A Toolkit for Reducing Wildlife & Domestic Animal-Vehicle Collisions in Utah

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ABSTRACT

The Utah Department of Transportation Wildlife Quality Improvement Team found domestic animal-vehicle collisions to be as significant as wildlife animal-vehicle collisions and recommended the development of this toolkit. A list of "Hot Spots" for Utah domestic and wildlife animal-vehicle collisions are included as well as GIS maps indicating these areas. The objective of this toolkit is to contain a summary of mitigation measures used in Utah, other states, North America and abroad regarding animal-vehicle collisions that can be used consistently throughout the Department regardless of the current phase of a project (Long Range Planning, Concept, Scoping, Preconstruction, Construction, Maintenance, etc.) to reduce the number of animal-vehicle collisions. This toolkit is to be updated as needed to reflect current practices.

SUMMARY
The Utah Department of Transportation Wildlife Quality Improvement Team (QIT) found domestic animal-vehicle collisions to be as significant as wildlife animal-vehicle collisions and recommended the development of this toolkit. This toolkit contains a summary of measures to mitigate animal-vehicle collisions that can be used consistently throughout the Department and updated as needed to reflect current practices. Using the countermeasures in this toolkit can reduce wildlife and domestic animal-vehicle collisions in Utah.

BACKGROUND INFORMATION
Due to the nominal data collection over the last decade a noticeable increase in animal-vehicle collisions have been occurring around the world; largely due to increased traffic volumes on roadways that bisect increasingly fragmented wildlife habitats and by urban areas expanding into outlying countryside where domestic animals (i.e. horses and cattle) are more prevalent. Several studies in Arizona, Colorado, Florida, Nebraska and numerous other states have identified various countermeasures for reducing these collisions. The Federal Highway Administration (FHWA), Transportation Research Board (TRB), American Association of State Highway Transportation Officials (AASHTO), along with other transportation agencies have participated in studies to determine the effectiveness of different countermeasures. The Utah Department of Transportation (UDOT) has tried several countermeasures with varying success rates; some worked well, some worked adequately, and some were valiant, if unsuccessful, attempts to make a difference.

The purpose of the Wildlife QIT was to coordinate team efforts regarding animal-vehicle conflicts from the initial planning phase of a "project" through the maintenance phase. A "project" is defined as any roadway improvement on a state route intended to address animal-vehicle conflicts.

This toolkit contains a summary of mitigation measures used in Utah as well as other states, North America and abroad that can be used consistently throughout the Department regardless of the current phase of a project (Long Range Planning, Concept, Scoping, Preconstruction, Construction, Maintenance, etc.) to reduce the number of animal-vehicle collisions.

Data Collection
Literature Search
An in-depth literature search provided study information from other states, Canada and Europe. One of the first major wildlife overpass crossings in North America was constructed in Canada's Banff National Park. It provided many lessons for future wildlife overpass design efforts. "The solution lies in providing enough distance from traffic and enough cover so that sensitive species such as elk, bears, wolverines, etc. can pass across the highway without being frightened. *(1)*" In addition, a significant amount of preliminary information was outlined in the August 2002, FHWA Scanning Tour Report No. FHWA-PL-02-011, titled "Wildlife Habitat Connectivity Across European Highways." This scanning tour assisted the Wildlife QIT in outlining the required components of a guide for reducing animal-vehicle collisions. The information was reviewed, compiled and discussed resulting in the lessons learned or "toolkit" approach. The Wildlife QIT wanted to provide all areas of the Utah Department of Transportation with a list of countermeasures and where possible, the identified effectiveness of these countermeasures.

Additionally, the Wildlife QIT looked at all available studies for Utah regarding animal-vehicle collisions. Several university studies were found as well as Department studies that had not been published. This information was evaluated and a new list of countermeasures specific to Utah was developed. In addition, regional experts were identified, contacted and visited with to determine what ongoing studies were available.

Sources of Data

Each region within the Utah Department of Transportation has a carcass removal contract. However, it was quickly realized that each region handles the removal, payment and tracking of carcasses differently. For example some of the region contracts are set up for payment per mile rather than number of carcasses removed, resulting in a variety of different tracking measures. This identified several concerns: comparability, repeatability, and ease of evaluation of the data. It was noted that very little of the carcass removal data was being tracked, let alone by GPS location, species, etc. (Central Maintenance has since become involved and is coordinating efforts to begin a database of carcass removal data. Eventually this will be the data source of choice.)

UDOT Traffic & Safety's Crash Data Almanac is available to all UDOT employees and relies on the accident reports filed by local law enforcement officers. This data can be sorted with simple filters (route, milepost, type of hit, date, time of day, etc.) and mapped and printed as needed. In regards to comparability and repeatability this appeared to be the best choice as it is available to all Divisions within UDOT.

Additionally, the Utah Division of Wildlife Resources (DWR) tracks wildlife animal-vehicle collisions as well. John Bissonette, a local expert, wildlife biologist, research specialist, and university professor for the U.S. Department of the Interior U.S. Geological Survey and the College of Natural Resources at Utah State University, gathers information on select projects throughout the state. This information provides a good check against UDOT data, but neglects domestic animal-vehicle collisions and is not readily available for UDOT personnel to evaluate on a regular basis. These efforts are currently being coordinated to develop the State Wildlife Conservation Plan and will be used in the future to identify areas with a high number of wildlife animal-vehicle collisions.

Wildlife connectivity data, in a geographic information system (GIS) format identifies wildlife habitat and corridors. It is available as a next level analysis in the decision making process. This information can be requested from Central Environmental for project level analysis. The Wildlife Biologist for UDOT Central Environmental coordinates the current connectivity data with the Utah DWR on a regular basis so both Departments are using the same data. The collaborative efforts of the two agencies results in a true picture of wildlife habitat and corridor movement that can be applied to any project.

In conclusion, the Wildlife QIT decided to use the UDOT Traffic & Safety Crash Data Almanac to gather all animal-vehicle collisions per state route per accident per mile over a four-year period (2000-2003).

Hot Spot Development

As the Wildlife QIT analyzed animal-vehicle collisions it became apparent that both wildlife and domestic hits could be addressed in a single document. The focus was on developing a consistent approach for all the Divisions within the Department to follow when addressing animal-vehicle conflicts.

Current "hot spots" were identified statewide based on the four-year period 2000-2003, and listed individually to give a starting point for the approaches recommended in this toolkit. It is not a step-by-step manual on how to fix every area where there is an animal-vehicle collision, rather a single source document with ideas and suggestions compiled from experiences in Utah, North America and abroad. "Hot spots" were defined with the following criteria using an accumulation of 2000-2003 UDOT Traffic & Safety accident data*:

- Domestic Vehicle Collision "Hot Spots" (Greater than 4 Accidents/Mile)
- Wildlife Vehicle Collision "Hot Spots" (Greater than 20 Accidents/Mile)

**Based on a similar research study prepared by Dr. Joseph Perrin & Rodrigo (2). This "Hot Spot" definition is different than the current hotspot definition being used by Bissonette & Kassar (3) who "defined a hotspot as a segment of road in which each mile had 11 or more deer-vehicle collisions occur within it over 11 years."*

This criteria was established where the natural break in the data (i.e. the point where the number of hits per mile exceeded the "typical" number of hits per mile) occurred. Nearly all of Utah's roadways have animal-vehicle collisions; the key was to identify where the greatest number of those collisions were occurring and if that data corresponded with previous data. Reassuringly, the data lined up with a previous University of Utah Research Study (noted above) and was only substantially different where mitigation countermeasures had already been taken by UDOT to reduce the number of animal-vehicle collisions. (Note: U.S. 6 was an exception to this analysis see page 17. Additional routes with similar issues will have to be handled on an individual basis until such time as the Central Maintenance Carcass Removal data is available.)

The following table indicates the animal-vehicle accident severity and costs that were gathered as part of the University of Utah Study. As indicated in Table 1, with increasing levels of accident severity, the gap between the number of wild animal and domestic animal-vehicle collisions decreases. In fact, if the UDOT were to look strictly at reducing the number of fatalities along its roadways, addressing domestic animal-vehicle collisions would be of highest priority. Therefore, the severity data further supports the Wildlife QIT's decision to include countermeasures for reducing domestic animal-vehicle collisions.

TABLE 1: Animal-Vehicle Accident Severity and Costs

(1992-2001)		Wild		Domestic		
Severity	Cost Per Accident	Number of Accidents	Cost in Millions	Number of Accidents	Cost in Millions	Total Cost in Millions
1	$2,300	20,629	$47.4	3,367	$7.7	$55.1
2	$6,000	582	$3.5	328	$2.0	$5.5
3	$45,000	418	$18.8	294	$13.2	$32.0
4	$565,000	293	$165.5	242	$136.7	$302.2
5	$3,000,000	10	$30.0	15	$45.0	$75.0
	Total	21,932	$265.3	4,246	$204.7	$470.0

Note: The accident severity number corresponds to the following: (1) No Injury; (2) Possible Injury; (3) Bruises and Abrasions; (4) Broken Bones or Bleeding Wounds; and (5) Fatal.

The costs per accident figures in the preceding table are based on vehicle damage and injury only. The cost of human life for a severity level 5 accident is estimated to be valued at $3 million per person. These costs do not include the UDOT expenses for carcass removal ($25.00/ carcass), or delay cost to the traveling public, which was calculated at $17.50/person/hour.

The Utah Division of Wildlife Resources estimates the value of a deer or elk at $488 per year-of-age (i.e. a 3 year old deer would be valued at $1464) and is based on the hunting-related expenses divided by the combined herd sizes. Looking at the hunting-related expenses divided by the number of harvested animals the dollar value jumps substantially to $4,108. Somewhere in the middle of these values are the restitution values the Utah Code prescribes for illegal taking, possession, or wanton destruction of protected wildlife: $750 per animal for elk, $400 per animal for deer, and $8,000 per animal for trophy elk or deer. Cost analysis in this report will use the value of $2,200 per wild animal, noting that many of the countermeasures recommended in this toolkit can be used to help other species (moose, coyote, bighorn sheep, badger, etc.) which costs have not been identified. For additional figures directly related to deer-vehicle collisions see John Bissonette's current research at http://www.deercrash.com. *(4)*

For domestic animals, the typical value of a horse in Utah ranges from $1500 to $2500, with exceptions for racing or breeding stock (which can cost well into the tens of thousands of dollars range). Typical cattle prices range from $2000-$4000 depending on the weight, with exceptions for breeding stock (which can also sell in the thousands to ten thousands of dollars range). Cost analysis in this report will use the value of $2,000 per domestic animal, noting that many of the countermeasures recommended in this toolkit can be used to help other species (llamas, goats, sheep, etc.) which costs have not been identified.

To determine the delay cost to the traveling public on high volume freeway segments that can carry 2090 passenger car equivalents per lane per hour (LOS D, as defined in the AASHTO Green Book: "Policy on Geometric Design of Highways and Streets"), an accident which closes

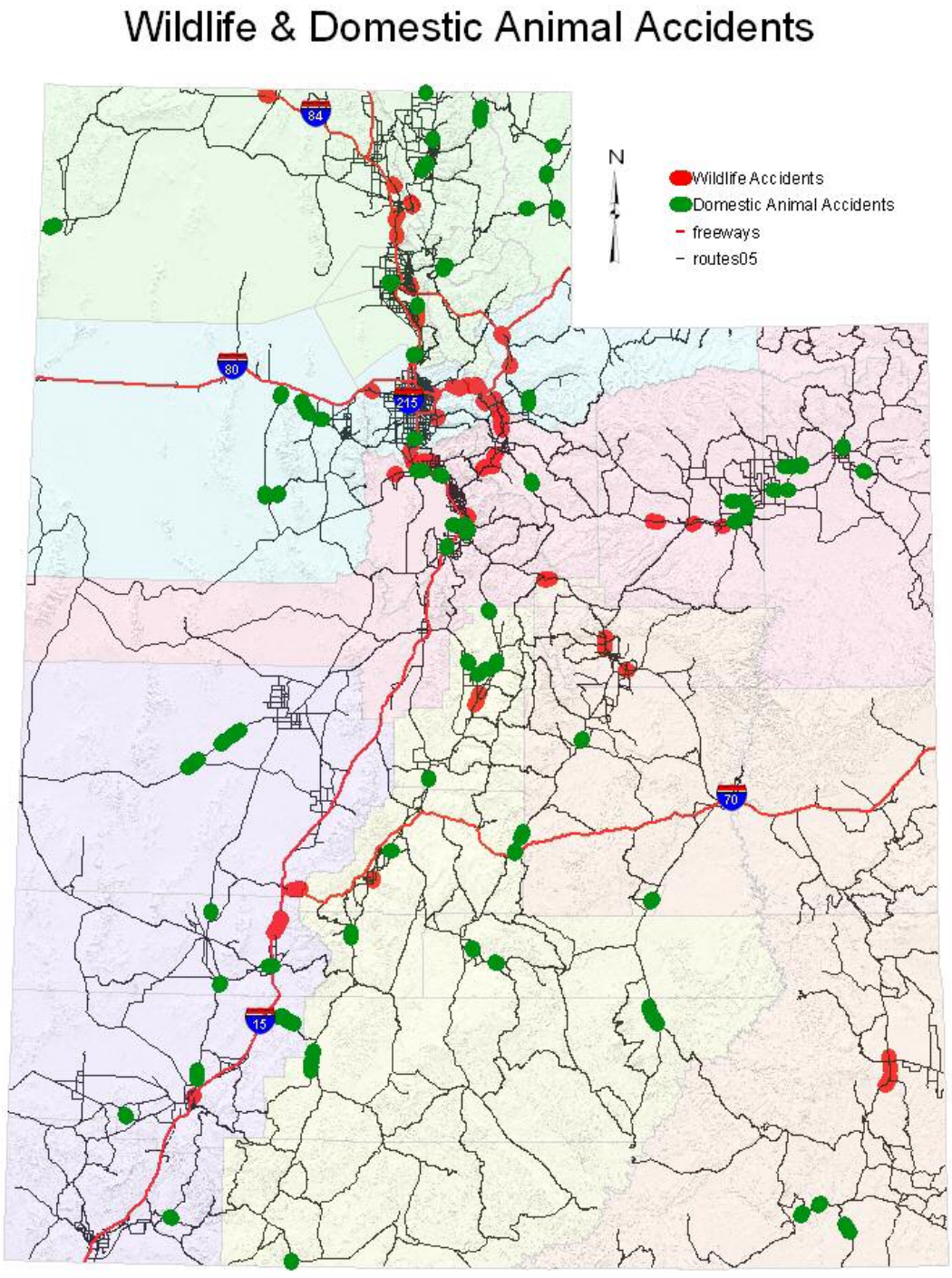
traffic lanes would cost the traveling public an additional $37,000 per lane/ hour in delays. (The $37,000 is the average annual crash cost determined by the delay cost to the traveling public of $17.50/person/hour times the passenger car equivalent per lane per hour, which is 2090 for a high volume freeway segment. The result being $36,575 that is then rounded to the nearest thousand to estimate $37,000 per lane/hour in delays.)

Benefit/Cost is calculated by multiplying the average annual crash costs times the design life of the measure and dividing this number by the estimated cost of the crash prevention measure. The design life may vary per measure used, i.e. a sign with flashers should be installed based on a design life of 15 years whereas a deer crossing is installed based on a design life of 30+ years with minimum maintenance. Crash costs can be estimated using the above table. For a measure to remain in consideration, the cost/benefit ratio should be 2 or higher.

$$\text{Benefit/Cost} = \frac{\text{(Average Annual Crash Cost x Design Life)}}{\text{(Estimated Cost)}}$$

On the next page the Domestic "Hot Spots" are listed by region and route followed by the Wildlife "Hot Spots." Each "Hot Spot" is identified by a single milepost (MP) along the route and the number of accidents per mile (Acc/Mi) or a continuous section of roadway with the ranges in number of accidents per mile (i.e. 5-8-5, indicating that the first mile consisted of 5 Acc/Mi, increasing to 8 Acc/Mi, and then decreasing to 5 Acc/Mi). Additionally, the GIS map for domestic and wildlife "Hot Spots" throughout the state follows. For more detailed maps contact Paul West at (801) 965-4672 or paulwest@utah.gov.

Wildlife "Hot Spots" (Greater than 20 Accidents/Mile)	**Domestic "Hot Spots" (Greater than 4 Accidents/Mile)**
REGION 1 Single MPs: None Continuous Section of Roadway: US 89; Entire Route (20-45 Acc/Mi) *Note: Worst Route; Coordinate all efforts with UDOT Environmental and Wildlife Biologist, Paul West at (801) 965-4672 or paulwest@utah.gov.*	Single MPs SR 39; MP 60 = 5 Acc/Mi SR 39; MP 20 = 4 Acc/Mi US 89; MP 397 = 8 Acc/Mi SR 91; MP 21 = 5 Acc/Mi SR 102; MP 10.5 = 4 Acc/Mi Continuous Section of Roadway US 89; MP 396.75—398.35 (5-8-5 Acc/Mi)
REGION 2 Single MPs: I-80; MP 138.91 (21 Acc/Mi)	Single MPs SR 138; MP 35.4 = 4 Acc/Mi Continuous Section of Roadway SR 32; MP 15.8—16.6 (4-6-5 Acc/Mi) SR 138; MP 6-7 (5-7-4 Acc/Mi)
REGION 3 Single MPs: US 40; MP 6 (23 Acc/Mi) US 40; MP 12.65 (20 Acc/Mi) Continuous Section of Roadway: US 40; MP 7.45—9.15 (20-33-20 Acc/Mi) US 40; MP 88.57-89.13 (23-24-21 Acc/Mi) SR 68; MP 34.79—35.76 (15-21-12 Acc/Mi) US 89; MP 287.19—288.07 (14-21-10 Acc/Mi) SR 92; MP 0.7—2.6 (12-30-10 Acc/Mi)	Single MPs I-15; MP 262 (5 Acc/Mi) *Note: All accidents occurred in 2003* Continuous Section of Roadway SR 121; MP 20.6—21.4 (5 Acc/Mi)
REGION 4 ***Richfield*** Single MPs & Continuous Section of Roadway None greater than 16 Acc/Mi	Single MPs SR 24; MP 39.51 (4 Acc/Mi) *Note: All accidents occurred in 2002.* US 89; MP 83 (4 Acc/Mi)
Cedar City Single MPs: None Continuous Section of Roadway I-15; MP 121.05-125.49 (10-23-10 Acc/Mi) I-70; MP 3-5.5 (11-20-11 Acc/Mi)	Single MPs SR 21; MP 105.7—106.7 (4 Acc/Mi) SR 125; MP 1 (4 Acc/Mi) SR 130; MP 40 (4 Acc/Mi) Continuous Section of Roadway US 6; MP 53.26—54.87 (3-4 Acc/Mi) US 20; MP 6-7 (4-14-7 Acc/Mi)
Price Single MPs: None Continuous Section of Roadway SR 191; MP 62.29—73.61 (10-20-10 Acc/Mi) *Note: Longest Stretch of 10+ Acc/Mi.*	Single MPs SR 10; MP 4.6—5.3 (4 Acc/Mi) SR 163; MP 34.9—35.5 (4 Acc/Mi) Continuous Section of Roadway SR 191; MP 12.7—14.9 (5 Acc/Mi)
US 6 MP 175-177, 188-190, 195-197, 200-207, 216-221, 236-240 *Note: Coordinate all efforts with Mike Miles, UDOT Project Manager*	


Wildlife & Domestic Animal Accidents
N
Wildlife Accidents
Domestic Animal Accidents
freeways
routes05
84
80
215
70
15

FUNCTIONAL CLASSIFICATION/PRIORITIZATION OF STATE ROUTES

Emphasis should be placed on reducing vehicle conflicts with wildlife and domestic animals on the highways that have the highest functional classification. The Interstate Highway and principal arterial networks are the highest functional classes of roadway systems and carry highest volumes of traffic. The wildlife QIT recommends prioritizing resources and efforts on solving conflicts on these critical transportation facilities. Roadways on the National Highway System (NHS), which includes the Interstate system, and important principal arterial roadways are also eligible for an additional funding under the Federal-aid NHS program.

The Functional Classification Maps are available from the UDOT website at: http://www.udot.utah.gov/index.php/m=c/tid=1224

The Functional Classification maps will be updated in 2008 and again after the 2010 Census results are made available. Questions concerning the Functional Classification Maps can be directed to UDOT Program Development Unit.

THE PROCESS

Planning

UDOT Systems Planning and Programming, in cooperation with municipal planning organizations, and resource agencies, identify and recommend animal-vehicle crash prevention measures for "hot spot" area projects as part of UDOT's Long Range Plan. Hot spot areas where other improvements are not part of the Long Range Plan may be called out as separate projects. Appropriate funding levels are incorporated for actions proposed.

Early Project Examination/Identification

Use Prioritization Mechanisms and perhaps GIS analysis in planning/budgeting. Emphasize early identification of issues in NEPA scoping.

The Planning divisions, both those in the Central Office as well as the regional planners, have access to GIS data to help them make determinations of wildlife impacts for every project. So far, such data consists of the following:

- Vehicle/Wildlife Accident Data
- Vehicle/Domestic Animal Accident Data
- Wildlife Connectivity Data
- Threatened and Endangered Species Data
- State Sensitive Species Data
- Statewide Critical and Sensitive Habitats Data

With these data sets, planners can identify areas that need further analysis through corridor studies and to plan for adequate wildlife protection measures early in the project definition and selection process. This facilitates early identification of issues while prioritizing projects to be added to the statewide transportation improvement program (STIP) and in NEPA scoping.

Regional and Central training sessions held in 2005 ensured that all "hot spots" were appropriately identified. The Utah DWR attended these trainings to encourage coordination among other agencies. Follow-up region field visits allowed coordination with Utah DWR to further evaluate potential treatments of greatest benefit at each identified "hot spot". Planners

will be encouraged to use this field information. During the NEPA phase, UDOT will identify issues prior to projects being listed on the STIP.

Early Environmental/Planning Coordination
UDOT Planning and Environmental divisions will work together to improve communication and to better integrate environmental considerations into planning activities, with the goal of a virtually seamless environmental process from the planning phase through the programming phase, design, permitting, construction and maintenance phases. Early consideration of wildlife and domestic animal crash "hot spots" will allow UDOT to develop potential remedies and costs based on existing data and proposed improvements and to provide more accurate estimates of overall project costs before the projects are programmed in the STIP.

Long Range Plan of Costly Projects
Some animal crash prevention measures will be too costly to perform under normal Region operations, spot improvements, and contingencies. Overpasses and underpasses are key examples. Exclusionary deer fencing may also fall into this category, depending on length and terrain. In these cases, proposed mitigation measures will need to be added to the statewide or metropolitan long-range plans.

The UDOT long-range transportation plan lists projects larger than those covered by maintenance and preservation activities. These projects include pavement reconstruction, shoulder widening, adding travel lanes, constructing new or rebuilding older interchanges, adding new highway alignments, and other capital-intensive activities. Project limits are typically defined by highway maintenance section, except for new alignments and localized improvements such as interchanges, bridges, and large-scale spot safety projects. Proposed animal protection measures and their projected costs should be included in the detailed descriptions for each project. In cases where a priority "hot spot" is located on a highway section not slated for other improvements, a separate mitigation project should be added to the list.

Projects are added to the long-range plan a number of ways, including Region input, public and resource agency comments, asset management, corridor studies, and local transportation master plans. One of the most effective ways to ensure needed mitigation measures are added to the long-range plan is to coordinate with the UDOT Planning Section, as individual corridor studies are prepared. In this way, these measures are included with the other identified needs of each corridor and their estimated costs.

In urbanized areas (Salt Lake – Ogden, Utah Valley, Dixie, Cache Valley), metropolitan planning agencies have the primary role for transportation planning, in partnership with UDOT. Their plans are prepared separately, and then integrated into the statewide plan. UDOT Environmental staff, resource agencies, and others who want to include wild and domestic animal-hit mitigation measures into plans for local and state roadways in metropolitan areas should coordinate with these agencies.

Statewide Transportation Improvement Plan (STIP)
A proposed project must appear in the statewide transportation improvement program (STIP) before development funds can be expended on it. Each year, the Regions work with the Programming Section, UDOT leadership, and the Utah Transportation Commission to determine which projects in the LRP have highest priority and should be forwarded to the STIP, either in

the Concept Development phase or directly in a funded year. In anticipation of this process, each Region may request that a detailed corridor study be performed to get a better understanding of corridor needs, project limits, level of environmental analysis needed, and anticipated costs. Specific mitigation measures should be recommended for any animal-hit "hot spots" identified within the corridor as part of these pre-STIP corridor studies.

Project Development

When "hot spot" area projects are advanced to the Concept Development phase of the STIP, the animal-vehicle crash prevention measures will be re-evaluated to determine: 1) If the measures remain appropriate; 2) If allocated funding is adequate; and 3) Cost/Benefit to the Department as well as the traveling public. Projects located in "hot spot" areas with no measures prescribed will also be re-evaluated and recommendations made, as appropriate. When a project moves to a funded year, animal-vehicle crash prevention should be part of the project purpose and need and an appropriate range of measures would be evaluated as part of the National Environmental Policy Act (NEPA) process. The NEPA process will help to select the most appropriate measure(s). As part of the NEPA document, performance measures should be developed to determine effectiveness. During final project design, the region environmental staff will ensure that all NEPA document commitments are made, including all animal-vehicle crash prevention measures. (Note: Recently, on Categorical Exclusion projects the concept phase was revised to include analysis of animal-vehicle collisions.)

Preconstruction

Wildlife

Design options help roadway designers provide wildlife with safe opportunities to cross roadways that result in reduced wildlife hits. Implementation of design options optimizes the mitigation measures placed in locations where animals naturally approach and cross a roadway. No single set of variables identifies preferred wildlife crossing locations. Every highway landscape is unique and requires mitigation measures and locations to be identified individually for each project. Once a "hot spot" has been identified guidelines for analysis include the following as gathered from the Colorado Department of Transportation *(5)*:

- Habitat suitability is the primary indicator for crossing activity.
- Landscape structure interaction with habitat suitability.
- Highway design influence on habitat suitability and landscape structure.
- Identify crossing areas for species.

Habitat and behavior of different species require professional input on the above items. Wildlife species do not cross highways randomly.

Design Considerations:

- Highway Placement: The characteristics of the surrounding landscape are important in determining sections of highway frequently crossed. Placement of a highway within a landscape affects how each section is crossed.
- Highway Design: Location of roadside barriers and structures like fencing and underpasses have significant impact on where animals are most likely to cross the road.

Conflict Zones:

- Highway segments crossed most frequently by wildlife as indicated by accident data, tracking data and professional knowledge. Features that correlate with conflict zones include suitable habitat, linear guide ways that encourage or discourage crossing depending on orientation to the roadway, and slope steepness/complexity.

Crossing Zones or Hot Spots:

- Location within a highway segment that has the highest rate of wildlife crossings. Features that correlate with crossing zones barriers, distance to cover, and linear guide ways.

Identification Criteria for Design Options:

- 20 hits per mile over a 3-year period.

Design-Based Approaches to Reduce Wildlife-Vehicle Conflicts:

- Combine habitat features on the roadside and the design of the highway to determine location of crossing zones. Crossing zones located where wildlife naturally cross the highway are the most successful to reduce wildlife/vehicle conflicts. On low volume roads use at-grade crossings. Maximize the at-grade crossing by minimizing the barrier effect of the highway. Use crossing structures on high volume/high speed roads to accommodate animal movements above or below the roadway. In unique and extraordinary circumstances overpasses may be used as coordinated with UDOT Environmental and the Utah Division of Wildlife Resources.

Option: At-Grade Crossing. Low Traffic Volumes

Possible Solutions: (As compiled from Keith Knapp's 2004 Countermeasure Toolbox *(6)*)

- Permanent Signing
- Temporary Signing
- Escape Ramps & Exclusionary Fencing (8 foot height)
  (Note: Option requires exclusionary fencing for a minimum of 1 mile from each direction leading to the crossing and on both sides of the roadway for a total of 4 miles of fencing with escape ramps spaced at approximately ¼ mile intervals as coordinated with the UDOT Wildlife Biologist. An escape ramp is an earth structure that allows wildlife in the right-of-way to exit the right-of-way. See UDOT Standard Drawings FG Series, www.udot.utah.gov)
- Locate in natural crossing areas
- Roadside Vegetation Management
  - Mowing or clearing of Right of Way
- Geometric Considerations:
  - Reduce speed limit
  - Curvilinear Curves
  - Wider cross section and narrower lane
  - Bridge height and length

Option: Below- Or Above-Grade Crossing

(Note: Option requires exclusionary fencing for a minimum of 1 mile from each direction leading to the crossing and on both sides of the roadway for a total of 4 miles of fencing with escape ramps spaced at approximately ¼ mile intervals as coordinated with the UDOT Wildlife Biologist. An escape ramp is an earth structure that allows wildlife in the right-of-way to exit the right-of-way. See UDOT Standard Drawings FG Series, www.udot.utah.gov)

Possible Solutions: (As compiled from Keith Knapp's 2004 Countermeasure Toolbox *(6)*)

- Escape Ramps & Exclusionary Fencing (8 foot height)
- Recommend using a structure rather than box or pipe culverts
- Simple span bridge with no or reduced vertical supports (pillars)
    - "These have proven much more effective than box or corrugated steel culverts for getting animals under the freeway, particularly when we are talking about elk." Bruce Bonebrake, DWR Habitat Manager
    - "The Swiss research indicates that overpasses with a width of 50 meters (164 feet) or greater are used by the widest variety of species, and the animals exhibit natural behavioral characteristics when using the structures." *(7)*
- Locate in natural crossing areas
- Design natural bottom and side slopes in structures
- Minimum vertical clearance for underpass structure of 16 feet with aspect to length ratio of 9.2 or greater
    - Wyoming Department of Transportation *(8)* "found that deer approaching the underpass were more likely to repel in response to smaller underpass sizes than larger. Deer were more sensitive to changes in the width of the underpass than the height. Height reductions down to 8 feet did not appear to substantially impact deer willingness to use the underpass, but reduction to 6 feet resulted in a large increase in percentage of deer repelling from the underpass." Future recommendations are that underpasses "be at least 20 feet wide and 8 feet tall, and have an openness ratio of at least 0.8."
- Maximize daylight area with natural slopes
    - Avoid use of vertical walls or walls covered with rock or concrete
    - Daylight underpass in center median where possible
- Successful reduction in wildlife-vehicle collisions considers the structure of the surrounding landscape, highway design, and species. See mitigation measures.
    - According to Bill Ruediger *(9)*, "Road and highway wildlife crossings should be planned and designed for multiple species. By applying ecological and behavioral concepts the effectiveness of wildlife crossing structures can be greatly improved. Future structures should appear more natural to increase use and should be placed in areas that animals naturally use."

Domestic

Design options to reduce domestic hits on roadways.

Identification Criteria for Design Options

- 4 hits per mile over a 3 year period

Design-Based Approaches To Reduce Domestic/Vehicle Conflicts:
- Fencing – UDOT Standard Drawings FG Series
- Swing Gates – UDOT Standard Drawings FG Series
- Cattle guards – UDOT Standard Drawings SW Series
- Signing (Temporary And Permanent)
- Public Information Outreach with Rancher Associations

Construction

UDOT will ensure that all commitments are incorporated into construction projects. If circumstances suggest modifications to the prescribed measures, then region environmental staff and relevant resource agency personnel will meet with construction staff to review the suggested changes. Regular site visits are scheduled for region environmental staff and resource agency staff to ensure proper construction of the crash prevention measures.

Maintenance

The crash prevention measures will require maintenance to ensure that they continue to function. Appropriate maintenance plans for the various measures are developed by UDOT in conjunction with wildlife resource agencies. Where possible, monitoring of measures should be performed to determine effectiveness. Accident data should be collected during this phase and analyzed to determine the effectiveness of the measures. These analyses are collected and used to determine appropriate measures for future projects. Crash prevention measure locations and goals are included in region maintenance goals. The UDOT Central Environmental Division will provide a list of suggested maintenance activities for design engineers and resource agency staff.

Possible Solutions: (As compiled from Keith Knapp's 2004 Countermeasure Toolbox *(6)*)
- Roadway Maintenance
    - Winter Maintenance (deicing or anti-icing salt mixes)
- Roadside Vegetation Installation & Maintenance
    - Choice of Reclamation Species
    - Mowing and Clearing of Right of Way
- Carcass Removal
    - Prevent Accidents by Hitting Carcass
    - Prevent Scavengers that can be a safety issue

MITIGATION MEASURES

National Mitigation Measures

Wildlife

The following mitigation measures are recommended to reduce hits by improving existing conditions. Wildlife mitigation measures work best when wildlife habitat and movement impacts to a roadway system are considered during development and operation. Generally, wildlife/vehicle hit occurrence is highest in the evening, nighttime, and early morning hours. Place mitigation measures at natural crossings.

Proven Mitigation Measures:
(Percentages from Keith Knapp's 2004 Countermeasure Toolbox *(6)*)

- Roadside Vegetation Management: Vegetation clearing up to 10 feet from the edge of the roadway. (20% reduction)
  - As noted in the follow up training session, roadside vegetation management needs to be followed per UDOT's policy, which is not to mow until the grasses are taller than 14 inches.
  - "When Fall rains hit, grasses green up and create greenbelts (feeding areas) for migrating deer, therefore caution should be used when mowing. In addition, if the grasses are cut too short erosion and/or invasive species development can occur." – Ira Bickford, UDOT Central Maintenance Planning Division
  - Recommend using unpalatable grass species during reclamation.
- Exclusionary Fencing 8 feet in height. This provides a physical barrier between animal and roadway. (60%-97% reduction)
- Underpass Crossings (Recommend using actual crossing structures, not hydraulic structures like boxes or culverts)+ Exclusionary Fencing 8 feet in height and escape ramps at approximately ¼ mile intervals. Underpass crossings need to evaluate location and landscape when determining placement. Suggested spacing is one mile.
- Escape Ramps. These are used 8 to 11 times more than one-way gates. UDOT has implemented new Standard Drawings for escape ramps; see UDOT Standard Drawings FG Series. ("Effectiveness of Earthen Ramps in Reducing Big Game Highway Mortality in Utah" by John A. Bissonette and Mary Hammer, November 2000)
- Exclusionary Fencing + Underpass/Overpass Crossing + Escape Ramps
- Roadway lighting (18% reduction)
- Reduction in posted speed limit
- Signing – Overuse/misuse will reduce effectiveness.
  - Seasonal use of flashing signs has been more effective than permanent signs.
  - The longer a sign remains in place the less effective it becomes as it begins to recede into the everyday background for the daily commuter.
- Public information and education – The more informed the public is the more award of the hazard they will become.
- Hunting or Herd Reduction
- Electrified Fence
- Communication/Coordination with other resource agencies allows UDOT to identify the best location as well as the most effective measure for that location.
- Policies/Standards – Policies/Standards must account for costs and benefits.
- Maintenance
  - Winter Maintenance
  - Roadside Vegetation Installation and Maintenance
  - Carcass Removal
  - Integrated Roadside Vegetation Management Plan

        - Fence Maintenance
    - Design:
        - Posted Speed Limit-reduction in speed
        - Curvature-more curvilinear
        - Cross Section-wider roadway (i.e. wider shoulder, right of way, increased clear zone, etc.) with narrower lane width
        - Bridge Height and Length (i.e. simple span bridge, open at the top, avoid the use of pillars, upright reinforcing or retaining walls that reduce the openness of the structure)
    - Roadway Alignment Location
    - Project Planning

Other Methods with Unproven Success:

- In-Vehicle Technologies
    - Animal Sensing Devices and In-Vehicle Displays
        - Not tested thoroughly
        - Can give false readings
        - Potential for Problems with Driver Compliancy
        - Information Overload/Distraction
        - High cost
- Deer Whistles
    - Questionable Scientific Evidence of Effectiveness
    - Deer May Not be Able to Hear Whistles
- Roadside Reflectors and Mirrors
    - No Conclusive Study Showing Effectiveness
    - High Installation Cost
    - High Maintenance/Cleaning Cost
- Designated Deer Crosswalks
    - Minimal Evidence of Reduced Road Kill After Installation
    - Animals on ROW Regardless
    - Fencing Needs to be Maintained
        - Gates Need to be Closed

Domestic

- Fencing – replace/repair/construct
- Electrified Fence
- Signing – temporary or permanent
- Cattle guards, see UDOT Standard Drawings SW Series
- Temporary signing in open range areas
- Rancher Association interaction

Mitigation Measures in Utah

Lessons Learned from Crossings in Beaver

1) Share information between state agencies.
2) Deer and elk use the underpasses.
3) Deer use the Beaver overpass. Overpass could also be improved with landscaping that is similar to the surrounding environment and blocks out the highway from view and noise; this type of work to be coordinated with Paul West as well as the Region Landscape Architects.
4) The underpass made use of existing drainage and frontage road.
5) Drive cattle through to make trail for deer to follow. (It is believed that his broke "new" ground reducing the human smells lingering from the recent construction activities.)
6) Increased traffic volume creates more hits and less success for deer to survive Interstate crossings.
7) Underpasses work well because they are open, have daylight, and are natural.
8) Frontage Road may impede wildlife crossings.
9) Deer accept the underpasses as a migration route.

Lessons Learned: US 6 Hot Spots

Initially, when using UDOT Traffic & Safety's Crash Data Almanac, US 6 had no wildlife vehicle collision "hot spots". After sending this toolkit out for review Utah DWR forwarded comments from the Draft EIS for US 6 that provided wildlife-vehicle collision totals of much greater magnitude than what UDOT's records indicated. After further investigation it was discovered the Utah DWR numbers were more realistic. The difference was accounted for by the presence of coal hauling trucks that were having wildlife collisions and not stopping or reporting them. The UDOT Maintenance Area Supervisors verified this information. As a result of this information US 6 and its appropriate mileposts were added to the wildlife-vehicle collision "hot spot" as a stand-alone route.

Additional Lessons Learned in Utah

Deer Gates Only 16% of the deer that approached the one-way gates installed in Summit County actually used them. Therefore, it was determined that the gates were not effective.

Reflectors Reflectors were installed on two routes to startle deer off the roadway when a vehicle's approaching headlights connected with the lens of the reflector. Spacing of the reflectors varied from 25 to 50 feet depending on the tangent or curve of the roadway. There were no reductions in the total number of deer-vehicle collisions in the accident database. Maintenance crews reported an increase in deer kills. There was a question of the reflectors working for mule deer as they were designed for whitetail deer. In addition, lens were difficult to keep clean. In the end, the use of reflectors was not recommended as an effective means for reducing deer-vehicle collisions.

Seasonal Signing One of the most effective measures used in Utah is seasonal signing. By installing flashers on deer crossing signs during the spring and fall when the highest numbers of animal-vehicle collisions often occur, drivers pay closer attention. The key to this measure is narrowing the "exposure" timeframe of the flashing signs. The longer the flashers remain in place the less effective they prove to be as drivers adjust to seeing them. Therefore, it is important that the time periods be clearly identified prior to installing the flashers on the signs.

This can be done through a detailed query of the Crash Data Almanac System for a particular state route.

Crosswalks In Summit County, a research project in Phase 1 of 3 installed painted crosswalks with riprap bordered dirt-crossing trails connecting to swing gate crossings in the deer fence. Three crosswalk use attempts were witnessed in the first three months after the crosswalks were installed. All three of these wandered outside the "confines" of the crosswalk. Six subsequent crossings were observed where the deer remained within the "confines" of the crosswalk; cars hit two of these. Therefore, it was determined that the crosswalks were ineffective. Due to lack of interest and funding following Phase 1 the next two phases were cancelled for this research project.

New Deer Crossing Standards Recently, the Standards Committee approved two types of deer crossing standards. The first is for areas where high migratory crossings have been identified and coordinated with the Division of Wildlife Resources. It consists of three deer escape ramps; two running along the fence line from either direction and one running perpendicular to the fence with fencing guiding the animals away from the roadway (see UDOT Standard Drawings FG Series for further detail). The second is the typical deer crossing with a single perpendicular escape ramp along the fence line.

Mitigation Measures for Further Research:

- Deer Crossing Signs And Technologies
- Typical deer symbol crossing warning signs
- Lighted "DEER XING" signs
- Animated deer crossing signs
- Utah primary and secondary temporary deer crossing sign designs
- Michigan temporary deer crossing sign design
- Dynamic elk sign and sensor system
- Solar powered animal sensors
- Repellents
    - Chemical
    - Biological
- Public Information And Education
- http://www.deercrash.com/releases.htm
- http://www.dps.state.ia.us/deercrashes/
- http://www.state.me.us/mdot/safety-programs/maine-crash-data.php
- http://www.semcog.org/TranPlan/TrafficSafety/MDCC/index.htm

POLICY & STANDARDS

A UDOT Policy that considers Planning, Project Development, and Operations aspects of wildlife and domestic hot spots should be developed and implemented. The policy may include determination of Cost/Benefit, Hot Spot definition and location, prioritization, project identification, environmental coordination, design, construction responsibility, maintenance, mitigation measures, project funding, and performance measures. UDOT Standard Drawings and Specifications need to be continually reviewed to incorporate the most up to date methods in reducing wildlife and domestic animal-vehicle collisions.

COMMUNICATION/COORDINATION

Collaboration with stakeholders provides opportunities to address wildlife and domestic animal concerns associated with transportation facilities. Many channels of communication already exist such as coordination with the US Fish and Wildlife Service, FHWA, UDWR, and property owners adjacent to our right of way on a project-by-project basis. A general Memorandum of Understanding (MOU) between UDOT and DWR recognizes the importance of collaboration on transportation and associated wildlife impacts and mitigation.

In addition to the key state and federal resource agencies, communication/coordination with other stakeholder agencies such as EPA, USACE, SITLA (State Institutional Trust Lands Administration), USFS, BLM, and Non-Government Organizations (NGOs) may be beneficial, as well as, individual involvement with farmers/ranchers, concerned citizens, and researchers/experts. UDOT region and central environmental staff should also be consulted and can supply stakeholder contact information.

Informational Websites:

FHWA Critter Crossing: http://www.tfhrc.gov/pubrds/marapr00/critters.htm
AASHTO Center for Environmental Excellence: http://environment.transportation.org/
ICOET (International Conference on Ecology and Transportation):
www.itre.ncsu.edu/cte/icoet/html
Wildlife Studies in Utah by Utah State University:
http://www.cnr.usu.edu/faculty/jbissonette/index.htm

FUNDING SOURCES

Sources of funding for wildlife crossings:

- Dedicated Hunter funds from DWR
- Code 1 Maintenance
- 3R Projects
- Reconstruction Projects
- Safety Spot Improvements
- Maintenance Spot Improvements
- Hazard Elimination Safety
- Transportation Enhancement
- High Priority Projects/Demonstration Projects
- Highway Research
- Priority Technology
- Roadside Vegetation Plan
- USFS & BLM Mitigation Funds
- FHWA Technology Transfer Funds
- FHWA Environmental Streamlining Funds

PERFORMANCE MEASURES

To evaluate crossing effectiveness crossing structures need to be monitored and long-term trends in animal hits pre- and post-construction need to be gathered. To compare two years or two time periods, divide the number of carcasses removed by the ADT. The assumption is that as ADT increases, the numbers of accidents are likely to increase. This comparison can only be used to compare the same stretch of roadway and not to compare different roadways.

Accident data on both sides (1-5 miles) of the proposed structure, or the fence that extends from the structure, should also be examined pre- and post-construction. This will help indicate crossing effectiveness and migration trends.

The before/after findings should be posted and shared with others. It is recommended that as countermeasures are implemented that the results be monitored and coordination with UDOT Central Environmental occur where a statistically valid study may be warranted.

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