VERTEBRATE MORTALITY ON TROPICAL HIGHWAYS: THE COSTA RICAN CASE

JULIAN MONGE-NAJERA, Biologia Tropical, Universidad de Costa Rica, San Pedro de Montes de Oca, Costa Rica. (Tel/Fax: 506-207-5550: E-mail: julianm@cariari.ucr.ac.cr)

In the United States of America, wildlife mortality caused by automotive vehicles has received attention by management experts for almost a century (Knutson 1987). Art estimate suggests that during a single holiday, one million vertebrates may die in the USA for this reason alone (Jackson 1986). In England, the main cause of mortality for some wildlife species is vehicle traffic (Sleeman *et al* 1985). This indicates the importance of including road killings among management considerations. A review of the factors mentioned by McClure (1951) and Knutson (1987) suggested that a species is affected by road mortality according to concentration, tendency to cross, avoidance capacity and traffic pressure.

Habitat features such as attractive vegetation or food availability may concentrate wildlife near roads, increasing mortality (McClure 1951). Animals cross roads more often when the weather is appropriate, during migrations, when they are young and inexperienced, etc. (Knutson 1987). The sexes and ages are affected differentially according to their tendency to move onto the road (Sleeman 1988).

Species with poor senses and slow movements are more probable victims, while alert and rapid animals such as coyotes and vultures are rarely killed (Jackson 1986). This explains why often a few species represent most of the casualties (McClure 1951).

Areas of denser and faster traffic have higher mortality rates (Knutson 1987). Interestingly, very wide highways may have very low mortality rates because some animals avoid crossing them (Garland and Bradley 1984).

In temperate countries, studies on this subject increased substantially after the 1970’s (Rosen and Lowe 1994), but very few (if any) publications deal with the tropics. This report analyses road and highway casualties of both wild and domestic vertebrates in Costa Rica.

Throughout 1993, road and highway vertebrate casualties (song-bird sized or larger) were recorded from a car usually moving at 70 km/hr or less. Whenever possible, the victims were identified to species *in situ.* This method underestimates counts (perhaps by 10%, Scott 1938) but is the only practical procedure when hundreds of kilometers are examined. Eight observers participated in the study. To avoid unnecessary assumptions, casualties per km were calculated according to the total amount of km covered in the habitats (Pacific, Middle, or Caribbean) where that species is known to occur. Although it was not possible to sample systematically, the data cover reasonably the whole country (Fig. 1), including national parks.

A total of 10,250 km of highway were sampled: 3,837 in Pacific lowland vegetation; 5,316 in middle and high elevations (mainly seasonal moist vegetation); and 1,097 km in Caribbean lowland vegetation. By total number of individuals (Table 1), the most affected species were the domestic carnivores *Canis familiaris* and *Felis domesticus,* and two wildlife species, *Didelphis marsupial is* and *Tamandua mexicana.* If the number of individuals per km is considered, the same two domestic species occupy first place, while wildlife species have relatively low mortality rates (Table 1).

Both in number of affected species and in total number of individuals, most casualties were mammals, followed at a distance by birds and then by reptiles; amphibians were rarely recorded (Table 1).

The relatively high number of *C. familiaris* and *F. domesticus* in the counts was predictable because their domestic nature concentrates them near humans, who are associated with automotive traffic (Knutson 1987, McClure 1951). The same applies to *Didelphis marsupialis* which has become an urban species, but I have no idea why *Tamandua mexicana* is also commonly killed, other than because of its relatively slow movements. The lack of information about relative abundances of amphibians, birds and reptiles near the sampled routes prevents a meaningful discussion about their representation in these counts. However, birds were the vertebrates I most commonly saw crossing roads and highways (81% against 19% mammals, 1993, n=53 animals). Their ability to escape by rapid flight seems to explain why they are underepresented in casualty counts.

As no information on vertebrate road casualties from tropical regions was found in the literature, results from this study were compared with equivalent records from Ireland and the USA (after recalculating all data in individuals/km). The comparative information appears in Fig. 2 and is based on Scott (1938) and McClure (1951).

For cats, dogs, black rats and vertebrates in general, mortality in Costa Rican roads and highways is lower than in Ireland (Sleeman *et* at. 1985). In the USA, where relative traffic density and speed are higher than in Costa Rica, casualty rates often are many times those given in Table I (Jackson 1986, Knutson 1987, McClure 1951).

The predominance of mammals among Costa Rican casualties is similar to counts made in Nebraska almost half a century earlier (McClure 1951), but very different from even earlier counts in Iowa, where birds were predominant (Scott 1938). Unfortunately, equivalent but more recent counts and ecological data on this regard are not available for either country.

Road casualty studies are likely to underestimate taxa of small body size such as rodents and invertebrates, which may also be significantly affected by traffic (Seibert and Conover 1991). For example, in Costa Rica, thousands of the pierid butterflies, *Eurema* sp., died during the Dec. 1993 migration over Guanacaste highways (pers. obs.). To improve the methodology I suggest considering both invertebrates and the effect of this sampling procedure. Hopefully, this report will inspire more studies in tropical areas.

Figure. 1. Costa Rican highway routes covered In this study.

Table 1. Taxonomic composition, month of occurrence and frequency of vertebrate road casualties on Costa Rican highways (1993).

Taxon	Number of individuals	Habitats[a]	Months recorded[b]	Individual s (1100 km)[c]	Taxon	Number of individuals	Habitats[a]	Months recorded[b]	Individual s (1100 km)[c]
Amphibia					*Mustela frenata*	1	PMC	9	0.010
Bufo marinus	4	PMC	1,4,8,9	0.039	*Mephilis macrooura*	4	P	1,6.8, 11	0.104
					Unidentified mustelids	3		2.6.8	
Reptilia					Procyonidae				
Ctenosaura similis	2	P	3	0.052	*Potos flavus*	2	PMC	3, 12	0.020
Iguana iguana	3	PMC	2,7	0.029	*Nasua narica*	1	PMC	4	0.010
Bothrops asper	3	PMC	1,2	0.029	Canidae				
Clelia clelia	2	PMC	10	0.020	*Canis familiaris*	31	PMC	1,3-11	0.302
Unidentified snakes	5		4.7, 11, 12		*Urocyon cinereoargenteus*	1	PM	7	0.011
					Unidentified foxes	5		4,5, 8	
Aves					Erethizontidae				
Icteridae					*Coendu mexicanus*	5	PMC	2,3, 12	0.049
Sturnella militaris	2	P	2,11	0.052	Sciuridee				
Quiscalus mexicanus	3	PMC	1,7	0.029	*Sciurus variegatoides*	5	PMC	2,3, 7, 10, 12	0.049
Thraupidae					*Microsciurus alfari*	1	PMC	11	0.010
Piranga bidentata		PMC	2	0.010	Muridae				
Piranga (unidentified)		PMC	2	0.010	*Rattus norvegicus*	2	PMC	7, 10	0.020
Embenzidae					Unidentified rodents (mice)	4		4,8,9	
Zonotrichia capensis	1	PMC	7	0.010	Leporidae				
Accipitridae (unidentified)	1		1		*Sylvilagus ;floridanus*	2	P	11	0.052
Gallus gallus	2	PMC	7	0.020	*Sylvilagus brasiliensis*	1	PMC	8	0.010
Unidentified birds	12		1,4,7, 11, 12		*Sylvilagus dicei*	2	M	1, 3	0.038
					Sylvilagus (unidentified)	1		2	
Mammalia					Myrmeeophagidae				
Didelphidae					*Tamandua mexicana*	11	PMC	1,3,6-9, 12	0.107
Caluromys derbianus	1	PMC	8	0.010	Bradypodidae				
Didelphis marsupialis	18	PMC	1-3,6-8, 10-12	0.176	*Choloepus hoffmanni*	1	PMC	7	0.010
Soricidae					Unidentified sloth	1		1I	
Cryptotis sp.		PMC	6	0.010					
Felidae					Unidentified mammals	21			
Felis domeslicus	25	PMC	1,4·12	0.244	Unidentified venebrates	11			
Mustelidae									
Conepatus semistriatus	3	PMC	3,4,8	0.029					

[a] P=Pacific; M=Middle; C=Caribbean
[b] Months: 1=January, 2=February, etc.
[c] In some cases, this value could not be calculated for lack of distance or habitat data.

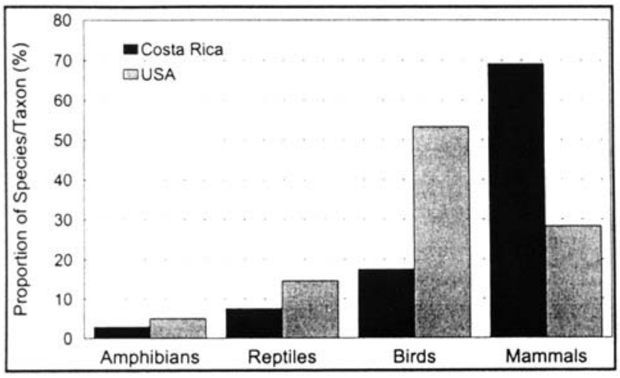

Figure 2. Proportion of species per taxon (%) killed by vehicles In Costa Rica and the United States. The pattern Is the same for proportion of Individuals per taxon.

ACKNOWLEDGMENTS

I thank R. M. Knutson and T. M. Torgersen who provided useful information. Zaidett Barrientos, Esther Dominguez, José Franco, Luis D. Gómez, Gail Hewson, Carlos Valerio and Carlos Villalobos assisted with data collecting. I am thankful to them all as well as David B. Clark for excellent suggestions to improve an earlier draft.

LITERATURE CITED

GARLAND, T., Jr. and W. G. BRADLEY. 1984. Effects of a highway on Mojave Desert rodent populations. American Midland Naturalist 111:47-56.

JACKSON, D. D. 1986. Nobody counts squashed skunks. Audubon (March):78-81.

KNUTSON, R. M. 1987. Flattened fauna: A field guide to common animals of roads, streets, and highways. Ten Speed Press, Berkeley, California, USA. 88 pp.

MCCLURE, H. E. 1951. An analysis of animal victims on Nebraska's highways. Journal of Wildlife Management 15:410-420.

ROSEN, P. C. and H. LOWE. 1994. Highway mortality of snakes in the Sonoran Desert of southern Arizona. Biological Conservation 68:143-145.

SCOTT, T. G. 1938. Wildlife mortality on Iowa highways. American Midland Naturalist 20:527-539.

SEIBERT, H. C. and J. H. CONOVER. 1991. Mortality of vertebrates and invertebrates on an Athens county, Ohio, highway. Ohio Journal Science 91:163-166.

SLEEMAN, D. P. 1988. Trish stoat road casualties. Irish Naturalists' Journal 22:527-529.

______ , P. SMIDDY and P. G. SWEENEY. 1985. Irish mammal road casualties. Irish Naturalists' Journal 21:544.

Associate Editor: David B. Clark
Received: March 15, 1995
Accepted: November 18, 1996