REFERENCE

D'Angelo, G, J., G. Gallagher, D. Osborn, K. Miller, and R. Warren. Evaluation of Wildlife Warning Reflectors for Altering White-Tailed Deer Behavior Along Roadways. *Wildlife Society Bulletin*, Vol. 34, No. 4, 2006, pp. 1175-1183.

INTRODUCTION

Researchers from the University of Georgia and Berry College completed this research study in 2004 and 2005. It focused on the collection, comparison, and evaluation of white-tailed deer behavior related to four colors of Strieter-Lite™ wildlife warning roadside reflectors (See Figure 1). These commercially available reflectors direct the light from oncoming vehicles onto the roadside and develop what is marketed as "an optical warning fence" for deer. Crash reduction studies completed before this project have shown a wide range of results (e.g., positive, negative, and mixed). This project focused on the potential impacts of the reflectors on deer behavior adjacent to a roadway in the Berry College Wildlife Refuge. This type of impact has only been considered in other research, but not in the same manner.

FIGURE 1 Strieter-Lite™ Wildlife Warning Roadside Reflector.

STUDY APPROACH

This evaluation of wildlife warning roadside reflectors was conducted along two roadway segments within the Berry College Wildlife Refuge in northwestern Georgia. The first roadway study segment was characterized by the project team as being in a "campus-to-farm transition area" with various grasses. The second roadway study segment had a roadside with lawns and trees, but sometimes was bordered by buildings. The deer density in these areas was estimated to be about 40 deer per square kilometer (15 deer per square mile). In addition, vehicle volumes along the roadway segments during the observation sessions averaged approximately 28.8 vehicles per hour. This volume is considered to be relatively low.

Strieter-Lite™ reflectors were installed along both roadway study segments according to manufacturer recommendations. A company representative approved the installation. The reflectors were placed 15.2 meters (approximately 50 feet) apart longitudinally and they alternated from one side of the roadway to the other. They were installed in this manner along the entire 182.9-meter (approximately 600 feet) length of each study segment. Distance markers were also installed along each study segment so an observer could accurately record the deer positions. In addition, an elevated observation platform was constructed at the midpoint of each study segment. It was equipped with a thermal camera for the observation of potential deer reactions to the activation of the reflectors. During the observation stage of the study deer within 27.5 meters (approximately 90.2 feet) of the roadway were considered to be within the area of influence of the reflectors. This limit was established by the manufacturer.

DATA COLLECTION PROCESS

Observations of deer behavior were completed before and after the installation of the wildlife warning roadside reflectors (See Table 1). Observations were made during the pretreatment phase without the reflectors and then the reaction of white-tailed deer to four colors of reflectors was observed during different time periods. The study segment and overall observation time period of these phases is shown in Table 1. It was concluded by the researchers that the natural differences in deer behavior during these time periods could be ignored because they were all after the peak fall rut and before spring fawning.

Each observation session lasted four hours and began 30 minutes after sunset. Overall, 15 observation sessions were conducted during each study phase and/or segment. The red and white reflectors were considered along the main campus study segment and the blue-green and amber reflectors along the mountain campus study segment. Observations sessions did not always occur on consecutive nights and were not held during precipitation or heavy fog.

Table 1. Study Phase Segments and Observation Period

Study Phase	Study Segment(s)	Observation Period
Pretreatment (No Reflectors)	Main and Mountain Campus	Nov. 18, 2004 to Jan. 25, 2005
Red Reflectors	Main Campus	Jan. 26, 2005 to Mar. 10, 2005
White Reflectors	Main Campus	Mar. 24, 2005 to Apr. 18, 2005
Blue-Green Reflectors	Mountain Campus	Feb. 8, 2005 to Mar. 18, 2005
Amber Reflectors	Mountain Campus	Apr. 8, 2005 to May 1, 2005

The data collection process involved the following. First, from the elevated observation platform an observer would select a “focal deer” along the study segment and within the designated reflector area of influence. The observer would then notify a co-worker on a two-way radio to drive through along the study segment at 48 kph (approximately 30 mph). The driver would use the vehicle high-beam lights as he/she drove through the test area unless another vehicle was present. The observer would record/categorize the action of the focal deer twice. First, an observation was made when the vehicle was within 50 meters (approximately 164 feet)

of the study segment. The second observation was then made when the vehicle passed the deer of interest. It was assumed the deer was would be exposed to the impact of the wildlife warning roadside reflectors when the vehicle passed.

The location of the focal deer with respect to the roadway (i.e., feet from the observation tower and the roadway edge) and its behavior were recorded at the two observation points indicated above. The deer behavior was categorized as passive (i.e., no movement), active movement toward the roadway pavement, active movement away from the roadway pavement, active movement parallel to the roadway pavement, or on the roadway pavement. The difference in the behaviors recorded between the first observation (i.e., before the vehicle was present) and the second observation (i.e., as the vehicle passed the deer) was the focus of the documented analysis. This difference was characterized and scored to represent the amount of deer reaction. These scores given to the difference in deer behavior ranged from a -2 (i.e., very negative response that might imply the deer behavior had a high likelihood to produce a DVC) to +2 (i.e., very positive response that might imply the deer behavior had a low likelihood to produce a DVC). For example, a -2 score may be a passive deer in the first observation that moved into the roadway for the second observation. A +2 score, on the other hand, may be a deer within the roadway during the first observation that became active and moved away from the roadway during the second observation. Specific rules for the ratings were not documented in the article.

STUDY RESULTS/CONCLUSIONS

The difference in deer behavior or actions between the two observation points was scored as negative, neutral, or positive (see above). The percentage of observations given each particular deer reaction score during each study phase is provided in Table 2. Overall, a total of 1,370 deer behavioral reactions were categorized. The researchers used a chi-square statistical test to determine the difference in reactions between the reflector phases and the pretreatment phase. Overall, the proportion of negative reactions increased during the reflector phases compared to the pretreatment phase. The proportion of positive and neutral reactions, however, varied (i.e., sometimes they increased and sometimes they decreased). The most commonly recorded difference in deer behavior (i.e., deer reaction) along both study segments and for all the wildlife warning roadside reflector conditions was “neutral.”

The researchers also analyzed a subset of 221 deer behavior observations in which the deer was actively moving toward the roadway pavement during the first period of observation (i.e., before the deer and vehicle interacted). The deer exhibiting this behavior were analyzed separately because it was determined to be most likely to cause deer vehicle collisions. The researchers found that found that the proportion of positive reactions for this subset of deer was lower during the reflector phases than it was during the pretreatment phase. Overall, the researchers suggested that the Strieter-Lite™ wildlife warning roadside reflectors, because most of the observations were “neutral” in nature and because deer often reacted negatively to the reflectors, did not deter deer from crossing the roadway when activated.

Table 2. Deer Behavior Observations and Reaction Categorization

			Reaction Score (Percent of all Observations)				
Study Segment	**Study Phase**	**Number of Observations**	**-2**	**-1**	**0**	**+1**	**+2**
Main Campus	Pretreatment (No Reflectors)	161	3.73	2.48	70.81	18.01	4.97
Main Campus	Red Reflectors	182	6.04	7.14	69.78	16.48	0.55
Main Campus	White Reflectors	295	7.12	10.50	51.10	21.02	10.20
Mountain Campus	Pretreatment (No Reflectors)	307	2.61	3.58	72.96	16.94	3.91
Mountain Campus	Blue-Green Reflectors	226	3.09	6.63	80.00	8.85	1.33
Mountain Campus	Amber Reflectors	199	9.04	7.54	54.77	20.10	8.54

DVCIR CENTER FINDINGS

Past studies that focused on the potential impacts of roadside reflectors have produced conflicting results. This study was well-designed and included a subjective categorization of the difference in deer behavior before and after the installation of reflectors (with four different colors).

An initial concern with the study was that it was completed on a college campus and at low speeds. This type of situation doesn't represent the typical environment of a DVC roadway. The study results related to deer reactions (or lack thereof) to the reflectors may need to be considered in the context of the observation environment. The results of this study, however, generally indicate that the actual impact of this device on deer behavior is somewhat suspect.

A more detailed explanation of the deer behavior categorization process would have been useful, but overall the proportion of negative reactions always increased when the roadside reflector was in place. In addition, the neutral reaction category always represented the largest proportion of observations. The percentage of positive reactions to the reflectors varied (i.e., sometimes it increased and sometimes it decreased). Overall, no less than approximately 70 percent of the observations when the reflectors were in place were neutral or negative.

Based on the study results the researchers concluded that the reflectors tested did not deter deer from crossing the roadways. This conclusion generally agrees with the opinion of some of the experts in the technical working group for the *Wildlife Vehicle Collision Reduction Study* (Report to Congress) (summarized separately in this toolbox update, www.deercrash.com). The research completed in this subject area, however, has a long history of conflicting results. It is proposed that the completion of a similar study, possibly along a higher speed and remote roadway, would be desirable to confirm or refute these results.