FEATURE ARTICLES

Collision of Vehicles With Deer Studied on Pennsylvania Interstate Road Section

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According to the Pennsylvania Game Commission, 21,607 white-tailed deer were reported killed on Pennsylvania highways in 1968 and 21,246 in 1969 (1, 2). Actual figures on numbers of deer killed are probably much higher, because many deer lie in the woods after they are struck and some carcasses may be moved by local residents before they can be investigated by wildlife personnel. Deer-vehicle collisions often result in extensive vehicle damage, injury or loss of human life, and high mortality of a valuable wildlife species (3).

We have been conducting a long-term study of activity, behavior, and mortality of deer on an 8-mile section of Pennsylvania Interstate 80 (4, 5, 6). The report presented here on a study conducted on 286 deer killed by vehicles on this section of highway during a 14-month period is condensed from a detailed study presented elsewhere (7).

The study section was 8.03 miles long and traversed the heavily forested Allegheny Plateau in North Central Pennsylvania. For convenience and accuracy in recording the site of road-kills and deer observed on or along the highway, the study section was divided into 212 contiguous sectors by wooden stakes placed at 200-ft intervals. This section of highway was opened to public use on September 29, 1968.

No permanent residences were found within a 4-mile strip parallel with the south side of this section of the highway, but several farms and the town of Snow Shoe were located within a 4-mile strip north of the highway. The section of highway that we studied traversed a mixed hardwood forest; elevations varied from 1,560 to 1,760 ft, and streams were common in the area. Topography of the right-of-way varied from flat to steep downslopes in fill areas, and the steep cuts were often terraced. The principal types of vegetation of the right-of-way and median strip were grasses and crown vetch, most of which had been planted by the Pennsylvania Department of Transportation. In some areas clover was abundant. The study area was intersected by only one interchange, which was constructed in a flat area and planted with grass. Chain-link fences (most less than 63 in. high) were constructed at the junction of the right-of-way and the woods in the vicinity of the interchange.

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The occurrence and site of deer-kills were recorded on a regular basis by the local Game Protector. He also disposed of deer carcasses. Data were recorded on form sheets provided by us. Each form contained the date, location (by sector number), highway lane (eastbound or westbound), sex and age of deer (fawn, yearling, or adult). All data were transferred to IBM punchcards on arrival at University laboratories.

Data on the numbers, location, and behavior of live deer on the right-of-way were also obtained during part of the study. Counts of live deer seen in each 200-ft sector along the south right-of-way were obtained by driving a vehicle at about 17 mph past all 212 sectors. The vehicle was driven from west to east on the asphalt emergency lane; a spotlight was used for spotting deer after dark. One such trip along the entire 8.03-mile study section was considered a "run."

In addition, the physical and vegetative characteristics that might affect deer behavior and mortality were analyzed for each sector. Such factors as the general types and amount of vegetation, topography, area of the right-of-way, and presence of fences or guardrails were used in the analysis. Five portions of each sector were considered in the analysis. These were the right-of-way on each side of the highway, the vegetation behind the right-of-way on each side, and the median strip.

A total of 286 deer were reported killed on the 8.03 miles of highway from November 9, 1968, through December 31, 1969; the mean weekly mortality was 4.8 deer. Forty-nine male fawns, 49 female fawns, 46 male yearlings, and 50 female yearlings were killed. Only 25 male adults were killed as compared with 66 female adults. A total of 152 deer-kills were found on or adjacent to the eastbound lanes (south of the median strip) and 134 on or adjacent to the westbound lanes (north of the median strip). Road mortality of deer was high in spring and fall and low in winter and summer. The greatest mortality was 44 road-kills for the last 22 days of November 1968; the second highest was 34 for December 1968. The lowest number of road-kills reported was 9 in August 1969. Jahn (8), in a 10-year study of highway deer mortality in Wisconsin, found seasonal trends in highway kills that were similar to ours; mortality of deer in both studies was very high in November. Reasons for this probably include hunter activity and the mating season for deer.

From November 1968 through May 1969 the number of deer observed per run was obtained for the 8.03-mile study section. A good correlation between the mean number seen per run per month and the number killed during that month was found. The relationship was highly significant ($P < 0.01$). Most of the deer seen on the right-of-way during runs appeared to be grazing (5); thus, it appears that many of the deer we observed, and presumably many of those killed by vehicles, were attracted to the roadside seeking food. On a seasonal basis, deer came to the right-of-way in greater numbers in late fall and in early spring, whereas numbers of deer seen in winter and summer were low. An explanation for the seasonal difference is that food becomes scarce in late fall through early spring, and the banks of the seeded rights-of-way are relatively more exposed to the sun's light and warmth than other areas in the predominantly wooded region. Vegetation in such areas will constitute a prime attractant for deer until it is covered by the winter's snow or unless the forest habitat provides an abundance of food. As might be expected, we were able to relate the number of deer killed by vehicles to the number seen along the right-of-way. We were somewhat surprised to find that road-kills tended to occur along long stretches of highway rather than being confined to specific "crossing" areas.

The maximum number of deer killed in any one sector was 9. Of the 212 sectors, only 68 (32.1 percent) did not have at least one deer killed in them during the 14 months. The maximum length of highway in which no kills were recorded during the study was 800 ft; three of these areas were found. These findings suggest that fencing to prevent deer from crossing highways will probably not be successful if limited to short sections of highway; if fencing is used, the entire highway should be fenced where deer are abundant on the adjacent right-of-way. Also, deer crossing signs would seem to be of limited value in forested areas such as the one we studied except to warn the motorist of the presence of deer. We could not single out specific danger sites.

An effort was made to correlate the general vegetative characteristics of the right-of-way sectors to numbers of deer killed in the traffic lane of that sector. Correlations between our rough estimates of the percent of grass, vetch, clover, or other plants and the number of road-kills in that sector on a monthly or yearly basis were very low. Neither the square footage of areas nor the slope of the right-of-way could be correlated with the number of deer killed per sector. Presence or absence of fences or guardrails was not related to numbers of deer killed per sector. Finally, the number of deer killed per sector on a monthly or yearly basis was not correlated with the number seen on the right-of-way adjacent to that sector. These low correlations indicated to us that, even though the number killed can be correlated with the number seen on the right-of-way along several miles of highway, one cannot predict the number killed on a short stretch of highway (200 ft in this study) by the physiographical or vegetative characteristics of the right-of-way or the number of deer observed on it. Apparently, then, most deer do not cross the road at right angles but rather tend to move along the right-of-way or the highway. Again, this supports our observations that deer do not simply cross a highway "to get to the other side" but specifically come to the right-of-way and stay there for relatively long periods of time, apparently to graze.

As we could not account for mortality by our sector-by-sector analysis, we analyzed our data in a less analytical manner by considering combinations of contiguous sectors with emphasis on general, overall characteristics. Three types of areas where deer mortality was excessive were as follows:

1. Long sections of road bordered by a steep, elevated median strip and a steep, elevated right-of-way, both enclosing the highway in a long "trough" (deer-kills were distributed fairly evenly along such troughs, and no one sector showed an excessive number of kills during the 14-month study);
2. Short sections of road where troughs end by a decrease in elevation of the median strip so that deer can cross it to the other side of the highway; and
3. Sections of road in flat areas where food (grass, clover, and other vegetation) is available on the right-of-way on both sides of the highway and on the median strip (high mortality occurred in such situations only if the entire relief was low).

Sections of highway with low mortality during the study were as follows:

1. The region of the Snow Shoe Interchange, where there is an abundance of potential deer food on the right-of-way but where there are nearby dwellings and roadside rest areas; few deer were seen on the right-of-way in this area, and, in addition, much of this area is fenced.
2. Long stretches of highway where the right-of-way declines to a stream or other lowland area; mortality was highest on the side of the road (north or south) where the decline is located.

The number of deer killed on our 8-mile study area did not appear to be unusually high when compared with similar areas. Wherever Interstate highways traverse densely forested areas with large deer populations, highway mortality is likely to be high. The planted rights-of-way seem to be prime attractants for deer in search of food, especially during the spring and fall. The rights-of-way may be visualized as long, narrow pastures bisected by high-speed highways. When deer wander about these pastures they follow the natural and man-created contours of the rights-of-way (including the median strip) and thus provide a hazard to the driver. Because the pastures are narrow, the chances of deer crossing the highway are high, further increasing the hazard.

For comparison with the forested region we made a concurrent study on a 7.7-mile section of Interstate 80 in an agricultural region of eastern Pennsylvania (Luzerne and Columbia Counties). Here most of the deer grazed in large fields adjacent to the highway and very few were seen on the right-of-way. The chances of their crossing the highway while wandering in search of food were considerably less. Only 40 deer were reported killed on this section of highway during the same 14-month period.

It may be possible for highway engineers to utilize knowledge about wildlife behavior and ecology in the design of future highways in order to significantly reduce collisions of vehicles with deer and to provide the motorist with a greater degree of protection. Currently, fencing appears to be the most commonly used and most feasible means of keeping deer off highways. Experimental work is needed in the design and placement of fences to ensure their effectiveness and to reduce costs. Fences along Interstate highways in forested regions are usually placed at the junction of the planted right-of-way and the adjacent forest. An alternate possibility that might be considered is that they be placed closer to the highway. Hungry deer will attempt to cross over or crawl under a fence to reach the right-of-way, especially when food is scarce in the forest. But if they are allowed to feed on the right-of-way their desire to cross a fence is probably lessened. In fact, shorter, less expensively constructed and maintained fences placed near the highway, at least in some areas, might prove to be more effective than high fences placed at the margin of the forest.

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REFERENCES

1. Over 21,000 Deer on State Roads in 1968. Pennsylvania Game News, Vol. 40, No. 5, 1969, p. 40.
2. Over 21,000 Road-Killed Whitetails in 1969. Pennsylvania Game News, Vol. 41, No. 6, 1970, p. 42.
3. Thompson, F. A. Deer on Highways: 1967 Supplement. New Mexico Dept. of Game and Fish, mimeograph, 1967, 8 pp.
4. Peek, F. W., and Bellis, E. D. Deer Movements and Behavior Along an Interstate Highway. Highway Research News No. 36, 1969, pp. 36-42.
5. Carbaugh, B. T. Activity and Behavior of White-Tailed Deer (Odocoileus virginianus) Along an Interstate Highway in a Forest Region of Pennsylvania. Pennsylvania State University, DEd thesis, 1970, 64 pp.
6. Vaughan, J. P. Influence of Environment on the Activity and Behavior of White-Tailed Deer (Odocoileus virginianus) Along an Interstate High-

way in an Agricultural Area of Pennsylvania. Pennsylvania State University, DEd thesis, 1970, 73 pp.
7. Bellis, E. D., and Graves, H. B. Deer Mortality on a Pennsylvania Interstate Highway. Jour. Wildlife Mgmt., in press.
8. Jahn, L. R. Highway Mortality as an Index of Deer Population Change. Jour. Wildlife Mgmt., Vol. 23, No. 2, 1959, pp. 187-197.

Careful Planning and Building of Roads Has Improved Stream Fishing in Montana

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In 1963, the Montana legislature enacted a stream preservation law for a 2-year trial period. The 1965 legislature gave the Fish and Game Department a permanent law to protect fishing streams which is the foundation of our stream preservation program. Therefore, we have been working on a day-to-day basis with the road-building community for the last 7 years to carry out the intent of this law. We believe the success of our program is the result of the excellent channels of communication between the engineer and the biologist. We really understand each others' problems, and we work together as a team in the problem-solving area.

From July 1, 1963, when the first law became effective, until June 30, 1969, we have reviewed legal notices for 259 projects. Of these, we asked for special considerations on 88 projects, roughly one of every three.

The following are highlights of what has been accomplished during the first 6 years with the law. Proposed road alignments were moved to avoid encroaching upon the Madison, Big Hole, Missouri, and Blackfoot Rivers. Meanders were designed and built in Prickly Pear Creek, the St. Regis River, and the Clark Fork River so that the channel was as long after construction as before. Extra bridges to preserve natural meanders were built in the Beaverhead and Missouri Rivers and are planned for the Blackfoot River. Brushy floodplain vegetation, removed to facilitate construction, has been replaced. Channel excavation has been limited to those times of the year when trout are not spawning and eggs are not in reeds. An elevated and independent alignment has been proposed and designed to preserve the St. Regis River and its scenic canyon. All of these fishery-saving accomplishments have been made by working with the state highway department with the concurrence of the Federal Highway Administration through the effective medium of a good law that established the framework.

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