Results of recent deer-vehicle crash information clearinghouse activities

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RESULTS OF RECENT DEER-VEHICLE CRASH INFORMATION CLEARINGHOUSE ACTIVITIES

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Abstract: Deer-vehicle crashes (DVCs) are a significant problem in many areas of the United States. Approximately two years ago the Wisconsin Department of Transportation (WisDOT) funded a regional deer-vehicle crash information clearinghouse (DVCIC). Representatives from the DOT and the Department of Natural Resources (DNR) of five states in the Upper Midwest (i.e., Michigan, Minnesota, Illinois, Iowa, and Wisconsin) are involved with the clearinghouse project.

During the last two years, clearinghouse staff have worked on several tasks related to DVCs. This paper briefly summarizes the current status of the key results from these ongoing tasks. First, a DVC countermeasure toolbox document is nearing completion. The primary objective of the toolbox is to provide a resource with enough detail that can assist professionals with their decisions related to the mitigation of DVCs. Published research, if available, for a number of DVC countermeasures is summarized in the toolbox document. Draft versions of five countermeasure summaries (two ongoing) are described here and the remainder are located on the clearinghouse webpage: www.deercrash.com. Second, DNR and DOT representatives from the region were interviewed about their collection and estimation methods related to vehicle travel, reported DVCs, and deer population data. The objective of this survey was to determine and define the similarities and differences of these databases. The results will impact the usefulness of any regional data summaries that are completed. A short summary of some key preliminary results from that survey is included. Third, two graduate students that worked for the clearinghouse recently completed their master's degree theses. The results of their work are currently being finalized and summarized, and their general conclusions are briefly summarized in this paper. The subject areas of their work included the development of prediction model(s) for DVCs in Wisconsin counties, and the analysis of DVC patterns in the vicinity of existing deer crossing signs. The latter project also included some suggested guidance for the placement of deer crossing signs. Other ongoing tasks of the clearinghouse staff include the development of a document summarizing gaps in DVC countermeasure research and some suggested criteria or standards for DVC crash reduction research. The creation of a deer, vehicle, and DVC data summary for the five-state region is also ongoing.

The objective of the DVC information clearinghouse and its activities is to provide information about DVCs that help better describe the problem. The DVCIC also assists professionals in their DVC mitigation decisions.

Introduction

It has been estimated that over 1.5 million deer-vehicle crashes (DVCs) occur each year in the United States, but less than half of them are reported (1). In Wisconsin, approximately one in seven reported crashes are DVCs. A summary of the reported DVC and/or animal-vehicle crashes for the Upper Midwest region is show in table 1.

In July 2001, the Wisconsin Department of Transportation (WisDOT) initiated a regional DVC Information Clearinghouse (DVCIC). Five states in the Upper Midwest (i.e., Michigan, Minnesota, Illinois, Iowa, and Wisconsin) are involved with this project. During the last two years the clearinghouse staff have been involved with three projects. First, the DVCIC staff have combed through hundreds of documents that summarize the current state of the knowledge related to DVC countermeasure effectiveness. The result of these activities has been the ongoing creation of a DVC Countermeasures Toolbox. The activity is ongoing and should be finalized this year. Second, a regional database management telephone survey has been completed, and the preliminary results are available. This survey asked DNR and DOT representatives about their collection and estimation methods of data related to DVCs (e.g., crash reports, carcass pick-up, deer population estimates, etc.). Third, two graduate students recently finished their master's theses. The subjects of this work included DVC patterns in the vicinity of existing deer crossing warning signs, and the development of county DVC prediction models. Some of the key results from all three of these activities will be briefly summarized here. More detailed discussions are either already available at www.deercrash.com in draft form, or this information will be published (or on the webpage) soon. The future activities of the DVCIC are presented at the end of this paper.

THE DVC Countermeasure Toolbox

The development of a DVC countermeasures toolbox is an ongoing task. The objective of the toolbox is to provide information to decision-makers about the current state of the knowledge related to the effectiveness of DVC reduction measures. The focus of the toolbox is to summarize documented and peer-reviewed published research, if available, about the relationship between 16 DVC countermeasures and what we know about their direct DVC impact. The current state-of-the-knowledge about the characteristics of each measure is identified, if relevant, and the countermeasure objectives described. The validity and transferability of the DVC countermeasure research is also investigated. However, documentation about the "effectiveness" of the DVC countermeasures also ranges from the anecdotal to some peer-reviewed research journal publications. DVC countermeasure studies that are poorly documented, questionably designed, and/or invalid or unrepeatable in their statistical validity are common. This situation is most likely the result of the variability, diversity, and complexity of the problem.

Table 1.
Upper Midwest Deer-Vehicle Crashes – Year 2000/01

State	Pre-Hunt Numbers in Deer Herd	Deer-Vehicle Crashes	Deaths	Injuries	Vehicle Damage**
Michigan	1,800,000	67,000	11	2,100	$114 mil
Wisconsin	1,500,000	19,900	9	800	$34 mil
Minnesota*	960,000	19,000	2	450	$32 mil
Illinois	750,000 (est.)	22,900	5	920	$39 mil
Iowa*	210,000	7,800	3	600	$13 mil
Total	5,220,000	136,600	30	4,870	$232 mil

**2000 Reported deer-vehicle or animal-vehicle crashes.*

***Damage estimate assumes $1,700 property damage per reported crash.*

The toolbox will attempt to summarize the current state of the knowledge about the DVC-reduction capabilities of the 16 countermeasures listed below. Those countermeasures in the list that are in italics are currently being summarized. The remainder of the summaries is in draft form. The objective is to have the entire toolbox finalized very soon. The reader is referred to the webpage (www.deercrash.com) for these draft summaries, and a complete listing of the references used.

- Noise/sound/whistle devices
- Roadside reflectors/mirrors
- Deer crossing signs
- Intercept feeding
- Speed limit reduction
- Highway lighting
- Repellents
- Deer flagging models
- Deicing salt alternatives
- In-vehicle technologies
- Wildlife grade separations and crossings
- Vegetation/roadside management
- Hunting or herd management
- Fences/barriers
- Highway planning
- Public education/awareness

The following paragraphs describe some of the toolbox findings related to five of the countermeasures listed. These five countermeasures include roadside reflectors/mirrors (draft form), deer crossing signs (draft form), speed limit reduction (draft form), fencing/barriers (ongoing), and wildlife grade separations and crossings (ongoing). The summaries for the first three countermeasures have been completed and are in draft form (see www.deercrash.com), but the last two are currently ongoing and only general findings are currently documented. A complete list of the references used in each summary is also at that web address.

Roadside Reflectors/Mirrors

The roadside reflector/mirror studies and literature reviewed for the toolbox were segmented into four categories. Past reflector/mirror research typically used a cover/uncover, before-and-after, or a control/treatment study approach to evaluate their impact. Researchers have also either observed deer movements as they evaluated the impact of roadside reflectors/mirrors on deer roadkill and/or DVCs or specifically considered deer behavior toward reflected light. Many of the studies summarized (which represent a sample of the many documents available), whether they focused on deer roadkill and DVC impacts or deer behavior, had conflicting results. Overall, five of the 10 studies summarized for the toolbox had conclusions that indicated roadside reflectors did not appear to impact deer roadkill or DVCs, and two of the 10 concluded that they did. Three of the 10 studies summarized appeared to reach inconclusive or mixed results. Most of the studies that evaluated deer behavior (many dealing with captive deer) were also inconclusive or concluded that the deer either did not appear to react to the light from the reflectors and/or quickly became habituated to the light. The experimental designs and details of all the studies evaluated did vary. The large amount of speculative and anecdotal information about roadside reflector/mirror DVC-reduction effectiveness is not included in the summary.

At this point in time it is difficult to conclude the roadkill- or DVC-reduction effectiveness of roadside reflector/mirror devices due to the conflicting results of the studies summarized. It is recommended that the completion of a definitive roadside reflector/mirror DVC-reduction effectiveness study be considered. A well-designed widespread, long-term statistically valid study of comparable and well-defined maintained roadside reflector treatment and control roadway segments (with consideration given to local deer travel patterns) is suggested.

Deer Crossing Signs

Two studies were summarized that implied there were speed reduction impacts related to the lighted deer crossing sign design improvements they were evaluating. However, the outcome of a more in-depth study by some of the same researchers of lighted and animated deer crossing signs did not appear to indicate that the resultant vehicle speed reduction resulted in a reduction of the number of deer roadkill. Unfortunately, these study results are based on only 15 weeks of data, and the variability in DVCs and the factors that impact their occurrence also limit their validity and transferability. It is proposed that additional and more long-term research be completed to support or refute the speed- and DVC-reduction impacts of existing and proposed improvements to deer crossing warning signs. The attention value of typical deer crossing signs is currently the focus of a study in Minnesota.

A number of systems that combine dynamic signs and sensors are also being considered or have been installed (e.g., Montana, Indiana, Minnesota, and Wyoming). Several of these systems are briefly described in draft toolbox at www.deercrash.com. The recent development of these systems requires an initial evaluation of their activation reliability. One key to the successful application of these systems is the minimization of false activations. The operation and effectiveness of some of the systems described in the draft toolbox are currently being studied, but only the Nugget Canyon, Wyoming system analysis appears to have been documented at this time. The researchers doing the evaluation concluded that when the system worked properly it produced a small, but statistically significant, reduction in average vehicle speeds. However, they did not believe the observed average vehicle speed reduction would reduce DVCs. Reductions in average vehicle speeds were also found when the lights on the signs were continuously flashed and/or a deer decoy was introduced on the roadside. In fact, the largest average vehicle speed reduction calculated was when the lights were flashing and the deer decoy was present. Another benefit of these types of systems is that the drivers become more attentive to the roadside, and this may lead to reductions in DVCs without an apparent reduction in average speed. At least one paper in this compendium also summarizes several European studies that did show some vehicle reduction, and may be included in the final draft of the toolbox.

Speed Limit Reduction

Two studies that evaluated speed limit reduction as a potential DVC countermeasure were reviewed for the toolbox. In both cases the researchers suggested that there was a relationship between animal-vehicle collisions and posted speed limits. In certain instances, but not all, their research results appear to show a less-than-expected number of animal-vehicle collisions along roadway segments with lower posted speed limits. To reach this conclusion, one study statistically compared the proportion of roadway mileage with a particular posted speed limit to the proportion of animals killed along those segments. The other study compared the frequency and rate per roadway length of animal-vehicle collisions before and after a posted speed limit change. No studies were found that focused on the number of white-tailed DVCs and posted speed limit.

There are several limitations to the posted speed limit reduction research that has been completed. Overall, like the analysis of many other animal-vehicle crash countermeasures, the two studies summarized do not address (or document), and/or attempt to control for, a number of factors that could impact the validity and usefulness of their conclusions. For example, neither study quantitatively considered the increase in traffic volume or adjacent animal population variability along the segments considered. A comparison of the proportion of animal-vehicle collisions to a proportion of particular roadway mileage also assumes a uniform distribution of animal population, and tends to ignore any positive or negative correlations that might exist between roadway design, topography, posted speed limit, operating speed, and animal habitat. Effectively determining and defining a relationship (if any) between reduced posted speed limits (or operating speeds) and the number of animal-vehicle collisions along a roadway segment will require additional research studies that attempt to address, control for, and/or quantify the impact and potential interaction of these and other factors.

One of the studies summarized also concluded that the choice of vehicle operating speed appeared to be primarily impacted by roadway and roadside design features (versus posted speed limit). This is a conclusion that is generally accepted in the transportation profession, and primarily supports the fact that a reduction in posted speed limit that is not considered reasonable by the driving public will generally be ignored (without significant enforcement presence). This type of situation has been shown to increase the general possibility of a crash (not DVCs) between two vehicles along a roadway because some drivers will slow and others will not.

Ongoing Reviews – Fencing/Barriers and Wildlife Grade Separations and Crossings

A preliminary scan of several documents related to wildlife grade separations/crossings and fencing/barriers has been completed. The final draft summary of these documents, along with findings and conclusions, will be released soon. The preliminary document scan reveals that these two measures have been widely implemented, and appear to have been studied to a greater extent than some of the other countermeasures in the toolbox. In addition, these two countermeasures are also commonly and appropriately implemented together. For this reason, determining the DVC-reduction effectiveness of one or the other may be difficult.

The effectiveness of wildlife separations/crossings is often measured by whether or not the device is used by the animals for which it is built. Not all of the animals that use a wildlife crossing, however, would result in a DVC. The change in DVCs that results from the implementation of a crossing is of interest. Some of the key decisions that need to be made with respect to wildlife grade separations and crossings include the location, height, width, and length of the measure. These characteristics also have an impact on the DVC reduction and/or use of a wildlife grade separation or crossing. There have been some general design suggestions or rules for some of these characteristics.

Studies that focus on the effectiveness of different deer fencing heights have also been documented. It appears, however, that these studies have had some inclusive or conflicting results. The key decision and considerations related to fencing include its location, height, length, and necessary maintenance. In some cases, the studies that have been completed have apparently produced inclusive study results because of researcher decisions related to these characteristics. For example, the study of fencing that is not maintained during the research project time period may invalidate the data collected. How fencing impacts animal migration and relates to the surrounding topography and roadway grade separations are also important to its effectiveness. Several studies of fencing effectiveness at removing animals from an area have also focused on the protection of valuable crops. The transferability of these types of results to the roadside needs to be investigated. In general, a fencing height of 8 to 10 feet is often suggested, but documentation about what percentage of white-tailed deer may be removed from a right-of-way (or the DVC-reduction effectiveness) due to different fencing heights may not exist.

Ongoing Data Management Survey

DNR and DOT representatives from the five states involved with the DVCIC were interviewed about their collection and estimation methods related to vehicle travel, reported DVCs, and deer carcass and population data. It is important to know this information in order to define the extent of the DVC problem in the region. Secondary questions about DVC-related activities, countermeasure implementation, DNR/DOT interaction, and crossing sign locations were also asked. Overall, 27 questions were submitted and the answers are currently being summarized. The general objective of the survey was to determine and define the similarities, differences, and usefulness of the existing databases. The methods used to collect and estimate these data will be shared, and a knowledge of how the data are defined will allow them to be more properly compared and combined both within and between different states, and from year to year. The combination or comparison of data from different systems that may not define the data in a similar manner can be invalid or will require additional explanation.

Some preliminary results from survey include the following. Annual deer populations are estimated in each of the five states, and they are either pre- or post-hunt. Some of these estimates are done by county, and others are done by deer management unit. The procedure used by Wisconsin to do its estimate is very well documented. It appears that DNR personnel are rarely consulted about animal-vehicle conflicts during the planning of roadways, or during the selection of locations for deer crossing signs. Wisconsin appears to be the only state in the region that contracts and records the number of deer carcass collections in each of its counties. In the other four states, carcass collection is primarily a state or local DOT activity, and the number and location of the carcasses collected are not typically recorded. DNR involvement with DVCs is often regulated to salvage tag or permit administration. The reported number of DVCs in a state can sometimes include both officer- and self-reported incidents. Finally, the minimum crash-reporting threshold for the five states varies from $400 to $1,000, and most states have changed this threshold in the last 10 years. The daily vehicle volume along each roadway is estimated every one to three years in each state.

Recently Completed and Ongoing Research Work

In May 2003 two University of Wisconsin graduate students completed their master's thesis work. These projects included an analysis of DVC patterns near existing deer crossing signs, and the development of Wisconsin county DVC prediction models. A summary of the approach used in the first study is presented below. A paper that describes the results of this study is currently being considered for publication. The results from the second project are being updated and finalized. Only some preliminary conclusions are presented here.

The DVC patterns near typical deer crossing signs have never been systematically considered. However, a typical assumption by drivers is that these signs represent roadway segments that have higher than the typical number of DVCs and/or deer crossings. The official guidance for the installation of deer crossing signs is mostly qualitative, and indicates they should be installed where animal crossings are unexpected. Past studies of deer crossing signs have generally focused on their enhancement and assumed that they are correctly located, but ineffective at DVC reduction. The proper installation of these signs at locations with a DVC problem would be more consistent, use limited resources more efficiently, and maximize whatever potential impact these signs might have on drivers. A research project completed by DVCIC staff investigated DVC patterns near 38 pairs of deer crossing sign pairs in five Wisconsin counties. Three years of reported DVCs were collected and summarized for the roadway segments between and within two miles of these pairs. Overall, one-quarter-mile and average segment DVC frequencies and rates were calculated between and outside each sign pair, and compared with each other and the county and state averages. Overall, the DVCs per mile and DVC rate (per volume) between the signs were found to be statistically greater than these measures outside the signs. Fourteen of the 38 sign pairs were also further evaluated because their average and peak DVC measures were all located between the signs. The findings of this research were used to develop a general set of installation guidelines for deer crossing signs.

The ability to estimate the number of DVCs expected to occur within a jurisdiction could be used to alter those activities or physical characteristics that may result in a DVC reduction. At least two or three county-level DVC models have been developed in the past. The dependent variable for these models has often been DVC density in crashes per square mile. Typical measures used in roadway safety research include frequency in crashes per year and rate in crashes per a measure of vehicle travel. A research project completed by DVCIC staff attempted to develop three Wisconsin county DVC models. The dependent variables for these three models were crash density, frequency, and rate. First, 12 of the 72 counties in Wisconsin were removed from consideration due to a lack of data or concerns about its validity. The relationships between and among variables related to deer and human populations, vehicle travel, roadway mileage, land use types and acreages (e.g., woodland, farmland, etc.), snow depth, and several other county characteristics were also evaluated. Several combinations and transformations of these variables were also investigated. Variables related to the level of deer and vehicle travel in a county were included in at least two of the three models. The DVC prediction model with the best fit used DVC frequency (i.e., DVCs per year) as its dependent variable. The results of this study are currently being finalized for potential submission and publication.

Future DVCIC Activities

The objective of the DVC information clearinghouse and its activities is to provide useful information about DVCs and some potential countermeasures to professionals and the general public. The long-term goal of the DVCIC is to help decrease the number of DVCs in the United States. The countermeasure toolbox, database management survey, and research activities described in this paper are the ongoing first steps towards the DVCIC objective and goal. In the near future, DVCIC staff will be finalizing, distributing, and transferring the content of the DVC countermeasures toolbox, the database management survey results, and the research results. Other ongoing tasks at the clearinghouse include the development of a document that summarizes the gaps in DVC countermeasure research and also suggests some criteria and/or standards for DVC crash reduction research. The creation of a deer, vehicle, and DVC data summary for the five state region will also be a product of the DVCIC.

Disclaimer: The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the data presented herein. The contents do not reflect those of the Wisconsin Department of Transportation or the Federal Highway Administration.

Biographical Sketch: Dr. Knapp is an assistant professor/program director in the Engineering Professional Development Department and the Civil and Environmental Engineering Department at the UW-Madison. He is also the director of the Upper Midwest Deer-Vehicle Crash Information Clearinghouse. He has over 12 years of experience in the areas of transportation consulting and research. The majority of his experience is in the analysis of traffic operations and safety, roadway design, and traffic control. His primary areas of research are the safety and mobility impacts of roadway system characteristics. Immediately prior to joining the University of Wisconsin, Dr. Knapp was an assistant professor at Iowa State University, and manager of Traffic and Safety Programs at the Center for Transportation Research and Education. He is currently a licensed professional engineer in Illinois, Michigan, and Iowa.

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