a typical ecologically sensitive area in North-East China. It hosts a large variety of wildlife, and is one of the largest volcanic areas of East Asia, with a volcanic lava tectonic geomorphology, water landscapes, glaciers, and periglacial landforms (Chen et al. 2010). However, with the development of economic and tourism industries, the density of road networks and the traffic volume have been growing rapidly in recent years, which has resulted in unavoidable impacts on wildlife (Wang et al. 2013). The current study focuses on bird road kills along 3 main roads around the Changbai Mountain Nature Reserve, from March 2007 to August 2013, with the aim to understand the impact of roads on bird populations, and provide bird mitigation advice in order to reduce this impact.

We selected 3 roads within the Changbai Mountain Nature Reserve area, and assigned transect sample lines at a length of 10km each along the roads (Fig 1). All of the roadside vegetation types were dominated by broad-leaved Korean pine forest, while white birch secondary forest was distributed adjacent to roadsides at a 200m distance. Roadside transects were positioned perpendicular to the road every 5km along the 3 sample lines. Roadside transects and each of the 3 sample lines were surveyed at 2-3 km/hour by foot or by bicycle. Investigations were conducted during favorable weather conditions (sunlight and no wind), from 5:00 to 8:00 AM in spring and summer, and from 7:00 to 10:00 AM in autumn and winter. We investigated all transects and sample lines at least twice every month, at intervals of 10 to 15 days, with generally 2-3 observers assigned to each line . We recorded the species richness, abundance (the number of individuals observed), and perpendicular distance to the highway for all individual birds recorded within a 200m range along the roadside transects (identified by binoculars and a Laser Ranger Finder Nikon-550 (maximum range 1000m)). In addition, we investigated the species richness of observed road kill, as well as the abundance and location (km), and took pictures of all observed road kills. As some birds killed on roads were difficult to identify, we only recorded identifiable carcasses that were present on the road. After recording this information, each carcass was removed from the road in order to avoid double counting. Species richness and the abundance of birds crossing the highway were also recorded.

Seventy two species of birds were recorded on the

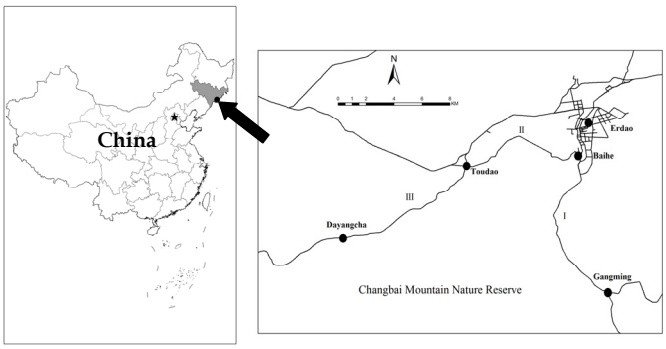

Figure 1. Sketch map of the research area.

roadside, and forty one species were recorded as being killed on the roads (Table 1). The highest road kill numbers were observed for shrub birds (289 individuals, 62.55%), followed by forest birds (72 individuals, 15.58%). Four species that experienced the highest road kill numbers belonged to the shrub birds group, including the Black-faced Bunting (*Emberiza spodocephala*) (33.55%), the Yellow-throated Bunting (*Emberiza elegans*) (11.47%), Tristram's Bunting (*Emberiza tristrami*) (8.01%) and the Grey-backed Thrush (*Turdus hortulorum*) (7.14%). Five of the recorded species are currently listed on the Chinese national protected species list, including the Buzzard (*Buteo buteo*), Ural Owl (*Strix uralensis*), Hazel Grouse (*Bonasa bonasia*), Collared Scops-Owl (*Otus bakkamoena*), and Eurasian Hobby (*Falco subbuteo*). Bird road mortality was positively correlated with roadside bird abundance (Spearman correlation, $P<0.01$, $R=0.498$) and frequency of crossing the highway (Spearman correlation, $P<0.01$, $R=0.534$), but a negative correlation was observed with perpendicular distance to the highway ($P<0.01$, $R=-0.388$).

Shrub birds generally use the roadside areas for foraging on seeds produced by the shrubs in this area (Fulton et al. 2008). In addition, shrub birds frequently crossed the highway at a low flight height (about 2m), which likely increases the probability of collision with vehicles (Erritzoe et al. 2003). In addition, many shrub birds select nesting sites in the shrub habitat along the roadside (Zhao 1985). Juvenile birds emerge from these sites, especially in June and July. These factors collectively contributed to the high road kills observed.

The large-sized Hazel Grouse was listed as the fifth highest species observed as road kill, explained by this species additionally feeding on gravel and soil to aid in digestive processes, and its utilization of bare ground along the roadside for sand baths (Wang et al. 2013). In addition, their slow take-off speed and flight ability further attributed to their mortality rates on the road (Erritzoe et al. 2003). Raptors were also prone to collisions with vehicles as they feed on rodents along roadside corridors (Piao et al. 2012). Raptors also scavenge upon wildlife killed by cars along the roads (Forman et al. 2003). In addition, the headlights of cars appear to be of great importance for contributing to collisions with nocturnal birds, as poor visibility reduces the awareness of drivers and increases their response time (Erritzoe et al. 2003).

The majority of road kills occurred between April and October, with the highest mortality rates observed in July (Fig. 3). May to October presented the non-snow season in the Changbai Mountain area, and many tourists visited the famous Tianchi lake, increasing traffic volume rapidly during this time, which potentially led to the observed higher mortality rate (Wang et al. 2013). Interestingly, however, bird annual mortality rates decreased over recent years (Kruskal-Wallis test, $Z=58.125$, $df=6$, $p<0.0001$) (Fig. 2). Birds have displayed a tendency to avoid roads over time following the timing of road openings (Forman et al. 2003). Furthermore, as wildlife road related deaths are not target specific, this potentially impacts healthy individuals in addition to weak individuals, contributing to a higher rate of population decline than otherwise anticipated (Bujoczek et al. 2011).

As a mitigation strategy to reduce bird road kills, we suggest the removal of any naturally germinating seed plants along roadsides. In addi-

Table 1. Bird road kills and abundance along the roads in Changbai Mountain Nature Reserve.

Common English name	Scientific name	Abundance (individuals)	Number of road mortalities	Perpendicular distance to highway (Mean±SD, m)	Frequency of crossing highway	Number of adult road mortalities	Number of juvenile road mortalities	Forage preference	Habitat	Daily activity pattern
Black-faced Bunting	*Emberiza spodocephala*	218	155	7.13±7.02	49	106	49	I	S	D
Yellow-throated Bunting	*Emberiza elegans*	153	53	9.76±10.81	27	31	22	I	S	D
Tristram's Bunting	*Emberiza tristrami*	43	37	13.13±12.29	10	32	5	I	S	D
Grey-backed Thrush	*Turdus hortulorum*	70	33	27.02±25.27	13	14	19	I	S	D
Hazel Grouse	*Tetrastes bonasia*	219	28	51.72±26.57	13	17	11	O	F,S	D
Eurasian Nuthatch	*Sitta europaea*	151	24	21.33±21.73	25	14	10	I	F	D
Grey Wagtail	*Motacilla cinerea*	44	17	3.39±8.77	27	5	12	I	S,G	D
Ural Owl	*Strix uralensis*	9	11	10±9.06	2	10	1	C	F	N
Long-tailed Tit	*Aegithalos caudatus*	75	10	12.14±10.16	1	9	1	I	F	D
Marsh Tit	*Parus palustris*	208	9	15.91±12.90	13	6	3	I	F	D
White Wagtail	*Motacilla alba*	45	8	2.78±4.95	20	5	3	I	S,G	D
Long-tailed Rosefinch	*Uragus sibiricus*	153	8	7.00±7.53	32	5	3	I	S	D
Barn Swallow	*Hirundo rustica*	5	7	0	0	2	5	I	H	D
Orange-flanked Bush Robin	*Tarsiger cyanurus*	13	6	7.63±7.73	4	6	0	I	F	D
Eurasian Tree sparrow	*Passer montanus*	26	6	18.75±15.48	0	3	3	O	H	D
Eurasian Bullfinch	*Pyrrhula pyrrhula*	26	5	6.15±8.08	7	5	0	O	F	D
Daurian Redstart	*Phoenicurus auroreus*	27	4	12.33±12.38	3	3	1	I	S,H	D
Great Tit	*Parus major*	144	4	15.00±10.99	24	3	1	I	F,S	D
Coal Tit	*Parus ater*	10	4	20.00±11.18	3	4	0	I	F	D
Pale Thrush	*Turdus pallidus*	0	3	0	0	3	0	I	F,S	D
Blue-and-white Flycatcher	*Cyanoptila cyanomelana*	28	3	34.77±20.15	0	3	0	I	F,S	D
Pallas's Leaf Warbler	*Phylloscopus proregulus*	124	3	25.90±15.41	2	3	0	I	F,S	D
Yellow-breasted Bunting	*Emberiza aureola*	0	2	0	0	2	0	I	S,G	D
Azure-winged Magpie	*Cyanopica cyanus*	34	2	6.11±9.61	5	2	0	I	F,S	D
Grey-headed Woodpecker	*Picus canus*	5	2	22.00±26.83	2	2	0	I	F,S	D
Common Buzzard	*Buteo buteo*	3	2	17.00±12.12	0	2	0	C	F,S,G	D
Oriental Turtle Dove	*Streptopelia orientalis*	53	2	35.63±42.42	12	2	0	O	F,S,Fa	D
Pine Bunting	*Emberiza leucocephalos*	0	1	0	0	1	0	I	F,S	D
Manchurian Bush Warbler	*Cettia* canturians	23	1	11.94±6.78	2	1	0	I	S	D
Common Moorhen	*Gallinula chloropus*	0	1	0	0	1	0	O	F,W	D
Brown Shrike	*Lanius cristatus*	8	1	26.00±5.48	2	0	1	I	S	D
Red-rumped Swallow	*Hirundo daurica*	3	1	0	0	0	1	I	H	D
Mugimaki Flycatcher	*Ficedula mugimaki*	4	1	18.33±18.93	0	1	0	I	F,S	D

Table 1. (Continued)

Common English name	Scientific name	Abundance (individuals)	Number of road mortalities	Perpendicular distance to highway (Mean±SD, m)	Frequency of crossing highway	Number of adult road mortalities	Number of juvenile road mortalities	Forage preference	Habitat	Daily activity pattern
Radde's Warbler	*Phylloscopus schwarzi*	23	1	14.55±9.81	1	1	0	I	S	D
Olive-backed Pipit	*Anthus hodgsoni*	3	1	7.50±3.54	0	1	0	I	F	D
Eurasian Hobby	*Falco subbuteo*	2	1	0	2	1	0	C	F,H,G	D
Lesser Spotted Woodpecker	*Dendrocopos minor*	13	1	21.54±20.53	3	1	0	I	F	D
Little Grebe	*Tachybaptus ruficollis*	0	1	0	0	1	0	O	F,W	D
Grey-capped Pygmy Woodpecker	*Dendrocopos canicapillus*	1	1	6	0	1	0	I	F	D
Collared Scops Owl	*Otus bakkamoena*	0	1	0	0	1	0	C	F,S	N
Dusky Thrush	*Turdus naumanni*	2	1	12	2	1	0	I	F,S	D
White-backed Woodpecker	*Dendrocopos leucotos*	18	0	45.35±25.24	0	0	0	I	F	D
Yellow-rumped Flycatcher	*Ficedula zanthopygia*	4	0	41.67±37.53	0	0	0	I	F,S	D
Green Sandpiper	*Tringa ochropus*	1	0	30.1	0	0	0	I	F,W	D
Common Redpoll	*Carduelis flammea*	41	0	1.73±1.79	5	0	0	I	S	D
Great Spotted Woodpecker	*Dendrocopos major*	15	0	41.54±39.55	0	0	0	I	F	D
Common Kingfisher	*Alcedo atthis*	1	0	30	0	0	0	O	F,W	D
Eurasian Cuckoo	*Cuculus canorus*	14	0	94.17±57.12	0	0	0	I	F	D
Large-billed Crow	*Corvus macrorhynchos*	20	0	21.50±39.30	9	0	0	O	F,H	D
Goldcrest	*Regulus regulus*	4	0	10	0	0	0	I	F	D
Asian Stubtail	*Urosphena squameiceps*	42	0	17.30±11.60	1	0	0	I	S	D
Common Stonechat	*Saxicola torquata*	2	0	20	0	0	0	I	S	D
Black-necked Grebe	*Podiceps nigricollis*	1	0	60	0	0	0	O	F,W	D
Black Woodpecker	*Dryocopus martius*	1	0	50	0	0	0	I	F	D
Yellow-browed Warbler	*Phylloscopus inornatus*	2	0	5	0	0	0	I	F,S	D
Ashy Minivet	*Pericrocotus divaricatus*	12	0	37.50±36.94	3	0	0	I	F	D
Arctic Warbler	*Phylloscopus borealis*	3	0	20.00±10.00	1	0	0	I	F,W	D
Winter Wren	*Troglodytes troglodytes*	2	0	15	0	0	0	I	F	D
Blue Rock Thrush	*Monticola solitarius*	5	0	38.75±74.20	2	0	0	I	F	D
Mallard	*Anas platyrhynchos*	24	0	29.33±21.01	0	0	0	O	W	D
Eurasian Woodcock	*Scolopax rusticola*	1	0	4	0	0	0	O	F,W	D
Dollarbird	*Eurystomus orientalis*	3	0	100	0	0	0	I	F	D
Three-toed Woodpecker	*Picoides tridactylus*	2	0	60	0	0	0	I	F	D
Indian Cuckoo	*Cuculus micropterus*	4	0	67.50±39.48	0	0	0	I	F	D
Eurasian Jay	*Garrulus glandarius*	120	0	12.10±20.04	55	0	0	O	F	D

Table 1. (Continued)

Common English name	Scientific name	Abundance (individuals)	Number of road mortalities	Perpendicular distance to highway (Mean±SD, m)	Frequency of crossing highway	Number of adult road mortalities	Number of juvenile road mortalities	Forage preference	Habitat	Daily activity pattern
Hawfinch	*Coccothraustes coccothraustes*	77	0	10.00±15.49	3	0	0	O	F	D
Spotted Nutcracker	*Nucifraga caryocatactes*	7	0	23.33±38.82	3	0	0	O	F	D
Eurasian Treecreeper	*Certhia familiaris*	1	0	10	0	0	0	I	F	D
Eurasian Wryneck	*Jynx torquilla*	2	0	69	0	0	0	I	H	D
Common Pheasant	*Phasianus colchicus*	8	0	68.75±37.20	2	0	0	O	S,Fa	D
Oriental Cuckoo	*Cuculus saturatus*	2	0	80	0	0	0	I	F	D
Band-bellied Crake	*Porzana paykullii*	1	0	3	0	0	0	I	G,W	D

F-forest; S-shrub; H-house; G-grass; W-wetland; Fa-farmland;
D-diurnal; N-nocturnal
I-insectivorous groups; C-carnivorous groups; O-omnivorous groups;

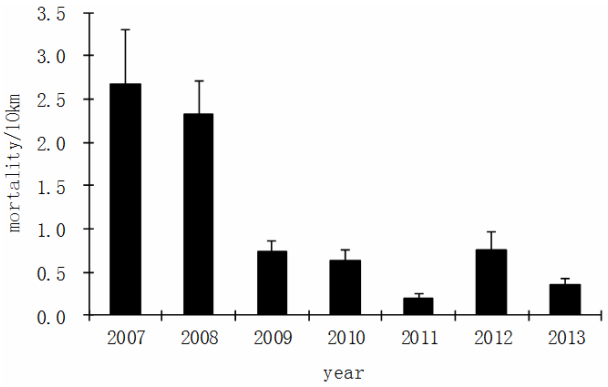

Figure 2. Bird mortality in different years.

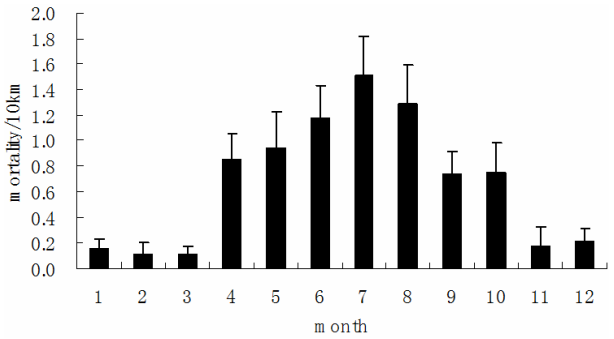

Figure 3. Bird mortality in different months.

tion, shrubs should be planted at a greater distance from the roadside to ensure better sight distance for both drivers and birds (Orlowski 2008). We also recommend that the speed limit be reduced to 60-70km/h and strictly enforced, especially at dawn and dusk. To protect raptors, it is vital to control traffic volume at night, through speed reduction and/or road closure measures. To protect the Hazel Grouse, roadside bare ground should be replaced through ecological restoration practices as soon as possible. Moreover, public education activities along the view points of highways may assist in the protection of birds and other native species within the Changbai Mountain Nature Reserve.

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