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16. Abstract

The Deer-Vehicle Crash Information and Research (DVCIR) Center is the only entity in the United States that focuses on the 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 databases 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 non-research activities and the research subject areas that may be funded by the DVCIR Center. These meetings were essential to the advancement and growth of the DVCIR Center pooled fund project.

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Investigation of Deer-Vehicle Crash Data and Countermeasure Implementation in Texas

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ABSTRACT

The Deer-Vehicle Crash Information and Research (DVCIR) Center is the only entity in the United States that focuses on the 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.

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DISCLAIMER

EXECUTIVE SUMMARY

The Deer-Vehicle Crash Information and Research (DVCIR) Center is the only entity in the United States that focuses on the DVC problem and its reduction. This project investigated the DVC data and countermeasure implementation in Texas and officially sponsored the DVCIR Center kickoff meeting and annual symposium.

The investigation of Texas data revealed an interesting set of characteristics and patterns. For example, the officially reported crash data in Texas are for animal-vehicle crashes (AVCs) rather than DVCs, and only those incidents that result in an injury/fatality or the towing of a vehicle are currently reported by the Department of Public Safety. In addition, crash reports can be completed by either the motorist or law enforcement, but only those done by law enforcement are included in the crash data summaries. The data indicated that the total number of AVCs in Texas decreased by about 6.5 percent 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. In fact, during this same time period the total number of all the crashes reported in Texas decreased by almost exactly the same amount. 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 volume and/or favorable deer habitat. Overall, comparisons of the AVC data and two estimates of these incidents (e.g., deer carcass removals and insurance claims) also indicate that police-reported crash data may not fully describe the AVC problem in Texas. Similar results (to varying degrees) have been found in other states. The use of alternative AVC databases to supplement the police-reported data was recommended to better describe the magnitude and patterns of the AVC problem in Texas.

The implementation of DVC or AVC countermeasures in Texas has been limited, but the state-of-knowledge in countermeasure crash reduction effectiveness also still needs to be improved. Existing bridges and/or culverts in Texas have been retrofitted for wildlife and new crossings proposed. Deer crossing warning signs have also been installed. In general, it is recommended that the existing countermeasures in Texas be evaluated and that several additional DVC or AVC reduction measures be considered for implementation and monitoring. It is critical, however, that these countermeasures be installed in the most appropriate locations (based on good DVC or AVC data) and that they then be correctly evaluated. Some of the database improvement recommendations proposed in this report may need to be completed before the countermeasure recommendations.

The meetings sponsored by the Southwest University Transportation Center through this project resulted in the identification and/or prioritization of the non-research activities and research subject areas that may be funded by the DVCIR Center. These meetings were essential to the advancement and growth of the DVCIR Center pooled fund project. In general, it is also believed that these two meetings may have resulted in the additional participation and funding of three states in the DVCIR Center.

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INTRODUCTION

The Deer-Vehicle Crash Information and Research (DVCIR) Center pooled fund project is a multi-state effort started at the Texas Transportation Institute (TTI) in the 2007. This center operates as a national focal point, depository, and exchange location for a wide range of DVC-related information, data, strategic planning, and research projects (see below and in Appendix A). During the last year the information sharing, data collection, and research gap identification activities of the DVCIR Center were partially supported by the Southwest University Transportation Center (SWUTC). These funds also allowed a more specific investigation of the DVC issue in Texas (one of nine states funding the DVCIR Center project). First, the current status and adequacy of DVC data in Texas were evaluated. Then, through discussions with Texas Department of Transportation (TxDOT) representatives and the use of two surveys, the DVC countermeasures implemented in Texas were identified. The results from these DVC data and countermeasure activities are summarized in this report along with the outcomes of the SWUTC-sponsored DVCIR Center kickoff meeting and annual symposium.

DVCIR Center Background

The DVCIR Center is the only entity in the United States solely focused on the DVC problem and its reduction. It is a pooled fund effort supported by TxDOT, the Federal Highway Administration (FHWA), and eight other state departments of transportation (DOTs). These state DOTs include Connecticut, Iowa, Maryland, Minnesota, New Hampshire, New York, Ohio, and Wisconsin. The DVCIR Center was proposed and organized to:

- Critically evaluate past and current DVC-related work,
- Collect, summarize, and disseminate DVC-related data and study results,
- Define an effective and application-oriented DVC-related research strategy,
- Provide funding for properly designed DVC-related studies,
- More effectively use limited resources on a complex problem, and
- Address questions from transportation and natural resource professionals, media, and the general public.

The lead agency of the DVCIR Center project is the FHWA Office of Natural and Human Environment, but each of the DOTs have also committed between $20,000 and $50,000 to the effort. The project funding provided by SWUTC also made it an official sponsor of the DVCIR Center in 2007. This funding was considered essential to the initiation of this national effort and the summary and critical evaluation of the DVC data and countermeasure implementation in Texas. The SWUTC funding (and the activities it supported) is believed to have led to between $85,000 and $170,000 in additional DVCIR Center support.

NATIONAL ESTIMATES

It has been grossly estimated that more than a million DVCs occur in the United States each year and that these crashes cost the traveling public over a billion dollars (*1*). The number of DVCs or collisions between large animals and vehicles (AVCs) in the United

States must be estimated because of a general lack of consistency in the data collection efforts connected to these incidents from state to state. Concerns related to this fragmented data collection approach, along with recommendations to improve the situation, have been documented (*2*, *3*). In fact, a recent synthesis of DVC, AVC, and roadside carcass removal data collection practices in the United States and Canada suggested the need for a more standardized and spatially accurate approach (*3*). DVCs and AVCs also result in fatalities and injuries. In 2006, for example, there were 220 fatalities due to AVCs (with "animal" as the first harmful event) (*4*). In addition, it has been estimated that the number of non-fatal injuries (that also result in a hospital visit) in the United States due to AVCs is approximately 13,300 per year (*5*).

Unreported Incidents

The national estimate of the DVC problem in the United States at least partially accounts for one common weakness in the data typically used to describe the magnitude and/or patterns of this type of incident (*1*). Overall, it is generally accepted that police-reported DVC or AVC data is somewhat incomplete. In fact, it has been estimated that only about half of the DVCs or deer-vehicle interactions in the United States are actually reported directly by the police (and subsequently entered into available and official databases) (*1*, *2*). For example, the ratio of the number of roadside deer carcasses removed in Wisconsin (a contracted service) to the number of police-reported DVCs in 2006 was about 2.1 (*6*). The amount of under-reporting or non-reporting that occurs with DVCs and/or AVCs, however, depends on many factors and varies from state to state. Some of these factors (among others) include:

- Confusing, misunderstanding, or changing rules or defining criteria (see below for Texas) about when property-damage-only DVCs or AVCs need to be reported to or by the police;
- Unavailability of law enforcement staff to respond to a DVC or AVC property-damage-only crash due to more pressing needs;
- Inclusion of DVC or AVC property damage in comprehensive insurance coverage that may or may not require a police report for payment;
- Large numbers of large trucks on the roadways that may not experience damage levels considered great enough to report the incident (and which may also have out-of-state or "through" drivers);
- Allowances for the reporting of property-damage-only crashes by the motorist (versus police-reported), but data systems and/or report forms that don't allow the summary of these crash data; and
- Lack of transfer and/or summary of DVC or AVC police-reported information from non-state enforcement jurisdictions (e.g., cities, towns, and counties) to primary data summary locations (e.g., state DOTs).

Not surprisingly, a certain amount of under-reporting or non-reporting of DVCs or AVCs also appears to be occurring in Texas (see the next section of this report). However, it should be noted that all property-damage-only crash types (like the majority of DVCs or AVCs) are under-reported to some extent. In addition, the other databases that are sometimes available to define the number of DVCs or AVCs in a jurisdiction (e.g.,

carcass removal maintenance records or natural resource agency permits) are not typically recorded or summarized statewide in a consistent, comprehensive, and/or systematic manner. In addition, not all roadside deer or large animal carcasses are the result of an incident severe enough that it would need to be reported (see the crash reporting criteria for Texas below) and not all police-reported AVCs result in a roadside carcass (i.e., the animal may leave the right-of-way).

TEXAS DATA INVESTIGATION

An exploratory investigation of the DVC or AVC data collected and generally available in Texas was completed as part of this SWUTC project. In the United States there are at least three types of DVC- or AVC-related data that are sometimes collected and/or summarized by individual Departments of Public Safety (DPSs), DOTs, and/or Departments of Natural Resources (DNRs). These data include crashes reported by the police, roadside carcass removal maintenance records, and the number of permits provided to the driving public to remove salvageable deer or animal carcasses from the roadside. The type and defining criteria of the data collected and the agency(ies) that collect and/or summarize it vary from state to state.

In Texas no evidence was found that any DVC- or AVC-related data were officially collected and summarized (i.e., generally available) other than that describing the AVC incidents reported directly by the police (e.g., the DPS). The characteristics or criteria that define the police-reported AVC data in Texas are discussed below, and the results of statewide and county data summaries are described. Two estimates of the number of AVCs that may go unreported are also noted.

Police-Reported Data Criteria

Currently, crashes that occur along Texas roadways need to be reported to law enforcement when they result in the injury or death of a person or a vehicle involved in the incident can not be normally or safety driven (*7*). In other words, property-damage-only crashes are only reported by the police (e.g., the Texas Department of Public Safety (DPS)) if a vehicle involved with the crash has to be towed. This change in crash reporting threshold in Texas occurred on July 1, 1995, and generally resulted in an overall reduction in the number of crashes reported by police (*8*). In the past, property-damage-only crashes that damaged a vehicle to a specific dollar amount (e.g., $500 or $1,000) were also recorded by the police. In Texas, for example, a person involved in a crash that is not investigated by the police still needs to report it to the DPS within ten days if it appears to have resulted in $1,000 of property damage (*7*).

The majority of DVCs or AVCs are property-damage-only collisions. In fact, a TTI study of AVC crashes along Texas rural highways from 1997 to 1999 showed that about 56 percent were property-damage-only (*8*). Many times these property-damage-only incidents are likely to result in an operable vehicle and, as noted above, a motorist reported collision (i.e., an incident not investigated or reported by a law enforcement officer). It is important to note that crashes reported by motorists rather than police officers are not summarized by the Texas DOT (or most state DOTs). The data summarized in this report are only for those reported by law enforcement.

The crash data available in Texas are for AVCs rather than DVCs. Crash data from states that do note this difference, however, generally show that the majority of AVCs are between a vehicle and deer. For example, a recent multiple-state review of 147 AVCs (that resulted in at least one fatality) showed that 77 percent of these incidents were with deer (*9*). In addition, a sample of 279 rural two-lane roadway AVC encounters (from one TxDOT district) also indicated that 62 percent of these crashes were with deer (*8*). In general, these types of comparisons can only be done by reading individual AVC police reports.

Statewide Summary

At the time this report was written, TxDOT was in the process of updating its crash data summary information system and finalizing its output. The most recent police-reported AVC data that were available in summary format (and considered final), therefore, were from 2001. The annual total number of crashes, police-reported AVCs (with "animal" as the first harmful event), and fatalities/injuries due to AVCs in Texas from 1992 to 2001 are shown in Table 1.

Table 1. Animal-Vehicle Crashes Reported by the Police in Texas

Year	Total Statewide Crashes	Animal-Vehicle Crashes[a]	Percent Animal-Vehicle Crashes	Fatalities[b]	Injuries[c]
1992	187,613	3,008	1.6	9	845
1993	194,750	3,190	1.6	6	823
1994	207,038	3,318	1.6	11	878
1995	180,527	2,648	1.5	5	1,089
1996	161,991	2,602	1.6	18	1,429
1997	169,520	2,443	1.4	17	1,345
1998	171,245	2,921	1.7	17	1,463
1999	172,730	2,871	1.7	5	1,432
2000	174,475	2,659	1.5	14	1,301
2001	175,582	2,810	1.6	12	1,379

[a]Total AVCs reported by police with "animal" as the first harmful event. Previous work by TTI shows that consideration of "other factor" crash report inputs of "swerved, animal" and "slowed, animal" increase the total number of "incidents" above by 15 to 32 percent annually (1992 to 1999) (*8*).
[b]The AVC fatalities noted for Texas in the National Highway Traffic Safety Administration Fatality Accident Reporting System are typically greater by 1 to 2 per year (likely due to further data updates).
[c]Consists of the sum of incapacitating injuries, non-incapacitating injuries, and possible injuries.

The average annual number of police-reported AVCs (with "animal" as the first harmful event) in Texas from 1992 to 2001 was 2,847. But, the annual number of AVCs recorded during this time period ranged from 2,443 to 3,318 (See Table 1). Overall, the annual total number of police-reported crashes and AVCs in Texas also decreased by about 6.5 percent between 1992 and 2001. Some of the factors leading to this systematic reduction (including the change in crash threshold reporting rules) were previously explained. In comparison, the number of police-reported DVCs or AVCs throughout the United States has generally increased (especially since the 1950s and 1960s) and a previous TTI study showed an increase of approximately 7.7 percent in AVC encounters (i.e., the total sum of crash reports with "animal" as the first harmful event (See Table 1) or "other factor" crash inputs of "swerved, animal" or "slowed, animal") along Texas rural roadways between 1992 and 1999 (*8*).

Overall, the police-reported AVCs in Texas represented between 1.4 and 1.7 percent of the total number of crashes reported in the state from 1992 to 2001(See Table 1). This percentage is relatively low, but not completely unlike the data from some other states (e.g., Maryland or New York). The TTI project noted above also found that approximately 7 percent of the police-reported crashes from 1997 to 1999 along two-lane rural roadways in Texas were AVC incidents (as defined in the previous paragraph) (*8*).

The annual number of police-reported AVC-related fatalities and injuries in Texas from 1992 to 2001 ranged from 5 to 18 and 823 to 1,463, respectively (See Table 1). The National Highway Traffic Safety Administration (NHTSA) Fatality Accident Reporting System (FARs) also indicates that Texas had between 14 and 27 AVC fatalities annually from 2002 to 2006 (*5*). In fact, Texas typically has more fatalities per year related to police-reported AVCs than any other state. It is, however, the second largest state in the country. It is interesting to note that while the annual number of police-reported AVCs in Texas decreased by 6.5 percent between 1992 and 2001 the number of AVC-related injuries increased by approximately 63 percent. This increase in the severity of AVCs could be the result of many factors (e.g., crash reporting procedures, general increases in vehicles speed, etc.) and has been found to some extent in other states.

County Summary

The number of police-reported AVCs (with "animal" as the first harmful event) in Texas from 1992 to 2001 was also summarized by county. Those counties that ranked in the "top ten" (of the 254 counties in Texas) for several different measures of the AVC problem are shown in Table 2. The first column in Table 2 shows the ten counties with the largest total number of police-reported AVCs from 1992 to 2001 (See Figure 1 also). Overall, there were 28,470 AVCs reported in Texas during this decade, and the number of AVCs in these ten counties represented about 15 percent of that total. The average number of AVCs per Texas county during this decade was about 112, but it was approximately 424 for the "top ten" in Table 2.

The counties that had the largest number of police-reported AVCs in Texas have characteristics similar to the "high crash" counties that have been identified in other states. These counties typically have a combination of land cover characteristics

Table 2. "Top Ten" Counties by Various Animal-Vehicle Crash Measures (1992 to 2001)[a]

Total Police-Reported AVCs[b]	Total Police-Reported AVCs per County Population (2000 Census)	Total Police-Reported AVCs per County Land Area (Square Miles)	Total Police-Reported AVCs per Million Vehicle-Miles-Traveled (2001)[c,e]	Total Police-Reported AVCs per 1,000 Centerline Miles (2001)[d,e]
Bexar	Kenedy	Travis	Throckmorton	Travis
Travis	King	Gregg	Shackelford	Comal
Montgomery	Glasscock	Comal	Cottle	Montgomery
Williamson	Throckmorton	Bexar	Collingsworth	Kenedy
Smith	Shackelford	Montgomery	Motley	Nacogdoches
Brazoria	Oldham	Smith	Briscoe	Bastrop
Nacogdoches	Cottle	Brazos	Hansford	Williamson
Harris	Roberts	Williamson	Fisher	Brazoria
Anderson	Motley	Nacogdoches	Young	Brazos
Pecos	McMullen	Madison	Jack	Liberty

[a]AVCs defined by crash reports with "animal" as the first harmful event.
[b]See Figure 1 for location of counties.
[c]Annual vehicle-miles-traveled only on roadways under TxDOT jurisdiction.
[d]Centerline miles only on roadways under TxDOT jurisdiction.
[e]Shown for comparison purposes only.

advantageous to a deer population (e.g., preferred food plus water) and large or growing traffic volumes. In Texas the four counties with the largest number of police-reported AVCs included or are adjacent to large cities (e.g., San Antonio and Austin). The top two counties are also within and/or near Texas Hill Country (which has a large deer population). The counties ranked third (Montgomery), fourth (Williamson), sixth (Brazoria), and eighth (Harris) are also adjacent to or included Houston or Austin. These areas have all experienced a large amount of land use development. Finally, the counties ranked fifth, seventh, and ninth (Smith, Nacogdoches, and Anderson, respectively) are in less populated areas but are rural in nature and have land cover characteristics preferable to deer. Pecos County (in west Texas) had the tenth largest number of police-reported AVCs in Texas from 1992 to 2001. This county is the second biggest (by land area) within Texas, and animals may also be attracted to the roadway right-of-way due to a general lack of vegetation (resulting in more collisions).

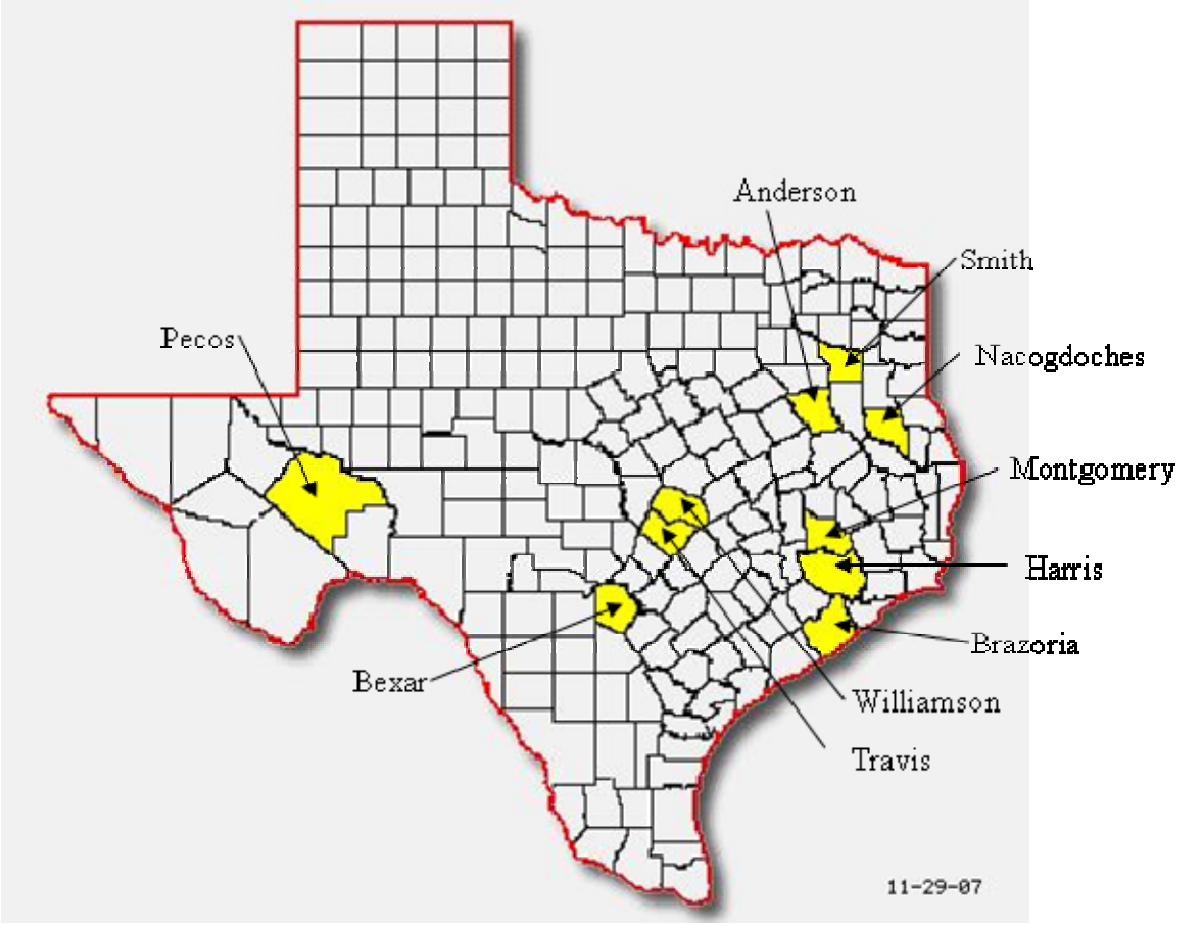

Figure 1. "Top Ten" Counties by Total Animal-Vehicle Crashes (1992 to 2001)

Table 2 also includes four other "top ten" AVC (with "animal" as the first harmful event) rankings for Texas. The second and third columns show the counties that ranked the highest when AVCs were measured per capita and by land area. Not surprisingly, there was no overlap found between the counties ranked by total AVCs and those ranked by population. The "top ten" counties ranked by AVCs per capita generally appear to be those with a small number of people that may have a lot of through traffic flow. Six of the "top ten" counties ranked by AVCs per square mile, however, were also on the "top ten" list of total AVCs. Three of the other counties are relatively small in area and/or somewhat populated (i.e., although they are small in area they may have some traffic flow).

The last two columns in Table 2 rank Texas counties by police-reported AVCs per annual vehicle-miles-traveled (VMT) and centerline mileage. It should be noted, however, that the VMT and centerline miles of roadways used were only for those under TxDOT jurisdiction during 2001 (more accurate calculations would include VMT and centerline miles for each year from 1992 to 2001). These last two "top ten" rankings, therefore, are

only included in Table 2 for comparison purposes. For example, four of the counties ranked by population are also listed in the ranking by VMT. In addition, all of the counties in the "top ten" by VMT are in north central Texas and the panhandle. These counties appear to have a relatively small amount of VMT on state jurisdictional roadways and a relatively small population (in comparison to other Texas counties). Five of the counties in the ranking by TxDOT centerline miles are in the listing for total AVCs. Two other counties (in the centerline mileage ranking) are also ranked in the "top ten" for AVCs per land area.

The overlap in the counties that appear in the Table 2 rankings can be used to support several conclusions. The counties of Travis, Montgomery, Nacogdoches, and Williamson appear in three of the five lists. This overlap in the table content suggests that these areas, based on police-reported data, should be AVC counties of interest in Texas. Bexar and Smith counties also appear in two of the lists along with a number of other more "rural" counties (e.g., Throckmorton, Shackelford, Cottle, and Motley). These "rural" counties seem to have a proportionally higher number of police-reported AVCs. Comal, Kenedy, and Brazos counties also appear in two of the lists. It is suggested that the data from all the counties appearing in Table 2 be considered more closely when more current or updated police-reported AVC data become available. The patterns shown in Table 2 may have changed in recent years.

Data and Estimate Comparisons

Comparisons of police-reported DVC or AVC data and information describing roadside carcasses or carcass removal maintenance activities have shown that a certain percentage of these crashes or incidents are not reported (*1*, *2*, *6*). Some of the reasons for this under-reporting have already been described. It is expected that there is a certain amount of AVC under-reporting that also occurs in Texas, and that the police-reported AVC (i.e., with "animal" as first harmful event) data available may only describe a portion of the problem. The amount of under-reporting that may be occurring, however, can only be approximated by a comparison of these police-reported data with estimates of AVC incidents (e.g., roadside carcasses, carcass removal activities, and/or insurance claims).

In Texas two "unofficial" estimates of AVCs or DVCs were discovered and then compared to police-reported AVC data (See Table 1). First, the data from an unofficial and informal summary of TxDOT deer carcass removal activities in Mason and Llano Counties (near Austin in the Texas Hill Country) were examined. This summary showed that in 2006 TxDOT maintenance personnel removed more than 1,000 deer carcasses in Mason County and approximately 900 in Llano County (e-mail communication, Dennis Markwardt, TxDOT, 2/7/2007). The number of carcass removals in these two counties may be some of the largest in the state. For comparison purposes, in 2001 (the most current year for which official data is available) the number of police-reported AVCs in Mason and Llano County, respectively, was 3 and 20. In fact, the number of carcasses removed within these two counties represents approximately 68 percent of the police-reported AVCs statewide in 2001 (See Table 1). Of course, not all roadside carcasses result in an AVC incident that needs to be reported by the police, but the difference in the

magnitude of this official data and the amount of carcass removal maintenance activity is substantial.

A second estimate of animal-vehicle incidents in Texas was also acquired. This estimate was an approximation by the State Farm Mutual Automobile Insurance Company© (State Farm) of the AVC insurance claims in Texas by (e-mail communication, Nelson Lafon, Virginia Department of Game and Inland Fisheries, 8/06/2007). The ability to review actual insurance claim information by researchers is typically limited due to individual and business privacy concerns, but State Farm did provide some basic information about how their estimate was calculated. First, they searched their own database of comprehensive insurance claims in Texas for the words "deer," "moose," and "elk." Then, the number of insurance claims that met these criteria was expanded (through an estimate, by State Farm, of its market share) to approximate the overall statewide occurrence of these events. The number of deer, moose, and elk (Texas does not have any of the latter two) collision insurance claims that State Farm estimated for Texas ranged from 29,986 to 38,765 annually (between July 2002 to June 2007). Overall, the annual average of this estimate was approximately 11.8 times the average number of police-reported AVCs in Texas between 1992 and 2001. But, again, not all animal-vehicle incidents that result in an insurance claim will result in a police-reported AVC, and the number of police-reported AVCs could have also increased in Texas from 2002 to 2007. In addition, this State Farm estimate is based on the accuracy of other approximations (e.g., market share). The difference between the magnitude of the official AVC data and the estimated number of insurance claims, however, is substantial.

Data Findings and Recommendations

An investigation of police-reported animal-vehicle collision data in Texas generally revealed a set of interesting characteristics and patterns. For example, the officially reported crash data in Texas is for AVCs rather than DVCs, and only those incidents that result in an injury/fatality or the towing of a vehicle are generally reported by the DPS. In addition, crash reports can be completed by either the motorist or law enforcement, but only those done by law enforcement (with "animal" as a first harmful event) are included in crash data summaries (and discussed in this report).

The police-reported AVC data in Texas decreased from 1992 to 2001 (the last year data is currently available). This trend is unusual in comparison to much of the United States, but it is likely due to the changes in crash reporting thresholds that occurred in Texas in 1995. In fact, during this same time period the total number of all crashes reported in Texas also decreased by almost exactly the same amount. The number of injuries that resulted from police-reported AVCs in Texas during this decade, on the other hand, increased dramatically. The county rankings of police-reported AVCs (See Table 2) in Texas included several counties that appeared in two to three of the lists developed. Many of these counties have large or growing amounts of traffic volume and/or favorable deer habitat.

Nationally, it is believed that police-reported DVCs represent about half of the incidents that occur. A comparison of the police-reported AVCs in two Texas counties to the

number of deer carcasses removed by TxDOT showed that a much larger number of the latter occurred. In addition, the average number of police-reported AVCs (with "animal" as the first harmful event) in Texas was also compared to a State Farm estimate of AVC insurance claims. The number of AVC claims was substantially greater than the AVCs reported by the police. A number of factors are described in this report that explain at least a portion of these differences, but these comparisons do indicate that more interaction between vehicles and large animals are likely occurring than implied by the official police-reported AVC data. For example, not all roadside carcasses or insurance claims will result in a police-reported AVC in Texas.

Overall, it is likely that the number of AVCs in Texas is greater than that represented by the police-reported AVC data (with "animal" as the first harmful event). Therefore, it is recommended that alternative AVC databases be considered to more properly define and evaluate this problem (statewide and along individual roadway segments). This database would be used as a supplement to the police-reported information currently available, and could be used to better describe the magnitude and patterns of roadway incidents between vehicles and deer (or other large animals). One opportunity to test the challenges of developing an alternative AVC database in Texas is an ongoing project at Montana State University. This project is evaluating the usefulness of equipment that can be used to collect standardized information about carcass removal maintenance activities. Alternatively, the application of a simplified manual methodology for this type of data collection (currently done or being considered in several states) could also be investigated. It is also recommended that a pilot study be completed to determine the amount of time (and funding) spent on this type of maintenance activity (i.e., roadside carcass removal) within various TxDOT districts. This research project could provide a better idea of the investment needed for this task and the number, variance, and patterns of roadside carcasses. The results of the study could also be used to show the difference between DVC or AVC incidents and official police-reported AVC data. A summary of motorist-reported AVCs in Texas (if possible) might also be of interest.

COUNTERMEASURE EFFECTIVENESS AND TEXAS IMPLEMENTATION

A number of potential DVC and AVC countermeasures have been implemented and/or evaluated throughout the United States. Some of these countermeasures include:

- In-vehicle technologies;
- Speed limit reduction;
- Deer crossing signs and technologies;
- Public information and education;
- Deer whistles;
- Deicing salt alternatives;
- Deer-flagging models;
- Intercept feeding;
- Roadside reflectors and mirrors;
- Repellents;
- Hunting and herd reduction;

- Roadside vegetation management;
- Exclusionary fencing;
- Wildlife crossings;
- Roadway lighting; and
- Roadway maintenance, design, and planning policies.

Several documents have been published that describe (to varying degrees) the research focused on these countermeasures (*10-14*). In fact, the most recent summary of AVC countermeasure effectiveness is a soon-to-be-released congressional report (*14*). The focus, significance, and robustness of the research related to the effectiveness of DVC and AVC countermeasures do vary, however, and the conclusions reached by the authors of these summaries are not always the same (*10-14*). Their results are the product of, among other things, different summary objectives and definitions for countermeasure effectiveness, various methods of determining the validity of research project results, the literature available, and the background of the authors (e.g., safety data analysis, ecology, etc.).

Crash Reduction Effectiveness State-of-the-Knowledge

In 2005 the author of this report evaluated and summarized DVC countermeasure crash reduction research (*13*). An outcome of this review was the categorization of the countermeasures based on a strict comparison of the research details to currently accepted safety data analysis methodologies (i.e., an identification of their crash reduction effectiveness). The countermeasure categories used (i.e., experimental, tried, and proven) were those from the American Association of State Highway and Transportation Officials (AASHTO) (*15*). The definition of these categories and the countermeasures placed within each are described below and shown in Table 3.

Crash Reduction Effectiveness Categories

The DVC countermeasures previously listed were classified into three crash reduction categories proposed within National Cooperative Highway Research Program (NCHRP) Project 500 (*15*). This project developed implementation guidance for the AASHTO *Strategic Highway Safety Plan* (*16*). It is expected that this plan and its guidance will be a primary application reference for safety improvements throughout the United States. The three safety improvement classification groups used in this guidance were "experimental," "tried," and "proven." A brief definition for each of the categories is provided below and the DVC or AVC countermeasures included in each group noted (*13*). The countermeasures in each category are shown in Table 3.

- "Experimental": These countermeasures/strategies are believed to have potential and have been applied on a small scale in at least one location (*15*). If used, they should only be implemented as controlled pilot studies and monitored with the most appropriate evaluation techniques (*15*).

- The DVC or AVC countermeasures that were included in this category are primarily those that have or are being used, but have either never had their DVC-

or AVC-reduction capabilities studied or have been studied only once or twice. Several new deer crossing sign designs and deer crossing sign/technology

Table 3. Countermeasure Crash Reduction Research Categories (*13*)

	Safety Strategy Groups		
Countermeasure	Experimental	Tried[b]	Proven
In-Vehicle Technologies	X		
Speed Limit Reduction		X	
Deer Crossing Signs and Technologies[a]	X	X	
Public Information and Education		X	
Deer Whistles		X	
Deicing Salt Alternatives	X		
Deer-Flagging Models	X		
Intercept Feeding	X		
Roadside Reflectors and Mirrors		X	
Repellents	X		
Hunting and Herd Reduction		X	
Roadside Vegetation Management		X	
Exclusionary Fencing			X
Wildlife Crossings			X
Roadway Lighting	X		
Roadway Maintenance, Design, and Planning Policies		X	

[a]Some signs or technologies can be considered experimental and others are being evaluated.
[b]It should be noted that these categories are based on the previous definitions and the research approach used, not the results of past research. The results of past research projects may be conflicting. The reader should reference the other documents noted for a detailed summary of past safety research results.

combinations (which are included in this category (See Table 3) have been implemented, and some are currently being studied within "pilot" programs.

- "Tried": These countermeasures/strategies have been implemented in a number of locations and may even have standard implementation guidance (*15*). However, valid crash reduction evaluations of their impacts are generally lacking. They are not expected to produce negative safety impacts but may have a positive result (*15*).

  The DVC or AVC countermeasures included in this category (See Table 3) are those that are used regularly in the field, but have either never/rarely been studied or have been studied with conflicting results. It has not yet been shown that the

proper implementation of these countermeasures in the roadway environment results in a reduction in DVCs or AVCs (through generally accepted safety data analysis methodologies). In addition, measures like posted speed limit reductions (a countermeasure included in this category), while promising, also have to be applied appropriately to avoid increases in vehicle-vehicle crashes that may result due to increases in the difference between individual vehicle speeds. Typical deer crossing signs were also included in this category because they are the most used potential DVC countermeasure in the United States, but no documented quantification of their DVC or AVC reduction capabilities (or lack thereof) has been found. Research has shown, however, that the attention value (and speed reduction impact) of these signs is generally low (*17*, *18*). The use of new sign designs and crossing sign/technology combinations are included in the "experimental" countermeasure category.

- "Proven": These countermeasures/strategies have been implemented in one or more locations, but have also had their safety effectiveness quantified with properly designed evaluation techniques (*15*). They can be implemented with a "…good degree of confidence," but also with the recognition that the crash reduction experienced may be different than what previous evaluations have shown (*15*).

  The two DVC or AVC countermeasures included in this category, exclusionary fencing and wildlife crossings, are often combined when they are implemented. Including these two DVC countermeasures in this category may also be somewhat premature because the safety evaluations completed for them have not used the most currently accepted Empirical or Full Bayesian approach to the statistical analysis of their related crash reduction impacts. This analysis approach was used to a certain extent, however, in the recently completed but yet to be published NCHRP 25-27 study on the use and effectiveness of wildlife crossings (see www.wildlifeandroads.org for interim documents). There has been a wide range of DVC and AVC reductions produced by what appear to be similar fencing/crossing installations, but all the projects have had positive impacts on safety (especially when the installations are designed well and there is attentive fencing inspection/maintenance and the removal of animals that do enter the right-of-way).

In summary, it should also be noted that at least two well-designed studies focused on roadside reflectors and deer whistles have been completed since the initial publication of the summary/categorization in *Transportation Research Record 1908* (*13*, *19*, *20*). The results of these studies generally coincide with the expert opinion of the influence these devices are likely to have on deer behavior (and ultimately the impact they might have on crash reduction). In general, both studies conclude that deer behavior did not appear to be directly altered by the use of these devices (*19*, *20*). It is the author's opinion, however, that the Table 3 categorization of these two countermeasures should not be revised due to the results of these two studies. This conclusion is based on a comparison of the studies to the categorization criteria used in this summary and the need for

repeatability of the research results (previous research results were conflicting and showed no overwhelming positive or negative patterns). It is possible that in the future these two countermeasures (along with several others) could be completely eliminated from consideration due to their "proven" ineffectiveness. For example, it is author's understanding that the soon-to-be-released congressional report, based on a different set of evaluation criteria, concludes that these two countermeasures (and others) are "ineffective" (*14*).

Texas Countermeasure Implementation

A preliminary investigation into the DVC or AVC countermeasures implemented in Texas was completed as part of this project. However, discussions with several TxDOT staff have generally revealed that this type of activity has been minimal. This conclusion was supported by the results of a survey completed as part of the yet-to-be-published NCHRP 25-27 report: *Evaluation of the Use and Effectiveness of Wildlife Crossings* (see www.wildlifeandroads.org for interim documents) and an internal TxDOT survey of district personnel (personal communication, Stirling Robertson, TxDOT, 12/18/07).

Overall, it appears that only two DVC or AVC countermeasures have been implemented in Texas. First, the results of the NCHRP 25-27 report and TxDOT surveys noted above revealed that some roadway structures in Texas have been retrofitted and that wildlife and/or cattle culverts have been built (or are planned). Deer have also been observed in some of the existing crossings. In addition, there are at least two bridge class culverts in the Amarillo District that have ledges or walkways for deer use, and three crossings in south Texas (Corpus Christi and Laredo TxDOT districts) have been built with ledges, brush plantings, and/or extended for Ocelot (or other "cat") use. Several Ocelot crossings (with wildlife fencing) are also planned for the Pharr TxDOT district. The second DVC or AVC countermeasure that has been implemented throughout Texas is deer crossing warning signs. These signs have also been used throughout the United States but their driver behavior impacts and crash reduction capabilities have been questionable (*13*, *17*, *18*). In fact, the Minnesota DOT has stopped installing these signs. In conclusion, it should also be noted that the deer or wildlife fencing that has been installed in Texas by private landowners could impact the occurrence of DVCs or AVCs along the roadway segments where it is used.

Countermeasure Findings and Recommendations

DVC or AVC countermeasure crash reduction research that meets currently accepted safety data statistical standards is almost non-existent. A number of countermeasures have also been studied with conflicting results. The variability in animal behavior and the rare and random nature of individual DVCs and AVCs requires a large amount of data and resources to produce what might be called definitive DVC countermeasure research results.

Overall, the crash reduction effectiveness of deer whistles, typical deer crossing warning signs, and roadside reflectors has been questioned. In addition, ecologists generally believe that deer flagging would not likely be effective as a DVC countermeasure because the deer would eventually habituate to the appearance of this experimental

device. Exclusionary fencing and/or wildlife crossings, however, have generally had a positive result on DVCs or AVCs when properly located and maintained. It is also assumed that if hunting and herd reduction activities were to reduce the deer population by a large amount (e.g., deer culling were to occur and the population reduced) that DVCs or AVCs would decrease (at least temporarily). The DVC or AVC reduction effectiveness of the majority of the potential countermeasures (See Table 3) have either not been studied enough (i.e., the countermeasure has only been studied once), at all, or in a statistically valid and acceptable manner. Therefore, additional monitoring is necessary to determine their safety improvement capabilities.

The implementation of DVC or AVC countermeasures in Texas has been limited, but the state-of-knowledge in countermeasure crash reduction effectiveness also needs to be improved. Therefore, it is recommended that the existing countermeasures in Texas be evaluated and that several additional DVC or AVC reduction measures be considered for implementation and monitoring. In fact, new types of countermeasures are continually being suggested and could result in DVC or AVC reductions. Before any new countermeasures are installed, however, the data collection improvement (or database supplement) activities recommended previously may need to be completed. It is critical that the countermeasures be installed in the most appropriate locations (based on good DVC or AVC data) and then correctly evaluated. In some cases the significance of an AVC or DVC problem along a roadway segment (based on existing police-reported data and a local understanding of the situation) may also be enough for the consideration of a countermeasure.

DVCIR CENTER MEETING RESULTS

The DVCIR Center pooled fund project was contracted to proceed in March 2007. The kickoff meeting of its technical advisory committee (TAC), however, was held in January 2007 due to the sponsorship of the SWUTC. This meeting was considered essential to the initiation, growth, and advancement of the DVCIR Center. A fall symposium/TAC meeting was also partially funded by SWUTC, but also received fiscal support from the American Automobile Association (AAA) of Minnesota/Iowa, the Western Transportation Institute, and the DVCIR Center agencies. The information sharing activities and tasks completed at these meetings are described below. In general, it is believed that these meetings resulted in the additional participation of three states and the FHWA in the DVCIR Center.

Project Kickoff Meeting

The DVCIR Center pooled fund project TAC kickoff meeting was held January 30-31, 2007, at the Minnesota DOT Arden Hills Training and Conference Center. This meeting was sponsored by SWUTC and representatives from all the funding states were in attendance (except WI). A representative from the Maryland State Highway Administration also attended, and Minnesota DOT personnel were present for portions of the meeting.

This kickoff meeting provided the pooled fund participants with a better understanding of the project proposal content and its current status. In addition, issues related to the

organization and advancement of the DVCIR Center were discussed, and presentations were made that described ongoing DVC-related work. The TAC representatives also reached agreement on the "non-research" or extension/outreach activities that should be completed by the DVCIR Center staff (e.g., data collection, critical review of literature, website updating, etc.). Overall, the media coverage of this project initiation meeting and its objectives challenging.

The DVCIR Center was also created to support the completion of research projects that focus on DVC-related subjects identified by the TAC. A brainstorming and prioritization session to identify potential research subjects was held as part of the kickoff meeting. Before the meeting ten potential research subject areas were provided by the TAC members and 23 were available for consideration from the 2005 document "Deer-Vehicle Crash Reductions: Setting a Strategic Agenda" (produced by the predecessor of the DVCIR Center) (*21*). An additional 27 ideas were suggested at the meeting. Overall, a total of 60 potential subjects were considered and discussed by the TAC, and 15 were prioritized through a voting process (the Wisconsin representative provided his votes after the meeting). The four subject areas that received the greatest number of votes are noted below.

Proposed DVCIR Center Research Projects

One of the critical outcomes of the DVCIR Center TAC meeting in January 2007 was the identification and prioritization of DVC-related subjects that might be considered by the research projects the center decided to fund. The four subjects that received the most interest from the participating states included:

- Investigation of methods to select and prioritize deer-vehicle crash locations of concern (final problem statement completed),
- Installation and driver vigilance impacts of various Static deer crossing warning signs (final problem statement completed),
- Deer-vehicle crash extension and outreach investigation and material development (draft problem statement completed), and
- Deer-vehicle crashes and roadside vegetation management policies (draft problem statement to be developed).

As noted above, the problem statements for three of the four subject areas listed were completed and reviewed by the October 2007 annual symposium (see below). One problem statement was still under development. Each of the problem statements included a discussion of the specific problem being evaluated, background knowledge in the area (from a preliminary literature review), proposed objectives and tasks, and a recommendation for the budget and time needed to complete the project. Decisions about whether to proceed to the "request for proposal" stage with these problem statements were made by the TAC at their October 2007 meeting.

Annual Symposium

The kickoff meeting for the DVCIR Center generally focused on the business of starting the pooled fund project. The October meeting of the TAC, however, was held from October 29 to 30, 2007, in Schenectady, NY (at the New York State DOT Region 1 Training and Conference Center) and was also combined with a 3/4-day annual symposium of speakers. This business meeting and symposium combination was suggested by the TAC at their kickoff meeting. It was also proposed that non-pooled fund members be invited to the one-day symposium.

Overall, approximately 35 people from 15 states attended the symposium in New York. In addition, a total of five speakers were invited to present their DVC research at different times throughout the day. As previously mentioned, this meeting was sponsored by the DVCIR Center (www.deercrash.com), SWUTC, the Western Transportation Institute, and the AAA of Minnesota/Iowa.

A TAC business meeting followed the symposium and included a discussion of the four problem statements or research ideas noted above. It was decided that only two of the problem statements (or research projects) should be taken to the "request for proposal" stage. The research projects that the TAC wanted to advance were the "Investigation of Methods to Select and Prioritize Deer-Vehicle Crash Locations of Concern" and an analysis of "Deer-Vehicle Crashes and Roadside Vegetation Management Policies." It was also determined that the latter problem statement should focus specifically on the characteristics of roadside mowing and its safety impacts. The TAC also advised the DVCIR Center staff to submit the deer crossing sign problem statement to the Transportation Research Board as a NCHRP synthesis idea, but they did not want to advance the extension and outreach problem statement in any form. The two problem statements of interest to the TAC will be at the "request for proposal" stage very soon.

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APPENDIX A
DVCIR CENTER VISION, GOALS, AND OBJECTIVES

DVCIR CENTER VISION

The general vision or mission of the DVCIR Center is to assist agencies with the numerous requests for information they may receive about their DVC problem, improve the general ability to define the DVC problem and its location, and more efficiently and effectively identify potential DVC countermeasures and evaluate their expected crash reduction impacts. The results of the research supported by the DVCIR Center should be based on the most current safety and ecological evaluation analysis techniques (or have a clear definition of the study approach, strengths, and weaknesses), and the approach used should provide a high level of confidence in the potential transferability of the results. The existence of the DVCIR Center will eliminate problems with the current approach to addressing the DVC problem and its potential solutions. It should also increase the likelihood that the most appropriate countermeasures will be implemented in the correct locations and ultimately lead to a reduction in the frequency and/or severity of DVCs in the most cost effective manner.

DVCIR CENTER GOALS/OBJECTIVES

- Continue and expand upon the critical evaluation of past and current research in the DVC problem area and become the repository for safety-focused summaries of this work. Critically evaluate the validity of past and current DVC-related research, and summarize the relevant study details, implementation issues, and safety results. Disseminate this information through the DVCIR Center website, annual symposia, reports, papers, presentations, and other extension activities. Update information on the webpage as new information is created.

- Continue and expand upon the existing DVCIC activities as a repository for deer population estimates, vehicle-travel amounts, reported DVC or AVC data, and roadside carcass removal information (if available) from participating states. This information should more properly define the DVC problem from location to location and within the United States. The origins and criteria for the data collected by the DVCIR Center will be properly defined and documented. In addition, the DVC-related data that are collected will be summarized by state and region, as appropriate, and any relevant trends defined. All of this information will also be widely disseminated.

- Identify and prioritize gaps in DVC-related research, define a strategy, and as appropriate create a request for proposals (RFPs) for projects to evaluate the DVC questions identified by participating states. Provide funding for properly designed DVC-related research. Require minimum levels of research quality and documentation of project teams and provide appropriate levels of funding. Potential requirements might include the use of multi-disciplinary project teams and the use of the most currently acceptable evaluation methodologies in the transportation safety and ecological impact analysis areas. Potential areas of supportable DVC-related research include

- Identification and definition of DVC-related data sources, collection, estimation, and management techniques;
- Definition and/or prediction of the magnitude and locations of DVC problem segments;
- Evaluation of existing and potential DVC countermeasure crash reduction capabilities and their implementation issues; and
- Investigation of and options to DVC-related roadway development programming, planning, design, operations, and maintenance decision-making approaches and policies.

- Disseminate the data and information summarized and the results of the projects funded by the DVCIR Center. This will be completed through the DVCIR Center webpage, reports, presentations, and papers at annual meetings and in national peer-reviewed journals. In addition, a DVCIR Center sponsored annual multi-disciplinary meeting that focuses on DVC-related problems and ongoing work will be held. This annual meeting could include a discussion of the DVCIR Center activities, multi-disciplinary analysis workshops, ongoing work presentations, and information sharing sessions. These activities will encourage the continuous discussion of the DVC problem and its potential reduction.