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Human Fatalities in Animal-Related Highway Crashes

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ABSTRACT

The objective of this paper is to investigate national and statewide trends in the relatively uncommon animal-related highway crashes that involve human fatalities. Highway crashes in which animals are struck by vehicular traffic regularly occur throughout the US. Such crashes are most damaging to the struck animals while injuries to humans are usually not as severe. As such, significant research has focused on the plight of animals involved in traffic crashes. However, over the past decade animal-related crashes in the US have claimed 1,353 human lives costing the nation well over a billion dollars in losses. Injury and property damage costs of crashes not involving human fatalities are in addition to the above estimate. Research reported in this paper is focused on national and statewide trends in fatality-producing animal-related vehicular crash frequencies and rates. Additionally, temporal aspects of these crashes and trends in persons and vehicles involved in these crashes are investigated.

The analysis utilized the Fatality Analysis Reporting System (FARS) database, which was combined with information from other sources in a geographic information system. Statistical analysis indicated that fatality-producing animal-related crashes are increasing nationally and this trend is attributable to increasing vehicle miles traveled. The rate for fatality-producing animal-related crashes is holding steady at the national level. Human fatalities in such crashes occur at times when animals are more active. Among human fatalities, unrestrained persons are more often killed than restrained persons. The information presented in this paper is suitable for agencies assessing the issue of human fatalities in animal-related crashes and for driver education and awareness programs.

Key words: data integration, transportation safety, national, state, trends

INTRODUCTION

Highway crashes that involve animals struck by vehicular traffic occur throughout the US. Invariably, these crashes are most damaging to the animals while humans usually escape with relatively less severe injuries. However, during 1991-2000, a total of 1,353 human fatalities were reported in 1,270 crashes involving 1,536 vehicles. Using Blincoe's (*1*) estimates for crash costs, the loss from these fatal crashes is well over one billion dollars. Injury and property damage costs from crashes not involving human fatalities are in addition to the above estimate. Unfortunately, animal-related highway crashes resulting in human fatalities have received relatively little attention in research and literature. The objective of this study is to review nationwide and statewide trends in animal-related crashes resulting in human fatalities and to investigate temporal aspects and trends in persons and vehicles involved in such crashes.

The following section provides a review of past literature on animal-related vehicular crashes. The section following the literature review describes the data analyzed in this study. The next section presents results of the analysis. The paper concludes with a summary of the findings and research conclusions.

LITERATURE REVIEW

Significant literature exists on the deleterious effects of highways and traffic on different animals. Some of the issues addressed include animal mortality, habitat partition, effects on animal diversity, and spatial distribution of wildlife in proximity of highways. The effects on animal population were of concern as early as 1933 when 598 dead rabbits were counted on 50 miles of two-lane asphalt road near Boise, Idaho in a single day (*2*).

Vehicular crashes with animals have received attention from safety professionals because the frequency of such crashes has increased over time. For example, Story and Kitchings (*3*) reported an annual increase of 43.8% in whitetail deer road kill during 1969–1977 compared to an 8.2% traffic volume increase. Mortality was highest in the fall, and more males than females were killed among both fawns and adult deer. Similarly, Hughes et al., (*4*) reported 69% increase in vehicle-animal crashes between 1985 and 1991. More recently, Johnson (*5*) reported a 50% increase in vehicular collisions with animals from 1999 to 2000.

Investigating crashes on two-lane rural North Carolina highways, Khattak & Hummer (*6*) reported animal-related crashes as one of the predominant crash category. Such crashes were

reported more often during November and December, under dark and unlit conditions, and more frequently involved passenger cars. Alcohol played almost no role in such crashes. Fewer animal-related crashes occurred over wet, snowy, and icy roadway surfaces. Straight roadway sections experience more animal collisions than anticipated.

Particular animals have been investigated for their propensity to be involved in vehicular crashes. Hughes et al., (*4*) indicated that deer were more frequently involved in traffic crashes than any other animal. Gunther et al., (*7*) studied road kill in the Yellowstone National Park and reported elk and mule deer as the species most often killed in animal-related traffic crashes. Other species killed included bison, moose, coyote, antelope, beaver, whitetail deer, bighorn sheep, black bear, bobcat, grizzly bear, raccoon, and wolf. They concluded that speed of vehicles was the primary factor contributing to vehicle-animal crashes. Land cover types and animal population also influenced crash frequency. Overall, vehicle-caused animal mortality did not have a negative impact on population of large mammals in the park.

Garrett and Conway (*8*) reported an increase of 23% between 1991 and 1995 in moose-vehicle collisions in Anchorage, Alaska. Of the 519 such reported crashes, 23% resulted in injury to 158 people, with no human fatalities. In another study, also focused on moose-vehicle crashes, Bjoernstig et al. (*9*) reported that non-fatal injuries were usually caused by the impact of moose on the windscreen and front part of the vehicle roof. Injury severity was correlated to vehicle deformation; head and neck injuries predominated among vehicle occupants, specially among those killed in the crash. Larger animals, higher speeds, and smaller-sized vehicles were other characteristic features of fatal accidents. Finally, Romin and Bissonette (*10*) provide information on the status of state monitoring activities and mitigation efforts related to deer-vehicle collisions and Conover (*11*) provides information on the monetary and intangible valuation of deer in the US.

Literature Summary

From the literature review, it seems that animal-related vehicular crashes are increasing over time and these crashes mostly involve deer. Vehicle speed, animal population, and land cover influence crash frequency. Animal-related crashes occur more often during November and December and usually involve passenger cars. Injuries to

humans are caused by animals hitting the vehicle windscreen while head and neck injuries predominate among human crash victims. Other important attributes in animal-related crashes resulting in human fatalities are the animal size, vehicle size, and vehicle speed.

The reviewed literature did not reveal information on national and statewide trends in animal-related crashes involving human fatalities. The next section presents information on the processes used to obtain an appropriate dataset that was subsequently analyzed to obtain information on national and statewide trends.

DATA

Data from multiple sources were manipulated in a geographic information system (GIS) to construct the dataset analyzed in this study. For GIS, Environmental Systems Research Institute (ESRI) software ArcView was utilized. State geographic files were obtained from files that accompany ArcView. Fatality Analysis Reporting System (FARS) 1991–2000 data were used to obtain information on animal-related crashes that resulted in human fatalities. The data are available online at: <http://www-fars.nhtsa.dot.gov/>. A ten-year period was deemed sufficient for this analysis. Consideration of a longer period may involve non-availability of data on some of the variables since FARS occasionally replaces existing variables with new variables. Given that human fatalities in animal-related crashes are relatively rare, a shorter period might not have enough observations to provide meaningful results.

Established in 1975, the FARS database includes information on all fatal crashes that occur within the 50 states, the District of Columbia, and Puerto Rico (*12*). To be included in this census, a crash must involve a motor vehicle that is traveling on a public roadway and it must result in the death of a person within 30 days of occurrence. FARS data files provide information on fatal crashes, persons involved, and vehicles involved in those crashes. Because of the seriousness of fatal crashes, the collected data are of high quality. For this research, the 10-year crash files were reduced to those involving animals. The corresponding person and vehicle files were then obtained by matching the state case number, which is unique for each crash and is common among the three (crash, person, vehicle) files. The data were summarized for each state and each year and then input to the GIS. Unfortunately, the FARS data do not contain any

information on the animal species that was struck in the crash. Therefore, the set of crashes analyzed in this paper involve many species and include domestic as well as wild animals. Given the abundance of deer involvement in animal-related crashes, it is fairly likely that the majority of crashes involved deer rather than any other animal. However, a definite statement cannot be made in this respect.

Data on public roads in each state were collected for 1991–2000 from the yearly published Highway Statistics (Section V: Roadway Characteristics and Performance) by the Federal Highway Administration (FHWA). These data are available online at: <http://www.fhwa.dot.gov>. Series HM-20 tables provided urban/rural mileage in each state by functional classification while Series VM-2 tables provided urban/rural vehicle miles traveled (VMT) for each state by functional classification. Yearly data for each state were input to the GIS.

The above processes resulted in the creation of a GIS-based dataset that could be analyzed for investigation of various trends over time. The next section provides details of the analysis of national and statewide trends in animal-related crashes involving human fatalities. It also presents temporal trends of such crashes as well as person and vehicle trends.

DATA ANALYSIS

National Crash Frequency and Rate Trends

A total of 1,270 animal-related crashes involving human fatalities were reported nationwide during the study period (1991–2000); these crashes involved 1,536 vehicles and resulted in 1,350 fatalities. On average, 1.21 vehicles and 1.06 human fatalities were involved in each fatality-producing animal-related crash. Figure 1 shows national trends in frequencies of fatality-producing animal-related crashes, vehicles involved, and human fatalities. All three factors are related in that vehicle frequency is consistently highest while frequency of fatalities is higher than crash frequency for each year. Year 1993 stands out for relatively low frequencies while 1998 is prominent for relatively high frequencies of all three factors. The increases over the 10-year study period in the frequencies of crashes, vehicle involvement, and fatalities are 27.43%, 25.58%, and 22.95%, respectively.

The trend in all three factors is increasing with time as seen in Figure 1. However, this observation was statistically confirmed by fitting a linear model of the following form to the ten-year national data.

$$y = \beta_o + \beta_1 x \quad (1)$$

Where:

y = the number of yearly animal-related crashes involving human fatalities,

x = time in years,

β_o = estimated intercept of the line, and

β_1 = estimated coefficient of time.

The t-statistic for the estimated coefficient of time (i.e., the slope of Equation 1) for each trend was used to judge the statistical significance of each trend. A statistic equal to or greater than 2.26 represents significance at the 95% confidence level (with nine degrees of freedom). The observed t-statistics for the trends in frequencies of fatality-producing animal-related crashes, vehicles involved, and human fatalities were 3.65, 3.16, and 3.62, respectively. As such, the frequency of crashes involving human fatalities, the number of vehicles involved in such crashes, and the number of fatalities are definitely increasing at the national level.

Nationwide yearly animal-related crashes involving human fatalities were combined with yearly VMT data to obtain national crash, vehicle involvement, and fatality rates for the study period. The 10-year rates for these three factors were 5.131, 6.205, & 5.466 per 100 billion VMT. Figure 2 presents rate trends in fatality-producing animal-related crashes, vehicle involvement, and fatalities. The rates for all three factors are consistently related to each other during the study period. Year 1993 is prominent for relatively low rates of all three factors while vehicle involvement rate and crash rate during 1998 are significantly higher. The change in the rates of crashes, vehicle involvement, and fatalities over the 10-year period are 0.62%, -0.84%, and -2.92%, respectively. Note that this calculation is based on the values of 1991 and 2000; increases would have been calculated if year 1998 values were used instead of year 2000. Linear models were fit to the rate trends and the statistical significance evaluated. The results of the t-tests not indicate any significance for any of the three trends. Consequently, these trends are neither definitely increasing nor definitely decreasing with time.

If human fatality-producing animal-related crashes are increasing over time while the rate is more or less unchanged (as indicated by the above analysis), then the increasing trend in crash frequency can be attributed to the increasing VMT trend (see Figure 3). VMT increased 26.65% over the study period while crash frequency increased 27.43%. An implicit assumption here is that no significant nationwide variations in large-animal populations occurred during the study period. Absent significant variations in the populations of large animals, the increasing trend in crash frequency can be attributed to the increasing VMT since both have registered almost equal percentage rise.

Statewide Crash Frequency and Rate Trends

Statewide fatality-producing animal-related crashes were investigated to uncover trends during the study period. Figure 4 presents the 10-year crash frequencies and rates (measured in crashes per 100 billion VMT) for the different states. No fatality-producing animal-related crashes were reported in Washington D.C., Rhode Island, Connecticut, and Puerto Rico during the study period. The states with the five highest frequencies were: Texas (111), Pennsylvania (53), Wisconsin (50), California (47), and New York (47). Linear models were fit to 10-year data from each state to analyze the trend in the frequency of animal-related crashes involving human fatalities. The trends for Idaho, Nebraska, South Carolina, and Wisconsin were found to be statistically significantly increasing (95% confidence). These trends for the four states are shown in Figure 5. The magnitude of the estimated coefficient for time variable (β_1 in Equation 1) was looked at for these four states to assess the rate of increase. It was highest for Wisconsin (0.41) while it was lowest for Nebraska (0.21). The values for Idaho and South Carolina were 0.27 and 0.38, respectively. These estimated coefficients indicate the yearly increase in the frequency of animal-related crashes involving human fatalities in the respective states. No state was found where the trend was statistically significantly decreasing.

The states with the five highest 10-year crash rates measured in crashes per 100 billion VMT were: Alaska (37.89), Montana (32.53), Wyoming (27.94), Maine (19.35), and South Dakota (18.14). The trend in the rate of animal-involved crashes resulting in human fatalities for each state was looked at for statistical significance. Only one state, South Carolina, had a statistically significantly increasing crash rate trend at the at 95% confidence level (t-statistic = 2.31). The rate trends in Nebraska and Idaho were significantly increasing at the 90% confidence

level as were rate trends in New York and New Mexico. Tennessee was the only state where crash rates were statistically significantly decreasing (t-statistic = -2.39). Figure 6 presents the crash rate trends of South Carolina and Tennessee.

Finally, the magnitude of the estimated coefficient for time variable in the crash rate models were looked at to assess the magnitude of change per year for the two states. The estimated coefficient for South Carolina was 0.78 while it was –0.62 for Tennessee.

Crash Temporal Trends

Time-based aspects of animal-related crashes involving human fatalities were looked at to uncover temporal trends at the national level. Figure 7 presents crash frequency by month of occurrence. The months of October and November stand out due to high crash frequencies. These two months usually constitute mating season for many large animals in the US as well as hunting season. Increased animal activity during mating and hunting are perhaps the main reasons for the increased human fatalities.

The day of the week when the crash occurred was investigated. Figure 8 shows the crash frequency for each day of the week. Friday, Saturday, and Sunday are days with higher frequencies than other days of the week. Increased travel to rural areas may be the reason for this trend. Finally, hour of the day was looked at to investigate hourly trends in animal-related crashes resulting in human fatalities. As is evident from Figure 9, the hours between 6:00 pm and midnight constitute the bulk of such crashes. Increased animal activity during these times and limited driver sight due to darkness may be reasons for this trend.

Person and Vehicle Trends

At the national level, many more men (69.5%) were fatally injured in animal-related crashes than women (30.5%). This ratio of male and female fatalities has been more or less constant throughout the study period. The ratio of male and female drivers as well as their ratio in the general population has been about 50% each during the 19990s. It seems that males are over involved in fatal animal-related crashes. However, if males travel more than females, then one would expect more of them to be involved in such crashes. Statistics on the relative travel by males and females were not readily available for use in this study.

Sixty-nine percent of those who died were drivers of their vehicles while 29% were vehicle passengers. Alcohol drinking was involved in 9.4% of the fatalities and 52.2% of the victims were hospitalized for their injuries. For unknown reasons, the Year 2000 fatalities when the driver was drunk are 78.5% higher than those of 1999 (Figure 10). This trend needs to be studied in the coming years to see if this jump is just a random anomaly or a precursor to increased involvement of drunken drivers in fatal animal-related crashes.

Restraint (seat belt, helmet, etc.) usage among those who were killed shows only 42.4% of the victims as using some form of restraint, 52.6% were not using any, and usage was unknown for 5% of the victims. Figure 11 shows restraint usage trend during the study period. Barring 1992 and 1993, more unrestrained persons have been killed than persons using some form of restraints. Since 1991, seat belt usage has exceeded non-usage; it was estimated at 68% during 1995 as well as during 1996. The fact that more unrestrained persons are killed in animal-related crashes underscores the need for education and enforcement of seat belt and helmet use laws.

Majority of the vehicles involved in the crashes were passenger cars (47.9%), followed by motorcycles (18.2%), pickups (16.2%), and light trucks and vans (10.4%). Other vehicles such as, medium and heavy trucks, constituted the rest. The ratio among registered motorcycles and all other registered motor vehicles is about 1:50 in the US. From these statistics it seems that many more motorcycles riders are involved in fatal crashes with animals than other types of vehicles. The reason for this is obviously the lack of protection of motorcycle riders in the form occupant compartment, air bags, and seat belts.

SUMMARY AND CONCLUSIONS

This paper brings to light trends in animal-related crashes involving human fatalities. Such crashes are relatively uncommon and little information was found on this topic in the literature. Analysis of 1991-2000 FARS data indicated that the frequency of animal-related crashes resulting in human fatalities is definitely increasing at the national level while crash rates are somewhat steady. The increasing crash frequency may be attributed to the increasing VMT since both have registered about 27% rise during the study period.

The states with the highest frequency of fatalities were Texas, Pennsylvania, Wisconsin, California, and New York. However, the 10-year trend was found to be statistically significantly

increasing for Idaho, Nebraska, South Carolina and Wisconsin. Among these four states, the yearly increase in crash frequency was highest for Wisconsin. South Carolina was found to have a statistically significant increasing crash rate, as well. Tennessee was the only state with a definite downward trend in crash rates.

Regarding temporal trends, majority of the crashes were reported during the months of October and November, on Friday, Saturday, and Sunday and between 6:00 pm and midnight. Majority of the victims were men and drivers of their vehicles. Many more unrestrained persons were killed than those using some form of restraint. Majority of the involved vehicles were passenger cars, however, motor cycles are over-represented in fatal animal-related crash.

The following conclusions are reached from this research:

1. National trend in the frequency of animal-related crashes involving human fatalities is definitely increasing while crash rates are holding somewhat steady.
2. The trend in the frequency of animal-related crashes involving human fatalities is increasing in Wisconsin, Idaho, South Carolina, and Nebraska.
3. The rate of animal-related crashes involving human fatalities is increasing in South Carolina while it is decreasing in Tennessee.
4. Human fatalities occur in animal-related traffic crashes at times when the animals are more active and among the fatalities, unrestrained persons are over-represented.

The information uncovered in this research should be useful to state and other agencies in assessing the issue of human fatalities in animal-related crashes in their jurisdictions. Since one of the main countermeasures for preventing animal-related crashes is driver education and awareness, the information on temporal trends and person and vehicle trends presented in this paper can be utilized in driver education and awareness programs.

ACKNOWLDGMENT

ESRI products were utilized in this research. Trade or manufacturer's names in this paper are cited only because they are essential to this paper and the citations do not constitute endorsements. The contents of this paper reflect the views of the author and do not necessarily reflect the views of any local, state, or national agency/organization.

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List of Tables and Figures

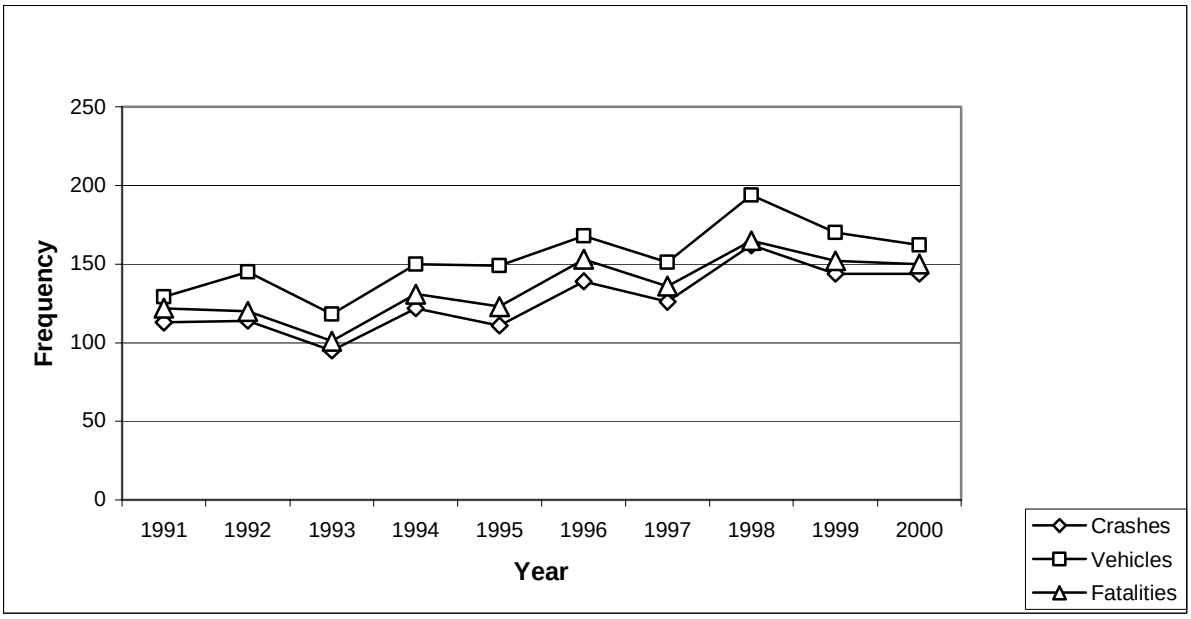

Figure 1. Frequency trends in fatality-producing animal-related crashes, vehicle involvement, and fatalities

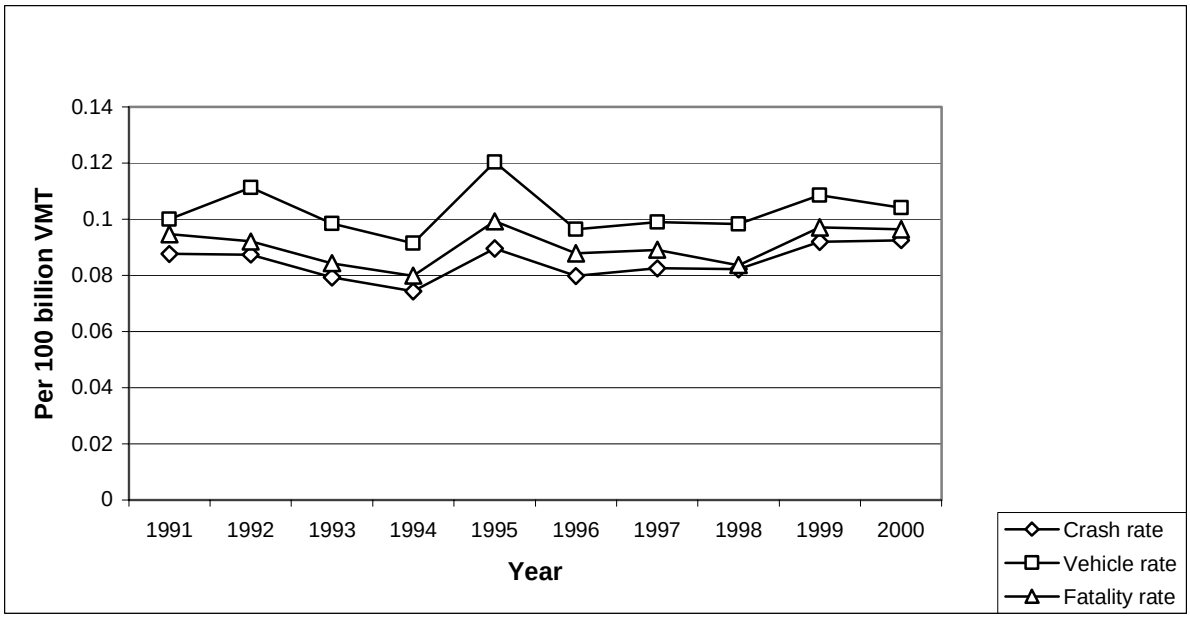

Figure 2. Rate trends in fatality-producing animal-related crashes, vehicle involvement, fatalities

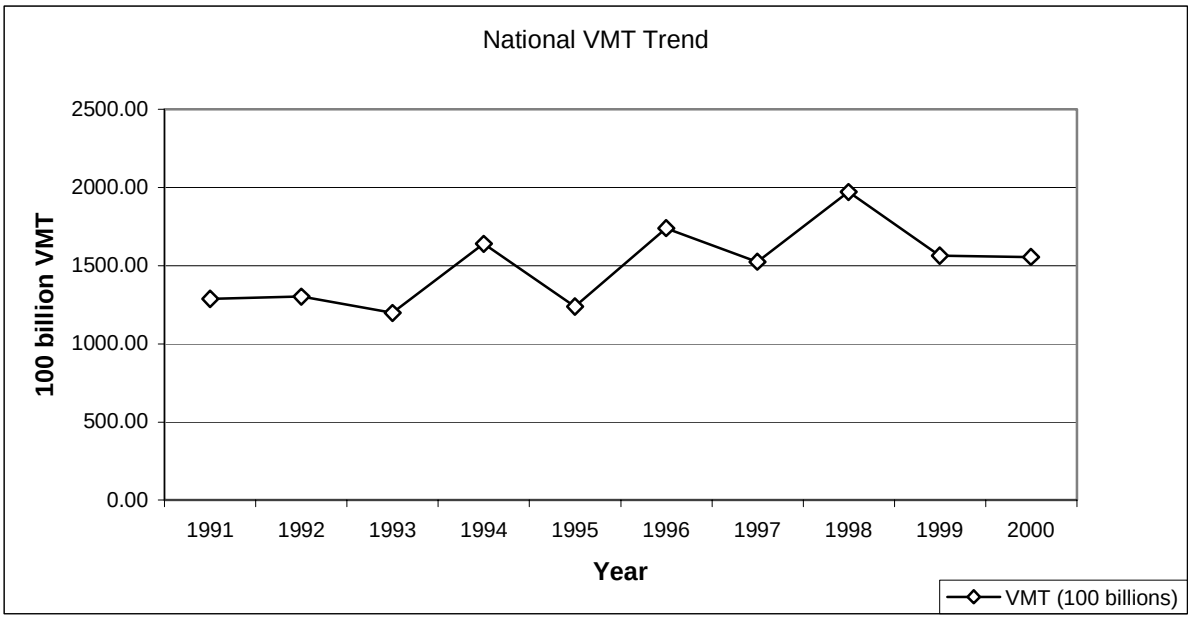

Figure 3. National VMT trend

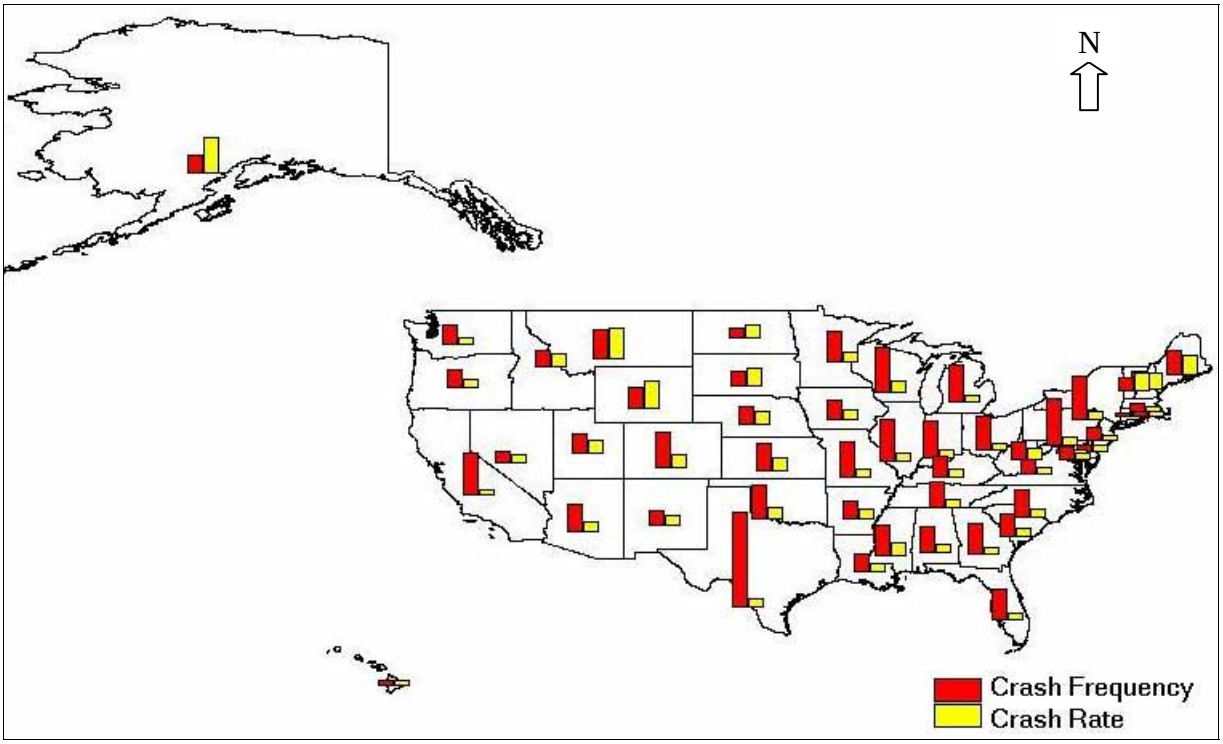

Figure 4. Frequencies and rates for fatality-producing animal-related crashes
(Note: Alaska & Hawaii displaced from their true geographic locations)

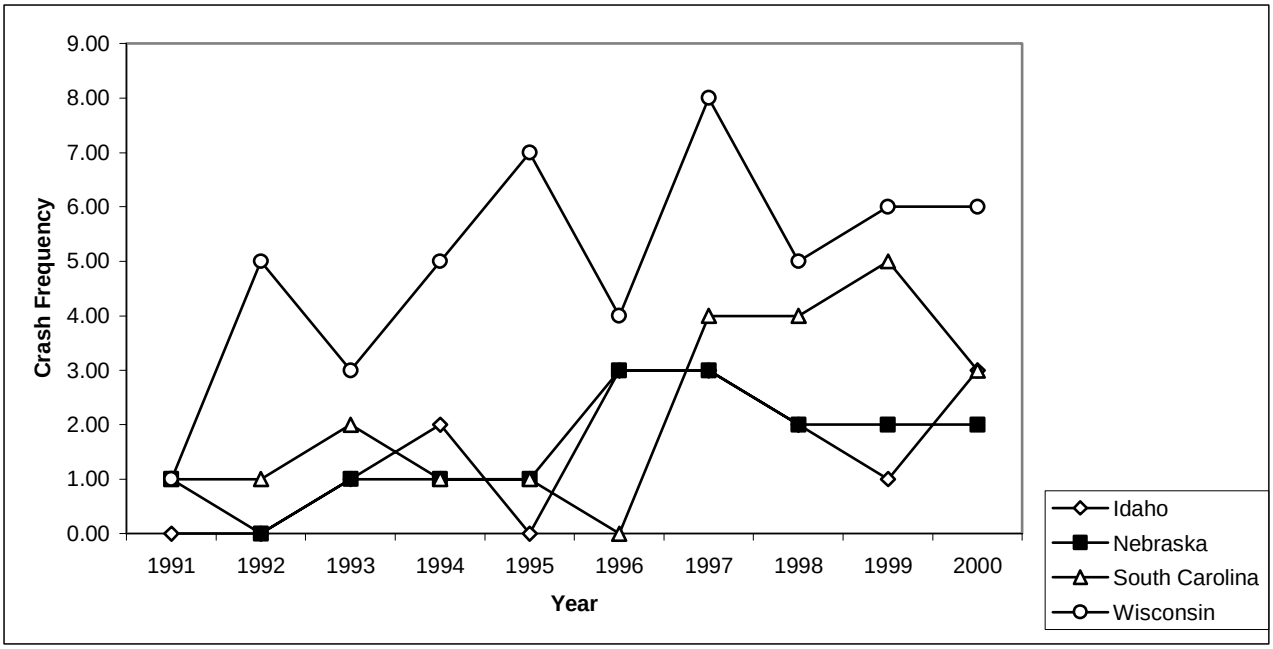

Figure 5. Statistically significantly increasing crash frequency trends for four states

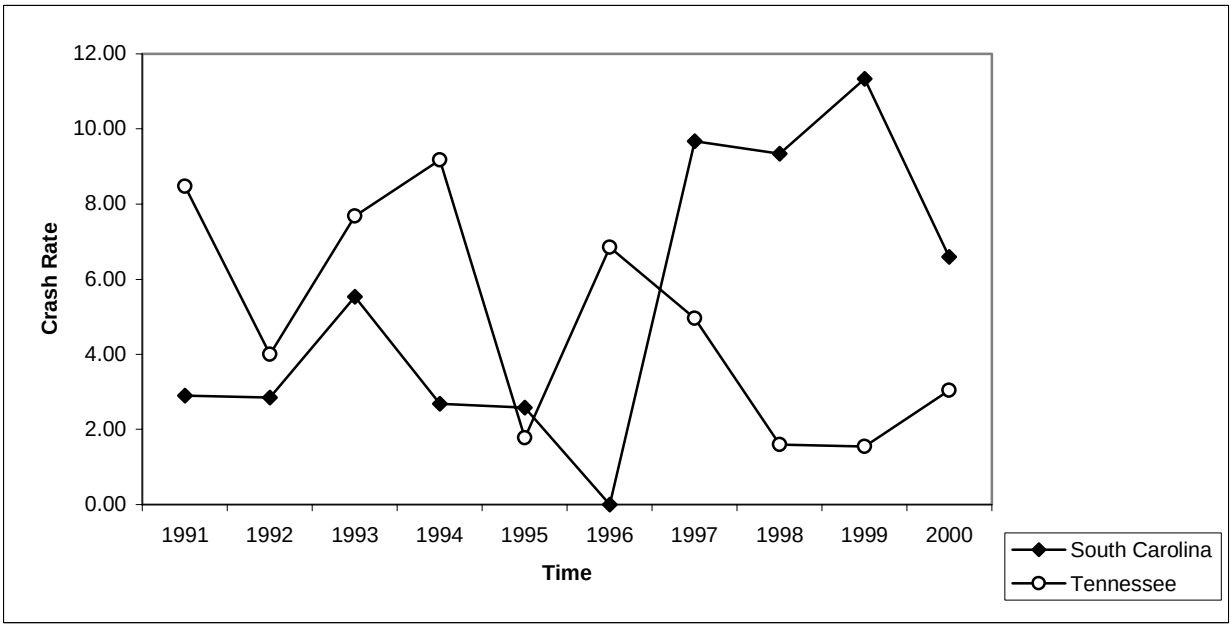

Figure 6. Crash rates for two states with statistically significantly increasing and decreasing trends

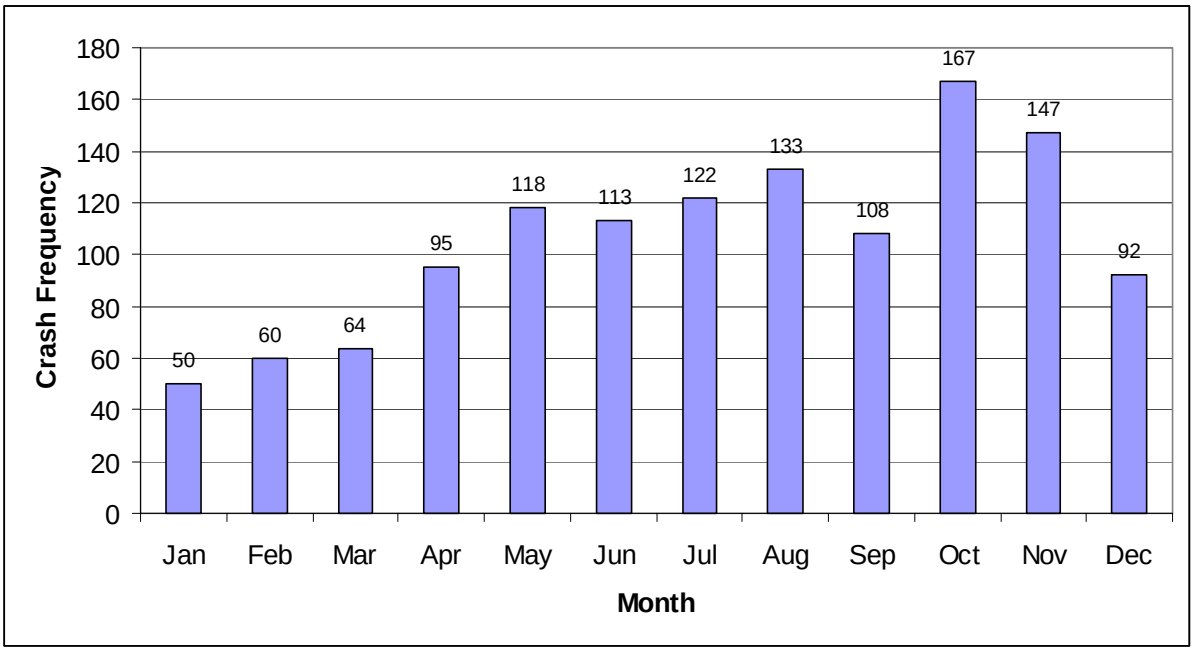

Figure 7. Monthly trend in animal-related crashes involving human fatalities

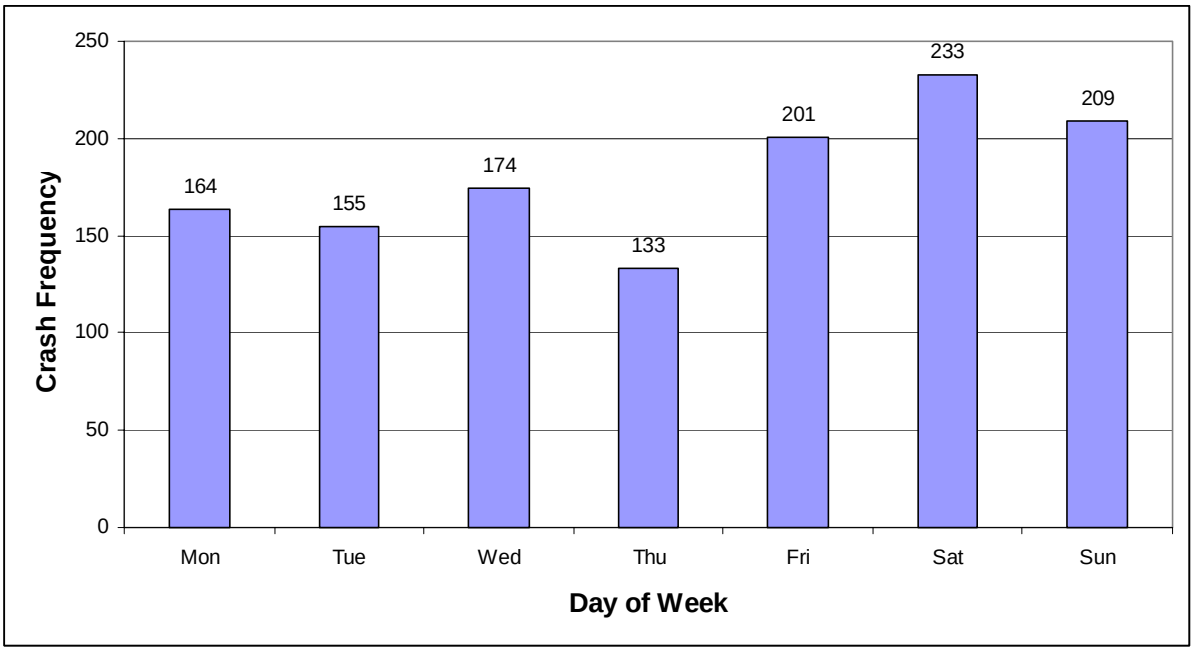

Figure 8. Weekly trend in animal-related crashes involving human fatalities

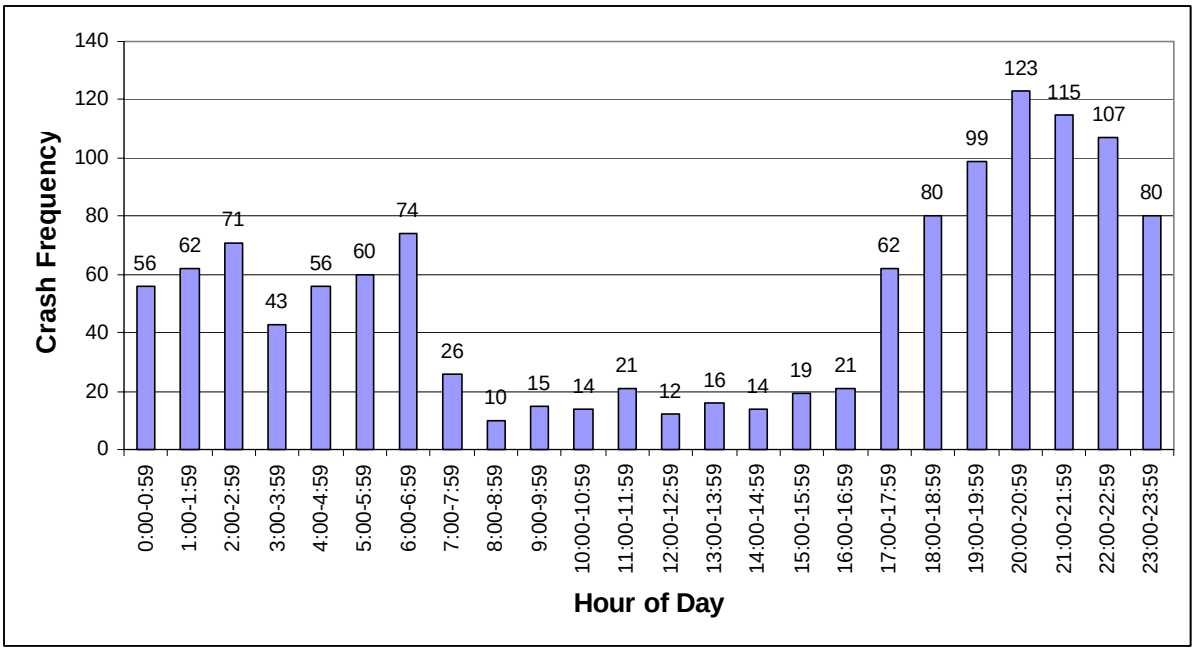

Figure 9. Hourly trend in the occurrence of animal-related crashes with human fatalities

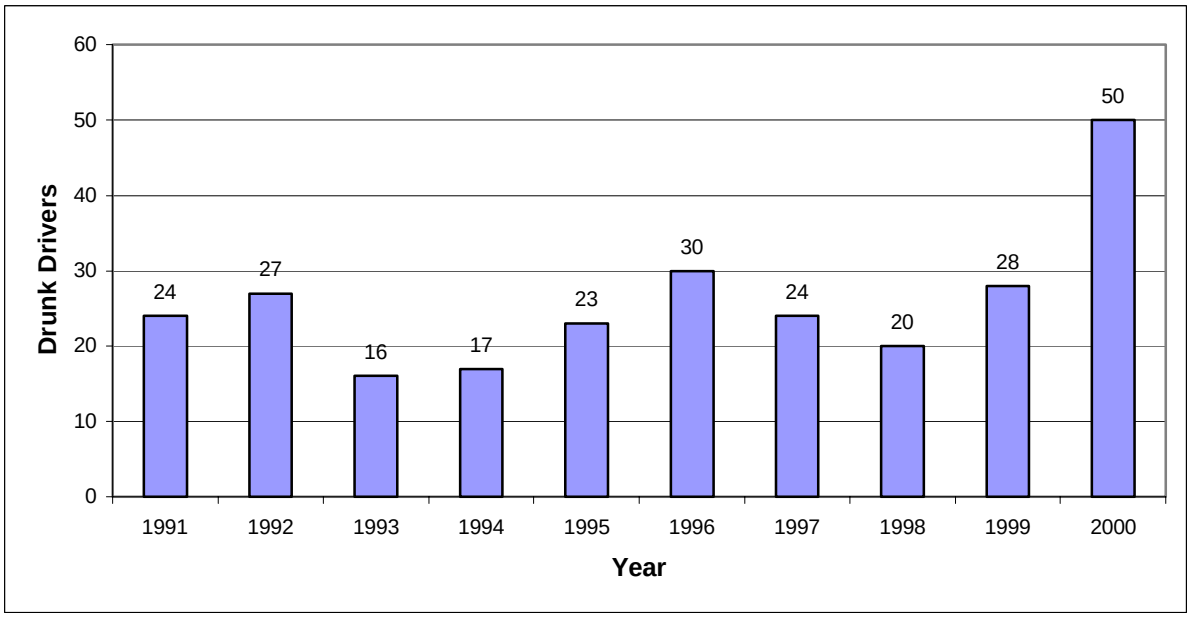

Figure 10. Animal-related fatal crashes involving drunk drivers

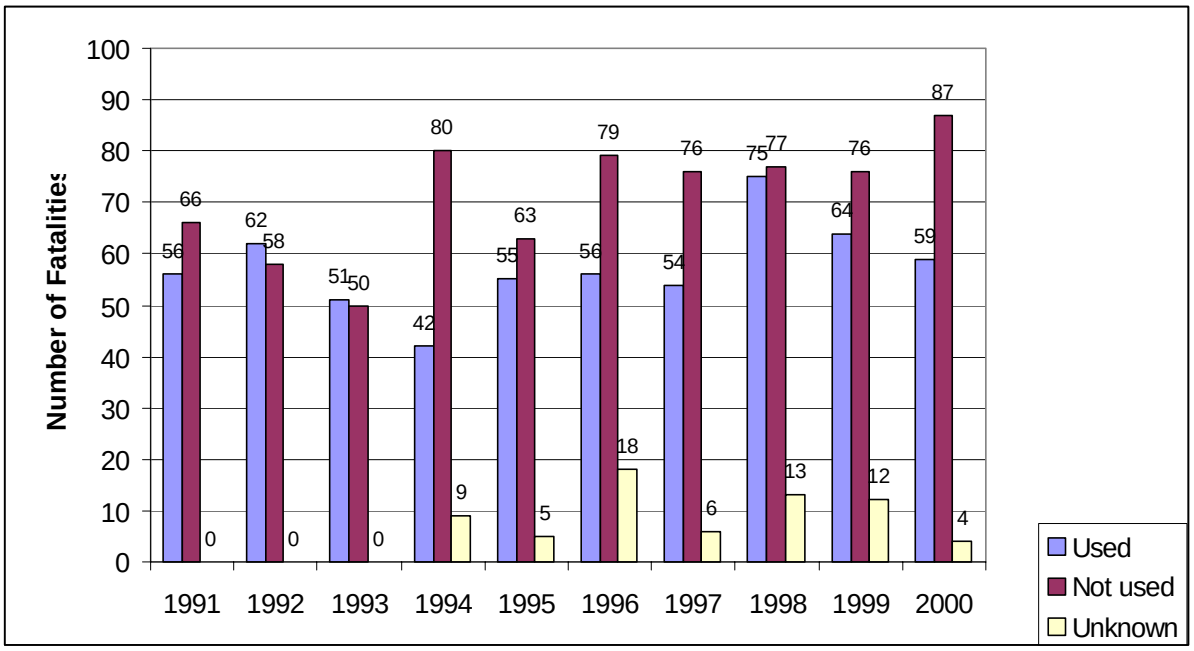

Figure 11. Restraint usage trend among fatalities