ROADWAY LIGHTING

There have been a number of studies done about the effect of roadway lighting, but little research has focused on its deer-vehicle crash (DVC)-reduction potential. Most DVCs occur in the evening, night, and early morning hours, and it has been proposed that roadway lighting would improve driver visibility and their ability to avoid a DVC. In fact, literature reviewed by Reed, et al. revealed that 92 percent of 1,441 deer kills on Colorado roadways occurred between 5:00 PM and 9:00 AM (*1*). The most active time for white-tailed deer (to forage and feed) overlaps with the time of minimum driver visibility.

Literature Summary

Only one study was found that evaluated the DVC-reduction effectiveness of roadway lighting (*1*, *2*). The researchers involved with this study had reviewed previous research and found that urban roadway lighting appeared to reduce the occurrence of vehicle-pedestrian crashes, and that the factors in that type of crash were similar to those of a DVC (*1*). Based on that review, Reed, et al. decided to evaluate the effect roadway lighting might have on the number of DVCs, deer crossing patterns, and on motorist behavior (*1*, *2*).

Study Design

The roadway test section for the Reed, et al. study was a 0.75-mile (1.2 kilometer (km)) section of State Highway 82 south of Glenwood Springs, Colorado (*1*). Along this section of highway, 13 clear mercury vapor lamps (37,000 lumens, 700 watt) were installed on poles 12.2 meters (40-feet) high. Nine of the lights were evenly spaced along a 0.3 mile (0.5 km) section of the highway test area, and two of the remaining four lights were each placed on the ends of the 0.75 mile (1.2 km) segment (outside the full lighted 0.3 mile (0.5 km) section) to act as transition lighting (*2*). After the installation of the lights, horizontal illumination levels were measured to determine uniformity in the lighting pattern along the roadway segment of interest (*1*).

The impact of the lighting was studied by turning them on and off for one-week periods from January to April between 1974 and 1979, and collecting DVC information, an estimated number and location of deer crossings, and vehicle speed data (*2*). The length of the test period was chosen to help reduce the impact of the annual and monthly variations observed in the data collected (*2*). During the study time period the location of each DVC was recorded along the study segment, and the number of deer crossings estimated by nightly spotlight counts, observations, and track counts (*2*). Deer were also captured and tagged to supplement and improve the crossing estimates (*2*). The effect of lighting on the pattern of deer crossings was studied by comparing their location along the roadway section during one to two hour evening time periods (i.e., a time of peak deer crossing and traffic volume) with and without the lights (*2*).

The effect of roadway lighting on motorist behavior was also studied by comparing the average of 80 vehicle speeds from 35 nights for similarly lighted and unlighted time periods and locations (within the defined study roadway segment). In addition, vehicle speeds were collected and compared from March 3, 1975 and March 17, 1975. The highway lighting was on for both data collection time periods, but in one case a taxidermy-mounted mule deer was placed in the emergency lane of the roadway (*2*).

Study Results

The number of estimated deer crossings, observed DVCs, and calculated crossings per DVC are shown in Table 1. However, no DVCs occurred along the roadway test section during the 1976 and 1977 study time periods, and these two years were removed from the Reed, et al. evaluation (*1, 2*). During the remaining four years there were 2,480 estimated deer crossings with the lights off and 2,611 with the lights on along the roadway test section (*2*). Table 2 also shows that 384 and 269 of these crossings, respectively, occurred in the transition area of lighting. In addition, despite the increase in deer crossings there were a total of 45 DVCs that occurred when the lights were off and only 39 when the lights were activated. The number of crossings per crash, therefore, decreased from 66.9 to 55.1 (See Table 1) (*2*). In other words, the number of crashes per

TABLE 1 Estimated Deer Crossings, Number of Crashes, and Deer Crossings per Crash (*2*)

	Estimated Deer Crossings		Number of Crashes		Crossings per Crash	
Year	**Lighting Off**	**Lighting On**	**Lighting Off**	**Lighting On**	**Lighting Off**	**Lighting On**
1974	600	502	9	4	66.7	125.5
1975	963	1,118	9	13	107.0	86.0
1978	177	250	5	4	35.4	62.5
1979	740	741	22	18	33.6	41.2
Total	2,480	2,611	45	39	55.1	66.9

TABLE 2 Estimated Number and Location of Deer Crossings (*2*)

Year or Lighting Status	Number of Deer Crossings: Transition Ends*	Number of Deer Crossings: Within Full Light Segment	Transition/Within Crossing Ratio
1974 to 79	653	5,091	0.13
Lights Off	384	2,480	0.15
Lights On	269	2,611	0.10

*Transition roadway length at each end of lighted area.

crossing was about 18 percent lower when the lights were activated along the roadway test section. Reed, et al. concluded that this difference was slight (*2*).

Reed, et al. also concluded that the roadway lighting did not appear to have an effect on the location of the deer crossings along the roadway segment (See Table 2) (*2*). The ratio of transition lighted to fully lighted deer crossings with and without the roadway lights activated ranged from 0.10 to 0.15 (See Table 2) (*2*). Reed, et al. concluded that the difference in the ratios was not significant (*1*, *2*). It is assumed by the authors of this document that this conclusion may be based on the fact that it was believed that these results fell within the natural variability of deer crossing numbers and locations. For example, the ratio described was twice as large during the two years before the study. The apparent variability in this type of data makes an interpretation of these results difficult. In general, however, the pattern of the crossing within the transition and fully lighted segments were similar whether the lights are on or off.

The study of mean vehicle speeds showed an average speed of 49.2 miles per hour (mph) (79.3 kilometers per hour (kph)) southbound and 49.5 mph (79.8 kph) northbound with the lights off (*2*). The mean vehicle speeds with the lighting activated were 49.4 mph (79.7 kph) southbound and 49.1 mph (79.2 kph) northbound. Not surprisingly, Reed, et al. concluded that mean vehicle speeds were not affected by the existence of lighting along a roadway (*1*, *2*). When a taxidermy-mounted deer was placed in the emergency lane of the roadway, however, there was an 8.3 mph (13.9 kph) reduction observed in the average vehicle speed (*1*, *2*). But, recall that this reduction information is based on the average speed from only one night. The addition of the mounted deer on the roadway was considered too much of a risk to vehicle safety for the continuation of this part of the study (*2*).

Conclusions

The Reed, et al. study was the only one found that attempted to directly relate the existence of roadway lighting to a reduction in DVCs. This study also investigated any changes in deer crossing patterns and average vehicle speeds that might occur with the addition of lighting. Reed, et al. concluded that the addition of lighting did not have an impact on DVCs, deer crossing patterns, or average vehicle speeds (*1*, *2*). They made this conclusion despite the fact that a reduction in the number of crashes per deer crossing appeared to decrease by about 18 percent with the addition of lighting along the roadway test segment. It is assumed by the authors of this review that Reed, et al. believed this to be within the normal variability of the data evaluated. The addition of a taxidermy-mounted full-size deer in the emergency lane did produce a reduction in average speed of about 8 mph (13 kph) when the lights were activated. However, not enough speed data was available to validate these results or determine whether this approach would have speed choice impacts in the long term. This approach to vehicle speed reduction (which may or may not equate to DVC reductions) in areas with a DVC problem shows some potential, but would need to be considered further in a more controlled environment. The addition of deer silhouettes on the roadside has been considered elsewhere and is discussed in another countermeasure packet.

Overall, the use of lighting as a DVC reduction measure would be extremely expensive if applied uniformly and not focused on specific locations. Additional research is needed to evaluate its effectiveness as a DVC-reduction tool. Future research in this area should also consider how the magnitude and variability of a moving target (e.g., deer) luminance appears to and impacts driver visibility of that target. The foreground and background lighting situation should also be consistent with actual normal roadway lighting. Non-uniform lighting might, in theory, have less of an impact on the number of DVCs along a roadway segment than shown in this study.

References

1. Reed, D. F., T. N. Woodard, and T. D. I. Beck. *Highway Lighting to Prevent Deer-Auto Accidents. Final Report*. Report CDOH-P&R-R-77-5. Colorado Division of Highways, 1977.

2. Reed, D. F. and T. N. Woodard. Effectiveness of Highway Lighting in Reducing Deer-Vehicle Accidents. *Journal of Wildlife Management*, Volume 45, Number 3, 1981, pp. 721 to 726.