Summary: Results are compiled from the databases named above. Links are provided for full-text, if applicable, or to the full record citation. I completed my searches using the following terminology: deer vehicle collision, data. Results are sorted into most and least relevant results.

Most Relevant Results

TRID

Donaldson, Bridget M; Kweon, Young-Jun. Effectiveness of Seasonal Deer Advisories on Changeable Message Signs as a Deer Crash Mitigation Tool. Transportation Research Record: Journal of the Transportation Research Board, Volume 2673, Issue 12, 2019, pp 548-557
https://trid.trb.org/view/1576945

Abstract: The Virginia Department of Transportation began posting deer advisory messages on changeable message signs (CMSs) along a 16.7-mi segment of Interstate 64 in October 2015. The posting of these messages during the peak of deer activity, from October to November from 5?p.m. to 9?a.m., was intended to raise driver awareness and reduce the high number of deer-vehicle collisions (DVCs) in the area. The effectiveness of deer advisory messages with regard to DVC reduction is not well known. Effectiveness in this study was determined by evaluating deer carcass removal data from three October and November deer advisory posting periods. Vehicle speed evaluations were also conducted to determine whether drivers reduced speed in response to the advisories. Carcass removals were lower when the deer advisories were posted than when they were not posted, and this difference was statistically significant. During the deer advisory postings, there were statistically significant speed reductions of up to 2.8?mph at four of the five vehicle sensor stations. Speed reductions were greater when deer advisories were posted during periods of lower traffic volumes. Seasonal deer advisory messages on an interstate appear to be an effective form of DVC mitigation. Posting seasonal deer advisories every other day on the five existing CMSs in this study’s project area is expected to save approximately $700,000 to $1.4?million over the service life of the CMSs.

Stapleton, Steven York; Ingle, Anthony; Gates, Timothy J. Factors Contributing to Deer-Vehicle Crashes on Rural Two-Lane Roadways in Michigan. Transportation Research Record: Journal of the Transportation Research Board, Volume 2673, Issue 10, 2019, pp 214-224
https://trid.trb.org/view/1600771

Abstract: Deer-vehicle crashes (DVCs) continue to be a problem in the United States, with 1.2?million such crashes occurring annually. DVCs are a particular issue on two-lane rural highways in Michigan, accounting for more than 60% of crashes. Such a high proportion of DVCs limits the transferability of existing safety models, including those found in the Highway Safety Manual (HSM), that are often based on data from states with considerably lower proportions of deer crashes. To counter this, a cross-sectional analysis of deer crashes was performed using data from Michigan. The data were analyzed across four categories of rural two-lane roadways, including: state highways, federal aid county roadways, non-federal aid county roadways, and
unpaved (gravel) county roadways. Mixed effects negative binomial regression models utilizing spatial and temporal random effects were generated separately for each of the rural two-lane roadway types. Results showed speed-related factors, including lane width, shoulder width, horizontal curvature, and peak level of service, had a significant effect on DVC occurrence for most types of rural two-lane roadways in Michigan. Wider lanes were associated with a greater occurrence of deer crashes, perhaps because of higher prevailing travel speeds. Conversely, horizontal curves with design speeds lower than the statutory speed limit were associated with fewer deer crashes, perhaps because of lower travel speeds through curves. Wider shoulders, which afford greater separation between the travel lanes and the roadside, were found to have significantly lower deer crash occurrence. The number of available hunting licenses did not have a consistent effect on DVCs.

**SPAHN, V** *Identification of road sections with a striking large number of deer-vehicle collisions*, Volume 63, Issue 1, 2019, pp 16-24
https://trid.trb.org/view/1632586
Abstract: The consequent eradication of identified black spots by means of target-oriented measurements has proved to be very effective in order to decrease selectively the number of accidents on road sections with a high accident occurrence. In Germany the identification of accident black spots is carried out according to the "Merkblatt zur Ärtlichen Unfalluntersuchung in Unfallkommissionen (M Uko)" (leaflet for local accident investigation in accident commissions). Hereby the main focus on highways is paid on reducing the number of fatalities and injured persons. By investigating black spots in this manner deer-vehicle collisions are markedly underrepresented due to the fact that they seldom result in personal injuries. However, it must be noted in this context that after all 45 % of all accidents (including material damage) are caused by deer-vehicle collisions and this tendency is rising. It was an aim of this article to test criteria for the identification of road sections with a striking large number of deer-vehicle collisions, where it seems to be purposive to carry out additional local investigations. For this purpose extensive data have been available, inter alia, more than 500,000 data of georeferenced deer-vehicle collisions on roads outside urban areas in Bavaria.

Donaldson, Bridget M. *Improving Animal-Vehicle Collision Data for the Strategic Application of Mitigation*. Virginia Transportation Research Council; Virginia Department of Transportation; Federal Highway Administration, 2017, 29p
https://trid.trb.org/view/1492059
Abstract: Virginia is consistently among the 10 states with the highest number of deer-vehicle collisions (DVCs), with more than 61,000 reported for the year ending June 30, 2016. Whereas DVCs represented 1 in 11 of the vehicle insurance claims nationwide in 2014, they represented 1 in 6 of the claims in Virginia. Although the insurance data provide some information on the magnitude of the DVC problem, insurance data do not provide location information for these crashes. Decision makers rely on reliable crash data to identify problem areas and determine the magnitude of the problem. Although the literature shows that animal-vehicle collisions (AVCs) are underrepresented in police crash report data, more detailed analyses are needed to determine the scale. Effective mitigation approaches to the AVC problem in Virginia are limited until a means to access and/or collect adequate data is identified. In this study, quality and cost evaluations of DVC data in Virginia were conducted that indicated an AVC underreporting phenomenon that is a problem nationwide. The study found that DVCs represent a considerable safety hazard in Virginia, but the magnitude of this problem is not apparent from the data that are currently available. According to deer carcass removal records, the number of DVCs in the evaluated areas was up to 8.5 times greater than what was documented in police crash reports, and DVCs were the most frequent type of collision in the areas evaluated. The underrepresentation of DVCs understates the costs of these collisions. DVCs were estimated to be 6 times costlier on average than what was indicated from police crash report data. The estimates used in this study put the DVCs as the fourth costliest of the 14 major collision types in Virginia, averaging more than $533 million per year. The underrepresentation of deer-related crash volumes relative to other collision types create missed opportunities for DVC mitigation in Virginia. Reliable data can be used to identify DVC hotspots for strategic mitigation, and
the success of countermeasures such as wildlife underpasses with fencing have led to an increase in such mitigation in the United States in recent decades. The study recommends that a carcass removal element be added to the Virginia Department of Transportation’s Highway Maintenance Management System (HMMS), currently in development. The HMMS is intended to provide a means for maintenance staff to track road maintenance activities digitally. Adding a module to the HMMS that would provide an efficient and accurate means to collect carcass removal records would lead to a high-quality DVC dataset if routinely used by maintenance staff. With better information, the Virginia Department of Transportation can address these collisions in a manner that is consistent with their impact on the driving public.

Hothorn, Torsten; Måløv, Jårg; Held, Leonhard; Måfjälst, Lisa; Mysterud, Atle. Temporal patterns of deer-vehicle collisions consistent with deer activity pattern and density increase but not general accident risk. Accident Analysis & Prevention, Volume 81, Issue 0, 2015, pp 143-152
https://trid.trb.org/view/1357548
Abstract: The increasing number of deer-vehicle collisions (DVCs) across Europe during recent decades poses a serious threat to human health and animal welfare and increasing costs for society. DVCs are triggered by both a human-related and a deer-related component. Mitigation requires an understanding of the processes driving temporal and spatial collision patterns. Separating human-related from deer-related processes is important for identifying potentially effective countermeasures, but this has rarely been done. The authors analysed two time series of 341,655 DVCs involving roe deer and 854,659 non-deer-related accidents (non-DVCs) documented between 2002 and 2011. Nonparametric smoothing and temporal parametric modelling were used to estimate annual, seasonal, weekly and diurnal patterns in DVCs, non-DVCs and adjusted DVCs. As they had access to data on both DVCs and non-DVCs, they were able to disentangle the relative role of human-related and deer-related processes contributing to the overall temporal DVC pattern. They found clear evidence that variation in DVCs was mostly driven by deer-related and not human-related activity on annual, seasonal, weekly and diurnal scales. A very clear crepuscular activity pattern with high activity after sunset and around sunrise throughout the year was identified. Early spring and the mating season between mid-July and mid-August are typically periods of high roe deer activity, and as expected the authors found a high number of DVC during these periods, although these patterns differed tremendously during different phases of a day. The role of human activity was mainly reflected in fewer DVCs on weekends than on weekdays. Over the ten-year study period, they estimated that DVCs increased by 25%, whereas the number of non-DVCs decreased by 10%. Increasing deer densities are the most likely driver behind this rise in DVCs. Precise estimates of DVC patterns and their relationship to deer and human activity patterns allow implementation of specific mitigation measures, such as tailored driver warning systems or temporary speed limits. To prevent a further increase in DVCs, state-wide measures to decrease roe deer density are required.

Kammerle, Jim-Lino; Brieger, Falko; Kroschel, Max; Hagen, Robert; Storch, Ilse; Suchant, Rudi. Temporal patterns in road crossing behaviour in roe deer (Capreolus capreolus) at sites with wildlife warning reflectors. PLoS One, Volume 12, Issue 9, 2017, e0184761
https://trid.trb.org/view/1487898
Abstract: Every year, there are millions of documented vehicle collisions involving cervids across Europe and North America. While temporal patterns in occurrence are relatively well described, few studies have targeted deer behaviour as a critical component of prevention. In this study, the authors investigated weekly and daily patterns in road crossing behaviour in roe deer. Using road crossing events and movement data obtained from global positioning system (GPS) telemetry, the authors employed mixed-effect models to explain frequency and timing of crossings at five road segments by a number of predictors including traffic volume, deer movement activity and the presence of wildlife warning reflectors. The authors analysed 13,689 road crossing events by 32 study animals. Individual variation in crossing frequency was high but daily patterns in crossing events were highly consistent among animals. Variation in the intensity of movement activity on a daily and seasonal scale was the main driver of road crossing behaviour. The seasonal variation in crossing frequency reflected differences in movement activity throughout the reproductive cycle, while daily variation in the probability to cross exhibited a clear nocturnal emphasis and reflected crepuscular activity peaks. The frequency of road crossings increased as a function of road density in the home-range, while traffic volume only exerted marginal effects. Movement activity of roe deer in the authors’ study coincided with commuter traffic mainly in the early morning and late
afternoon during winter and during periods of high spatial activity such as the rut. Both timing and frequency of crossing events remained unchanged in the presence of reflectors. The authors’ results emphasise the importance of behavioural studies for understanding roe deer vehicle-patterns and thus provide important information for prevention. The authors suggest that mitigation of risk should focus on strategic seasonal measures and animal warning systems targeting drivers.

Abstract: Every year in the United States, over 1.5 million deer-vehicle collisions occur, resulting in one billion U.S. dollars in damages. Based on 2007-2009 data recorded in the Crash Records Information System (CRIS) database, the average annual number of collisions in Texas involving an animal is 12,123. The primary objective of this study is to identify the scenarios associated with severe animal-vehicle collisions in Texas. Armed with this knowledge, mitigation techniques can be applied, reducing the frequency and severity of such events. With further development, safety-prediction models of these types could be implemented into transportation management systems.

Abstract: The increasing number of deer-vehicle-accidents (DVAs) and the resulting economic costs have promoted numerous studies on behavioural and environmental factors which may contribute to the quantity, spatiotemporal distribution and characteristics of DVAs. Contrary to the spatial pattern of DVAs, data of their temporal pattern is scarce and difficult to obtain because of insufficient accuracy in available datasets, missing standardization in data acquisition, legal terms and low reporting rates to authorities. Literature of deer-traffic collisions on roads and railways is reviewed to examine current understanding of DVA temporal trends. Seasonal, diurnal and lunar peak accident periods are identified for deer, although seasonal pattern are not consistent among and within species or regions and data on effects of lunar cycles on DVAs is almost non-existent. Cluster analysis of seasonal DVA data shows nine distinct clusters of different seasonal DVA pattern for cervid species within the reviewed literature. Studies analyzing the relationship between time-related traffic predictors and DVAs yield mixed results. Despite the seasonal dissimilarity, diurnal DVA pattern are comparatively constant in deer, resulting in pronounced DVA peaks during the hours of dusk and dawn frequently described as bimodal crepuscular pattern. Behavioural aspects in activity seem to have the highest impact in DVAs temporal trends. Differences and variations are related to habitat-, climatic- and traffic characteristics as well as effects of predation, hunting and disturbance. Knowledge of detailed temporal DVA pattern is essential for prevention management as well as for the application and evaluation of mitigation measures.

Nichols, A P; Huijser, M P; Ament, R; Dayan, S; Unnikrishnan, A. Evaluation of Deer-Vehicle Collision Rates in West Virginia and a Review of Available Mitigation Techniques. Rahall Appalachian Transportation Institute; Western Transportation Institute; West Virginia University Institute of Technology, Montgomery; West Virginia Department of Transportation, 2014, 293p https://trid.trb.org/view/1324594
Abstract: This project reviewed police reports involving deer and carcass data reported by the West Virginia Department of Transportation from 2008-2012. The police reports were deemed the most reliable in terms of location reliability and consistency across the state. This data was used for identifying hotspots across the state based on 2-mile segment lengths. Segments identified as being “high” ranged from 13-22 reported deer-vehicle collisions (DVC) over the 5-year period, which is assumed to be lower than the actual number due to underreporting. Modeling completed as part of the project suggested that the DVC frequency was positively related to landscape diversity and urban/urbanized areas and negatively related to presence of roadside slopes exceeding 60 degrees (uphill or downhill). The report provides a
summary of DVC mitigation measures and funding mechanisms, including specific mitigation recommendations for West Virginia. The report evaluates various transportation metrics for normalizing state-by-state DVC estimates generated by State Farm insurance for national ranking purposes, including the rural and urban components of the metrics.

Barnum, Sarah A; Gray, Mary E. A Comparison of Methods to Identify Deer-Vehicle Crash Hotspots. Transportation Research Board 91st Annual Meeting, Transportation Research Board, 2012, 15p
https://trid.trb.org/view/1130923
Abstract: This project evaluated the advantages and disadvantages of two methods to examine the underlying distribution of point data and six methods to identify and prioritize deer-vehicle crashes (DVC) hotspots. The methods tested included those currently used by state DOTs, as well as other methods identified in a literature review, and consisted of average nearest neighbor distances and Moran’s I to identify the underlying distribution of the data, and expert analysis, visual analysis, density-based measures, models, and two types of spatial statistics to identify hotspots locations. Each approach was applied to four different DVC data sets provided by the Iowa and New York State DOTs, the results produced by each method were compared, and each method was also evaluated based on the level of expertise and resources needed for implementation. The results of the comparison do not indicate a single “best” method to identify DVC hotspots, but model-based approaches and spatial statistics appear to offer advantages because meeting assumptions required for their implementation reduces the subjectivity of results interpretation. Applying multiple approaches and looking for the locations that are repeatedly identified as a hotspot may yield the best results.

https://trid.trb.org/view/967899
Abstract: The increase in animal-vehicle collisions (AVCs) on U.S. roadways raises significant concerns for human safety, property damage and injury costs, and viability of wildlife populations. Valuable AVC data can be obtained from documentation of instances and locations of animal carcasses on the roadway, but most transportation organizations do not systematically record these data. In 2006, accidents reported by police in Virginia represented less than 14% of the 45,000 deer-vehicle collisions (DVCs) estimated from insurance industry claims. A project was carried out to test a personal digital assistant (PDA) enabled with a Global Positioning System (GPS) receiver for the collection and analyses of animal carcass removals from the roadway and to initiate the integration of this data collection method into regular practice by the Virginia Department of Transportation (VDOT). VDOT maintenance personnel collected 8 months of spatially accurate carcass removal data by using GPS-enabled PDAs. DVC estimates from this procedure were more than nine times greater than the number reported by police. Given the findings and efforts from the study, VDOT plans to integrate collection of carcass removal data with PDAs into regular practice. The procedures described in the report can guide other states interested in implementing a systematic and spatially accurate method for collecting AVC data. Implementing mitigation in high-density AVC areas can ultimately lead to fewer AVCs and associated reductions in human deaths, injuries, and financial losses; improved traffic operations; a reduction in maintenance costs related to carcass removal and disposal; and wildlife conservation.

Gkritza, Konstantina; Baird, Michael; Hans, Zachary N. Deer-vehicle collisions, deer density, and land use in Iowa's urban deer herd management zones. Accident Analysis & Prevention, Volume 42, Issue 6, 2010, pp 1916-1925
https://trid.trb.org/view/934446
Abstract: Many states are striving to keep their deer population to a sustainable and controllable level, while maximizing public safety. In Iowa, measures to control the deer population include annual deer hunts and special deer herd management plans in urban areas. While these plans may in effect reduce the deer population, traffic safety in these areas has not been fully assessed. Using deer population data from the Iowa Department of Natural Resources and data on deer-vehicle crashes and deer carcass removals from the Iowa Department of Transportation, we examine the relationship between deer-vehicle collisions, deer density, and land use in select urban deer management zones in Iowa. Further, we estimate models to investigate the
factors that influence the frequency and severity of deer-vehicle crashes in these zones. The estimation results showed that multiple factors affect deer-vehicle crashes and corresponding injury outcomes in urban management zones. The identified roadway and non-roadway factors could be useful for identifying locations on the transportation system that significantly impact deer species and safety, and determining appropriate countermeasures for mitigation.

DeZort, Neil. Developing a Crash Prediction Model for Deer-Vehicle Collisions. Western Transportation Institute; Research and Innovative Technology Administration, 2010, 33p
https://trid.trb.org/view/1257428
Abstract: The information on the locations where deer-vehicle collisions are likely to occur is of great use to transportation safety officials. Knowing the relationship between average daily traffic, deer population density, and deer-vehicle collisions will allow officials to identify the locations of greatest concern so they can implement mitigation techniques with increased success. This study is the first to specifically investigate the joint relationship in an attempt to create a crash prediction model that will estimate the number of deer-vehicle collisions a roadway segment will experience based on the combination of traffic volumes and deer population density. Data were collected from the Montana Department of Transportation and Montana Fish, Wildlife, and Parks and used to develop several models that attempted to identify a relationship. These models were then analyzed using statistical tests to see if the models were statistically significant. The models showed, based on Montana data, that the deer population surrounding a roadway segment does not have a significant effect on the number of deer-vehicle collisions observed when used in a model combined with the average annual daily traffic. These results suggest that perhaps when a deer population stays within a certain range, the crash rate depends solely on the traffic volume observed. Understanding the relationship between average annual daily traffic, deer population, and the number of collisions observed will help transportation safety officials create a driving environment that is safer for the motorists using a road network.

Pooledfund.org

Deer Vehicle Information and Research (DVCIR) Center Pooled Fund
https://pooledfund.org/Details/Study/352

Least Relevant Results
TRID

https://trid.trb.org/view/1339134
Abstract: Wildlife-vehicle collisions (WVC) are a significant transportation safety issues in the United States, causes several billions of dollars property damage and many human injuries and fatalities annually. A major portion of WVCs involve white-tailed deer. As human and infrastructure expansion is increasing in many states and municipalities, along with increasing deer populations in some suburban areas, the deer-vehicle (DVC) issue has drawn greater attention. It is useful to determine what roadway and roadside factors contribute to the presence and frequency of DVC and to identify hot spots for potential mitigation. Previous studies have examined these relationships through various modeling efforts. In this research, the modeling effort is conducted along two specific roadway segments in West Virginia using Negative Binomial (NB) models with carcass pickup data, as well as the roadway features and adjacent landscape characteristics. The contribution of this paper is to investigate the spatial autocorrelation in the data. This relationship is detected in the residuals along one of the routes using Moran’s I permutation test, which invalidates the modeling assumption of spatial independence. An autoregressive modeling method is therefore applied to account for the spatial autocorrelation, resulting in an improved DVC model. Future work is also suggested to improve the CAR models for DVC data.
https://trid.trb.org/view/1286448

Abstract: Deer-vehicle crashes are a growing problem in Iowa where deer-vehicle crashes represent 13% of all crashes reported. In 2009, these crashes resulted in nine fatalities and 451 injuries in the state. Deer-vehicle crashes are a problem even in urban areas of Iowa. It is known that deer-vehicle crashes are typically underreported. To address this underreporting, deer carcass salvage reports may be used to augment deer-vehicle reports. The objective of this paper is to exploit two sources of deer-vehicle data using a statistically reliable assessment methodology, empirical Bayes, to assess the potential for safety improvement of 150 urban highway sections in Iowa. Reconciliation of records to reduce double counting is discussed and a negative binomial regression model of deer-vehicle frequency as a function of roadway and environmental factors is estimated. The 25 most promising segments for deer-vehicle countermeasures are identified, mostly located on high-speed roadways, roadway segments with gravel right shoulders, and segments adjacent to grasslands. The methodology facilitates the identification of locations for countermeasure implementation as well as monitoring deer-vehicle trends.

Baird, Michael James; Gkritza, Konstantina; Souleyrette, Reginald R; Danielson, Brent J. **Empirical Bayes Model to Assess Deer-Vehicle Crash Safety in Urban Areas in Iowa.** Transportation Research Board 90th Annual Meeting, Transportation Research Board, 2011, 19p
https://trid.trb.org/view/1091812

Abstract: Deer-vehicle crashes are a growing problem in Iowa. In 2008, deer-vehicle crashes represented 12% of all crashes reported and included 9 fatalities and 442 injuries. These crashes are especially problematic in urban areas of Iowa, where the prevalence of deer-vehicle crashes is becoming a more visible issue. Quite a bit of research has been conducted on countermeasure action that could help mitigate deer-vehicle es. However, little previous work has attempted to model deer-vehicle crashes in urban areas using the two data sources available: deer carcass salvage reports and deer-vehicle reports. The objective of this paper is to assess the safety of roadway segments in three cities with long-running deer management programs using both deer-vehicle and deer carcass salvage data. The authors reconciled records to help eliminate double counting and estimated count data models to examine deer-vehicle frequency as a function of roadway and environmental factors. The count model estimates were used in an empirical Bayes model to predict deer-vehicle crashes in the select urban areas of Iowa. This model can be used to help allocate safety funds to implement appropriate deer-vehicle countermeasures in high-risk locations.

Gkritza, Konstantina; Baird, Michael; Hans, Zachary. **An Assessment of Traffic Safety in Urban Deer Herd Management Zones in Iowa.** Center for Transportation Research and Education; Iowa Department of Transportation, 2010, 124p
https://trid.trb.org/view/915826

Abstract: Many states are striving to keep their deer population to a sustainable and controllable level while maximizing public safety. In Iowa, measures to control the deer population include annual deer hunts and special deer herd management plans in urban areas. While these plans may reduce the deer population, traffic safety in these areas has not been fully assessed. Using deer population data from the Iowa Department of Natural Resources and data on deer-vehicle crashes and deer carcass removals from the Iowa Department of Transportation, the authors examined the relationship between deer-vehicle s, deer density, and land use in three urban areas in Iowa that have deer management plans in place (Cedar Rapids, Dubuque, and Iowa City) over the period 2002 to 2007. First, a comparison of deer-vehicle counts and deer carcass removal counts was conducted at the county level. Further, the authors estimated econometric models to investigate the factors that influence the frequency and severity of deer-vehicle crashes in these zones. Overall, the number of deer carcasses removed on the primary roads in these counties was greater than the number of reported deer-vehicle crashes on those roads. These differences can be attributed to a number of reasons, including variability in data reporting and data collection practices. In addition, high rates of underreporting of crashes were found on major routes that carry high volumes of traffic. This study also showed that multiple factors affect deer-vehicle crashes and corresponding injury outcomes in urban management zones. The identified roadway and non-roadway factors could be useful for identifying locations on the transportation system that significantly impact deer species and safety and for determining appropriate countermeasures for mitigation. Efforts to reduce deer density adjacent to roads and developed land and to provide wider shoulders on undivided roads are recommended. Improving the consistency and accuracy of deer carcass and deer-vehicle data collection methods and practices is also desirable.
Knapp, Keith K. **Investigation of Deer-Vehicle Crash Data and Countermeasure Implementation in Texas.** Texas Transportation Institute; Southwest Region University Transportation Center, 2008, 36p

https://trid.trb.org/view/855956

Abstract: The Deer-Vehicle Information and Research (DVCIIR) Center is the only entity in the United States that focuses on the deer-vehicle (DVC) problem and its reduction. This project investigated the status of DVC data and countermeasure implementation in Texas. Two meetings on the subject were also sponsored. The investigation of Texas data revealed an interesting set of characteristics and patterns. The police-reported data are actually for animal-vehicle crashes (AVCs) and generally only for those incidents resulting in an injury/fatality or the towing of a vehicle. The data indicate that the total number of police-reported AVCs in Texas decreased from 1992 to 2001 (unlike most of the country), but it was also determined that this was likely due to a change in the crash reporting threshold. The number of AVC-related injuries, on the other hand, increased dramatically. The “top ten” AVC counties in Texas generally include those with large or growing traffic volumes and/or favorable deer habitat. Overall, comparisons of the AVC data and two estimates of these incidents also indicate that the former may not fully describe the AVC problem. The use of supplemental alternative AVC data was recommended. The implementation of countermeasures to reduce collisions between large animals and vehicles in Texas has been limited. Existing bridges and culverts have been retrofitted for wildlife and new crossings proposed. Deer crossing warning signs have also been installed. It is recommended that existing and new countermeasures be implemented and/or monitored. The two meetings sponsored by this project resulted in the identification and/or prioritization of the nonresearch activities and the research subject areas that may be funded by the DVCIIR Center. These meetings were essential to the advancement and growth of the DVCIIR Center pooled fund project.

Knapp, Keith K; Lyon, Craig; Witte, Adrian; Kienert, Cara. **Crash or Carcass Data: Critical Definition and Evaluation Choice.** Transportation Research Record: Journal of the Transportation Research Board, Issue 2019, 2007, pp 189-196

https://trid.trb.org/view/801784

Abstract: Reported animal-vehicle crashes (AVCs) and deer carcass removal have been used to define the deer-vehicle problem, identify its locations of concern, and evaluate its countermeasures. However, it has been shown that AVC magnitudes can be dramatically different. This research quantifies and compares the magnitude and patterns of AVC and deer carcass removal data from Iowa. Differences in these characteristics can affect the results produced by these activities. The difference in the magnitude of these two data sets is confirmed, and some of the factors that may affect the size of this difference are discussed. Visual and quantitative comparisons are completed by using summary measures, geographic information system plots, and generalized linear regression models with a negative binomial error structure. This modeling approach has not been applied in the past to AVC or deer carcass removal data. AVC and deer carcass removal prediction (not causal) models for rural two-lane and multilane roadways were developed. The similarities and differences in the AVC and deer carcass removal models are discussed and the implications of these differences described. The differences found make the choice of database used critical to AVC-related roadway development decisions and policies, countermeasure location identification, and interpretation of research results. The recommendations provided focus on how AVC or carcass removal data bases, as they typically exist, might be used and what improvements might be made for a more well-defined collection and application of these data.

Knapp, Keith K; Kienert, Cara; Witte, Adrian. **Statewide and Upper Midwest Summary of Deer-Vehicle Crash and Related Data from 1993 to 2003.** Midwest Regional University Transportation Center; Wisconsin Department of Transportation; Federal Highway Administration, 2005, 101p

https://trid.trb.org/view/790899

Abstract: This document contains a summary and discussion of deer-vehicle (DVC) and DVC-related data from five states in the Upper Midwest of the United States. These data were obtained from Departments of Transportation, Public Safety and/or Natural Resources in Illinois, Iowa, Michigan, Minnesota, and Wisconsin. More specifically, annual police-reported total crashes and DVCs [or animal-vehicle crashes (AVCs) in Iowa], annual vehicle-miles-traveled, DVC or AVC fatalities and injuries, deer population estimates, and carcass removal data were primarily provided by these agencies for the time period from 1993 to 2003. Some of these data are plotted and described directly in this report and others have been used to calculate the percentage of total crashes represented by DVCs/AVCs and a DVC/AVC rate. The trends observed in these safety measures from 1993 to 2003 for each of the five states and the overall region are presented. The limitations and defining criteria for each dataset are also noted, as appropriate, in the figures and text. This information is needed when interpreting the statewide and regional trend discussion, conclusions, and recommendations.
The content of this report will be used to define regional data to assist in the more proper identification of DVC-related activities. It is believed that better communication would improve the application of DVC countermeasures.

Survey responses also show that there is a limited amount of communication between the DOT and DNR with respect to record or summarize all of this possession/salvage permits, carcass removal reports, and/or traffic flow information. Not all of the states in the region report or summarize all of this data. The criteria that define each of the databases are contained in this document. The trend summary is not completed by most states, and a detailed regional summary of this type of data has never been attempted in the past. The data show that total reported crashes in the region were relatively stable between 1993 and 2003, but that the annual vehicle-miles-traveled steadily increased. The annual number of DVCs/AVCs in the region has also increased as have their proportion of total es. These trends have resulted in a regional DVC/AVC rate that has been relatively stable between 1993 and 2003. Overall, the regional number of annual DVC/AVC fatalities and injuries has ranged from 12 to 45 and 3,888 to 5,324. The regional deer population estimates show a cyclical pattern of increases and decreases several years long. Regionally, the percentage of total crashes represented by DVCs/AVCs (when data from all five states were available) ranged from 9.2 to 10.9%. However, on average, approximately twice as many deer carcasses are removed from the roadside as DVCs/AVCs reported.

Ramakrishnan, Uma; Daugherty, Laura; Pelkey, Neil W; Williams, Scott C. Effects of Gender and Season on Spatial and Temporal Patterns of Deer-Vehicle collisions. 2005 International Conference on Ecology and Transportation (ICOET 2005), North Carolina State University, Raleigh, 2005, pp 478-488
https://trid.trb.org/view/1359295

Abstract: White-tailed deer (Odocoileus virginianus) are a serious accident hazard, especially in suburban communities with high deer densities. Such areas are becoming more common as deer populations continue to grow throughout the northeastern United States. This study analyzed deer-vehicle collision data collected from police reports in Connecticut for 2000, 2001 and 2002. The purpose of this project was to integrate the use of standard crime mapping tools, multi-temporal remotely sensed vegetation imagery, human infrastructure, and the behavioral aspect of white-tailed deer to create a spatially explicit model of gender-specific deer-vehicle accident probabilities. The authors found marked differences between number, location, and seasonality of male and female accidents. Through most of the year, the number of males and females involved in accidents were relative to their proportion in the population. However, during the breeding season, there were a higher proportion of males involved in accidents. The spatial distribution of accidents involving deer also varied by season and sex - outside of the breeding season, accidents involving male deer were concentrated in a few key locations in the state. The difference in the spatial location of male and female accidents could be the result of resource partitioning exhibited by the species, with males occupying broader ranges in peripheral habitats. This model can be used to predict high risk areas as they change over the different seasons and design warning programs and adaptive education to these target areas.

Knapp, K K; Thimm, W; Rathmann, C. REGIONAL SURVEY OF DEER POPULATION, VEHICLE TRAVEL, AND DEER-VEHICLE CRASH INFORMATION COLLECTION AND MANAGEMENT. University of Wisconsin, Madison; Wisconsin Department of Transportation; Federal Highway Administration, 2004, 27 p.
https://trid.trb.org/view/697974

Abstract: In March 2003 a survey was completed by the Deer-Vehicle Information Clearinghouse (DVCIC). The objective of this survey was to investigate regional Department of Transportation (DOT) and Department of Natural Resources (DNR) activities related to the collection and management of deer-vehicle (DVC) and DVC-related data. The respondents to this email and telephone survey were the DOT and DNR representatives on the standing Technical Advisory Committee of the DVCIC. A total of 27 questions were asked. The answers to these questions are summarized in this report. Overall, each of the state DNRs annually estimates either a pre-hunt or post-hunt deer population. The DOTs, State Police, or Department of Public Safety maintain the database of officially reported data (which includes DVCs), and the majority of the reports in each state are completed by law enforcement. All five of the states also allow some form of citizen self-reporting of a… Four of the states in the region allow a… to be reported as a DVC. The fifth only uses the more general animal-vehicle designation. Three minimum property-damage reporting thresholds are used. Several DVC-reduction countermeasures are being used and/or evaluated in the region. These countermeasures include exclusionary fencing, roadside reflectors, and an advanced sign/roadside detector system. Several DVC-related databases also exist in each state. These databases include white-tailed deer populations, DVCs, carcass possession/salvage permits, carcass removal reports, and/or traffic flow information. Not all of the states in the region record or summarize all of this data. The criteria that define each of the databases are contained in this document. The survey responses also show that there is a limited amount of communication between the DOT and DNR with respect to DVC-related activities. It is believed that better communication would improve the application of DVC countermeasures. The content of this report will be used to define regional databases, compare DVC data temporally and spatially, and also assist in the more proper identification of DVC-related data problems.
Donaldson, Bridget M; Elliott, Kaitlyn E M. Enhancing Existing Isolated Underpasses With Fencing to Decrease Wildlife Crashes and Increase Habitat Connectivity. Virginia Transportation Research Council; Virginia Department of Transportation; Federal Highway Administration, 2020, 32p
https://trid.trb.org/view/1709151

Abstract: The impact of wildlife-vehicle collisions on drivers and wildlife populations has been gaining increasing attention in the United States. Given the established success of wildlife crossings with fencing in reducing wildlife crashes and connecting habitat, a growing number of states, including Virginia, have enacted wildlife corridor legislation, some of which encourages or requires the construction of wildlife crossings along identified wildlife corridors and/or high-crash areas. Because of the growing interest in wildlife crossing measures, research is needed on cost-effective means of implementation for departments of transportation. When wildlife crossings are constructed, they are often built into new road construction projects as a series of two or more underpasses and/or overpass structures connected by exclusionary fencing. Given limited transportation budgets, enhancing existing underpasses on previously constructed roads has also been recognized as a cost-effective mitigation opportunity. More research is needed, however, on the effects of adding fencing to existing underpasses, particularly those that are too far from one another to be connected with contiguous fencing. The purpose of this study was to determine the effectiveness of enhancing existing isolated underpasses with wildlife fencing. One mile of 8-ft-high wildlife fencing was added to a large bridge underpass and a large box culvert 5 mi apart on Virginia’s I-64. Effectiveness was determined by conducting a 2-year post-fencing camera monitoring study and comparing the findings with those from a 2-year pre-fencing study with regard to the frequency of deer-vehicle collisions (DVCs); the use of the underpasses by deer and other wildlife; and roadside deer activity. The study also used deer behavior and activity data to make comparisons among different fence end designs and jumpout designs applied at the study sites. The study found that the addition of wildlife fencing to certain existing isolated underpasses can be a highly cost-effective means of increasing driver safety and enhancing habitat connectivity for wildlife. After fencing installation, DVCs were reduced by 92% on average (96.5% and 88% at the box culvert and bridge underpass, respectively). Deer crossings increased 410% at the box culvert and 71% at the bridge underpass. Use of the culvert and bridge underpasses by other mammals increased 81% and 165%, respectively. DVCs did not increase at the fence ends, but there was high deer activity at the ends that did not tie into a feature such as right-of-way fencing. At the study sites, the benefits from crash reduction exceeded the fencing costs in 1.8 years, and fencing resulted in an average savings of more than $2.3 million per site. The findings from this study should be considered when DVC mitigation and/or wildlife connectivity measures are needed. Wildlife crossing and fencing guidelines will be developed to provide the Virginia Department of Transportation with a resource for the cost-effective implementation of this wildlife crash mitigation measure.

Cramer, Patricia; Hamlin, Robert. U.S. Highway 89 Kanab-Paunsaugunt Wildlife Crossing and Existing Structures Research. Patricia Cramer; Utah Department of Transportation; Federal Highway Administration, 2019, 88p
https://trid.trb.org/view/1659701

Abstract: The U.S. Highway 89 Kanab-Paunsaugunt Project was constructed in 2012-2013 to help reduce mule deer-vehicle collisions and provide connectivity for the Paunsaugunt Mule Deer herds and other wildlife in their north-south movements across the highway. Utah Department of Transportation (UDOT) and partners placed 12.5 miles (20.1 km) of fence to guide wildlife to four existing structures and three new wildlife crossing culverts. The study used motion sensitive remote cameras to photograph wildlife at the structures and determine the success of each structure and the changes in mule deer movement around the fenced ends. From September 2013 through June 2018, the study cameras recorded 4.56 million photographs, 102,517 mule deer total movements at the seven structures, and 78,610 mule deer Success Movements through the seven structures. The overall Success Rate at all seven structures during the entire study was 77 percent. Six of the structures had mule deer Success Rates over 90 percent by year five of the study. Annual mule deer Success Movements through all seven structures steadily increased each year of the study. Mule deer movements around fence ends generally decreased. Mule deer Success Rate increased with increasing structure height, width, and openness ratio and decreased with increasing lengths. Before-After-Control-Impact
(BACI) analyses of UDOT crash data determined there was good evidence that the wildlife crossing structures and wildlife exclusion fence had an effect on the crash rate within the mitigation section. The US 89 Kanab-Paunsaugunt project is one of the most successful mule deer mitigation projects in all of North America.

Druta, Cristian; Alden, Andrew S. Implementation and Evaluation of a Buried Cable Roadside Animal Detection System and Deer Warning Sign. Virginia Transportation Research Council; Virginia Department of Transportation; Federal Highway Administration, 2019, 37p https://trid.trb.org/view/1629290
Abstract: Animal-vehicle collisions (AVCs), and deer-vehicle collisions (DVCs) in particular, are a major safety problem on Virginia roads. Mitigation measures such as improved fencing and location-specific driver alerts are being implemented and evaluated in Virginia and elsewhere. One of the most promising mitigation methods uses a buried cable animal detection system (BCADS) to provide roadside or in-vehicle warnings to approaching drivers based on the active presence of an animal on or near the roadway. BCADS may also be deployed in combination with exposure controls such as fencing to provide monitored, at-grade, animal crossing zones where conventional passages (e.g. culverts and bridges) are unavailable. In this study, the Virginia Department of Transportation (VDOT) in collaboration with the Virginia Tech Transportation Institute (VTTI) implemented and monitored the performance of a BCADS on a public road to provide a real-world assessment of system capabilities and possible operation issues. The BCADS has proved effective and reliable in a previous evaluation performed under more controlled and secure conditions at the Virginia Smart Road facility in Blacksburg, VA. A BCADS was installed on State Route 8 in the town of Christiansburg, VA on a road segment known to have a relatively high rate of DVCs. The system identified crossings of large- and medium-sized animals and provided data on their location along the length of the sensing cable. The BCADS and associated surveillance and communications equipment were powered by a solar photovoltaic system. A cellular modem provided for remote system monitoring and data collection. A flashing light "Deer Crossing" warning sign was installed at the site and was wirelessly linked with the BCADS to alert approaching drivers when an animal crossing was detected. Continuous BCADS and all-weather video surveillance data were collected during an 11-month period (November 2017-September 2018) to monitor animal movement, vehicle traffic, and system performance. Data on driver response to the activated warning sign during the dawn and dusk hours were collected in two separate daily sessions within a 3-month period. Study findings indicate that the BCADS is capable of detecting larger animals such as deer, and sometimes smaller animals such as coyotes, with approximately 99% reliability. The system also performed well when covered by approximately 60 cm (2 ft) of snow. Moreover, the system was tested under various vehicle traffic conditions, and rare instances of relatively minor interferences were observed. Vehicle speed and brake light application data collected during warning sign activation showed that approximately 80% of drivers either braked or slowed in response, indicating that the sign was effective.

Abstract: The Virginia Department of Transportation (VDOT) began posting deer advisory messages on changeable message signs (CMSs) along a 16.7-mile segment of I-64 between Waynesboro and Charlottesville, Virginia, in October 2015. The posting of these messages during the peak of deer activity, October-November from 5 P.M. to 9 A.M., was intended to raise driver awareness and reduce the high number of deer-vehicle collisions (DVCs) in the area. The effectiveness of deer advisory messages with regard to DVC reduction is largely unknown. This study investigated the effectiveness of seasonal deer advisory messages as a DVC mitigation option. Effectiveness was determined by evaluating deer carcass removal data from three October-November deer advisory posting periods. Vehicle speed evaluations were also conducted to determine whether drivers reduced speed in response to the advisories. For the 16.7-mile section of interstate evaluated, deer carcass removals were significantly lower when deer advisories were posted than
when they were not posted, and this difference was statistically significant. During the time deer advisories were posted, there were statistically significant reductions in speeds of up to 2.8 mph at four of the five vehicle sensor stations. Speed reductions were greater when deer advisories were posted during lower traffic volumes. Given the findings in the study area, seasonal deer advisory messages on an interstate appear to be an effective form of DVC mitigation. The study recommends that deer advisory messages continue to be posted on the CMSs selected in this study and that the number of postings be increased from the current 29% proportion of the days in the posting period to at least a 50% proportion when possible. Posting seasonal deer advisories every other day on the five existing CMSs in this study’s project area is expected to save approximately $595,500 to $1.2 million over the service life of the CMSs. The findings of this study will be shared with appropriate VDOT staff so they may consider posting deer advisory messages on CMSs in areas with high frequencies of deer crashes where appropriate.

Gagnon, Jeffrey W; Loberger, Chad D; Sprague, Scott C; Boe, Susan R; Ogren, Kari S; Schweinsburg, Raymond E. Wildlife-Vehicle Collision Mitigation on State Route 260: Mogollon Rim to Show Low. Arizona Game and Fish Department; Arizona Department of Transportation; Federal Highway Administration, 2017, 94p
https://trid.trb.org/view/1483161
Abstract: Wildlife-vehicle collisions (WVC) account for 32 percent of all collisions along State Route (SR) 260 above the Mogollon Rim (Rim). To facilitate projected traffic volumes and improve design standards from Overgaard to U.S. Route 60, the Arizona Department of Transportation first initiated a Location/Design Concept Report (L/DCR). This research study then was initiated to inform and adjust preliminary solutions to address WVC and maintain habitat connectivity along SR 260 from the Rim to Show Low (mileposts 280-340). The primary objectives were to evaluate elk and deer movements along SR 260 and spatial and temporal WVC patterns, before then recommending locations for wildlife crossing structures. The research team used Global Positioning System (GPS) and WVC data and additional factors to identify 18 priority one mile segments for consideration of wildlife crossings. The team also made recommendations for right-of-way wildlife-exclusion fencing, wildlife crossings, escape ramps, lateral access roads, and maintenance considerations.

https://trid.trb.org/view/1437358
Abstract: Deer-vehicle collisions (DVCs) are a nationwide concern resulting in loss of human lives and financial loss from vehicle damage. Wildlife warning reflectors, vehicle-mounted sound emitters, and roadside fences have been proposed to mitigate DVCs. However, these deterrents have been marketed and implemented with little scientifically based testing of their efficacy, especially in terms of how they are perceived by deer and how they do (or do not) alter deer behaviors. This paper provides a detailed review of a 14-year collaborative research program between Georgia Department of Transportation (GDOT) and university researchers designed to investigate the sensory abilities of white-tailed deer (Odocoileus virginianus) and deer behavior as a basis for testing methods for deterring deer from entering roadways. State highway departments should consider the results of this empirical research before implementing vision- or sound-based deterrents or roadside fencing. These results also will provide a basis for planning additional research projects designed to mitigate DVCs in other states.

Abstract: Animal-vehicle crashes (AVCs), though somewhat rare as compared to other crash types, can result in severe injuries to crash-involved persons. This may be especially true when these crashes involve large animals such as cattle, horses, elk, or deer; a particular concern in western US states. A majority of the previous research on AVCs has focused on factors affecting the frequency of such crashes, and much has focused exclusively on deer-vehicle crashes. In order to gain new insights into factors affecting the severity of AVCs involving different animal types, this study presents an analysis using six years of AVC crash data from the state of Arizona. Factors affecting the injury severity of over 12,000 drivers and front-seat occupants (as well as motorcyclists) involved in single-vehicle AVCs were analyzed through the development of an ordered logit statistical model. In order to account for unobserved heterogeneity, random parameters (RP) were introduced and the RP ordered logit model provided a significantly superior fit compared to a standard ordered logit model with fixed parameters. Several person-vehicle-roadway-environmental-related variables, as well as animal type, were found to significantly affect the injury severity of persons involved in AVCs. Interestingly, AVCs involving animals classified as livestock or pets were more likely to result in severe injury outcomes than those involving wild game or non-game animals. Ultimately, the results of this study provide important insights which can be used by transportation agencies for planning engineering-, enforcement-, or educational-related countermeasures aimed at reducing the severity of AVCs.

Donaldson, Bridget M; Kweon, Young-Jun; Lloyd, Lewis N. An Evaluation of Roadside Activity and Behavior of Deer and Black Bear to Determine Mitigation Strategies for Animal-Vehicle Collisions. Virginia Transportation Research Council; Virginia Department of Transportation; Federal Highway Administration, 2015, 43p
https://trid.trb.org/view/1371706
Abstract: Virginia is consistently among the top 10 states with the highest number of deer-vehicle collisions (DVCs), with more than 56,000 DVCs per year since 2007. The Virginia Department of Transportation has targeted a section of I-64 on and near Afton Mountain for safety and mobility improvements because of a high number of crashes and traffic stoppages. DVCs are a primary driver safety concern in the area, and vehicle collisions with black bears are also relatively frequent. Mitigation strategies are needed to address this issue. The purpose of this study was to evaluate white-tailed deer activity and behavior along (1) an interstate roadside adjacent to unfenced isolated underpasses used by deer and (2) a stream corridor / highway intersection with no viable underpass for deer. Although not a primary focus, black bear and other wildlife activity was also evaluated. Two years of camera data and animal carcass removal data were analyzed to gain a better understanding of deer and black bear activity and behavior relative to the two road and landscape features. Cameras were installed at a large bridge underpass and a box culvert (both used by deer to cross beneath the highway) and along the adjoining 0.5-mile roadside on both sides of the underpasses. Despite frequent use of the underpasses by deer (1,187 per year), there was high deer activity along the adjacent roadside (1,182 per year). A statistically significant relationship was found between roadside deer activity and DVCs (i.e., as deer activity increased, DVCs increased), and this relationship was strongest in October and November. Although highway crossing attempts comprised a low proportion of deer behavioral responses (n = 100 crossing attempts), crossing attempts resulted in 7.5 DVCs per year on the 1-mile highway segments adjacent to each unfenced underpass. Deer along the roadside exhibited relatively low responsiveness (or vigilance) to the interstate; predominant behaviors included walking along the roadside and feeding. At the stream corridor / highway intersection, cameras were installed at the intersection and extended along the adjoining 0.25-mile roadside on both sides of the intersection. Bear were more active along the roadside near the stream corridor than at the underpass sites. The stream corridor and associated topography were found to concentrate deer movement toward a relatively short section of highway; deer activity was statistically higher nearest the stream corridor / highway intersection and decreased farther away from this intersection. DVCs were statistically correlated with roadside deer activity and were significantly higher during October and November than during the other months of the year. Study recommendations include (1) the installation of fencing along the roadside adjacent to existing large underpasses, and (2) an animal advisory message on the dynamic message signs along I-64 in the Afton Mountain area. Messages should be displayed from dusk
through dawn from October through November (to correspond with periods of higher deer activity and DVCs). Fencing both sides of just one underpass is expected to result in a savings in costs associated with DVCs of $501,473 over its service life. A planned post-mitigation study may find that these low-cost forms of mitigation could have a substantial impact on drivers and wildlife, particularly if implemented on a larger scale.

Osborn, David A; Stickles, James H; Warren, Robert J; Miller, Karl V. Development and Evaluation of Devices Designed to Minimize Deer-Vehicle Collisions: Phase III. University of Georgia, Athens; Georgia Department of Transportation, 2015, 109p
https://trid.trb.org/view/1376008
Abstract: To better understand factors that might contribute to deer-vehicle collisions (DVC), the authors captured 32 deer within a 5-mile test roadway along Interstate 20 near Madison, Georgia and fitted them each with a Global Positioning System collar to monitor their use of the highway right-of-way (ROW). Deer ROW use occurred primarily during nighttime hours with about 37% of locations within the ROW occurring between 2200-0300 hours. Increased ROW use by female deer during May and June was likely due to females selecting the ROW for parturition. The authors also evaluated the annual distribution of DVCs in Georgia based on records of DVCs from 2005-2012 (n = 45,811) to identify peaks in DVCs for each of Georgia’s 159 counties, compared to statewide data on deer breeding dates. The authors observed high concurrence among timing of peak DVCs, peak conception, and peak rut movement. The authors also evaluated DVC risk based on the temporal pattern of DVCs; traffic volume; deer movement rates; and known frequency, timing, and landscape features associated with deer road-crossing activity. The results indicated that DVC risk for individual motorists was high throughout the entire nocturnal period, not just during the crepuscular period as would be suggested solely by the incidence of DVCs without considering traffic volume. Also, the increased frequency of road crossings by deer in low-traffic, forested areas may lead to a greater risk of DVC than suggested by evaluations of DVC frequency alone. To potentially reduce DVC risk, the authors recommended: (1) targeted removal of deer that were frequent ROW users, (2) warnings issued to motorists about the increased risk of encountering deer in the ROW during late-night travel, and (3) modifying ROW habitat to help maintain ROW fences and reduce food and cover resources. For assessing the timing of the breeding season at a county or regional scale, DVC data are cost effective and less susceptible to measurement biases compared to traditional methods employing deer fetus measurements. In addition, mapping the peak occurrences of DVCs can be used to strategically warn motorists of increased risk within a few weeks of peak deer breeding at the county level. The authors also conducted an operational field trial to retrofit top-mounted outriggers to existing 1.2-m, woven-wire, ROW fencing. Despite repairing the existing ROW fence and adding the outrigger, access to the ROW by deer was not prevented, but these results were based on a small sample size of deer that had previously accessed the ROW. Repair and maintenance of existing ROW fencing for conversion to an outrigger-style fence likely was unjustified as neither cost-efficient nor adequately effective at preventing deer from accessing the ROW. However, the outrigger-fence design might be justified for new fence construction in un-wooded terrain and when used in conjunction with traditional 2.4-m deer exclusion fence to provide deer within the ROW a route of escape.

Osborn, David A; Stickles, James H; Warren, Robert J; Miller, Karl V. Development and Evaluation of Strategies to Reduce the Incidence of Deer-Vehicle Collisions: Phase III - Operational Field Trial, Part A. University of Georgia, Athens; Georgia Department of Transportation; Federal Highway Administration, 2014, 56p
https://trid.trb.org/view/1346744
Abstract: To better understand deer movements that might contribute to deer-vehicle collisions (DVC), the authors conducted preparatory field work necessary for an operational field trial of the efficacy of a 1.2-m woven-wire fence with a top-mounted outrigger. The authors worked with officials from Georgia Department of Transportation (GDOT) and the Federal Highway Administration-Georgia Division to select a 5-mile segment of I-20 near Madison, Georgia. During February-June 2012 and January-April 2013, the authors captured 32 deer within the 5-mile test roadway and fitted them each with a Global Positioning System collar, programmed to
collect 24 locations per day, and monitored surviving deer until April 2014. Each deer was classified as: (1) frequent user, (2) occasional user, or (3) rare user based on highway right-of-way (ROW) utilization. Frequent users (359.5 + 41.7 m) were closer (P < 0.01; F2, 27=8.46) to the median of I-20 than occasional (715.3 + 236.4 m) and rare (766.6 + 72.3 m) users, but occasional and rare users were the same distance (P > 0.05) from the median. Within the frequent user group, the percentage of ROW locations for individuals ranged from 1.7% to 25.8%. Deer ROW use occurred primarily during nighttime hours with about 37% of locations within the ROW occurring between 2200-0300 hours. Increased ROW use by female deer that were frequent users during May and June was likely due to females selecting the ROW for parturition. The authors also evaluated the annual distribution of DVCs in Georgia based on records of DVCs from 2005-2012 (n = 45,811) to identify peaks in DVCs for each of Georgia’s 159 counties, compared to deer breeding data from the Georgia Department of Natural Resources. The authors observed high concurrence among timing of peak DVCs, peak conception, and peak rut movement. To potentially reduce DVC risk, the authors recommend: (1) lethal removal of frequent ROW users, (2) warning motorists of the increased risk of encountering deer in the ROW during deer breeding seasons and while driving late at night, and/or (3) modifying ROW habitat to help maintain ROW fences and reduce food and cover resources that can attract deer to roadways.

Abstract: The authors investigated the reliability and effectiveness of a microwave break-the-beam animal detection system along State Hwy 3 near Ft Jones, northern California, USA. The results indicated that the system was capable of detecting a human and was therefore likely to be able to detect large ungulates such as black-tailed deer. While blind spots were absent some of the beams did show evidence of desensitizing during testing. A comparison of the detection data to video images associated with the system showed that at least 74% of all detections could be considered “correct.” Unidentified triggers occurred mostly in the late afternoon or night when camera range was limited. About 93% of the correct detections related to vehicles turning on and off the highway on side roads. Only about 4% of the correct detections related to black-tailed deer. Drivers reduced vehicle speed by about 5.5% when warning signs were activated (from 56.2 mi/hr (90.4 km/h) to 53.1 mi/hr (85.4 km/h)). Regarding the effectiveness of the system, speed reductions were greatest during the evening and night. There was one deer-vehicle collision recorded in the road section with the system after the system and signs were put into operation. However, it was not possible to conclude whether the animal detection system may have reduced the number of large mammal-vehicle collisions. The authors recommend improving the reliability of the system, reducing potential downtime, operation, and maintenance costs, improving the warning signs, and to implement an extensive public outreach program.

Abstract: A nine mile stretch of U.S. 97 Alternate Route (US 97A), north of Wenatchee, has a long history of high rates of collisions between vehicles and deer. In this area, the highway parallels the Columbia River. In 2002, bighorn sheep began frequenting the roadsides attracted, in part, by lush irrigated landscaping plants on properties bordering the highway and lining the Columbia River shoreline. Losses of deer and sheep to collisions concerned everyone, especially the Washington Department of Fish and Wildlife and the local Sportsmen’s Association. Annual deer carcass removals from this nine mile stretch of highway were typically 30-50 animals, with a high of 67 in 2003. Some years, as many as nine bighorn sheep were known killed here. Bighorn sheep were also known to create a driver distraction, with drivers slowing or stopping in hazardous locations, likely contributing to additional accidents. Although bighorn sheep do not comprise a
significant portion of the wildlife mortalities on US 97A, their visibility, uniqueness, and relatively small numbers
endear them to the public. Construction of a barrier fence was considered beneficial to both bighorn sheep and
deer. Prior to making the decision to pursue funding and public support for constructing such a fence, the
Washington Department of Fish and Wildlife determined that the animals did not need to cross the highway to
get to water or other important resources in the narrow strip of land between the road and the river. Obtaining
funding and permits and securing a route for the fence took years. However, a nine mile fence was eventually
built, in two phases. Each phase came with its share of challenges that included excessively rocky, often steep
terrain, oppositional landowners, quite a few intersecting side roads and the need to consider how to get
animals out of the right-of-way once they found their way in. Contractors, engineers and biologists all had input
into fence design and construction. The budget implications of designing the fence to contain bighorn sheep
contributed to a cost increase on the order of 100% (or more) due largely to the ability of sheep to traverse
very steep, rocky terrain. The total cost of the project was $2.8 million. It is now almost two years past
completion of the last phase of fence construction. Fence ends and several wildlife guards and jumpouts have
been monitored with motion-triggered cameras, with some interesting results. Reviews of carcass removal
data show a 79% reduction in deer vehicle collision rates since construction was started. Collisions with
bighorn sheep continued during fence construction but have ceased since the last section of fence was
completed. For a more robust evaluation of fence performance, several more years of carcass removal data
need to be collected and analyzed.

Barnum, Sarah; Alt, Gary. Effect of Reduced Roadside Mowing on Rate of Deer-Vehicle Collisions. Transportation Research Board 92nd Annual Meeting, Transportation Research Board, 2013, 12p
https://trid.trb.org/view/1242942
Abstract: The investigation’s objective was to determine if reducing roadside mowing causes measurable
change in deer vehicle collision (DVCs) rates. Decreased mowing may change vegetation structure which
could affect deer density and/or behavior at the roadside, or motorists’ ability to detect and react to deer
entering the roadway. Both these effects would be expected to increase the DVC rate. However, the results of
a literature review and survey of current practice conducted for the project indicated that no quantitative
evaluation of this concept has been conducted. The number of DVC/year were compared before and after
mowing was reduced at six locations in Maryland and four locations in New York to determine if there was a
statistically significant difference in DVC rate between the two time periods. Three years of before data were
compared to three years of after data, and the predictive relationship of mowing regime on DVC rate was also
examined. Five study areas reported more DVC/year after mowing was reduced, four reported more DVC/year
before mowing was reduced, and one experienced essentially no change. Results from three New York study
areas were marginally significant (p =0.10), but the direction of change was inconsistent. None of the Maryland
study area changes were significant. The R2 values between DVC and mowing were significant (p value
<0.05) for only one of the ten study areas tested. Small sample sizes were used, and results should be
interpreted with care. However, the results do not suggest DVC rates are related to mowing regime.

Jackels, Jon; Hansen, Ken. Wildlife Detection and Warning - Phase II. ITS America 22nd Annual Meeting &
https://trid.trb.org/view/1215858
Abstract: This presentation will detail a study that MnDOT is conducting to reduce the number of deer/vehicle
crashes (DVC). It is estimated that there are over 35,000 DVC yearly in the state resulting in 3 to 11 deaths,
over 400 personal injuries, and close to 4,000 reported property damages of one thousand dollars or more.
The design chosen for the Wildlife Detection and Warning project implements a break-the-beam detection
system. A deer is detected when it crosses through an infrared beam. Once detected, a wireless signal is
transmitted to flashing beacon mounted on a standard deer crossing sign. The flashing beacon will warn
motorists of the presence of deer increasing awareness and potentially speed. The first system installed in
Minnesota is along Trunk Highway 23, 12 miles south of Marshall, MN. The one mile section is between the
wooded area of Camden State Park and farm fields. DVC data was collected based off of deer carcass counts
provided by the Minnesota DNR. During the first year of operation DVCs were reduced by 57%. During the first 6 months of the second year, DVCs were reduced by 33%. The second system installed in Minnesota is along Hennepin County State Aid Highway 121 in Dayton, MN. The 0.6 mile section is located along the wooded area of Elm Creek Park. In addition to the break-the-beam detectors, this system will use one passive infrared device to demonstrate new technology. Also, inductive loops are also placed at the entrance to an archery range to eliminate false deer detections by entering or exiting vehicles. Given the previous experience with the Marshall wildlife detection system reducing DVC, the Dayton wildlife detection system will be evaluated based on operational time. This analysis will determine what percentage of the time drivers will likely receive the DVC reduction. Preliminary conclusions and recommendations of the Dayton wildlife detection system will be presented.

https://trid.trb.org/view/910902
Abstract: Collisions between vehicles and wildlife are a serious problem in many countries around the world. Ungulate-vehicle collisions are the most problematic, because the damage from such collisions, including injuries and fatalities of humans and animals, tends to be serious. The number of sika deer on Hokkaido, the northernmost island of Japan, is steadily increasing, as are deer-vehicle collisions (DVCs) there. To achieve greater traffic safety and harmony between wildlife and humans by developing measures to prevent such collisions, this study investigated the details of DVCs on the seven national highways in the Tokachi area, one of the most DVC-prone area in Hokkaido, using a database that includes the number of DVCs for the 12 years from 1995, each DVC location, the route name and the pickup date. First, the relationship between DVC frequency and deer seasonal behavior was investigated. Next, a Poisson regression model was used to understand the effect of explanatory valuables on the number of DVCs. These explanatory valuables included DVC site topography features such as avg. annual max. snow depth, avg. elevation, vegetation type, land-use classification, distance from the nearest river and average day traffic volume (ADT). A topographic dataset including the spatial distribution of avg. elevation and of avg. annual max. snow depth, and landscape features within 1,000-m-radius zones around each kilopost on each sample route was created by using GIS software. Those analysis results identified the specific conditions of DVC-prone sites. For example, it was found that collisions tended to be more common in the spring migratory season and the autumn breeding season, and on road sections through woodland or those in a border area between woodland and farmland. These results provide useful information for identifying what DVC prevention measures should be implemented and where they should be implemented.

Pooledfund.org
Wildlife Vehicle Reduction and Habitat Connectivity
https://pooledfund.org/Details/Study/610

Animal Vehicle Mitigation Using Advanced Technologies
https://pooledfund.org/Details/Study/305

Animal Vehicle Mitigation Using Advanced Technologies
https://pooledfund.org/Details/Study/222