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Driver knowledge, beliefs, and attitudes about deer–vehicle collisions in southern Michigan

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Abstract: Deer–vehicle collisions (DVCs) are one of the most frequent and costly human–wildlife conflict throughout the range of white-tailed deer (*Odocoileus virginianus*). We conducted a self-administered, mail-back survey of Michigan drivers to determine: (1) driver attitudes and knowledge about DVCs; (2) reporting rates of DVCs; and (3) effects of being in a DVC on attitudes toward desired deer population levels. From a sample of 3,600 randomly-selected licensed drivers ≥18 years of age in southeast Michigan, we obtained 1,653 completed questionnaires (48% response rate). Although 18% of respondents reported experiencing ≥1 DVC within 5 years of the survey and 81% of them perceived DVCs to be a serious problem, drivers stated a willingness to make only modest changes in their driving behavior to minimize risk of a DVC. Most respondents (79%) believed DVCs were unavoidable. Only 46% of drivers involved in ≥1 DVCs indicated that they reported it to police, and 52% reported the DVC to their insurance company. Drivers involved in DVCs were more likely than other drivers to be male, drive more, be more knowledgeable about DVCs, and be more likely to desire a decrease in the deer population. If reporting rates revealed in this study are an indication of rates elsewhere, DVCs are a much greater hazard than previously estimated.

Key words: deer–vehicle collisions, human–wildlife conflicts, Michigan, *Odocoileus virginianus*, reporting rates, white-tailed deer

Deer–vehicle collisions (DVCs) affect the health and economic and psychological well-being of people throughout the world (Conover 2002, Forman et al. 2003), and are an especially acute human–wildlife conflict within the range of white-tailed deer (*Odocoileus virginanus*). In Michigan, ≥60,000 DVCs annually cause an average of 7 human fatalities and >1,880 human injuries. Deer–vehicle collisions represented nearly 16% of all vehicle collisions in Michigan during the period 1993 to 2003 (Deer–Vehicle Crash Information Clearinghouse 2009). At an estimated cost of $2,300 per damaged vehicle (Marcoux et al. 2005), the annual economic losses from reported DVCs may be nearly $150 million in Michigan. Recent cost estimates that include human fatalities (Bissonette et al. 2008) report as much as $3,470 per DVC. Estimating the total effect of DVCs with accuracy, however, is confounded by uncertainty associated with reporting rates by drivers to insurance companies and to traffic safety agencies (Allen and McCullough 1976, Decker et al. 1990).

The frequency of DVCs can be influenced by deer density, season (Sudharsan et al. 2006), time of day (Marcoux et al. 2005), landscape changes due to human settlement (Nielsen et al. 2003), type and quality of habitat that roads traverse (Finder et al. 1999), as well as road types and speed limits on them (Sudharsan et al. 2009). Techniques have been recommended to reduce the number of DVCs based on increased understanding of the causes of DVCs (Mastro et al. 2008). Although reduction in deer density is frequently indicated as a management option, a decreased ability to control deer populations throughout much of the range of white-tailed deer (Brown et al. 2000, Riley et al. 2003) creates a need for alternatives aimed at changing driver behavior through information and education (Evans 1996). Systematically collected information about drivers' understanding of DVCs and the effects of DVCs on attitudes toward deer is needed for more effective policy and educational programs about DVCs (West 2008).

The objectives of this study were to (1) determine driver attitudes and knowledge about DVCs, (2) estimate rates at which DVCs are reported to insurance companies and police, and (3) determine what effect being in a DVC has on drivers' attitudes about desired deer population levels. We conducted an extensive survey of licensed drivers in 3 counties of

southeast Michigan whose white-tailed deer habitats were typical of habitats throughout the Midwest and much of the eastern range of the species (Walter et al. 2009).

Study area

The study area consisted of Oakland, Washtenaw, and Monroe counties in southeast Michigan (Figure 1). These counties represented a gradient of deer habitats from low to high quality (Sudharsan 2005), human settlement from urban to rural, and traffic conditions from high to low volume. Situated just north of the Detroit Metro area, Oakland County was the most suburban county, although much of it contained northern hardwood forests intermixed with farms. Monroe County, the most rural of the 3 study counties, consisted of large tracts of agricultural land dominated by hay and row crops interspersed with major riparian areas of the Raisin and Saline rivers. Washtenaw County was intermediate between Oakland and Monroe in terms of human density and proportion of the landscape in agriculture. Nearly 95% of households in the entire study area owned ≥1 vehicle, and the working population commuted an average of 25 minutes daily to work (Marcoux 2005).

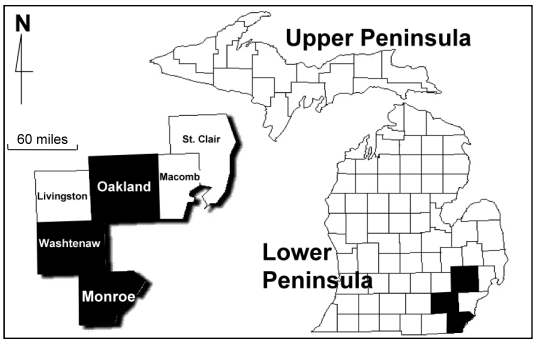

Figure 1. Location of study area counties (shaded) in southeast Michigan, USA.

Methods

Formulation of the questionnaire

We conducted 30 open-ended interviews (10 in each county) of adult drivers ≥18 years of age. To identify salient issues and understand terminology used by drivers when considering DVCs, we randomly selected interviewees through a convenience sampling scheme at shopping malls and parks within each county. All respondents resided in the county in which they were interviewed. Results from the interviews were used to formulate a questionnaire that contained 6 primary subject areas: (1) experiences with deer and beliefs about the current size of the deer population in the areas respondents frequently drive, and desired future deer populations in those areas; (2) involvement with DVC and reporting rates of DVCs to police and insurance authorities; (3) knowledge about DVCs and how to avoid them; (4) attitudes about DVCs; (5) sources of information about DVCs obtained by drivers; and (6) demographic characteristics of respondents. A complete version of the questionnaire is in Marcoux (2005).

We provided 10 potential ways people could have interactions with deer, including being in ≥1 DVC as a driver or passenger within 5 years of receipt of the questionnaire. We estimated the 5-year time period as a reasonable length of time for people to have accurate recall; this period previously was used in similar research (Messmer et al. 1999). We asked respondents who had been involved in a DVC to fill out a special section that addressed situational characteristics of their particular DVC incidents. We compared data on attitudes, beliefs, and behaviors of respondents who had been involved in ≥1 DVC to data from respondents who had not experienced a DVC. In particular, we investigated whether level of concern regarding involvement in a DVC was high enough to change intended driving behavior to decrease the probability of being involved in a DVC. Questions focused on driver behaviors associated with DVCs and the level of concern drivers held about possible consequences of being involved in a DVC.

Respondents who reported having been a driver in a DVC were used as the sample population on which reporting rates were determined. Respondents who indicated they had not reported their DVCs were asked why they chose not to do so. Choices included: not enough time, did not think it was necessary, believed reporting would affect driving record, believed reporting would result in a ticket, and believed reporting would affect insurance rates. Respondents were also provided an opportunity to write in other reasons.

To measure driver knowledge about DVCs and how to avoid them, we asked a series of

7 questions: (1) Do most DVCs occur at dawn to sunrise? (2) Do most DVCs occur at dusk to sunset? (3) Do most DVCs occur during early winter months? (4) Are DVCs most likely to occur on 2-lane roads? (5) Does driving faster make it harder to avoid a DVC? (6) Would your insurance rates increase if you reported the DVC to your insurance agency? (7) Would you be ticketed for the DVC if you reported it to the police? For each of these knowledge questions, we coded responses as 2 if the respondent answered "definitely true", 1 if "probably true", and 0 if "definitely false", "probably false," and "unsure". We totaled points for each question, with each respondent receiving a possible score between 0 and 14. Only respondents who answered at least 6 of the 7 questions were included in this part of the analysis. We inferred that an "unsure" response indicated a lack of knowledge. We used independent *t*-tests to compare mean knowledge scores of male and female drivers, and mean scores of drivers who had been involved in DVCs with those who had not.

Respondents were queried on where they obtained information about DVCs, including newspapers, magazines, brochures, driver education courses, billboards, or friends. We determined profiles of respondents by a series of questions on demographics, including the type of area they lived in, tenure of residency, the type of vehicle they drove most often, numbers of miles per week they normally drove for work and for non-work purposes, gender, age, and highest level of education.

Survey implementation

We obtained a list of the entire population of licensed drivers ≥18 years of age registered in Oakland, Washtenaw, and Monroe counties on March 24, 2004, from the Michigan Secretary of State. We then randomly selected approximately 1,200 records from each county population, for a total of 3,600 drivers in the study population.

The questionnaire mailing procedure was a modified version of the Tailored Design Method (Dillman 2000). We first mailed questionnaires on April 19, 2004. We included a cover letter from Michigan State University and a letter from the Southeast Michigan Council of Governments with the first mailing to encourage participation in the study. As an additional incentive to complete and return the survey, we included 3 first-class postage stamps in the first mailing of the questionnaire. We sent a postcard reminder 10 days after the first mailing; we followed this with a third mailing of a new cover letter and questionnaire approximately 21 days after the first mailing. We sent the third mailing only to those people who had not responded by the twentieth day. Fourteen days after the third mailing, we sent final reminder postcards to everyone who had not yet responded.

We attempted to assess nonresponse bias by sending a postcard with a brief questionnaire to everyone who did not respond to the original questionnaire within 6 weeks of the first mailing. The nonresponse questionnaire was limited to 7 key questions regarding demographics, experience with deer, involvement with DVCs, and reasons for not answering the original survey.

The University Committee on Research Involving Human Subjects reviewed and approved the questionnaire development and survey protocol under Internal Review Board #04-075.

Data analysis

We calculated frequencies and summary statistics for all variables. We used unpaired *t*-tests to test for differences between DVC involvement as a driver and mean knowledge scores and mean km driven for work (t_w) and personal (t_p) reasons. We derived estimates of miles driven from responses to the questionnaire and converted to them km. We used analysis of variance to test for differences in mean knowledge scores for the occupant variable (driver in DVC, passenger in DVC, both, or none) and for the respondents from urban, suburban, and rural areas. We used crosstabs and Chi-square analyses to test for differences in DVC involvement and several categorical variables. We rounded percentages reported in the text to the nearest whole number for clarity and ease of reading.

Results

Response rate and respondent demographics

We received a response rate of 48% (n = 1,653) after excluding 156 ineligible surveys (e.g., expired addresses or death of the intended respondent). We estimated an overall sampling

error of ±2.4% at a 95% confidence level using the most conservative estimate (50%) of the standard error of a binomial (Salant and Dillman 1994, Babbie 1990). Nearly 17% of respondents described where they lived as urban, 45% suburban, and 38% rural. The average age of the respondents was 47.8 years (SD = 15.5, range = 18 to 90 years). Although there is a nearly 50:50 gender ratio among drivers in the study area, 53% of respondents were female. Nearly 75% of respondents reported having attended at least some college, with 22% reporting having earned a 4-year college degree, and 20% a graduate or professional degree.

We received 196 responses to the nonresponse survey. Average age (46.9 years; SD = 17.8, range = 18 to 92 years), proportion of female respondents, and the proportion of respondents from each residential area in the nonrespondent sample were not statistically different from the sample of respondents to the original questionnaire. Of those people responding to the postcard questionnaire, 19% stated they were involved in a DVC either as a driver or a passenger. Although we received a slightly greater proportion of responses to the original questionnaire from females, we suspected a slight male bias in the reporting of involvement in DVCs because the proportion of responses from male drivers involved in DVCs (67%) was higher than the proportion of DVCs involving males (61%) from highway safety crash data (Marcoux et al. 2005). We do not believe, however, that the slight bias in male respondents was great enough to appreciably affect inferences drawn from the questionnaire data.

Interactions with deer and deer–vehicle collisions

Twenty percent of respondents reported having been involved in ≥1 DVC in their lifetime. Of those, 18% reported having been involved in >1 DVC. Nearly 12% of total respondents reported being involved in a DVC as a driver during the previous 5 years; people who reported being a passenger in a DVC during the past 5 years comprised 6% of respondents. Drivers involved in a DVC were more likely to be male (67%) and reside in rural (55%) or suburban (36%) areas, rather than in urban areas (9%).

Drivers involved in DVCs in the previous 5 years drove more miles for work and more miles for personal reasons ($\bar{x}$ = 205 and 124, respectively) per week than the number of those not involved in DVCs ($\bar{x}$ = 147 and 100, respectively). Additionally, the number of miles driven per week for work and for personal reasons were greater for males ($\bar{x}$ = 207 and 112, respectively) than for females ($\bar{x}$ = 110 and 94, respectively).

Most (94%) respondents reported that they had seen deer while driving, and 31% reported seeing deer at least weekly. Only 3% of respondents indicated that they had never seen a deer while driving, and 3% had no opinion. Most (79%) drivers believed deer were common in the area where they lived. Respondents who reported being a driver involved in a DVC were more likely (36% versus 21%) to report seeing deer at least weekly or daily (14% versus 4%) than respondents who had not been a driver in a DVC.

Attitudes toward deer and driver-stated behavior

Most respondents (whether or not they were involved in a DVC) reported that they were always (53%) or sometimes (35%) excited to see deer while driving; yet, 94% of respondents worried that deer would run in front of their vehicle. Drivers involved in a DVC were less likely to view deer positively; only 44% of them were "always excited to see deer while driving," and more of them (98%) indicated that they were "always worried that deer would run in front of their vehicles." Previous experience with a DVC had limited effect on driver behavior in reaction to deer-crossing signs. When respondents were presented with a scenario that involved seeing a deer while driving, 77% of drivers involved in DVCs indicated that they would slow down in reaction to a deer-crossing sign, while 73% of them who had no prior DVC involvement indicated that they would slow down. Only 39% of respondents indicated they would definitely slow down in response to spotting a deer-crossing sign while they were driving.

Respondents expressed a willingness to reduce driving speed by 16 km per hour if it would reduce their chances of being involved in a DVC. A majority (76%), however, said they were unwilling to take a special driver's education course or eliminate driving at dawn,

Table 1. Respondents' concerns about potential outcomes of DVCs, Oakland, Washtenaw, and Monroe counties, Michigan, USA. Responses were to the survey question, "When you think about deer–vehicle collisions, how concerned would you say you are about each of the following situations?"

Potential outcome	*n*	% concerned	% unsure
Losing control of vehicle and swerving to avoid a deer	1,625	92	<1
Injuring passengers or others	1,619	91	<1
Cost of repairing damages to vehicle	1,621	90	1
Being injured	1,628	88	<1
Insurance rate increase	1,612	82	4
Injuring or killing the deer	1,615	76	1
Cost of repairing other property damage	1,594	75	4
Medical bills due to injury	1,610	68	2
Receiving a ticket if reporting DVC to police	1,614	37	7

dusk, or after dark. There was no statistical difference in any of these behavioral intentions between drivers who were or were not involved in a DVC.

The 5 concerns that drivers most often expressed about DVCs were, damaging their vehicle when swerving to miss a deer, injuring passengers or other drivers, damaging their vehicle from direct collision with deer, being injured themselves, and increasing their insurance rates (Table 1). More respondents were concerned about injuring or killing deer than about costs of medical bills resulting from a DVC. These concerns ranked in the same order both among respondents who had been in a DVC and those who had not, with only 1 exception. Respondents who reported having been in a DVC ranked the costs of repairing vehicle damages as their top concern about DVCs. Concerns about losing control of the car while swerving to avoid a deer was ranked third on their list of concerns.

Knowledge about DVCs

Drivers involved in DVCs had higher mean knowledge scores ($\bar{x}$ = 4.03) than those not involved in a DVC ($\bar{x}$ = 3.48, t = 3.56; df = 1, 418; P < 0.001). Respondent groups had different mean knowledge scores (F = 5.01; df = 3, 415; P = 0.002) based on level of involvement in a DVC (driver in DVC, passenger in DVC, both driver and passenger, or no DVC involvement) Respondents who had been involved in a DVC as both a driver and a passenger had the highest mean knowledge score ($\bar{x}$ = 4.11 out of 14), followed by drivers, passengers, and those respondents with no involvement.

There was no difference in knowledge scores between males ($\bar{x}$ = 4.08) and females ($\bar{x}$ = 3.92) who had been involved in a DVC (t = 0.53, df= 175, P = 0.595). Of respondents who had not been involved in DVCs, however, males had greater mean knowledge scores ($\bar{x}$ = 3.74) than females ($\bar{x}$ = 3.30; t = 3.99; df = 1, 228, P < 0.001). Differences in mean knowledge scores existed for those drivers from urban ($\bar{x}$ = 3.50), suburban ($\bar{x}$ = 3.36), and rural ($\bar{x}$ = 3.72) areas who were not involved in a DVC (F = 4.23, df = 2 and df = 1, 345; P = 0.015). Respondents checked "unsure" 19 to 33% of the time on knowledge-based questions; respondents who had been a driver in a DVC checked "unsure" half as often as those not involved in a DVC.

Despite previously stating they were not willing to make changes to their driving habits, 78% of all respondents indicated they were willing to receive information and education materials regarding DVCs. The newspaper was the preferred communication medium (47%), followed in order of preference by brochures (27%), billboard (27%), magazine (14%), television (4%), Internet (3%), and radio (3%).

Reporting rates of DVCs

Fewer than half (46%) of respondents involved in a DVC within 5 years of the questionnaire reported their DVC to police agencies, such as sheriff, highway patrol, or city police, whereas, 52% reported the DVC to their insurance agency. The most commonly cited reason for

not reporting a DVC was that those involved did not think it was necessary, while the second most common reason was that there were no injuries or only slight vehicle damage (Table 2). Some (14%) of those who did not report a DVC to their insurance company also cited concern that insurance rates would be affected, or they believed they did not have the proper insurance coverage (11%).

No statistical relationship was detected between reporting rates and gender, vehicle type, or the type of area (urban, rural, or suburban) where the respondent resided. Drivers who believed their insurance rates would increase if they reported a DVC were less likely to report to their insurance company than were drivers who did not believe rates would increase (14 versus 57%).

When presented with a list of entities that could be potentially responsible for preventing DVCs and allowing for multiple answers, 64% of respondents indicated that drivers were most responsible for preventing DVCs; 53% indicated Michigan Department of Natural Resources; and 34% identified the Office of Highway Safety Planning (OHSP). Yet, 79% of respondents involved in DVCs believed their DVC could not have been prevented. There was no apparent influence of previous DVC involvement on drivers' assignment of responsibility for DVCs.

Driver attitudes toward DVCs and deer population

Deer–vehicle collisions were perceived as a serious problem in Michigan by 81% of respondents. Fifty-one percent of drivers who had been in ≥1 DVC indicated DVCs were a serious problem in Michigan. In comparison, only 33% of those who previously had not experienced one indicated that DVCs were a problem. Nearly 48% of respondents reported a desire to see the deer population in their area remain the same, while 23% wanted a reduction, and only 8% wanted the deer population to increase. Those respondents unsure about their beliefs toward the future size of the deer population represented 21% of the sample. Drivers involved in DVCs, however, more frequently (34%) wanted decreased deer populations in the future than drivers who had not been involved in DVCs (21%).

Discussion

Deer–vehicle collisions are one of the most widespread human–wildlife conflicts in the United States (Conover 2002, Bissonette et al. 2008). Our estimated reporting rate of approximately 50% is consistent with, but greater than, a 42% reporting rate previously estimated by Decker et al. (1990) from a smaller sample size in a smaller geographical area in New York State. If these accounts of reporting rates are indicative of rates elsewhere, the extent of the DVC problem is much greater than previously estimated. For example, in Michigan if a 50% underreporting rate is assumed throughout the state, the annual number of DVCs would be ≥120,000 per year. If this rate were applied nationally, the number of DVCs would greatly exceed 2 million per year.

Efforts to reduce or mitigate DVCs require effective information and education programs

Table 2. Percentage of respondents who did not report a DVC, by reason, to police or insurance agency, Oakland, Washtenaw, and Monroe counties, Michigan, USA.

Reasons for not reporting to police	% (n = 135)	Reasons for not reporting to insurance	% (n = 105)
Thought it was not necessary.	69	Thought it was not necessary.	39
No injuries sustained or no damage done.	15	Little or no damage done.	28
Reporting would take too much time.	7	Would affect insurance rates.	14
Reporting would affect driving record.	2	Didn't have proper insurance coverage.	11
Other.	6	Other.	6
Believed they would be ticketed.	1	Reporting would take too much time.	2

aimed at changing driver behaviors (Stout et al. 1993, West 2008). Previous studies suggested education as a means for reducing DVCs (Allen and McCullough 1976, Groot Bruinderink and Hazebroek 1996, Romin and Bissonette 1996). Our data indicate, however, that communication planners will need to overcome underlying beliefs about DVCs before driver behaviors can be expected to change; the most important of these beliefs is about the perceived randomness of DVCs.

Communication that informs drivers that DVCs are not random events and that enables drivers to recognize environmental and other characteristics factors associated with DVCs may help them identify areas of greater risk and lead to safer driving behavior. Although participants in our study held themselves, as opposed to an agency, responsible for preventing DVCs, most also believed DVCs were unavoidable because they also believed DVCs occurred randomly. That is, drivers believe there was not much that could be done to avoid them. Most research to date within the range of white-tailed deer (e.g., Finder et al. 1999, Hubbard et al. 2000, Nielsen et al. 2003, Sudharsan et al. 2009), however, indicates that DVCs do not occur randomly. Conveying this message may enhance the probability of drivers' behavioral changes, which could lead to fewer DVCs.

Other effective ways to influence behavior involve incentives (Zaza et al. 2001). Our results indicate that respondents who had experienced a DVC were worried most about costs. Communication campaigns that draw attention to the potential cost of car repair and medical bills resulting from involvement in DVCs may be most effective at changing behaviors. Most changes in driver behavior result from drivers' adherence to new laws and enforcement of these laws (Williams 1994). Redmon (2003) found drivers more willing to exhibit safer driving behavior at the threat of receiving a traffic ticket than at the possibility of endangering a human life. When speed limits were decreased from 70 to 55 mph during the early 1980s, the number and severity of reported DVCs decreased (Langenau and Rabe 1987). Enforcement of speed limits may play an important role in reducing the frequency of DVCs (Hedlund et al. 2003) because our data indicate that drivers are unwilling to voluntarily make changes to their driving behavior.

Stout et al. (1993) suggested that past involvement in a DVC or fear of being involved in one might negatively affect attitudes toward state wildlife and transportation agencies, as well as preferences for smaller deer population sizes. Our results and those of Lischka et al. (2008) in a nearby study area substantiate a direct and significant relationship between DVC involvement either as a driver or passenger and a person's preference for reduced deer densities. Moreover, Sullivan and Messmer (2003) reported that state wildlife and transportation agencies each believe that the other agency should be more financially responsible for the management of DVCs. Although we found that drivers believed the Michigan Department of Natural Resources should be the agency most responsible for the management of DVCs, drivers also indicated that they did not know which agency is responsible for management of DVCs. More clearly communicated roles and responsibilities may help build trust and create greater opportunities for education.

Conclusions

The gross under-reporting of DVCs either to insurance or law enforcement agencies suggests that the effects from DVCs are considerably greater—perhaps twice as great—than previously estimated. An impediment to attaining more accurate reporting of DVCs may be the perception that insurance rates will increase if DVCs are reported. A prevailing belief among drivers is that DVCs are random events, which is contrary to results from research and leads to an attitude that not much can be done on the part of drivers to prevent DVCs. Our survey results provide insights about drivers' attitudes, knowledge, and behavior that should be useful in development of programs aimed at promoting awareness of DVCs and influencing driver behavior.

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Literature cited

Allen, R. E., and D. R. McCullough. 1976. Deer–car accidents in southern Michigan. Journal of Wildlife Management 40:317–325.

Babbie, E. 1990. Survey research methods. Second edition. Wadsworth, Belmont, California, USA.

Bissonette, J. A., C. A. Kassar, and L. J. Cook. 2008. Assessment of costs associated with deer–vehicle collisions: human death and injury, vehicle damage, and deer loss. Human–Wildlife Conflicts 2:17–27.

Brown, T. L., D. J. Decker, S. J. Riley, J. W. Enck, T. B. Lauber, P. D. Curtis, and G. F. Mattfeld. 2000. The future of hunting as a mechanism to control white-tailed deer populations. Wildlife Society Bulletin 28:797–807.

Conover, M. R. 2002. Resolving human–wildlife conflicts: the science of wildlife damage management. Lewis, Boca Raton, Florida, USA.

Decker, D. J., K. M. Loconti-Lee, and N. A. Connelly. 1990. Deer-related vehicular accidents in Tompkins County, New York: incidents, costs, and implications for deer management. Transactions Northeast Section Wildlife Society 47:21–26.

Deer Vehicle Crash Information Clearinghouse. 2009. Statewide and upper Midwest summary of deer–vehicle crash and related data from 1993 to 2003. Minneapolis, Minnesota, USA, <http://www.deercrash.com>. Accessed August 21, 2009.

Dillman, D. A. 2000. Mail and Internet surveys: the tailored design method. Wiley, New York, New York, USA.

Evans, L. 1996. Comment: the dominant role of driver behavior in traffic safety. American Journal of Public Health 86:784–786.

Finder, R. A., J. L. Roseberry, and A. Woolf. 1999. Site and landscape conditions at white-tailed deer/vehicle collision locations in Illinois. Landscape and Urban Planning 44:77–85.

Forman, R. T., D. Spearling, J. A. Bissonette, A. P. Clevenger, C. D. Cutshall, V. H. Dale, L. Fahrig, R. France, C. R. Goldman, K. Heanue, J. A. Jones, F. J. Swanson, T. Turrentine, and T. C. Winter. 2003. Road ecology science and solution. Island Press, Washington, D.C., USA.

Groot Bruinderink, G. W. T. A., and E. Hazebroek. 1996. Ungulate traffic collisions in Europe. Conservation Biology 10:1059–1067.

Hedlund, J. H., P. D. Curtis, G. Curtis, and A. F. Williams. 2003. Methods to reduce traffic crashes involving deer: what works and what does not. Insurance Institute for Highway Safety. Arlington, Virginia, USA.

Hubbard, M. W., B. J. Danielson, and R. A. Schmitz. 2000. Factors influencing the location of deer–vehicle accidents in Iowa. Journal of Wildlife Management 64:707−713.

Langenau, E. E., and M. L. Rabe. 1987. Deer–vehicle accidents in Michigan: a task force report. Michigan Department of Natural Resources Wildlife Division Report 3072, Lansing, Michigan, USA.

Lischka, S. A., S. J. Riley, and B. A. Rudolph. 2008. Factors affecting acceptance capacity for white-tailed deer among residents of southern Michigan. Journal of Wildlife Management 72:502–509.

Marcoux, A. 2005. Deer–vehicle collisions: an understanding of accident characteristics and drivers' attitudes, awareness, and involvement. Thesis, Michigan State University, East Lansing, Michigan, USA.

Marcoux, A., G. J. Hickling, S. J. Riley, and S. R. Winterstein. 2005. Situational and driver characteristics associated with deer–vehicle collisions in southeastern Michigan. Proceedings of the Wildlife Damage Management Conference 11:246–255.

Mastro, L. L., M. R. Conover, and S. N. Frey. 2008. Deer–vehicle collision prevention techniques. Human–Wildlife Conflicts 2:80–92.

Messmer, T. A., M. W. Brunson, D. Reiter, and D. G. Hewitt. 1999. United States public attitudes regarding predators and their management to enhance avian recruitment. Wildlife Society Bulletin 27:75–85.

Nielsen, C. K., R. G. Anderson, and M. D. Grund. 2003. Landscape influences on deer–vehicle accident areas in an urban environment. Journal of Wildlife Management 67:46−51.

Redmon, T. 2003. Assessing the attitudes and behaviors of pedestrians and drivers in traffic situations. Institute of Transportation Engineers Journal 73:26–30.

Riley, S. J., D. J. Decker, J. W. Enck, P. D. Curtis,

T. B. Lauber, and T. L. Brown. 2003. Deer populations up, hunter populations down: implications of interdependence of deer and hunter population dynamics on management. Ecoscience 10:356–362.

Romin, L. A., and J. A. Bissonette. 1996. Deer–vehicle collisions: status of state monitoring activities and mitigation efforts. Wildlife Society Bulletin 24:276–283.

Salant, P., and D. A. Dillman. 1994. How to conduct your own survey: leading professionals give you proven techniques for getting reliable results. Wiley, New York, New York, USA.

Schwabe, K. A., P. W. Schuhmann, and M. Tonkovich. 2002. A dynamic exercise in reducing deer–vehicle collisions: management through vehicle mitigation techniques and hunting. Journal of Agricultural and Resources Economics 27:261–280.

Stout, R. J., R. C. Stedman, D. J. Decker, and B. A. Knuth. 1993. Perceptions of risk from deer-related vehicle accidents: implication for public preferences for deer herd size. Wildlife Society Bulletin 21:237–249.

Sudharsan, K. 2005. Environmental factors affecting the frequency and rate of deer–vehicle crashes (DVCs) in southern Michigan. Thesis, Michigan State University, East Lansing, Michigan, USA.

Sudharsan, K., S. J. Riley, and H. Campa III. 2009. Relative risks of deer–vehicle collisions along road types in southeast Michigan. Human Dimensions of Wildlife 14:1–12.

Sudharsan, K., S. J. Riley, B. A. Rudolph, and B. A. Maurer. 2005. Deer–vehicle crash patterns across ecoregions in Michigan. Proceedings of the Wildlife Damage Management Conference 11:246–255.

Sudharsan, K, S. J. Riley, and S. Winterstein. 2006. Relationship of fall hunting season to the frequency of deer–vehicle collisions in Michigan. Journal of Wildlife Management 70:1161–1164.

Sullivan, T. L., and T. A. Messmer. 2003. Perceptions of deer–vehicle collision management by state wildlife agency and transportation administrators. Wildlife Society Bulletin 31:163–173.

Walter, W. D., K. C. VerCauteren, H. Campa III, W. R. Clark, J. W. Fischer, S. E. Hygnstrom, N. E. Mathews, C. K. Nielsen, E. M. Schauber, T. R. Van Deelen, and S. R. Winterstein. 2009. Regional assessment on influence of landscape configuration and connectivity on range size of white-tailed deer. Landscape Ecology 24:1405–1420.

West, B. C. 2008. Echinacea and deer whistles: science and trust in the wildlife arena. Human–Wildlife Conflicts 2:7–8.

Williams, A. F. 1994. The contribution of education and public information to reducing alcohol-impaired driving. Alcohol, Drugs, and Driving 10:197–205.

Zaza, S. D., D. A. Sleet, R. S. Thompson, D. M. Sosin, and J. C. Bolen. 2001. Reviews of evidence regarding interventions to increase use of child safety seats. American Journal of Preventive Medicine 21:31–47.

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