Animal-Vehicle Collision Mitigation in Texas, USA

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A familiar experience...

(Source: http://www.youtube.com/watch?v=zYxbqQoyPXw)
Introduction

In the United States:

• **2001 estimate**: 1.5 million deer-vehicle collisions
  - >29,000 human injuries
  - >200 human fatalities
  - 1.3 million deer fatalities
  - >$1 billion-worth property damage

• **2009 estimate**: 2.4 million deer-vehicle collisions
Introduction

• Deaths due to animal-vehicle collisions increasing:
  – 1994: 131 people died
  – 2008: 210 people died

• Top 5 states with most deaths in animal vehicle collisions (2004-2008):
  1. Texas, 88 deaths
  2. Wisconsin, 62 deaths
  3. Ohio, 51 deaths
  4 & 5. Pennsylvania and Michigan, 46 deaths each
Introduction

• SH-130 in Texas:
  – Opened October 2012
  – The fastest toll road in the U.S., 85mph (140 km/h)
  – south of Austin
  – feral hog collisions on this new highway

– SUV after hitting hogs (March 2013)
Introduction

• To effectively manage animal-vehicle collisions:
  • Knowledge on spatial distribution
  • Knowledge on severity of collisions

• Statistical models can identify
  • High-risk accident roads
  • Features associated with severe crashes
This study

- **Objective of this study:**
  - Develop *logistic regression models* to predict the severity of animal-vehicle collisions in Texas based on:
    - Month and time of day
    - Outdoor light condition
    - Rural vs. urban setting
    - Domestic vs. wild animal
    - Vehicle type & traffic
    - Road width, road type
    - Driver age

- Data was obtained from **Crash Records Information System (CRIS)** of Texas.
Crashes during 2007-09

Animal-related crashes in Texas 2009

- 12,123 total
- 32 deaths
- 335 serious injuries
- 1,382 moderate injuries
- 1,741 minor injuries
- 8,633 property damage only
Data: 2007-2009 average/yr. (Vehicle Type)

Overall:
- 4252 4-D sedans
- 3462 pickups
- 2138 SUV's
- 343 motorcycles

- **Severe injury or death:** motorcycle most
- **Mod/minor injury or prop.damage:** 4-D sedans most
Data: 2007-2009 average/yr. (Month)

Overall:
October: 1433 crashes
November: 1739 crashes
December: 1196 crashes

- Most
  October & November (all severity levels)

- Least (varied per severity level)
  July (prop.damage only)
  January (severe injury or death)
Data: 2007-2009 *average/yr.*
(Hour)

• **Moderate or minor injury or property damage only:**
  9pm most

• **Severe injury or death:**
  8pm, 12am, 4am, & 6am most

### Graph Details
- **X-axis:** Hour of the day
- **Y-axis:** # of Crashes
- **Legend:**
  - Severe Injury or Death
  - Moderate or Minor Injury
  - Property Damage Only

The graph illustrates the distribution of crashes by hour, with peaks at 9pm for moderate or minor injuries and property damage only, and 8pm, 12am, 4am, & 6am for severe injuries or death.
Data: 2007-2009

Outdoor light condition:  
(overall)  
• 7108 crashes – dark, not lighted  
• 3115 crashes - daylight

Animal Type:  
(overall)  
• 7007 crashes – wild  
  - white-tailed deer  
  - feral hogs  
• 4136 crashes – domestic  
  - free range livestock  
  - pets

(Elgin, TX, September 2013)  
(Austin, TX, October 2013)
Logistic Regression Model

\[ P(y_i \mid x_i') = \frac{1}{1 + e^{-x_i'\beta}} \quad 0 \leq P(x_i) \leq 1 \]

Where,

\[ x_i' \beta = \beta_0 + \beta_1 x_{i1} + \ldots + \beta_k x_{ik} \]

- The linear predictor

- \( \beta \) parameters need to be estimated.
  - Maximum Likelihood technique
  - Use a statistical computer package: SAS
Developed Models

• **Model 1:** \( P(\text{serious injury or death} \mid x) \)

• **Model 2:** \( P(\text{moderate or minor injury} \mid x) \)

• **Model 3:** \( P(\text{property damage only} \mid x) \)
## Results

### Logistic Regression Model for the Probability of *Property Damage Only*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter Estimate</th>
<th>St. Dev.</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.37</td>
<td>0.038</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Indicator: Motorcycle</td>
<td>-4.04</td>
<td>0.17</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Indicator: Sedan4D</td>
<td>-0.115</td>
<td>0.042</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Indicator: SUV</td>
<td>-0.241</td>
<td>0.051</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Indicator: October</td>
<td>0.205</td>
<td>0.059</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Indicator: November</td>
<td>0.421</td>
<td>0.058</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Indicator: December</td>
<td>0.199</td>
<td>0.065</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Indicator: 12am</td>
<td>-0.390</td>
<td>0.080</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Indicator: 1am</td>
<td>-0.213</td>
<td>0.089</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Indicator: 2am</td>
<td>-0.431</td>
<td>0.091</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Indicator: Wild</td>
<td>0.374</td>
<td>0.039</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Indicator: Daylight</td>
<td>-0.249</td>
<td>0.046</td>
<td>&lt; 0.01</td>
</tr>
</tbody>
</table>
Conclusion

• **Need to identify high-risk areas** for mitigation
• The models can help understand scenarios that are potentially dangerous
  – Identify the vulnerable time and location
  – Prioritize locations
  – Identify appropriate mitigation technologies
  – Perform cost-benefit analysis
  – Recommend investment options
Thank You!