Title

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Abstract: Animal-vehicle collisions affect human safety, property and wildlife, and the number of animal-vehicle collisions has substantially increased across much of North America over the last decades. Systematically collected animal-vehicle collision data help estimate the magnitude of the problem and help record potential changes in animal-vehicle collisions over time. Such data also allow for the identification and prioritization of locations that may require mitigation. Furthermore, systematically collected animal-vehicle collision data allow for the evaluation of the effectiveness of mitigation measures in reducing the number of animal-vehicle collisions. In the United States and Canada, animal-vehicle collision data are typically collected and managed by transportation agencies, law enforcement agencies and/or natural resource management agencies. These activities result in two types of data: data from accident reports (AR data) and data based on animal carcass counts (AC data). Here we report on a survey that examined the extent to which AR and AC data are collected across the United States and Canada. While a substantial percentage of the DOTs and DNRs collect and manage AR and/or AC data, many of them do not. Furthermore, DOTs and DNRs that do collect or manage AR or AC data typically do this for different or only partly overlapping reasons. In addition, DOTs and DNRs use different reporting thresholds, have varying search and reporting effort, and only have partial overlap in the parameters recorded. These differences also occur between DOTs and between DNRs, and oftentimes one and the same organization collects inconsistent data as certain parameters may only be recorded 'sometimes'. These differences and inconsistencies affect the comparability and ultimately the usefulness of the data. Before an AR or AC program is initiated or improved, it is important to illustrate the needs and benefits of such data collection. We list the most important needs and benefits and provide considerations for the initiation or improvement of AR and AC data collection programs.

Introduction

Animal-vehicle collisions affect human safety, property and wildlife, and the number of animal-vehicle collisions has substantially increased across much of North America over the last decades (Hughes et al., 1996; Romin & Bissonette, 1996; Khattak, 2003; Tardif & Associates Inc., 2003; Knapp et al., 2004; Williams and Wells, 2005; Huijser et al., in prep. a). Systematically collected animal-vehicle collision data help estimate the magnitude of the problem and help record potential changes in animal-vehicle collisions over time. Such data also allow for the identification and prioritization of locations that may require mitigation. Furthermore, systematically collected animal-vehicle collision data allow for the evaluation of the effectiveness of mitigation measures in reducing the number of animal-vehicle collisions.

In the United States and Canada, animal-vehicle collision data are typically collected and managed by transportation agencies, law enforcement agencies and/or natural resource management agencies. These activities result in two types of data: data from accident reports (AR data) and data based on animal carcass counts (AC data). However, not all transportation agencies, law enforcement agencies and/or natural resource management agencies record animal-vehicle collisions. Furthermore, the agencies that do record such data often use different methods, causing difficulties with data integration and interpretation, and ultimately with the usefulness of the data.

Here we report on a survey that examined the extent to which AR and AC data are collected across the United States and Canada. This paper is a subset and a summary of a full report (see Huijser et al., in prep. b).

Methods

We sent a survey to the transportation agency (DOT) and natural resource management agency (DNR) in each state (n=50) or province (n=13) of the United States and Canada. The survey questions covered a wide range of topics related to AR and AC data, starting with if and why the DOTs or DNRs collect these data. Other key sections of the survey focused on the parameters recorded and potential reporting thresholds.

We approached at least two key persons for each state or province: a representative of the DOT (with a focus on public safety) and a representative of the DNR (with a focus on natural resource conservation). The survey was posted on a website and the interviewees were encouraged to fill out the survey on this website. The survey was also available in MS Word and PDF format which could be sent in by e-mail, fax or mail. The survey was sent to the interviewees on 6 March 2006 and the survey ended on 5 April 2006.

If there was more than one respondent for an individual DOT or DNR the answers for these respondents were combined into one response. This resulted in a maximum of two responses for each state or province; one for a DOT and one for a DNR. The responses were summarized through calculating the percentage of respondents that selected the different options or categories for their responses. The percentages were calculated as the number of responses in each category divided by the total number of respondents to that question. Furthermore, several questions permitted multiple responses, in which case the sum of the percentages in the categories could add up to more than 100%.

In addition to the survey, the crash forms posted on the website for the National Center for Statistics and Analysis of the National Highway Traffic Safety Administration (NHTSA, 2006) for all 50 states were reviewed with regard to the type of information recorded for animal-vehicle collisions (AR data). The data for the 50 states (NHTSA, 2006) were supplemented with accident report forms from two provinces (British Columbia and Northwest Territories), and the four responses from other Canadian provinces (Alberta, Manitoba, Newfoundland and Nova Scotia) to the survey.

Results

Response Rate

For DOTs and DNRs combined the response rate to the survey was 88.9% (56 out of 63 states and provinces). DOTs (63%) had a slightly higher response rate than DNRs (57%). However, not all respondents answered all questions.

AR Data

According to the survey, most of the responding DOTs (65%) and some DNRs (36%) collect AR data. However, a review of the crash forms showed that 49 out of 50 states (98%) and all of the provinces (100%) that sent in their crash forms allow for the recording of animal-vehicle collisions on their crash forms in one way or the other. Multiple organizations collect AR data, but according to the combined responses of DOTs and DNRs this type of data is typically collected by Highway Patrol or other law enforcement agencies (44%). Others who were reported to collect AR data include DOTs (23%), DNRs (19%), and local contractors and the public (11%).

Based on the survey, DOTs indicated public safety was the number one reason they collect or manage AR data (80%) with wildlife management or conservation as the number two reason (61%) and accounting as the third (53%). DNR respondents were divided between wildlife management/conservation (50%) and public safety (42%) as the number one reason they collected or managed AR data. Similarly DNR respondents were divided between wildlife management/conservation (50%) and public safety (40%) as the number two reason. Accounting reasons formed the third most important reason for DNRs (53%).

Many crash forms only have a checkbox for 'animal' (36% of all reviewed crash forms) and do not have a space dedicated to the entry of the species name of the animal involved. Based on the survey, most DOTs (65%) identify large wild mammals (deer and larger) only to the genus level whereas DNRs typically identify them to the species level (69%). According to the review of the crash forms, most states and provinces have reporting thresholds (typically a minimum of $1000 in damages (46% of all reviewed crash forms)). The search and reporting effort for ARs typically depends on the reporting of an animal-vehicle collision by the public and on whether law enforcement personnel happens to pass by an accident location shortly after the collision (DOTs 32%; DNRs 45%).

The location of the crash is usually described based on the distance to certain road or landscape features such as mi or km markers or road sections (56% of all reviewed crash forms). Based on the survey results the accuracy is always or usually 0.1 mi/km for DOTs (68%) and always or usually 1.0 mi/km for DNRs (63%). Relatively few states and provinces (36% of all reviewed crash forms) use coordinates (obtained through either a Global Positioning System (GPS) or a map).

AC Data

According to the survey, half of the responding DNRs (50%) and some DOTs (37%) collect AC data. Multiple organizations collect AC data but according to the combined responses of DOTs and DNRs this type of data is typically collected by DOTs (30%). Others who collect AC data include DNRs (28%), and local contractors and the public (21%).

Based on the survey, DOTs indicated public safety was the number one reason they collect or manage AC data (42%) with wildlife management or conservation as the number two reason (50%) and accounting as the third (33%). DNR respondents indicated wildlife management or conservation was the number one reason they collect or manage AC data (75%) with public safety as the number two reason (50%).

Most DOTs and DNRs never record amphibians or reptiles for AC data. However, most DOTs (100%) and DNRs (92%) do record large wild mammals (deer and larger), and the agencies that record AC data for this species group mostly identify them to the species level (DOTs 70%; DNRs 92%). Some DOTs and some DNRs record birds (DOTs 56%; DNRs 55%), small wild mammals (smaller than deer) (DOTs 60%; DNRs 60%), and domesticated animals (DOTs 90%; DNRs 89%). Most DOTs (70%) and DNRs (57%) have reporting thresholds for AC data. Most DOTs reported that in order to be reported a carcass had to be in the road or in the right-of-way, regardless of the visibility to drivers (77%). DNRs usually record only certain species (54%). The species of interest were deer, moose, 'bear', 'medium- and large-sized mammals' (including livestock, 'furbearers' and carnivores), other ungulates and birds. Most DOTs (55%) search and report for ACs on a daily basis as part of their routine while the search and reporting effort for DNRs is based on 'when they occur' or when they are reported (46%).

Most of the responding DOTs and DNRs always or usually record the date of the observation (DOTs 100%; DNRs 91%), the district or unit (DOTs 80%; DNRs 91%), the name of the observer (DOTs 60%; DNRs 64%), the road or route number or name (DOTs 100%; DNRs 73%), the carcass location (DOTs 80%; DNRs 64%), the species name of the animal involved (DOTs 89%; DNRs 100%), and whether the carcass was removed (DOTs 50%; DNRs 55%). Most DNRs also record the sex (64%) and the age (55%) of the individual involved.

Animal carcass location recording varied between DOTs and DNRs. Most DOTs never use GPS technology (89%) or maps to derive coordinates (67%). Most DOTs always or usually use mile or kilometer reference posts (90%) or road sections (80%). Of the responding DNRs, most rarely or never make use of GPS technology (60%) or maps to derive coordinates (55%). DNRs sometimes use mile or kilometer reference posts (50%) and usually or sometimes record the road sections (78%). DOTs always or usually record AC data with 0.1 mile or kilometer (67%) or 1 mile or kilometer accuracy (57%). DNRs always or usually record AC data with 0.1 mile or kilometer (33%) or 1 mile or kilometer accuracy (50%).

Implementation or Improvement of AR and AC Programs

DOTs and DNRs identified the lack of a demonstrated need, underreporting, poor data quality (consistency, accuracy - especially spatial accuracy - and/or completeness), and delays in data entry as the main obstacles to implementing or improving AR or AC data collection and analyses programs. Using more rigid and standardized procedures, including centralized databases, GPS technology, and the use of GIS were specifically mentioned to address some of these problems and improve the data collection and data analyses procedures.

Discussion and Conclusion

While a substantial percentage of the DOTs and DNRs collect and manage AR and/or AC data, many of them do not. Furthermore, DOTs and DNRs that do collect or manage AR or AC data typically do this for different or only partly overlapping reasons. In addition, DOTs and DNRs use different reporting thresholds, have varying search and reporting effort, and only have partial overlap in the parameters recorded. These differences also occur between DOTs and between DNRs, and oftentimes one and the same organization collects inconsistent data as certain parameters may only be recorded 'sometimes'. These differences and inconsistencies affect the comparability and ultimately the usefulness of the data.

Needs and Benefits of AR/AC Data Collection Programs

Before an AR or AC program is initiated or improved, it is important to illustrate the needs and benefits of such data collection. The most important needs and benefits are:

- With a standardized AR/AC data collection program the occurrence of incidents that affect human safety, natural resource conservation, and monetary losses are documented.
- With a standardized AR/AC data collection program changes in animal-vehicle collisions in time or space can be documented.
- With a standardized AR/AC data collection program locations that may require mitigation can be identified and prioritized, allowing for an effective use of resources.
- With a standardized AR/AC data collection program the effectiveness of mitigation measures in reducing collisions can be evaluated. This allows for modifications (if needed) and the application of the lessons learned at other locations, again allowing for an effective use of resources.

Considerations for AR and AC Programs

Based on the results of the survey, one may consider the following points when initiating new, or improving existing, AR or AC data collection programs (also partially based on Knapp and Witte, 2006):

- Include animal-vehicle collisions as a check box on all crash forms (AR data) and allow for checkboxes and/or free space to write down the name of the species.
- Coordinate with the other data collection program (AR or AC) (if applicable) in the state or province and coordinate within and between agencies (especially DOTs and DNRs in the same state or province). This may expand into coordination with insurance companies and municipalities that manage smaller roads.
- Standardize the parameters and procedures, not just at the state or provincial level, but preferably at a national, or even international level (United States and Canada). Such standardization could include "priority" and "non-priority" variables. The latter group would allow for the collection of specific variables in certain states or provinces or by certain organizations, and not in or by others.

- Increase the spatial accuracy for the crash location (e.g. through the use of GPS).
- For AC data, focus on large species that are a concern to human safety and species that are a conservation concern and that can be readily identified by the personnel collecting the data. Do not focus on species that are neither a safety or conservation concern, especially if these species are very frequently hit by vehicles or if the species cannot be readily identified by personnel collecting the data.
- Establish a central database, starting at the state or provincial level, and eventually at a national level.
- Consider direct data entry in a digital database through the use of handheld field computers, eliminating manual data entry in the offices.
- Have a follow-up procedure in place to identify errors, retrieve missing data, and verify unusual data.
- Train personnel in data collection, especially with regard to species identification and an accurate description of the location of the crash. Such efforts will also help reduce underreporting for AC data. Training for DOT personnel may have to place more emphasis on animal related parameters, especially species identification, whereas training for DNR personnel may have to be initiated altogether.
- Provide resources for data management and analyses, including GIS facilities.
- Share the (raw) data and reports, especially within and between agencies (e.g. DOTs and DNRs).

At a minimum, use the data to:

- Illustrate the magnitude of the problem and analyze trends.
- Identify and prioritize road sections that may require mitigation measures and to evaluate their effectiveness in reducing collisions.
- Evaluate the status and performance of the program on a regular base and make adjustments where necessary.

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Biographical Sketches: Marcel Huijser received his M.S. in population ecology (1992) and his Ph.D. in road ecology (2000) at Wageningen University in Wageningen, The Netherlands. He studied plant-herbivore interactions in wetlands for the Dutch Ministry of Transport, Public Works and Water Management (1992-1995), hedgehog traffic victims and mitigation strategies in an anthropogenic landscape for the Dutch Society for the Study and Conservation of Mammals (1995-1999), and multifunctional land use issues on agricultural lands for the Research Institute for Animal Husbandry at Wageningen University and Research Centre (1999-2002). Currently Marcel works on wildlife-transportation issues for the Western Transportation Institute at Montana State University (2002-present). He was a member of the Transportation Research Board (TRB) Task Force on Ecology and Transportation (through December 2006) and currently co-chairs the TRB Subcommittee on Animal-Vehicle Collisions.

Julie Fuller received her B.S. in wildlife biology at the University of Montana, Missoula, MT, in 2001. She received a M.S. in Fish and Wildlife Management at Montana State University, Bozeman, MT in 2006. Her M.S. focused on bison population demography in Yellowstone National Park, and her coursework emphasized statistics and population dynamics. At WTI-MSU, Julie worked with connectivity questions regarding wildlife fencing and wildlife-vehicle collisions along the I-90 corridor outside of Bozeman, MT, the pre-construction data analysis for black bear and deer crossings along the US 93 corridor near Polson, MT, and a national synthesis of animal-vehicle collisions. Currently employed by Montana Fish, Wildlife and Parks, her research focuses on elk and wolf interactions in southwest Montana.

Meredith Wagner received her B.S. in biology from California State University, Chico in 1994 and an M.S. from the School of Natural Resources and Environment at the University of Florida in 2004. Her master's thesis evaluated potential causes of a cheetah population decline in a human dominated landscape in Nakuru District, Kenya. Her work demonstrated the negative effect humans can have on wild populations even when necessary resources are available and abundant and the will to conserve wildlife exists. In 2006, Meredith participated in several road ecology projects at WTI-MSU. She is currently working on a Ph.D. at the University of Florida. Her work explores how striped hyenas alter their behavior patterns and landscape use in response to variation in human pressures. She is currently living in Kenya while conducting the research for her doctoral degree.

Amanda Hardy obtained her B.S. in biology - fish and wildlife management in 1997 and an M.S. in ecology - fish and wildlife management in 2001 at Montana State University, Bozeman, MT. She began studying transportation and wildlife interactions in 1998 with the initiation of her research thesis assessing bison and elk behavioral and stress hormone responses to winter recreation in Yellowstone National Park. Amanda joined WTI-MSU in 2001 and helped to develop the wildlife and transportation program into one of WTI-MSU's focus research areas. Her current work relates to the evaluation of wildlife crossing structures and driver responses to wildlife warning signs, as well as methods to analyze animal-vehicle collision data. She is also serving as a facilitator of an interagency effort to develop an ecosystem approach to mitigation of the highway program impacts on ecosystem processes. Amanda has served on the planning committee of the 2003, 2005 and 2007 International Conferences on Ecology and Transportation and was a co-organizer of the Wildlife Crossing Structure Field Course in Banff National Park, Alberta, Canada, in September 2002. Ms. Hardy is an appointed member of the Transportation Research Board's (TRB) Task Force on Ecology and Transportation, co-chairs the TRB Animal-Vehicle Collisions Subcommittee, and acts as a liaison between these groups and other TRB affiliates including the TRB Environmental Analysis in Transportation Committee.

Tony Clevenger is a senior wildlife biologist at the Western Transportation Institute at Montana State University. In 1996, he was contracted by Parks Canada to carry out longterm research assessing the performance of mitigation measures designed to reduce habitat fragmentation on the Trans-Canada Highway in Banff National Park, Alberta, Canada. Tony is currently a member of the U.S. National Academy of Sciences Committee on Effects of Highways on Natural Communities and Ecosystems. Since 1986, he has published over 40 articles in peer-reviewed scientific journals and has co-authored three books including, Road Ecology: Science and Solutions (Island Press, 2003). Tony has worked as a research wildlife biologist for the World Wide Fund for Nature–International (Gland, Switzerland), Ministry of Environment–France (Toulouse), U.S. Forest Service, and U.S. National Park Service. Tony is a graduate of the University of California, Berkeley, has a master's degree in wildlife ecology from the University of Tennessee, Knoxville and a doctoral degree in Zoology from the University of León, Spain. He is currently an adjunct assistant professor at the Department of Ecology, Montana State University. He lives year-round outside Banff National Park.

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