Report No. FHWA/RD-82/061

EVALUATION OF DEER MIRRORS FOR REDUCING DEER-VEHICLE COLLISIONS

May 1982

Final Report

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Federal Highway Administration

Offices of Research & Development
Environmental Division
Washington, D.C. 20590

FOREWORD

This report documents the work conducted under a study concerned with the effectiveness of reflective devices in reducing deer-vehicle collisions. The report also reviews other similar research. This report will be of interest to traffic and maintenance engineers, environmental specialists, wildlife biologists, and State wildlife agencies.

Research concerning the effects of highways on wildlife and the reduction of deer-vehicle collisions is included under Task 2 of Project 3F, "Pollution Reduction and Environmental Enhancement," of the Federally Coordinated Program of Research and Development.

D. Solomon

for Charles F. Scheffey
Director, Office of Research

NOTICE

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16. Abstract

Deer mirrors were placed in 12 random 0.5-mile test sections along 14.8 miles of I-95 between Topsham and Gardiner, Maine, to test the effectiveness of the mirrors in reducing deer-vehicle collisions. In nearly 4 years, 11 deer-vehicle collisions were reported. Of these, 4 were on the mirrored sections, 2 were on the non-mirrored sections, and the remainder were on off-ramps or at unknown locations. There was no evidence to support the claim that mirrors were effective. A review of other studies reveals a lack of data to support the effectiveness of mirrors. The data available indicates mirrors and reflectors are ineffective deterrents to deer-vehicle collisions.

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PREFACE

This is a report of an experiment to evaluate the effectiveness of deer mirrors on a segment of I-95 in south-central Maine and a review of similar studies on the use of such reflective devices for reducing deer-vehicle accidents.

This research could not have been attempted without the cooperation of many individuals and agencies. The Maine Department of Transportation and especially Mr. Fred Boyce and Wilbur Dunphy of the Materials and Research Division, were instrumental in establishing the deer mirrors along sections of I-95 and monitoring progress of the study. The Maine Department of Transportation also maintained the mirrors and cooperated in reporting deer-vehicle accidents.

The Maine Department of Inland Fisheries and Wildlife provided assistance throughout the study. The Wildlife Division, notably Mr. Lee Perry, provided input on the design of the project and coordinated reporting efforts. The Warden Service Division and the Maine State Poli reported deer-vehicle accidents through Warden Supervisor John Marsh.

METRIC CONVERSION FACTORS

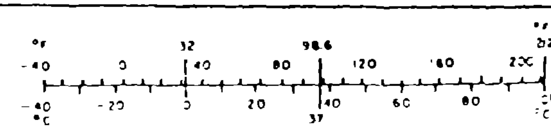
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



INTRODUCTION

One of the major problems associated with U.S. highways is the frequency of collisions between large game species, primarily deer, and motor vehicles. Several methods for reducing these collisions have been tried and are currently being evaluated. Among these methods is the use of mirrors or reflectors to reflect the headlights of oncoming automobiles off the side of the road. In theory, this reflection "freezes" the deer at the side of the road until the automobile has passed.

These deer mirrors have been tried on a limited basis in several states, provinces, and in Europe, but their effectiveness has not been determined. The mirrors are basically of two types. One is the red reflector manufactured by Swareflex. The other, a polished metal mirror with dimpled indentations, is the type evaluated in this study. This type was selected because an earlier preliminary evaluation in Maine (Howe, 1968) had indicated promising results.

The objective of this research was to evaluate the effectiveness of deer mirrors in reducing deer-vehicle accidents on a section of newly-opened Interstate-95 between Topsham and Gardiner, Maine.

METHODS

The study area was along Interstate-95 between the Cathance River in Topsham, Maine, and the exit ramp for Route 201 in Gardiner, Maine. The total length of the test area was 14.76 miles (23.62 km). Two intersections (at Routes 138 and 197) were excluded from the test area because of complexities in locating any mirrors.

Within the 14.76 mile test area, 12 0.5-mile (0.8-km) sections were designated for installation of mirrors (Fig. 1). These 12 sections were located randomly such that they were separated by at least 0.5-mile (0.8 km) non-mirrored sections. The 0.5 mile (0.8 km) test distance was selected as a compromise between a distance that would be small enough to fairly distribute each habitat type between mirrored and non-mirrored sections while minimizing problems of potential kills at edges between the two types.

The right-of-way was inspected by personnel of Inland Fisheries and Wildlife during the winter prior to opening of the road. They found deer sign throughout the area, but with some concentration in the Sedgely Brook vicinity (test sections 10-15). After the mirrored sections were selected, they inspected the route again and saw no reason to believe that the mirrored and non-mirrored sections were not representative of the test area.

A total of 1,940 mirrors were installed beginning 19 September 1977. Each mirror was a 3.5 inch (8.9 cm) square of polished stainless steel with 5 dimples, one at each corner and one in the center. Mirrors were attached to metal posts at a height of 30 inches (76 cm) above the center-line elevation. The posts were set such that the mirror was at a 45 degree angle with the center-line and would reflect light back across the road. This followed the procedure used in the earlier test in Maine and the original Van de Ree Mirror placement instructions.

Posts with mirrors were located on both the outside and median sections of the north and south-bound lanes in each mirrored test section. The posts were set 66 feet (20.1 m) apart on each test section, with the posts on the median shoulder off-set 33 feet (10.0 m) from those on the outside shoulder. Posts with mirrors were set 2 feet (0.6 m) off the edge of the pavement to minimize damage to the posts during snow-plowing operations. In areas with guard rails, they were set 3 feet (0.9 m) behind the guard rail to allow snow plot winging.

The posts in each mirrored test section were given a unique one or two color paint stripe so that actual locations of each deer killed could be noted. A deer killed in a non-mirrored section was then reported as being between the mirrored sections of particular colors.

The Maine Warden Service, Department of Inland Fisheries and Wildlife, recorded this additional information on each form for a deer-vehicle

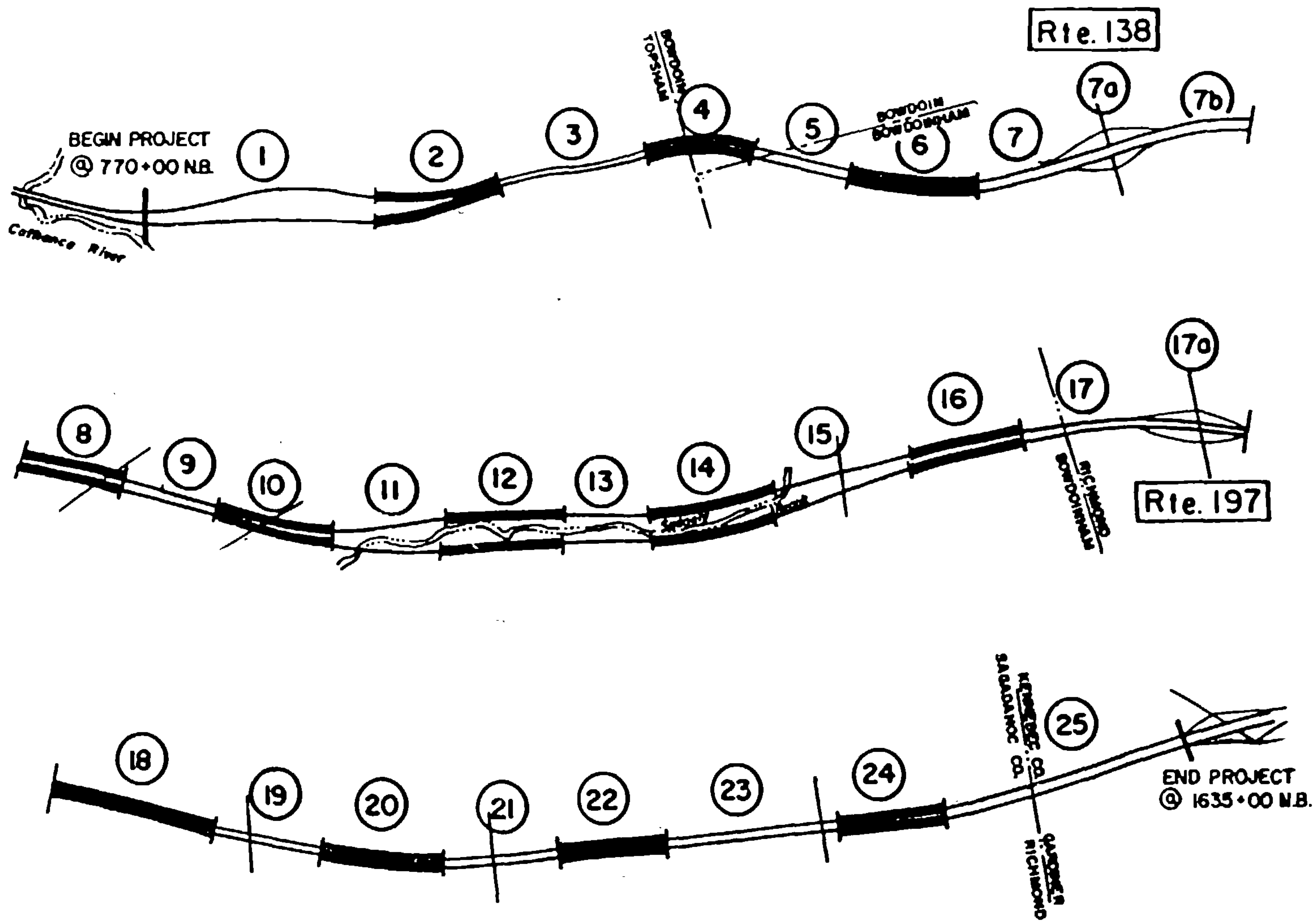


Figure 1. Location of the 0.5 mile (0.8 km) mirrored test sections (wide lines) and alternating non-mirrored test sections along Interstate 95 between Topsham and Gardiner, Maine.

accident occurring in the study area. The Maine State Police also recorded this information on such accidents. Finally, the maintenance crews for the Maine Department of Transportation reported independently any deer killed by vehicles.

The test was run from late October, 1977, until July, 1981. Late each summer the mirrors and posts were straightened or replaced as necessary.

During the winter, personnel from the Maine Department of Transportation frequently counted deer tracks crossing each test section of the road.

The study was designed to allow statistical evaluation of the effectiveness of deer mirrors by comparing the fraction of the total number killed in the mirrored areas with the fraction of the road which was mirrored (0.406). Each year the data were to be analyzed to determine if significantly more deer were killed on the mirrored sections than would be expected if the kill was proportional to the fraction of the area with mirrors. A significant conclusion would result in termination of the project to avoid annual maintenance. A non-significant conclusion would result in continuation of the project.

The expected project duration was 4 years, at which time 28 to 56 deer were expected to be killed in the study area. Previous data for I-95 between Augusta and Bangor indicated 1 deer per year could be killed for every 1 or 2 miles (1.6-3.2 km) of highway.

At the end of the project, the data were analyzed to determine if significantly fewer deer were killed on the mirrored areas than expected. The test used was a one-tailed Students-t test for proportions, corrected for continuity (Zar, 1974):

$$t_c = [(a+0.5)/n-0.406]/[(0.406)(0.594)/n]^{1/2} \quad (1)$$

where a = number of deer killed in the mirrored section, and
n = total number of deer killed in the test area.

RESULTS AND DISCUSSION

Eleven deer were killed on the I-95 study area between October 1977 and July 1980 (Table 1). Of these, 2 were killed at unknown locations, 2 at interchanges not included in the test area, 3 in non-mirrored zones, and 4 in mirrored section. The effective sample size of 7 was not sufficient to test the hypothesis that fewer deer were killed in the mirrored areas compared to unmirrored areas. However, given 4 deer killed in mirrored sections, an additional 16 deer would have to have been killed in the non-mirrored sections for there to be a demonstrable effect of the mirrors.

The number of deer killed on the test area was much less than expected. Eight of the deer were killed in the fall of 1977 and 3 were killed during the first half of 1978. No deer were reported killed on the test area between mid-1978 and mid-1981. The reporting system remained intact throughout this period, and few if any deer would be missed by all three state agencies responsible for reporting.

The number of deer killed by vehicles on roads around the study area was less in the second year of the study than in the first (22 vesus 16). Statewide, the number of deer killed by vehicles was at or below normal for the years of the study (Maine Dept. Inland Fisheries and Wildlife, unpublished data).

Perhaps the best explaination for the decline in sample size as the study progressed comes from the work of Bellis and Graves (1978) in Pennsylvania. On an 8 mile (12.8 km) segment of I-80 a total of 286 deer were killed in the first 14 months following its opening in 1968, 22 were killed in 10 months of 1970-1971, 2 were killed in 12 months in 1973-1974, and 6 were killed on 6 miles (9.6 km) of the same area in 1974-1975. Bellis and Graves (1978) found no correlation between the numbers killed and number of deer in the area, and suggested that deer were simply not remaining on the right-of-way as long as they were when the interstate first opened. The decline in numbers of deer killed on the newly opened section of I-95 in Maine may well be the result of a similar "acclimatization" of deer to the right-of-way.

The distribution of the deer killed on the study area indicated deer were using the entire area (Table 1). The area near Sedgely Brook (test sections 10 through 15) did seem to be an area of some concentration, although sample size was again insufficient to warrant statistical examination. Track counts in each test section during the winters of 1977-78 and 1978-79 indicated crossings throughout the study area, but fewer tracks crossing the right-of-way in the second winter (22 per inspection) than in the second winter of the experiment (6 per inspection).

Table 1. Locations and dates of deer killed along the I-95 study area, Maine, between October 1977 and July 1981.

Report Number	Test Section Number	- Treatment	Date	Remarks
1	unknown		10-28-77	possibly outside area
2	7A	Interchange	11-02-77	
3	14	Mirrors	11-04-77	
4	unknown		11-14-77	reported at toll booth
5	17A	Interchange	11-15-77	
6	10	Mirrors	11-19-77	
7	10	Mirrors	11-20-77	
8	14	Mirrors	11-20-77	
9	5	No mirrors	05-19-78	
10	5	No mirrors	05-26-78	
11	?	No mirrors	07-03-78	

In spite of the fact that sample size was too small to warrant any conclusion that the mirrors were effective in reducing deer-vehicle collisions, there was no trend of the data toward such a conclusion. In fact, the low number of deer killed throughout the area, combined with the fact that more deer were killed in the mirrored areas than the non-mirrored areas, would lead to the conclusion that the mirrors were probably ineffective and anyway not justified in areas with so few deer-vehicle accidents.

REVIEW OF OTHER STUDIES

There has been concern for a number of years with the problem of deer-vehicle accidents, both because of the loss of deer and because of the damage to property. Several methods have been attempted to reduce the frequency of such collisions, among which is the use of mirrors or other reflectors to direct light from vehicle headlights to the side of the road. This light is supposed to startle the deer and make them hesitate to enter the right-of-way until after the vehicle has passed.

A number of studies, including the one reported here, have attempted to determine if such reflective devices are effective in reducing deer-vehicle accidents. It is the purpose of this section of the report to summarize and critically evaluate these past efforts and to suggest refinements in study design.

Types of Reflectors

The mirrors used have been primarily of two types. The first to be tested was a flat polished stainless steel square about 4 by 4 inches (10 by 10 cm). This "Van de Ree" mirror most often had 4 or 5 small "dimples" or indentations. These stainless steel mirrors are available from several sources, both in the United States and Europe. They are mounted as diamonds or squares on posts located on the shoulders of the road. Some tests with these mirrors have been set up to reflect light away from the road, some back across the road, and some both ways (Gordon, 1967).

The second type of reflector is a red glass and plastic lens known as a Swareflex reflector. It is manufactured in Austria, where it was first tested in about 1971. The lenses are mounted on posts along the road shoulders so that light is reflected away from the right-of-way.

The Swareflex reflector was developed on the theory that red light is particularly effective in attracting a deer's attention. Basic to this theory is the claim that deer can distinguish red color. The evidence available for this is a study of one female red deer (Backhaus, 1969), a theory developed by Koenig (1974) that predator eyes appear red to deer, and a popular article by Weiss (1981). Predators eyes do not reflect light except from human sources. Further, there is a wide variability in the ability of mammals to distinguish color, and what might be true for one species is not true for another. We do not know that white-tailed or mule deer can see red color. Even if it was established that red color could be distinguished, the behavioral impact of this compared to white light from headlights would require exhaustive investigation.

Chronology of Experiments

The original test of the Van de Ree reflectors was a "before-and-after" study in the Netherlands which compared the numbers of deer killed between 1958 and 1960 on a 2.4 mile (4 km) length with the numbers killed between 1960 and 1962 after mirrors were installed (McLain, 1964). They reported a reduction from 20 to no deer killed when the mirrors were in place.

Several states installed and tested these or similar mirrors following the report of the Netherlands study. Maine installed about 7 miles (11 km) of mirrors in segments from 0.25 to 1 mile long (0.4 to 1.5 km) over a period of 5 years (Howe, 1964, 1965, 1966, 1967, 1968). There was no reliable information on the number of deer killed prior to installation, but the conclusion was made that the mirrors were successful. However, all deer kills in the mirrored segments were discounted because of faulty installation or damage to the mirrors.

New Jersey installed mirrors along 7.8 miles of highway (McLain, 1964). They planned to evaluate the success of the mirrors by comparing counts of deer kills in the areas before installation with the number following. Indiana installed Van de Ree mirrors on two 1-mile (1.6 km) sections of road in 1964 (Nettles, 1965). One section was mirrored for two years (the second held as a control) then the mirrors were switched to the other section for another two years (Grimmett and Bartholomew, 1968). They compared only kills at night and concluded that nocturnal mortality was not affected.

Colorado evaluated the Van de Ree mirrors in an 8 year study in Grand Valley (Gordon, 1969). They compared the number of collisions in 4 years the mirrors were installed with the numbers killed in adjacent areas and in the previous 4 years on the same areas. They concluded that the mirrors had no effect.

Michigan established two test areas where round, convex mirrors were installed along 2 and 7.5 miles (3.2 and 12.0 km) of four-lane highway (Queal, 1968). They compared kill 3 years before with the 3 years after installation and concluded that they were not effective.

The original test of the Swareflex reflector took place in Austria in the early 1970's. The results were first reported in the Bulletin of the Austrian Academy of Science (No. 6, 1974) and summarized by Rudelstorfer and Schwab (1975). Forty-two segments totaling 58 miles (94 km) were evaluated on a before-after basis after the reflectors had been installed from 3 to 24 months. The evaluation was conducted by questionnaire, with engineers, maintenance personnel, etc., giving information on the number of deer killed before and after reflectors were installed. Data from another 10 segments was not included in the analysis because the questionnaires were not understandable or not reliable. The data presented indicated a reduced kill since reflectors were installed.

The only completed study in the United States which evaluates the Swareflex reflector is in Colorado (Woodard, et al., 1973). In a one winter study along I-70 near Wolcott, reflectors were mounted and removed in alternate weeks for 24 weeks. They recorded 11 deer killed when the reflectors were on and 8 deer killed when reflectors were off.

Tests of Swareflex reflectors are presently being conducted in several states and provinces. Iowa has reported that its study design is a comparison of kills in the reflector area with kills previously and in adjacent areas (Gladfelter, 1980). The preliminary data from this test (V. Marks, 1981 communication to Strieter Corporation, U.S. distributor for Swareflex) reports that some reduction in kill has occurred on two of the four test sites in the first year after installation. A similar first year reduction has been reported to Strieter Corporation by V. Beckerman (1981) for a test section of I-94 in Minnesota.

Critique of Designs

To be fair, it should be stated that many of the reports on deer mirrors were not of studies specifically designed to evaluate the effectiveness of deer mirrors, but were applications of the mirrors to attempt to solve a problem along a particular segment of highway. However, the results of several of these have been reported as evidence of success of the deer mirrors.

Very few of the studies have incorporated any statistical design into their planning. Especially critical in developing a project is to eliminate the effect of year to year fluctuation in the number of deer crossing the right-of-way. Most studies recognized that the numbers killed on control sections of road varied widely from year to year, depending on weather, number of deer, traffic volume and speed, habitat changes, etc. As a result, comparisons of the number of deer killed before with after installation have little value because the effect of these other factors is confounded.

Another problem which could arise is comparing the numbers of deer killed at one time of year (with no treatment) to those killed at another time of year (with treatment). That deer activity and susceptability to vehicles varies with the time of year is well known. Mule deer are more vulnerable when they are on winter ranges closer to highways (Gordon 1969). White-tailed deer are more vulnerable when they are moving more during October and November (Bellis and Graves, 1971). The Austrian study of Swareflex reflectors could be criticized on this basis if, as would be reasonable to expect, red deer demonstrated similar variability in behavior or susceptability. Some of the evaluations in that study were done for less than a year, and few were done in multiples of 12 months.

Some studies have attempted to eliminate the year to year effect by comparison of the kill with that in a control area. This has some merit if the numbers of deer killed in each area were to follow the same pattern. However, this is not often demonstrated. One way to solve the problem of pattern consistency is to expand the number of control and test areas to attain a larger sample size, as was done in the present study. If there are enough areas and the test areas are assigned randomly, the effect of area variability can be smoothed.

Another means of solving the area by area variability is by switching the control and test areas, as was done by Grimmett and Bartholomew (1968) in Indiana. They switched control and test areas half-way through the 4 year study.

It would be advantageous to switch between control and test more frequently, as was done by Woodard, et al. (1973) in Colorado. By removing reflectors every other week, they were able to achieve a test which avoided year to year and area to area confounding factors.

Finally, sample size is a problem in many studies. Reductions (or increases) in deer killed may not be significantly different from what could be expected by chance if few deer kills occur. Studies have made conclusions with very few deer kills on very small sections of road.

Conclusion

There is no statistically valid evidence that either the Van de Ree stainless steel mirrors or the Swareflex red reflectors reduce vehicle-deer collisions. The only statistically valid test with a minimally sufficient sample size concluded that the Swareflex reflector was ineffective (Woodard, et al., 1973).

BIBLIOGRAPHY

Anon. 1974. [Behaviourism helps to prevent animals from being killed in traffic accidents]. Austrian Academy of Science, Bull. 6 (Oct.):5-6.

Backhaus, D. 1969. [Experimental investigations on the activity of vision and color vision in some hoofed animals]. Z. F. Tierpsychologie 16(4):465-467.

Bellis, E. D., and H. B. Graves. 1971. Deer mortality on a Pennsylvania interstate highway. J. Wildl. Manage. 35(2):232-237.

Bellis, E. D., and H. B. Graves. 1978. Roadside fences· Can they control vehicle collisions with deer? Rural and Urban Roads. April:62-65.

Boyd, R. J. 1966. "Deer mirrors"--do they work? Colorado Game, Fish, and Parks Dept., Game Info. Leaflet No. 44, 2pp.

Gladfelter, L. 1980. Stop signs for deer. Iowa Conservationist Magazine 39(8):10-11.

Gordon, D. F. 1967. A report on the effectiveness of Van de Ree mirrors. Paper presented at Midwest Wildlife Conference, 14pp. Mimeo.

Gordon, D. F. 1969. "Deer mirrors"--a clearer picture. Colorado Game, Fish, and Parks Dept., Game Info. Leaflet No. 77, 3pp.

Grimmett, H., and R. M. Bartholomew. 1968. Evaluating the effectiveness and practicality of deer mirrors. Mimeo. 6pp.

Howe, W. S. 1963-1968. Experimentation with reflective devices. Annual Job Completion Reports, Project W-37-R-12 (Maine).

Howe, W. S. 1967. Deer mirrors save deer ... and cars. Maine Fish and Game, Winter 1966-67. 2pp.

Koenig, O. 1974. [Eye-point of vision]. Transl. from Strieter Corporation. Mimeo. 9pp.

McLain, P. D. 1964. The story of the deer mirrors on the parkway. New Jersey Outdoors, Dec. 1964:13-18.

Nettles, K. 1965. Mirrors to reduce deer-auto collisions. Outdoor Indiana. Feb. 1965:20-23.

Queal, L. M. 1968. Effectiveness of roadside mirrors in controlling deer-car accidents. Mich. Dept. of Conserv., Research and Development Report 137, 9pp.

Rudelstorfer, K., and K. Schwab. 1975. [Optical devices for traffic safety]. Univ. Innsbruck, Schriftenreihe, No. 4.

Weiss, J. 1981. Deer do see color! Outdoor Life 167(3):64F.

Woodard, T. N., D. F. Reed, T. M. Pojar. 1973. Effectiveness of Swareflex wildlife warning reflectors in reducing deer-vehicle accidents. Colorado Div. Wildlife, Mimeo. 5pp.

Zar, J. H. 1974. Biostatistical analysis. Prentice-Hall, Inc., Englewood Cliffs, N.J. 620pp.

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The diagonal double stripe on the cover of this report represents a highway and is color-coded to identify the FCP category that the report falls under. A red stripe is used for category 1, dark blue for category 2, light blue for category 3, brown for category 4, gray for category 5, green for categories 6 and 7, and an orange stripe identifies category 0.

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