Outline

- Background
- Objectives
- Data sources
- Analysis
- Results
Background

- In 2001, perceived energy shortage in West
  - Governor requires 10% reduction
- Oregon DOT considers illumination
  - Field review
  - Rigorous safety analysis
  - Directive – “only the safest”
47 interchanges
6.03 miles lineal lighting
Group A - 33 sites - Full to partial interchange lighting.

Group B - 2 sites, 2.5 mi - Full lineal to no lighting.

Group C - 2 sites, 3.5 mi - Full lineal to partial lineal lighting.

Group D - 14 sites - Partial plus to partial interchange lighting.
Objective

- Observational before-after crash based analysis
- Quantify the safety effects of lighting reductions
  - Few previous evaluations
- Not comparing “designs”
Crash
• 1996-2005
• 5 yr before
• 4 yr after
• Coded
  • Day
  • Dawn
  • Dusk
  • Dark

+0.2 mile from last ramp
Exposure - Volume

- 1996-2005
- Night volumes estimated
  - Sunrise/set data
  - ATR data

Geometry

- AASHTO Classifications
- Lighting from plans and digital video log
Methodology

• Develop models from a reference group
  – Negative binomial regression
  • Repeated measures
    – Total and Injury-only (both day & night)

• Estimate expected crash performance without lighting modifications
  – Empirical-bayes

• Compare observed with expected crash performance
Empirical Bayes-Methods

\[ \tau = E(\tau)\alpha + (1 - \alpha)K \]
\[ \alpha = \frac{1}{1 + (E(\tau) \cdot Y) / \phi} \]

*\( \tau \) is best estimate expected # of crashes

Source: Harwood et al 2002
Reference Groups

- Interchanges with full and partial lighting
  - 38 sites
- Urban freeway sections with and without lighting
  - 42 sites, 53 miles
<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Total</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>Std Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL_DAY</td>
<td>4,087</td>
<td>0</td>
<td>88</td>
<td>11.95</td>
<td>14.39</td>
</tr>
<tr>
<td>TOTAL_NIGHT</td>
<td>1,386</td>
<td>0</td>
<td>22</td>
<td>4.05</td>
<td>4.29</td>
</tr>
<tr>
<td>INJ_DAY</td>
<td>1,710</td>
<td>0</td>
<td>35</td>
<td>5.00</td>
<td>6.26</td>
</tr>
<tr>
<td>INJ_NIGHT</td>
<td>613</td>
<td>0</td>
<td>14</td>
<td>1.79</td>
<td>2.22</td>
</tr>
<tr>
<td>DAYS_RAIN</td>
<td>-</td>
<td>68</td>
<td>190</td>
<td>145.52</td>
<td>31.66</td>
</tr>
<tr>
<td>ALL_VOL</td>
<td>-</td>
<td>12,160</td>
<td>219,400</td>
<td>91,934</td>
<td>57,622</td>
</tr>
<tr>
<td>LIGHTING</td>
<td>-</td>
<td>Full or partial</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INT_TYPE</td>
<td>-</td>
<td>Diamond, Partial cloverleaf, Directional</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable Name</td>
<td>Total</td>
<td>Min</td>
<td>Max</td>
<td>Mean</td>
<td>Std Dev</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------</td>
<td>-----</td>
<td>-----</td>
<td>-------</td>
<td>---------</td>
</tr>
<tr>
<td>TOTAL_DAY</td>
<td>2,174</td>
<td>0</td>
<td>43</td>
<td>5.75</td>
<td>7.91</td>
</tr>
<tr>
<td>TOTAL_NIGHT</td>
<td>884</td>
<td>0</td>
<td>21</td>
<td>2.34</td>
<td>3.28</td>
</tr>
<tr>
<td>INJ_DAY</td>
<td>930</td>
<td>0</td>
<td>22</td>
<td>2.46</td>
<td>3.58</td>
</tr>
<tr>
<td>INJ_NIGHT</td>
<td>392</td>
<td>0</td>
<td>16</td>
<td>1.04</td>
<td>1.69</td>
</tr>
<tr>
<td>DAYS_RAIN</td>
<td>-</td>
<td>68</td>
<td>190</td>
<td>139.10</td>
<td>35.17</td>
</tr>
<tr>
<td>LENGTH</td>
<td>53</td>
<td>0.43</td>
<td>2.63</td>
<td>1.27</td>
<td>0.58</td>
</tr>
<tr>
<td>LANES</td>
<td>-</td>
<td>4</td>
<td>6</td>
<td>4.48</td>
<td>0.85</td>
</tr>
<tr>
<td>VOLUME</td>
<td>-</td>
<td>6,860</td>
<td>165,620</td>
<td>58,494</td>
<td>46,937</td>
</tr>
</tbody>
</table>
Model Form – Neg. Binomial

Interchanges

$$\tau_{j,y} = (VOL)^{\beta_1} EXP(\alpha_{YEAR} + \beta_0)$$

Lineal Sections

$$\tau_{j,y} = (VOL)^{\beta_1} EXP(\alpha_{YEAR} + \beta_0)^*(LNGH)$$
Total

Obs = 2,002
Est = 2,034
-1.6%

Obs = 194
Est = 215
-9.5%

Obs = 149
Est = 144
+3.6%

Obs = 839
Est = 812
+3.5%

Obs = 95
Est = 74
+28.9%

Obs = 46
Est = 72
-35.2%

Day Crashes
Night Crashes

% Change

A B/C D A B/C D
Injury

Day Crashes

Night Crashes

Obs=838
Est =918
-8.7%

Obs=87
Est =114
-23.4%

Obs=53
Est =62
-13.8%

Obs=339
Est =383
-11.4%

Obs=45
Est =33
+39.2%

Obs=22
Est =37
-39.2%
Conclusions

• Group B/C - Lineal sections
  – Negative safety effect

• Group A – Full to partial reductions
  – Less clear
  – Mixed individual site performance
  – Negative safety effect

• Group D – Partial Plus to Partial reductions
  – View with caution
  – Rural, small sample
  – No safety effect
Discussion

- Challenging analysis
  - Partial reductions
  - No field measurement
  - Selection bias
  - Maintenance issues
Acknowledgments

• Oregon Department of Transportation
• At Portland State University
  – Michael Wolfe, Thareth Yin, Kartik Srinvas, Max Stephens and Peter Bosa
• Craig Lyon of Ryerson University
• Anonymous reviewers at University of North Carolina Highway Safety Research Center
Questions?

Thank You!
www.its.pdx.edu