Normandeau Associates, Inc. *Methods To Identify And Prioritize Deer Vehicle Crash Locations – Final Report*. Federal Highway Administration, U.S. Department of Transportation, Washington, D.C., June 2011.

This project was completed to investigate the methods and practices used to identify and prioritize deer-vehicle crash (DVC) "hotspot" locations. DVC "hotspots" are locations "…where more DVCs occur than are expected by chance." The effective identification and prioritization of DVC "hotspots" can help State Departments of Transportation (DOTs) more efficiently implement DVC countermeasures.

The project objectives were to review methods, data sources, and the current state of practice with respect to DVC-related crash analysis; summarize existing and potential methods for the identification and prioritization of DVC "hotspots"; and, conduct case studies applications to evaluate a subset of analysis methodologies. The project included three main tasks to accomplish these objectives. The first task was a comprehensive literature review that focused on methods to identify DVC "hotspots". Factors related to DVC locations and results of the methods used to define these relationships were also included in the literature review. The second task was a survey of 24 State DOTs that generally investigated the crash analysis methods they used and DVC-related data they collected. The last task was an evaluation of a subset of the analysis methodologies available for the identification and prioritization of DVC "hotspots." This task was completed through the application of these methodologies using data from several case study roadway segments. The advantages and disadvantages of the methods evaluated are provided along with recommendations about their use. The report referenced above emphasized the results of this last task, but the output from the first and second tasks are also included as appendices. This final report also included a discussion of two methodologies that were documented as being specifically developed to predict potential animal-vehicle collision "hotspots". It should be noted, however, that the researchers acknowledged that all or most of the modeling approaches described in the report could be used to accomplish this prediction task (they just found no documentation of them being used in this manner).

The research team reviewed a wide range of literature. Appendix A is the summary of the literature review results (which was completed in February 2010). The studies considered generally focused on highway safety and DVC-related road ecology. The majority of the literature reviewed and cited were from peer-reviewed ecological journals, some were from the National Cooperative Highway Research Program (NCHRP), and a few were federal or state reports. The literature review results were divided into three general methods of DVC "hotspot" identification. These methods included non-quantitative, traditional statistics, and spatial statistics approaches. Non-quantitative methods (e.g., expert analysis and visual analysis) and traditional statistics (e.g., density measures such as crash rate, crashes per mile, etc.) are currently used by DOTs. It was noted, however, that the typical application of density measures to identify crash "hotspots" was generally based on an assumption of a normally distributed dataset and this was not mathematically correct for crash data (*1*). Similarly, the researchers indicated that ecologists use various methods to study deer-vehicle and/or deer-highway interactions, but they also are not generally "statistically rigorous or mathematically appropriate." Overall, it was concluded by the research team, from their literature review, that not enough guidance has been provided to assist DOT safety personnel and ecologists in this area of analysis (e.g., choosing the most appropriate study area size or “hotspot” thresholds). In addition, no conclusion was made, based on the literature review, about a “best practice” because it was noted that this selection depended upon the safety issues faced by DOTs, the limitations and bias in the data, and a number of other factors.

As part of literature review the research team did summarize the factors that 16 ecological studies determined were associated with DVC locations. These studies used several quantitative methods to define these potential relationships and a variety of data sources and analysis approaches were used. Overall, however, the research team concluded that logistic regression was the most commonly used technique. The variables identified in the 16 studies considered, and their general relationship with DVC locations, were also summarized in the research report. The variables were divided into land use (e.g., amount of crop land), habitat (e.g., amount/contrast of habitat edges), topography (e.g., number of drainages/bridges), roadway (e.g., pavement width), and traffic (e.g., volume). The weaknesses in most of the modeling approaches used by ecologists (and safety personnel) in the past, however, are noted in the previous paragraph. In addition, the reviewers of this project document (and past studies of this nature) caution the reader that the approaches used for these models, the robustness of the statistical approach and application, and the interpretation of the actual “significance” or “size” of a potential “relationship” between these factors and DVC locations is highly variable. The meaning of any regression-based relationship always need to be considered in the context of the application details. The summary table in the report, for example, shows that some of the same characteristics potentially are shown to have a positive and a negative “relationship” with DVC data in different studies.

In addition to summarizing the literature that focused on regression analysis the research team also identified two documents that specifically described DVC “hotspot” prediction models (*2, 3*). One method used a Geographical Information System (GIS)-based statistical distance model and the other an expert-based model (*2*, *3*). The statistical distance model was developed to predict bobcat roadkill locations and required roadside landscape data (*2*). The researchers that developed the model concluded that the value of the results from this method was highly dependent upon the quality of the data. However, the research team for the pooled fund project also appeared to conclude that the approach might be useful for the prediction of DVC “hotspots” because landscape data are usually readily available. Efforts would, however, need to be made to ensure the right dataset are used to produce more accurate predictive estimates. The expert-based model required input from experts familiar with the studied species (*3*). The expert input on factors that impact crashes would then be combined with the application of GIS software to create crash location estimates.

The research team also conducted a survey of 24 states through a phone interview process. The objective of the survey was to investigate current practice for DVC “hotspot” analysis. The results showed that 16 of the 24 states conducted DVC “hotspot” analysis, but that the methods used varied significantly. Non-quantitative methods, like visual analysis, appeared to be the most common approach. In addition, many of the states in western United States used a visual analysis approach that was combined with statewide wildlife and habitat linkage maps developed by State DOTs in cooperation with natural resource agencies and/or non-governmental environmental organizations. In these states, the DVC "hotspot" analysis were often conducted by the environmental branch of a DOT or the State Fish and Wildlife Department. Eight of the surveyed states, however, had DVC "hotspot" analysis programs within the safety office of their DOT. It was found that safety personnel DOTs typically used visual analysis and traditional statistics for their evaluations and that the data they used was typically from their general reported crash database. Seven of the surveyed states did no DVC hotspot identification analysis. It was noted that these states generally considered DVCs to be a random event, but that none of them had tested this assumption. The research team also noted that none of the 24 states had evaluated the effectiveness of their DVC "hotspot" identification methods. All of the surveyed states considered DVCs to be a significant safety issue.

The research team also evaluated and documented their investigation of six DVC "hotspot" identification and prioritization methods. The six methods investigated were identified from the literature review and survey. They included approaches that were non-quantitative (i.e., expert opinion and visual analysis), traditional statistics (i.e., density measures and models), and spatial statistics (i.e., point pattern and cluster analysis). The methods were described in detail within the report and the research team used data from the same case study segments to apply all six methods. The data used were collected along Interstate 35 and United States Route 65 in Iowa, and Interstate 90 and United States Route 28 in New York. The data each method needed, software used, and the strengths and weaknesses of each methodology was summarized in the report. Their results and advantages and disadvantages were also compared. In general, the results of the six methods at each case study location were not always consistent.

Based on their case study evaluation the research team provided recommendations related to the selection of methods to identify and prioritize DVC "hotspots" locations. They noted that their case study comparison did not allow the recommendation of one "best" approach. However, they did recommend the use of model-based and spatial statistic methods to increase the confidence in DVC "hotspot" identification. The model-based approaches were recommended because they can be designed to work appropriately with non-normal data and define "hotspot" thresholds. However, their disadvantage was that they might be too complex for practitioners. Spatial analyses were recommended because the software and/or tools are defined specifically to identify spatial relationships. However, most of the software used is designed for area analysis rather than linear (i.e., roadway) analysis. Also, spatial analysis requires user-specified inputs and this might lead to modeling errors. The research team suggested that any method that was selected should match the goal of analysis being completed and recommended that multiple methods (or the same method with multiple inputs) be applied and their results compared. More confidence can be placed on "hotspot" locations that that are identified by more than one method. Overall, the project team also recommended that the identification of DVC "hotspots" be more widely considered when roadway projects are planned and designed.

REFERENCEs

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