Mortality of Vertebrates and Invertebrates on an Athens County, Ohio, Highway[1]

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ABSTRACT. **Although previous road-kill surveys have tallied the number and kinds of vertebrates that were victims of vehicular traffic (mostly birds and mammals), none has recorded invertebrate mortality. A 14-month survey on foot of each side of a 1.6 km (1 mi) stretch of dual lane highway provided 188 vertebrate and 1,162 invertebrate victims. Finding rare and unusual species of invertebrates suggests that this technique be used as a supplementary faunal survey.**

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INTRODUCTION

Even the most casual observer has noted the remains of animals killed by vehicular traffic along our motorways. At the speed that most traffic flows, it is possible to recognize only the larger vertebrate specimens and be completely unaware of the fact that small vertebrates and especially invertebrates may be victims, also.

All previous investigations of highway mortality have been limited to vertebrates, many, in fact, to only one group of vertebrates or even to just one species: for example, red-headed woodpeckers (Sharp 1930), rabbits (Gordon 1932, Sperry 1933), snakes (Bugbee 1945, Dodd et al. 1989). Garland and Bradley (1984) limited their study to desert rodents, Davis (1940) recorded only mammals, and Cottam (1931), mostly birds. More generalized studies over longer periods of time, over longer distances, and including all vertebrates, are to be found in Stoner (1936), Scott (1938), Dickerson (1939), and McClure (1951). In the majority of these reports, coverage was haphazard in both space and time, and limited to what could be observed from a moving automobile, although McClure's (1951) was the most consistent as it lasted over 40 months and covered 77,000 mi of Nebraska highways. His list of vertebrate victims is extensive.

Some of the generalizations and conclusions derived from these studies can be summarized as follows: all vertebrates are capable of being victims, whether large or small, localized in distribution (ring-tailed cats), or rare in numbers (golden eagle). Davis (1940) found mortality heaviest in fall and winter, while Dickerson (1939) found mortality was highest in midsummer, as also claimed by Knutson (1987), with another smaller peak in midwinter. McClure (1951) found that the greatest losses occurred in July, which he attributed to young, inexperienced animals and to increased travel by motorists. Scott (1938) noted that increased activity by amphibians during and immediately following storms resulted in an increased mortality. Mortality is not evenly distributed along the length of any highway. For instance, Sperry (1933) counted 14 carcasses of cottontails and jackrabbits per 1.6 km for the first 24 km of a trip from Boise to Preston, ID, 11 per 1.6 km for the next 56 km, 1.5 per 1.6 km for the next 128 km, and practically none for the next 192 km. Gordon (1932) reported comparable results. Data such as these can be useful in determining the spatial distribution and density of a particular species as related to cover type. Adams (1983) tallied the number of all the vertebrates reported as traffic victims in 19 journal articles. In none of these studies are invertebrates mentioned.

Simmons (1938) so aptly stated that "Not many of us have gone so far as to determine whether the killing is confined to rabbits, skunks and an occasional game bird or whether it includes a cross-section of the entire wildlife population." It is the purpose of this report to document the mortality of all animals caused by traffic on a limited portion of paved highway.

MATERIALS AND METHODS

The study site was a 1.6 km stretch of dual highway (U.S. 33) approximately 9.6 km northwest of Athens in Athens County, OH. At one end of the mile stretch was a roadside rest area and at the other end on the opposite side were four small buildings separated from the road by a wire fence. The Hocking River flowed on one side and the opposite side was a steep hillside. Most of the riverbank consisted of a riverine elm-maple-sycamore woodland and the opposite hillside was essentially red oak-white oak forest. Small areas of open field occurred only at the extreme ends. Each lane measured 6.08 m in width, with a 2.74 m shoulder on the outer edge and a grassy median 12.16 m wide separating the two. Exactly 1.6 km of one lane was canvassed on foot by walking along the shoulder. Sequentially numbered reference marks were placed at intervals on highway reflectors, guardrails, signs, and so forth, so that specimens seen and/or collected were recorded in a notebook with respect to identity and locality. Specimens not immediately identifiable were collected to be subsequently mounted on pins or preserved in alcohol for future identification. With the exception of the moths and spiders, all identifications were made by the senior author. Voucher specimens are deposited in the Museum of Zoology, Department of Zoological and Biomedical Sciences, Ohio University. At the end of the 1.6 km survey, the highway was crossed to the other lane and the process repeated for the return trip to the original point of departure. A small scraper or putty knife was an indispensable tool to loosen and remove squashed specimens from the highway surface.

The survey began 13 June 1987 and ended 15 August 1988. A total of 50 excursions was made during that period at weekly intervals whenever possible.

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RESULTS

The vertebrate road-kills were mostly mammals which included 11 species, predominantly opossums, groundhogs, and raccoons (Table 1). The absence of skunks can only be explained as a sampling error as the animal occurs in the region. As many as seven dead skunks were counted on this highway on 8 October 1987 as we drove the 9.6 km to the study site but none that day were within the studied site. Dense forested vegetation kept the rabbit kill lower than one would expect.

Our experience was that no time limit could be established for the expected survival of any vertebrate carcass. One oposum that was killed on 7 May 1988 had disappeared on 8 May. On the other hand, two groundhogs that died on or before 13 June 1987 had identifiable remains until 15 September 1987, albeit they were much shredded and flattened. Invertebrates rarely lasted more than one or two days. On several occasions we noted fresh, intact specimens being dragged off the highway by ants.

Only one–fourth as many birds as mammals were killed, yet 12 species were represented. Although crows and starlings, being roadside feeders, were not unexpected victims, red–eyed vireos and Kentucky warblers were unexpected. Apparently no one species is more or less prone to be hit by a car than another.

Nearly 40% of the vertebrate victims were amphibia, a high number compared to the lists of other investigators, possibly because of the presence of the Hocking River and the fact that these smaller and more fragile carcasses are not readily seen from a car. Many of their remains had to be scraped off the highway and taken home to be soaked in water before identification could be accomplished. As Scott (1938) pointed out, the number of amphibia killed increases after rainfall. On 4 April 1988, 20 amphibia were collected following a heavy rain on the preceding day. Similarly, rains on 30 July and 15 September produced intensive movements of amphibia, as indicated by the road-kills. Surprisingly, newts (*Notophthalmus viridescens*) were still attempting to cross the road in November and December.

Over 1,000 insects, belonging to 11 orders, were collected (Table 2). Spiders, harvestmen, myriapods, and snails were also among the victims. The insects comprised a minimum 249 species (a number of specimens could not be identified to the specific level either because of their poor condition or the authors' lack of expertise) belonging to 84 families and included those that could crawl, hop, or fly, both diurnal and nocturnal. The correlation of this sample to the actual abundance and diversity of the insect fauna is not known but smaller insects (e.g. mosquitoes) were either too small to be found or else were swept away by the automobile slipstream without harm, whereas heavy–bodied insects (e.g. *Phyllophaga, Tabanus, Bombus*) were easier victims and more readily collected.

If repeated frequently enough, roadside kills reveal activity periods such as for the Japanese beetle (18 July–10 August), for fireflies (6 June–1 August), and for bagworm migrations (1 August–25 August).

A tally of earthworms was attempted but it soon became clear that it was not always possible to distinguish between those that were actually killed by automobiles and those that died from exposure, dehydration, and so forth, though one could argue that the presence of the artificial highway surface was responsible for their deaths and they were therefore highway victims. In any case, we counted the largest numbers after rainfalls; thus, 4 April 1988, the same day that the amphibian kill was so high, the movement of large numbers of earthworms was also evident by the high count of dead specimens tallied.

DISCUSSION

Several species were collected that were poorly represented in the Ohio University insect collections or not at all. Two species of *Tabanus*, one chrysomelid, one dragonfly, and five moths were entirely new, in addition to nine more moths that were represented by only one specimen. In spite of the bias toward certain groups of insects, roadside kills should be considered as a supplemental technique in any local faunal survey. Diversity was high with values of H' = 2.81 nats for Diptera and 3.44 nats

TABLE 1

Road–kills of vertebrates.

Mammals		Birds		Reptiles		Amphibians	
Didelphis virginiana	19	*Coccygus americanus*	1	*Sternotherus odoratus*	1	*Notophthalmus viridescens*	16
Blarina brevicauda	1	*Otus asio*	2	*Terrapene carolina*	9	*Eurycea longicauda*	3
Eptesicus fuscus	1	*Zenaida macroura*	1	*Chrysemys picta*	1	*Bufo fowleri*	9
Felis catus	2	*Columba livia*	1	*Lampropeltis triangulum*	1	*Bufo americanus*	5
Procyon lotor	18	*Sturnus vulgaris*	4	*Elaphe obsoleta*	1	*Bufo* sp.	1
Marmota monax	18	*Vireo olivaceus*	1	unidentified	1	*Rana palustris*	11
Sciurus niger	5	*Dumetella carolinensis*	2			*Rana catesbeiana*	1
Sciurus carolinensis	2	*Oporornis formosus*	1			*Rana sylvatica*	1
Peromyscus sp.	1	*Passerina cyanea*	1			*Rana* sp.	1
Sylvilagus floridanus	7	*Spinus tristis*	1			*Hyla crucifer*	12
Odocoileus virginianus	1	*Cardinalis cardinalis*	1			*Hyla chrysoscelis*	4
unidentified	4	*Corvus brachyrhynchos*	2			unidentified	10
		unidentified	3				
Total	79		21		14		74

TABLE 2

Road-kills of invertebrates.

Family	#	Family	#	Family	#	Family	#
Arachnida–48		Heteroptera–28		Lepidoptera–213		Hymenoptera–207	
Lycosidae	22	Reduviidae	4	Tineidae	1	Tenthredinidae	1
Pisauridae	3	Lygaeidae	17	Psychidae	8	Braconidae	1
Araneidae	5	Coreidae	5	Sesiidae	1	Ichneumonidae	4
Androdiaetidae	2	Pentatomidae	1	Hesperiidae	11	Tiphiidae	3
Salticidae	2	Cydnidae	1	Papilionidae	18	Scoliidae	1
Thomisidae	1			Pieridae	9	Formicidae	28
undetermined	13	Homoptera–4		Lycaenidae	1	Vespidae	33
		Cicadellidae	2	Nymphalidae	10	Pompilidae	13
Phalangida–17		Cicadidae	1	Satyridae	3	Sphecidae	19
Opilionidae	17	Aphididae	1	Danaidae	2	Halictidae	4
				Megalopygidae	2	Megachilidae	4
Ephemeroptera–1		Coleoptera–184		Pyralidae	2	Andrenidae	4
undetermined	1	Cicindelidae	5	Geometridae	9	Anthophoridae	8
		Carabidae	48	Lasiocampidae	7	Apidae	83
Odonata–22		Dytiscidae	1	Saturniidae	5	undetermined	1
Aeschnidae	1	Histeridae	1	Sphingidae	5		
Gomphidae	8	Staphylinidae	12	Arctiidae	48	Chilopoda–7	
Libellulidae	10	Silphidae	5	Noctuidae	71	undetermined	7
Calopterygidae	1	Scarabaeidae	41				
undetermined	2	Buprestidae	1	Diptera–214		Diplopoda–4	
		Elateridae	4	Tabanidae	64	undetermined	4
Neuroptera–5		Lampyridae	33	Asilidae	17		
Ascalaphidae	1	Lycidae	2	Therevidae	1	Isopoda–1	
Corydalidae	4	Cantharidae	4	Syrphidae	28	undetermined	1
		Erotylidae	1	Bombyliidae	3		
Trichoptera–1		Coccinellidae	7	Stratiomyidae	1	Gastropoda–16	
Hydropsychidae	1	Tenebrionidae	2	Bibionidae	1	Polygyridae	16
		Meloidae	6	Sarcophagidae	17		
Orthoptera–190		Cerambycidae	2	Calliphoridae	65		
Acrididae	130	Chrysomelidae	5	Muscidae	7		
Tetrigidae	1	Curculionidae	4	undetermined	10		
Tettigoniidae	21						
Mantidae	1						
Gryllacrididae	3						
Gryllidae	28					Total Inverts–1162	
Gryllotalpidae	1						
Blattidae	5					Total Insecta–1069	

(Pielou 1974) for moths. Of the 66 species of Coleoptera collected, 45 were single specimens and 10 species were represented by only two individuals. In a few instances, the opposite was true; for example, we collected increasingly large numbers of dead calliphorids (blow flies) within a short walking distance, with the count climaxing near a raccoon carcass.

McClure (1951) concluded that road-kills were proportional to the density of cover, to the age composition, and to the density of the wildlife population rather than to the amount of traffic and degree of road improvement (increasing speed of traffic). Dickerson (1939) recommended that better planning of the highway environment be considered as a means of reducing the death toll. Road-kills of deer have been utilized successfully (McCaffery 1973) or unsuccessfully (Jahn 1959) as an index of the size of deer populations by wildlife personnel. Other uses of road-kills are suggested by Adams (1983).

No attempt to extrapolate or quantify the data in terms of numbers per km of highway or to compare our results with other published information is being made. The methodologies employed by others are too disparate to make comparisons with our material useful. Variables such as the weather, traffic volume, scavenging pressure, not to mention the efficiency of the collectors, are not possible of replication. For instance, McClure's (1951) survey lasted 40 months and covered 77,000 miles of Nebraska highways, while Walro's (1976) study was centered solely on the intensity and precise location of deer kills in southeastern Ohio that, by use of appropriate statistical techniques, enabled him to determine the factors in the deer's behavior most responsible for the accidents. Quantification is further rendered difficult by the survival time of carcasses on the highway, considered to be about 2.2 days (McClure 1951) to 4 days (Scott 1938), but Simmons (1938) stated "that the length of time an animal may lie on the road following death ... if not picked by crows and other carrion feeders ... from two to fourteen days, and in cool weather even longer." We concur with this appraisal.

There is no reason to believe that sampling invertebrates killed by automobile collisions is more or less efficient than random sweeps with an insect net. The distinct advantage of this sampling technique is that as long as traffic keeps flowing it operates on a 24-hour basis throughout the activity period of the species. This advantage applies only for certain groups of invertebrates and should be considered, therefore, as a supplement to other specialized methods of faunal surveys.

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OAS Newsletter

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