

4.) A New Factor in the Destruction of Mammals.

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Mit zwei Abbildungen.

Thirty years ago, when driving along the highways of the east-central part of the United States, one would occasionally see a chicken or dog which had been injured or killed by running beneath the wheels of a passing vehicle. Today, in driving over these same roads, and carefully observing their surfaces, one will often see numbers of mammals, birds, reptiles and amphibians which have been crushed to death in the passing traffic.

The reason for this marked change in animal mortality on highways, has been the development of the automobile, together with the construction of widespread systems of hard surfaced roads. These two factors have resulted in increasing tremendously, both the amount and the speed of traffic. It is now possible to travel thousands of miles on excellent roads with an ease not dreamed of years ago. For several years the number of people speedily traveling long distances by automobile, as well as the number of automobiles on the roads, has been steadily growing. This great increase in traffic and speed has naturally been reflected in the highway mortality of all kinds of animals.

While on a 2200 mile automobile trip thru eastern New York and the New England States in late summer of 1927, the writer became interested in highway mortality thru the observation of five skunks, *Mephitis nigra* (PEALE and BEAUVAIS) in one day's drive. Three of the five animals were seen within a distance of seven miles. This observation eventually led to other observations on vertebrates in general, of which only the results of mammalian mortality are here presented.

The collection of this data, begun in August 1927, has been continued by the author on auto trips up to Jan. 1. 1931. The distance covered during this time has been 25 000 miles but it is impossible to determine the percentages of mileage driven in the city, and in the country. Naturally, by far the greater mortality occurs in the country, but many cases of cats, dogs, rats, birds and even rabbits and skunks occur within the boundaries of both the small and the large cities. The most of these observations were made on the roads of western New York within a radius of one hundred and fifty miles of Buffalo, N. Y. The one trip into the New England States at the beginning of the observations and several trips thru northwestern Pennsylvania and into the eastern half of Ohio are also included. The region covered is indicated in Chart 1.

An examination of Chart 2 shows that the remains of eighteen species of mammals have been seen, and three hundred and five individuals have been recorded. Of this number of mammals killed, two hundred and fifty-seven or 84%, of them belong to the first four species and only 16% are included in the remaining 14 species. In the total number of victims seen during the observations, the Eastern skunk, *Mephitis nigra*, heads the list with 90 victims (30%), the cotton-tail rabbit, *Sylvilagus floridanus*, is second with 82 victims (27%), the domestic cat, *Felis domestica* (which may be semi-wild in the country districts) ranks third with 45 (14%), and the Norway rat, *Rattus norvegicus*, is fourth, with 40 victims (13%).

It is interesting to note that the skunk heads the list each year in New York State, but in the lists made in Ohio, the cotton-tail rabbit stands first. The large number of rabbits in the June figures for 1930 was seen mainly in Ohio. While crossing the city streets at night, the Norway rat is often run down by an automobile and it is also frequently killed out on the country roads, quite a distance from any buildings. The two spermophiles and the five opossums were all seen in Ohio and all four of the weasels were found in New York State. The ranges of both the opossum and the weasel are very wide and cover both states but their greater frequency in the casualty lists in certain regions probably indicates relatively greater numbers in those localities.

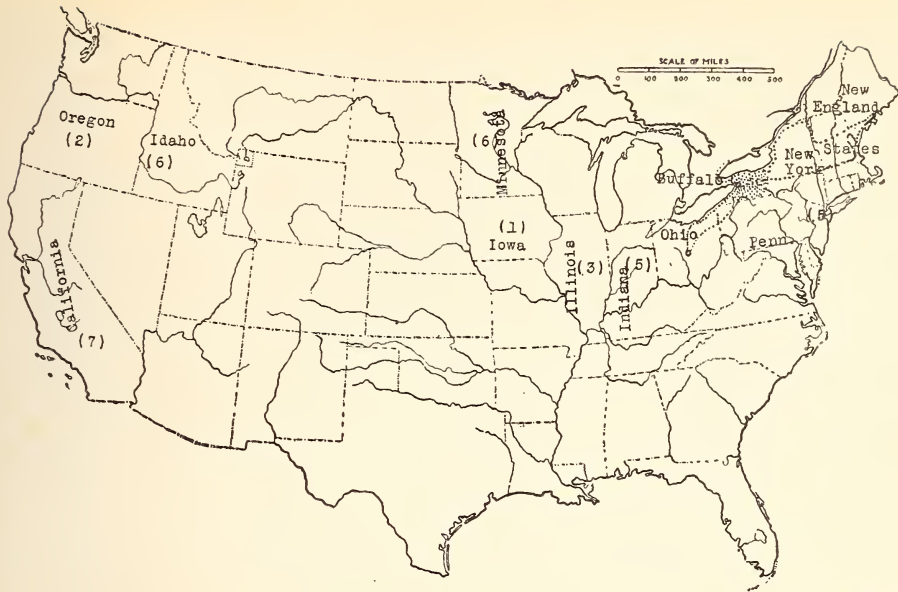


Chart 1. United States.

The dotted area around Buffalo and the dotted lines in New York, Pennsylvania, Ohio and the New England States indicate the regions covered by the author's observations. The number refers to the reports cited in the bibliography as follows: 1, STONER; 2, NEFF; 3, FLINT; 5, HADLEY; 6, GRANT; 7, HALL.

Common Name	Scientific Name	1927	1928	1929	1930	Total	%
1 Eastern Skunk	<i>Mephitis nigra</i> (P. and B.)	25	24	18	23	90	30
2 Cotton-tail Rabbit	<i>Sylvilagus floridanus</i> (ALLEN)	8	16	21	37	82	
3 Domestic Cat	<i>Felis domestica</i> (L.)	2	16	11	16	45	
4 Norway Rat	<i>Rattus norvegicus</i> (ERXL.)	7	13	9	11	40	
5 Dog	<i>Canis familiaris</i> (L.)	2	1	3	2	8	
6 Muskrat	<i>Ondatra zibethica</i> (L.)	3	1	2	0	6	
7 Opossum	<i>Didelphis virginiana</i> (KERR)	1	2	0	2	5	
8 Red Squirrel	<i>Sciurus hudsonicus</i> (ERXL.)	2	0	2	0	4	
9 New York Weasel	<i>Mustela novboracensis</i> (EMMONS)	0	1	2	1	4	
10 Woodchuck	<i>Marmota monax</i> (L.)	0	2	0	2	4	16 2/3
11 Chipmunk	<i>Tamias striatus</i> (L.)	0	3	0	1	4	
12 Hairy-tailed Mole	<i>Parascalops breweri</i> (BACHMAN)	0	2	0	0	2	
13 Red Bat	<i>Nycteris borealis</i> (MÜLLER)	0	2	0	0	2	
14 Short-tailed Shrew	<i>Blarina brevicauda</i> (SAY)	0	2	0	0	2	
15 Field Mouse	<i>Microtus pennsylvanicus</i> (ORD)	0	2	0	0	2	
16 Thirteen-striped Spermophile	<i>Citellus tridecimlineatus</i> (MITCHILL)	0	1	0	1	2	
17 Common Mole	<i>Scalopus aquaticus</i> (L.)	0	0	2	0	2	
18 White-footed Mouse	<i>Peromyscus maniculatus</i> (WAGNER)	0	0	1	0	1	
		50	88	71	96	305	100 2/3

Chart No. 2
 Distribution of Species per Year.

It is also noteworthy that the numbers of skunks have held fairly constant from year to year, while the numbers of rabbits have shown a very decided increase. The number of rabbits seen in 1930, is 50% more than the number recorded in 1929. The increase is clearly shown in the numbers listed in the last four years which are eight, sixteen, twenty-one, and thirty-seven. The lists of cats and rats have been fairly constant.

Chart 3 shows the monthly results for each year, December being the only month in which no casualties are recorded. January and February 1930, and February 1929 show one kill each. In each case it is the rabbit, — an animal which is active the year around. The months from March to and including November, are the ones in which practically all of the casualties occur. June is the month in which the greatest number of deaths is recorded. It will be noted that each July record is very low but this is due to a lack of observations at this time of year and not to a greatly reduced mortality rate. Taking the totals of the monthly figures for the three full years, '28, '29 and '30, and plotting them as a graph, one finds the results as shown in Chart 4. The full line shows the graph according to the actual figures of dead mammals recorded, and the broken line represents a correction to allow for months in which few or no observations could be made. These corrections were made as follows. No observations for September 1930 could be made, so an average of the figures for September for the other years was taken. When this figure is used for September 1930, it gives the correction for that month. May and July particularly show the correction, because of the fewer opportunities the writer had for observations during these months. For the same reason a correction is also made for November '28, the last half of August '29 and September '30.

It is quite evident that in the region of Buffalo, N. Y., the rise in the graph starts in March. This is the month in which the activity of animals begins to increase, following the long three months winter period of comparative inactivity. In March, during periods of moderate weather, the skunks come out of hibernation and begin their hunting. As the weather improves in April, greater animal activity and increased traffic brings higher mortality rates on the highways. During May, the number of deaths drops in spite of a continued increase in traffic. This drop is not an actual reduction in the number of fatalities, but is due largely to lack of time to make many observations during this month. I believe the corrections suggested on Chart 4 approximate very closely the number of victims that would be found if the same amount of road were covered each month. Further observations along this line will be made in an effort to check this point.

June shows a marked increase both in number of species killed and also in the number of individuals of the various species. Rabbits, cats, and Norway rats become much more frequent victims. In August, the skunks are frequently found, for it is at this time that the young ones are seen along the roads. In October they are again numerous and appear practically full grown for they are large and fat and will soon begin to hibernate.

From June to September, the automobile traffic is at its maximum both in intensity and in the rate of speed, and this peak coincides with the peak of animal activity and the period of greatest highway mortality. December, January, and February are the months showing the minimum traffic, and because of the ice and snow on the roads of this region, the speed of traffic is at its lowest rate. This coincides with the period of minimum activity of the animals, and the period of lowest highway mortality.

The rate of mortality is highest on hard surfaced roads, is considerably lower on well-kept gravel and sand roads, while the rate on side roads and dirt roads may drop to zero. Hard surfaced roads in bad repair, also show a marked lower mortality. Thus one can see a direct correlation between the road surface and the speed of traffic, and between this speed and the mortality rate. This agrees with what STONER (1925, 1929), NEFF (1926), and GRANT (1927) found in other parts of the country.

That these deaths are practically always accidents which are unavoidable, has been my conclusion from my own observations. During more than three years of collection of data, only once have I seen a man deliberately try to run down an animal and that was a ring-

Observations on mortality of Mammals on American Highways 1927—1930.

Animal	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Totals	Per Cent
1930														
Rabbit	1	1	2	2		(1) 19		7		4	1		(1) 37	40%
Skunk (Eastern)			4	2	2	2	(1) 2	(1) 6		4	1		(2) 23	24%
Cat			3				8	2		2	1		16	17%
Norway Rat				1		7	1	1			1		11	12%
New York Weasel													1	
Dog			1								1		2	
Woodchuck						1		(1)					(1) 2	
Opossum				1		2							2	
Spermophile, 13-str						1							1	
Chipmunk										1			1	
Annual Totals (10 species)	1	1	10	6	2	(1) 40	(1) 3	(2) 17	0	11	5	0	(4) 96	
1929														
Rabbit		1		4	2	7		1	6				21	30%
Skunk (Eastern)			1	1	1	2	3		(2) 3	(2) 3	(2) 4		(6) 18	25%
Cat				3	2	3		2	1				11	16%
Norway Rat				3		4					2		9	12%
Dog				1		1	1						3	
New York Weasel					(2) 2								(2) 2	
Red Squirrel						1			1				2	
Mole						2	1						2	
Muskrat						1							2	
White-footed Mouse						1							1	
Annual Totals (10 species)	0	1	1	12	(2) 7	22	5	3	(2) 11	(2) 3	(2) 6	0	(8) 71	
1928														
Skunk (Eastern)					1	1	(2) 3	(4) 11	3	5			(6) 24	27%
Rabbit					1	7	1	5	1	1			16	18%
Cat					2	(1) 7	1	2	3	1			(1) 16	18%
Norway Rat				1		5	1	2	3	1			13	15%
Chipmunk						1	2						3	
Opossum						2							2	
Hairy-tailed Mole						2							2	
Red Bat								1	1				2	
Field Mouse						1		1					2	
Shrew (short-tailed)									1	1			2	
Woodchuck					(1) 1			1					(1) 2	
Muskrat									1				1	
Weasel								1					1	
Spermophile, 13-str.						1							1	
Dog						1							1	
Annual Totals (15 species)	0	0	0	1	4	(2) 29	(2) 8	(4) 24	13	9	0	0	(8) 88	
1927														
Skunk (Eastern)								7	5	11	2		25	50%
Rabbit									3	5			8	16%
Norway Rat									1	4	2		7	14%
Muskrat									1	2			3	6%
Cat									1	1			2	
Red Squirrel									2				2	
Dog									1		1		2	
Opossum										1			1	
Annual Totals (8 species)	0	0	0	0	0	0	0	7	14	24	5	0	50	
Grand Total (18 species)	1	2	11	19	13	91	16	51	38	47	16	0	(20) 305	

Chart No. 3.

The numbers that are definitely known to be young ones are marked thus (1).

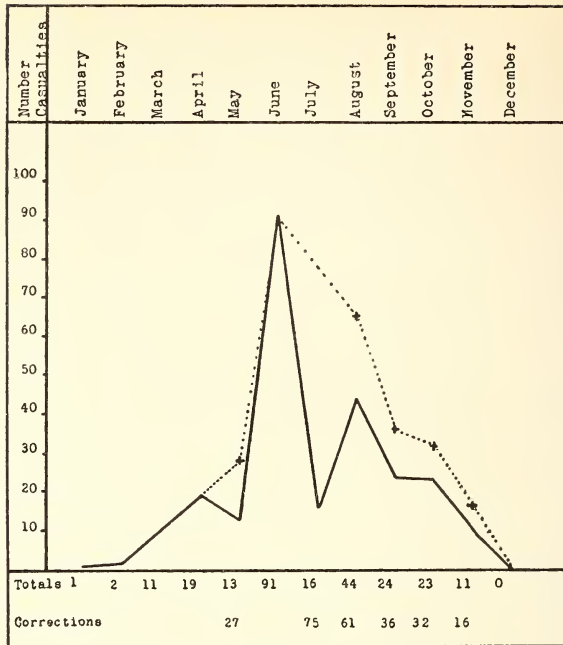


Chart 4.

Total Monthly Distribution of Casualties Observed 1928—1929—1930. The full line represents the graph according to the total recorded monthly casualties. The broken line represents corrections made for months in which the observations were not as extensive as they were in the other months, as in the case of May, July and the first half of August of each year, and in November '28, the last half of August '29 and September '30 when there was little or no opportunity for observations.

necked pheasant, which he could have used for food. GRANT seems to be of the opinion that if an animal is killed, it is the animal's fault. My observations have led me to think that this is only partially true. Much of the killing of these animals occurs at night and in early morning because of the habits of greater activity at this time. Besides this, the animals are often blinded by headlights and during their confusion they are run down, as in the case of rabbits. The skunk casualties (SHADLE 1930) are probably largely due to their slow locomotion and their self-confidence. Few animals will attack the skunk and its ability to protect itself by its odor, has led it to form the habit of standing its ground in the face of attack, but this habit leads to fatal results on the highway. One of the weasels which I found, had caught a meadow-mouse and had carried it to the road to eat it, but was run down while at its meal. After they have once safely crossed the road, deer and other animals in their fright, often wheel and dash again into the path of the car, where they are struck. This same reaction we see in humans when they become scared and confused. Deer also travel in groups and often run diagonally across the road. While the leaders may cross in safety, the young and the stragglers which try to keep with the group, are caught before they get across the road. Some of the animals, such as the skunk and opossum may even frequent the road to feed upon the carcasses of other victims found there. All of these factors and doubtless many others enter into causes for the mortality. To these must be added the occasional driver who has retained enough of the savage habits to want to kill every wild thing which he sees. Fortunately, this type of individual is not numerous, but if drivers in general were more thoughtful of the welfare of the wild animals, the fatalities might at least be somewhat reduced.

In examining the reports of other observers in various parts of the United States, we find points upon which there is general agreement, and also some rather interesting points of difference. The regions from which these reports come are indicated by the numbers on Chart 1.

STONER (1925) in a report of dead animals observed on a trip of 316 miles thru Iowa in June, and the return trip over the same road in July 1924, listed 9 species of mammals and 43 individuals, of which 27 were found in June and 16 in July. This agrees with my graph showing a reduction in fatalities in July. It is noteworthy that the thirteen-striped ground-squirrel, *Citellus t. tridecemlineatus* (MITCHILL), heads the list with 13 in June and 5 in July, and the cotton-tail rabbit, *Sylvilagus sp.*, is second with 8 in June and 4 in July. Only one skunk and one rat are recorded.

A report of NEFF (1926) from Western Oregon in 1925, showed 114 mammals of seven species seen in an aggregate of 5000 miles traveled. Ninety per cent of these victims were found on the 230 miles of paved road. The remainder of the road was largely good hard gravel surface, on which some of the animals were seen, but few victims were found on common rural and mountain roads. In this region the results were as follows:

Black-tailed Jack Rabbitt	<i>Lepus c. californicus</i> GRAY	61
Gray Digger	<i>Otospermophilus grammarus</i> SAY.	17
Cotton-tail Rabbit	<i>Sylvilagus sp.</i>	17
Skunk	<i>Spilogale phenax latifrons</i> (MERRIAM)	12
Cat	<i>Felis domestica</i> L.	4
Golden-mantled Ground Squirrel	<i>Callospermophilus c. chrysodeirus</i> (MERRIAM)	2
Oregon White-tailed Deer	<i>Odocoileus leucurus</i> (DOUGLAS)	1

The observations of the writer and those of NEFF on the correlation between the types of roads and highway mortality, check very closely.

In 299 miles of travel in the vicinity of Champaign, Ill., in the summer of 1925, FLINT (1926) reported sixty mammals as follows:

	April	May	June	July	Aug.
Miles traveled	(54)	(68)	(74)	(64)	(39)
Gophers	10	8	6	4	1
Rabbits	4	5	6	7	0

It is interesting to note that the gophers were most numerous in April which would be soon after they become active, and they gradually decreased in numbers throughout the months of observations. Thus, the greater numbers in the earlier months may be due largely to the killing of young ones (of which there is only one litter per year), but this point is not mentioned in the report. On the other hand, the number of victims among the rabbits gradually increases up to July, which again may be due largely to the killing of young animals which are active at this time.

In his discussion of Highway Mortality, JONES (1927) mentions the abundance of Jack-rabbits in the drier parts of the west and the great numbers of gophers in the prairie region. He also reports a horse as a victim in 1925. HADLEY's (1927) list of mammals seen on a 1000 mile trip thru the states of New Jersey, New York, Pennsylvania, Ohio, Indiana and return reported results very similar to my own, except that he saw more squirrels than I have seen. Much of the territory which he covered corresponds to that for which my report is made. He records 14 skunks, 10 rabbits, 7 squirrels, 3 chipmunks, and 3 opossums, a total of 5 species and 37 individuals. It is noteworthy that skunks and rabbits head his list as well as mine and it would be interesting to know if he too found the opossums in Ohio.

GRANT (1927) on a trip thru Minnesota, observed 7 species and 46 individuals, and in his list, rabbits are first with 19, muskrats second with 15. When one reflects upon the enormous numbers of small and large lakes and marshes in Minnesota, the presence of such a large number of muskrat victims is not surprising. He also mentions that he knows of several cases of coyotes, two cases of deer (Northern White-tailed Deer), and one moose that have

been killed in Minnesota. Thus it is evident that even the largest of our domestic and wild animals fall victims to this new lethal factor, the automobile.

GRANT also cites one of the two most remarkable cases of destruction which have come to my attention. On a 25 miles trip of paved road near Boise, Idaho, he found the remains of 538 Jackrabbits, an average of nearly 22 animals to a mile.

During the outbreak of mice in Kern County, California, in 1926 and '27, HALL (1927) tells us that the passing automobiles killed these animals in such numbers that the roads in some places were slippery and covered with a slush of crushed mice

In addition to the eighteen species in my own list, the following species have been listed from the literature cited, except No. 31 which was reported to me verbally (1930) by JAMES SAVAGE of Buffalo, and No. 34 which was seen by CHARLES KNUDSON in Northeastern Pennsylvania. The animal No. 31 had been killed on the Tamiami Trail in Florida.

19 House Mouse	<i>Mus musculus musculus</i> L.	HALL
20 Golden-mantled ground squirrel	<i>Callospermophilus chrysodeirus chrysodeirus</i> (MERRIAM)	NEFF
21 Franklin's ground squirrel	<i>Citellus franklini</i> (SABINE)	STONER
22 Pocket gopher	<i>Geomys</i> sp.	STONER
23 Gray squirrel	<i>Sciurus carolinensis</i>	FLINT
24 Western fox squirrel	<i>Sciurus niger rufiventer</i> (GEOFFROY) . . .	STONER
25 Oregon spotted skunk	<i>Spilogale phenax latifrons</i> (MERRIAM) . . .	NEFF
26 Prairie spotted skunk	<i>Spilogale interrupta</i> (RAF.)	STONER
27 Black-tailed Jack Rabbit	<i>Lepus californicus californicus</i> GRAY . . .	NEFF
28 Long-tailed weasel	<i>Mustela longicauda longicauda</i> BONAPARTE .	STONER
29 Coyote	<i>Canis latrans</i> SAY.	GRANT
30 Pig	<i>Sus scrofa</i> L.	STONER
31 Florida cougar	<i>Felis coryi</i> BANGS	SAVAGE
32 Oregon white-tailed deer	<i>Odocoileus leucurus</i> (DOUGLAS)	NEFF
33 Northern white-tailed deer	<i>Odocoileus virginianus borealis</i> (MILLER) . .	GRANT
34 Virginia deer	<i>Odocoileus virginianus virginianus</i> (BODDAERT)	KNUDSON
35 Horse	<i>Equus caballus</i> L.	JONES
36 Moose	<i>Alces americana americana</i> (CLINTON) . . .	GRANT

It is very evident that no animal of any size, and not even man himself is immune to the destructive effects of this new factor. In fact the vital statistics show that man too, is subject to a great highway mortality from this same cause. In the case of both man and wild animals, this increase in highway mortality will continue its rapid rise as long as man continues to try to satiate his almost insane desire for speed at any cost.

Conclusions.

1. At the present time the highway mortality rate of mammals is much higher than it formerly was and is rapidly increasing.
2. Improvement of roads, especially hard surfaced roads and the consequent increased traffic, together with the greatly increased speed of traffic, are directly responsible for this higher mortality rate.
3. By far the majority of the casualties are without doubt purely accidental, though some of them, as in the case of rabbits, skunks, deer and other larger forms might frequently be avoided by more care on the part of the driver and a more moderate speed.
4. The killing of wild animals is not confined to the country but often occurs well within the limits of cities.
5. According to these observations, the peaks and the greatest depressions of traffic load, traffic speed and highway mortality are coincident.
6. In forty-one months, eighteen species of mammals numbering three hundred and five victims were observed by the writer, and a total of thirty-six species has been reported.

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