Estimating the probability of potential vehicle collision from birds crossing roads in interior British Columbia

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Introduction

In most countries roads are the primary mode of transportation for both commercial goods and people. In British Columbia, roads not only aid in networking communities, but also provide access to natural resources such as timber, oil, and minerals, as well as to campsites, lakes, and scenic vistas. The many uses of roads in our province are reflected in the types we have, such as single or multi-lane highways, residential streets, logging and rural farm roads, and dirt tracks used in remote areas to access gas wells. Wildlife collisions with vehicles is just one of the many negative consequences of roads wherever they are built (Forman et al. 2003). Many animals naturally come into conflict with vehicles because as they move around within their territory or home range, or as they migrate or disperse, roads are commonly encountered. If a road is not deliberately avoided when encountered, then animals will cross them with some perceived natural risk, such as exposure to predators (Lima and Dill 1990), but also with anthropogenic risk, such as vehicular collision.

Birds occupy nearly every habitat type in British Columbia, and both their abundance and ease of detectability, especially along roadsides (*e.g.,* North American Breeding Bird Surveys, Roadside Raptor Surveys), makes them especially appealing for studying the additional contribution that roads have on overall mortality rates (*i.e.,* mortality over and above predation, disease, window collisions, cat kills, etc.). While we may be quick to assume that birds have distinct advantages over other major taxonomic groups (*e.g.,* amphibians, mammals excluding bats, and reptiles) because they can fly, there appears to be huge variability in road-crossing ability or tendency that likely affects species-specific collision potential. Gallinaceous birds (*e.g.,* grouse, pheasant, and quail; Figure 1) for example prefer to walk across roads, and often "freeze" when a fast-traveling vehicle approaches. In one study conducted along the entire length of Interstate 80 in Nebraska from 1969-1975, 7,195 Ring-necked Pheasants (*Phasianus colchicus*) were found dead as result of vehicle collision (Case 1978). Species such as Golden-crowned Kinglet (*Regulus satrapa*), Black-capped Chickadee (*Poecile atricapillus*), and Red-eyed Vireo (*Vireo olivaceus*) appear to avoid crossing gaps (Desrochers and Hannon 1997, St. Clair 2003). Many diurnal birds of prey often soar on thermals or updrafts, and might be considered relatively free of collision by height alone, but several studies have documented high numbers of mortality as a result of feeding behaviour along roadsides (*e.g.,* Keran 1981, Varland et al. 1993, Buehler 2000). For some species, roads are effective barriers (Develey and Stouffer 2001) and thus greatly limit the probability of road-crossings and subsequent encounters with vehicles. These limits on movement, however, have other consequences (see Preston pgs. 8-15 in this issue).

Height-dependent road crossing success by birds is a challenge to study empirically since most dead birds observed have no associated heights, and the proportion of total birds crossing the road within

Figure 1. When crossing roads, species such as this California Quail (*Callipepla californica*) often prefer to walk rather than fly. Consequently, upon approach of a fast-moving vehicle, it is not uncommon for them to remain motionless - a natural reaction for these birds in response to predators. Near Keremeos, BC. 11 April 2003 (Michael I. Preston).

striking distance is largely unknown. In this paper, we use a novel approach for determining the effects of roads via vehicle-induced collision, by estimating the probability of potential collision for select species based on crossover height. Furthermore, we attempt to examine the effects of three road types on crossing propensity, as well as for potential interactions between road types and crossing heights.

Study Area and Methods

Our study area included a variety of roads throughout British Columbia, although most data were recorded in the Rocky Mountain Trench from Cranbrook north to Radium, and in the Boreal Plains from Chetwynd north to Sikanni Chief, including Fort St. John and Dawson Creek. Major connecting highways from which data were also collected include Highway 1 from Vancouver east to Golden, and Highway 97 from Kamloops north to Chetwynd.

We classed roads into three types:

1) Primary highways – moderate to heavy traffic volume, high speed, one or more lanes each way;

2) Secondary highways – low to moderate traffic volume, moderate speed, one lane each way; and

3) Gravel roads – very low traffic volume, low speed, lanes generally indistinguishable (Figure 2).

The distance traveled on each road type was also measured, although we did not include driving on city streets in our study.

We recorded species, numbers, and heights of all birds observed flying across all road types from 28 April to 29 June 2006, and from a shorter trip from 13 to 18 July 2006. We also recorded all roadkilled birds, including those hit by our own vehicle. Heights of birds flying across the road were recorded to a maximum of 13-m (43-ft), at which point we believed it was difficult to distinguish whether a bird was purposefully crossing the road. Heights were estimated to the nearest 0.3 m (1 ft), using vehicles and other landmarks with known heights for reference.

To assess potential vehicle collision, we grouped birds walking or flying across roads into three height Classes:

1) $\leq$ 1.8 m (6 ft);

2) between 1.8 and 4.6 m (15 ft); and

3) between 4.6 m and 13 m (43 ft).

We determined that on average, birds in Class 1 are susceptible to collision with all vehicles, birds in Class 2 are susceptible mainly to large transportation trucks, and birds in Class 3 avoid collision altogether (Figure 3). While more precise probabilities would require knowing how many unsuccessful crossings versus successful crossings are made, and which vehicle types are involved, our goal is to provide general probabilities based only on crossover heights. Thus, if 100 birds are observed crossing roads, and 25 fly at $\leq$ 1.8 m and the remainder fly > 4.6 m, then we estimate that the probability of potential collision is one in four, or 25%.

Figure 2. A typical gravel road used primarily for logging and access to gas wells in northeastern British Columbia. Near Kobes Creek, BC. 19 June 2006 (Michael I. Preston).

Results and Discussion

A total of 23,732 kms were driven during the study period, of which 20,760 kms (87.5%) were used for data collection. We drove 11,042 kms on primary highways (53.2%), 3,033 kms on secondary highways (14.6%), and 6,685 kms on gravel roads (32.2%).

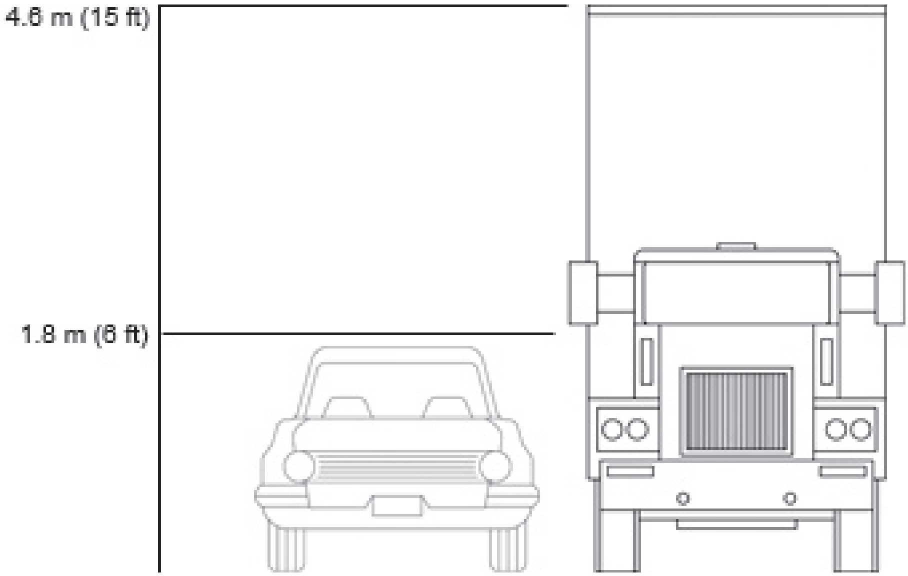

Figure 3. Height classes used to calculate probability of potential collision with birds walking or flying across roads. Birds lower than 1.8 m may be hit by both vehicle types, whereas birds flying between 1.8 and 4.6 m are susceptible only to larger transportation trucks. Birds crossing roads at heights greater than 4.6 m are at little risk of collision with vehicles.

We observed 636 individual birds representing 74 species. Of these, 51 individuals of 19 species were found dead, five individuals comprising five species were hit and killed by our vehicle, and the remaining 580 birds representing 71 species successfully flew across the road. Of the 580 successful crosses, 385 (66.4%) were comprised of six species. These include, in decreasing order, American Robin (*Turdus migratorius*) (n = 204), Dark-eyed Junco (*Junco hyemalis*) (n = 50), Yellow-bellied Sapsucker (*Sphyrapicus varius*) (n = 49), Brewer's Blackbird (*Euphagus cyanocephalus*) (n = 32), Northern Flicker (*Colaptes auratus*) (n = 27), and Gray Jay (*Perisoreus canadensis*) (n = 23). Of the 19 species found dead, only Eastern Kingbird (*Tyrannus tyrannus*) (n = 1) and House Sparrow (*Passer domesticus*) (n = 1) were not observed flying across roads. Among birds of prey, there was one observation each of an immature roadkilled American Kestrel (*Falco sparverius*; Figure 4) and an adult Northern Harrier (*Circus cyaneus*). Of the five species that collided with our vehicle, Pine Grosbeak (*Pinicola enucleator*) was the only species that did not have additional crossover observations. In total, there were 27 species with only one crossover observation.

Probability of potential collision with a vehicle was determined for the six most frequently observed species and summarized for all roads, as well as individual road types (Table 1). Among all roads, the highest percentage of crossovers in height Class 1 was observed for American Robin (54.9%), Dark-eyed Junco (86.0%), Brewer's Blackbird (46.9%), and Northern Flicker (44.4%). The highest percentage of crossovers in height Class 2 was observed for Yellow-bellied Sapsucker (67.3%). The Gray Jay crossed roads in height Classes 2 and 3 equally (43.5%). Among road types, the percentage of American Robins crossing in different height classes was similar on primary highways (28.6 – 36.7%), but on secondary roads and gravel roads, there was a noticeable preference for lower heights (Table 1). A similar pattern was observed for Yellow-

Figure 4. This juvenile American Kestrel, which was probably still learning to forage, met an untimely demise on Highway 5A near Stump Lake, BC. 18 July 2006. (Michael I. Preston).

bellied Sapsucker, whereby lower crossover heights on secondary and gravel roads tended to be more frequent than on primary roads. The Gray Jay, when crossing primary roads, preferentially crossed in height Class 3, compared to lower crossover heights on gravel roads. Differences in crossing heights among road types for these species may be a learned behaviour or an adaptation for reducing collision potential.

Table 2 summarizes the percentage of crossovers by road type for the six most frequently observed species, and includes a correction factor to account for different distances driven on each. There was little difference in percentage crossovers by road type for American Robin, whereas all other species appear to show preference. The percentage of total crossovers for Gray Jay (76.7%) and Dark-eyed Junco (74.8%) were substantially greater for gravel roads, suggesting that these species may be sensitive to crossing wider and busier roads. The Yellow-bellied Sapsucker (Figure 5) was most commonly observed crossing primary roads, but as mentioned earlier, appears to reduce the potential for collision by flying higher than on other road types. The Brewer's Blackbird showed a similar pattern, with most crossover observations coming from primary highways, but with crossover heights being greater than those on secondary roads. The Northern Flicker was the only species commonly observed crossing

Table 1. Probability of potential collision with vehicles by crossover heights within each road type for the six most frequently observed species. AMRO = American Robin, DEJU = Dark-eyed Junco, YBSA = Yellow-bellied Sapsucker, BRBL = Brewer's Blackbird, NOFL = Northern Flicker, GRJA = Gray Jay. Totals for each species within each road type sum to 100%. Height classes are: 1) ≤ 1.8 m, 2) 1.8 – 4.6 m, and 3) > 4.6 m.

	Probability of potential collision with vehicles (%)											
	All roads			**Primary**			**Secondary**			**Gravel**		
Height Class	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Species												
AMRO	54.9	27.5	17.5	36.7	34.7	28.6	67.4	27.9	4.7	74.6	15.9	9.5
DEJU	86.0	14.0	0.0	100	0.0	0.0	75.0	25.0	0.0	85.0	15.0	0.0
YBSA	14.3	67.3	18.4	8.6	68.6	22.9	20.0	60.0	20.0	33.3	66.7	0.0
BRBL	46.9	37.5	15.6	37.0	44.4	18.5	100	0.0	0.0	0.0	0.0	0.0
NOFL	44.4	29.6	25.9	36.4	36.4	27.3	66.7	11.1	22.2	28.6	42.9	28.6
GRJA	13.0	43.5	43.5	0.0	25.0	75.0	0.0	0.0	0.0	20.0	53.3	26.7

Table 2. Percentage of crossovers by road type for the six most frequently observed species. Percentages are corrected to account for differences in the total distance driven on each road type. Height classes are: 1) ≤ 1.8 m, 2) 1.8 – 4.6 m, and 3) > 4.6 m. See Table 1 caption for species codes.

	Percentage crossovers (%)		
Road type	**Primary**	**Secondary**	**Gravel**
Species			
AMRO	27.3	43.6	29.0
DEJU	7.0	16.9	76.7
YBSA*	61.2	23.3	15.5
BRBL	59.6	40.2	0.0
NOFL	19.9	59.3	20.9
GRJA	24.2	0.0	74.8

*distance used for correction corresponds with the species range in British Columbia.

secondary roads, with crossover heights being distinctly lower than those on primary roads. The Brewer's Blackbird was never observed crossing gravel roads, and the Gray Jay was never observed crossing secondary roads.

To our knowledge, there are no studies that have attempted to determine the probability of potential collision of birds with vehicles among different road types. Instead, of the few studies that do report on bird-vehicle collisions, the numbers reported are usually only of dead birds, and not of those that successfully cross. Those dead birds are then commonly presented as the number per unit of distance driven (*e.g.,* Banks 1979, Sargeant 1981, Ashley and Robinson 1996) and mortality estimates are extrapolated to much broader geographic areas. From a limited number of studies, Banks (1979) estimated that the total number of birds killed on roads in the United States was highly variable and ranged between 10.7 and 380 million birds per year. The National Wind Coordinating Committee (2001) has since revised that estimate to an average of 80 million birds per year, accounting both for new information from more recent studies, as well as the increased amount of roads and vehicles.

Figure 5. The Yellow-bellied Sapsucker is a common road-crossing species in northeastern British Columbia, especially where nesting occurs near road edges and foraging areas are on the opposite side. Kiskatinaw River, BC. 23 June 2006. (Michael I. Preston).

Banks (1979) identified huge variability in estimating the number of birds that are killed by vehicles annually. That variability is almost certainly a result of numerous factors, including road type, traffic volume, annual and regional differences in bird abundance, roadside habitat type, gap-crossing tendency among species, seasonality, dispersal and migration periods, and either learned behaviours or adaptations to reduce collision potential. In our study, we have identified apparent differences in both the kinds of roads crossed and the preferred crossing heights by different species, and that a potential interaction occurs between the two, with some species preferentially crossing roads of different types at different heights, possibly as an adaptation to reducing risk. Because of our findings, we feel that although vehicle-induced mortality is a serious issue, mitigation can be more effective if studies consider probability of potential collision among species, the kinds of roads in question, and species-specific differences in crossing roads of different types at different heights.

Literature Cited

Ashley, E.P., and J.T. Robinson. 1996. Road mortality of amphibians, reptiles, and other wildlife on the Long Point Causeway, Lake Erie, Ontario. Canadian Field-Naturalist 110:403-412.

Banks, R.C. 1979. Human related mortality of birds in the United States. United States Department of the Interior, Fish and Wildlife Service. Special Scientific Report, Wildlife No. 215. Washington, DC. 16 pp.

Buehler, D.A. 2000. Bald Eagle (*Haliaeetus leucocephalus*). *In* The birds of North America, No. 506 (Poole, A. and F. Gill, eds.). The birds of North America, Inc., Philadelphia, PA.

Case, R.M. 1978. Interstate highway road-killed animals: a data source for biologists. Wildlife Society Bulletin 6:8-13.

Desrochers, A., and S.J. Hannon. 1997. Gap crossing decisions by forest songbirds during the post-fledging period. Conservation Biology 11:1204-1210.

Develey, P.F., and P.C. Stouffer. 2001. Effects of roads on movements by understory birds in mixed-species flocks in central Amazonian Brazil. Conservation Biology 15:1416-1422.

Forman, R.T.T., D. Sperling, J.A. Bissonette, A.P. Clevenger, C.D. Cutshall, V.H. Dale, L. Fahrig, R. France, C.R. Goldman, K. Heanue, J.A. Jones, F.J. Swanson, T. Turrentine, and T.C. Winter. 2003. Road ecology: science and solutions. Island Press, Washington, DC. 481 pp.

Keran, D. 1981. The incidence of man-caused and natural mortalities to raptors. Journal of Raptor Research 15:108-112.

Lima, S.L., and L.M. Dill. 1990. Behavioural decisions made under the risk of predation: a review and prospectus. Canadian Journal of Zoology 68:619-640.

Erickson, W.P., G.D. Johnson, M.D. Strickland, D.P. Young Jr., K.J. Sernka, and R.E Good. 2001. Avian collisions with wind turbines: a summary of existing studies and comparisons of avian collision mortality data in the United States. National Wind Coordinating Committee. Available on-line at www.nationalwind.org.

Sargeant, A.B. 1981. Road casualties of prairie nesting ducks. Wildlife Society Bulletin 9:65-69.

St. Clair, C.C. 2003. Comparative permeability of roads, rivers, and meadows to songbirds in Banff National Park. Conservation Biology 17:1151-1160.

Varland, D.E., E.E. Klaas, and T.M. Loughin. 1993. Use of habitat and perches, causes of mortality, and time until dispersal in post-fledging American Kestrels. Journal of Field Ornithology 64:169-178.

"*Earth and sky, woods and fields, lakes and rivers, the mountains and the sea, are excellent schoolmasters, and teach some of us more than we can ever learn from books.*"

Sir John Lubbock