Assessing Wildlife Responses to Highway Wildlife Crossing Designs

Patricia Cramer, PhD

TRB 2018 Learning from Natural Experiments: Evidence Based Decisions
Thank You to Research Sponsors
Overview

- Wildlife, Roads, Vehicles – Addressing Safety and Ecological Issues
  - The Problem – Safety, Wildlife Deaths, and Habitat Fragmentation
  - Why Research was Needed
  - Study Design, Methods
  - Findings – and the Value of Results

- What Was Learned About the Process of Researching Wildlife Along Transportation Corridors
  - New Approaches to Wildlife Movements and Roads
  - Information and Lessons Learned
Wildlife, Roads, Vehicles – Addressing Safety and Ecological Issues

The Problem

Motorists at Risk of Collision
Animals Killed
Habitat Fragmentation
Animals Avoid Road Areas
Ecological Effects – De-icing Salts, Air pollution, Sound Pollution

Decreased Connectivity
Record Dispersal Movement by South Dakota, Puma

Wildlife Need to Leave Home – Especially Large Carnivores

Map: Path of Connecticut Puma

2,897 kilometers
Thelma’s Amazing Journey over 30 km each way out and back

Desert Tortoise - Arizona

Photo credit: B. Borman

Slide courtesy of T. Edwards
Roads & Vehicles Don’t Just Kill Wildlife – They Also Form Barriers

We also look at who is prevented from crossing roads

Slide
Courtesy of Jeff Gagnon
AZGFD
Solution Options

Human Side

Wildlife Side

Transportation Planning

Otter - Florida
Driver Solutions

Addressing Human Responses
Wildlife Solutions

White-Tailed Deer, Montana

Desert Tortoise, Utah

Mule Deer, Utah

Mule Deer on Overpass, Colorado

Photo credit: A. McLuckie

Connie Marcy, Feb 2016
Wildlife, Roads, Vehicles – Addressing Safety and Ecological Issues

Why Research was Needed
Wildlife Use of Structures

Include Wildlife in Transportation Planning
Wildlife, Roads, Vehicles – Addressing Safety and Ecological Issues

Study Design, Research Methods
Evaluation of Wildlife Crossing Structures on US 93 in Montana’s Bitterroot Valley

Patricia Cramer
Robert Hamlin
Objectives

1. White-tailed deer use of wildlife crossing structures and wildlife crossing sites;

2. White-tailed deer usage rates of wildlife crossing structures including height, width, length, and material;

3. Relationships between usage rates of wildlife crossing structures and landscape variables;
Methods

19 Structures, 2 Cameras Each Structure
Right-of-way Cameras
Pre-Construction Cameras
WVC – Crash and Carcasses
Success Rates
Movement-per day
Statistics
ANOVA, Linear Regression, Mixed
White-Tailed Deer Use of Structures

Methods - Camera Placement

Pre-Construction Monitoring
  Original Bridges, Habitat, ROW on 93 and CR 370

Control Cameras
  ROW on CR 370

Post-Construction Monitoring
  19 Structures
Camera Monitoring
Wildlife, Roads, Vehicles – Addressing Safety and Ecological Issues

Findings – and the Value of Results
Results – Creating Performance Measures

Pre-construction ROW cameras recorded white-tailed deer
With a 64% success rate for moving over US 93, repellency = 8%
With a 63% success rate for moving over CR 370, repellency = 5%
These values became the performance measures with which we evaluated the subsequent wildlife crossing structures.

Minimum success rate = 60%
Repellency rate ≤ 10% or less.
# Results

## Top 9 Most Successful Wildlife Crossing Structures based on white-tailed deer success rate

<table>
<thead>
<tr>
<th>Wildlife Crossing Structure</th>
<th>Success</th>
<th>Repellency</th>
<th>Parallel</th>
<th>Total Movements</th>
<th>Success Rate (%)</th>
<th>Rate of Repellency (%)</th>
<th>Parallel Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dawns Crossing Bridge</td>
<td>5204</td>
<td>65</td>
<td>94</td>
<td>5363</td>
<td>97</td>
<td>1</td>
<td>2</td>
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<tr>
<td>Bass Creek Fishing Access Culvert</td>
<td>3257</td>
<td>118</td>
<td>21</td>
<td>3396</td>
<td>96</td>
<td>3</td>
<td>1</td>
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<tr>
<td>Bear Creek South Bridge</td>
<td>2554</td>
<td>30</td>
<td>113</td>
<td>2697</td>
<td>95</td>
<td>1</td>
<td>4</td>
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<tr>
<td>Sweathouse Creek Bridge</td>
<td>2419</td>
<td>61</td>
<td>102</td>
<td>2582</td>
<td>94</td>
<td>2</td>
<td>4</td>
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<tr>
<td>Blodgett Creek Bridge</td>
<td>1037</td>
<td>25</td>
<td>36</td>
<td>1098</td>
<td>94</td>
<td>3</td>
<td>3</td>
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<tr>
<td>Kootenai Creek Bridge</td>
<td>2470</td>
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<td>97</td>
<td>2717</td>
<td>91</td>
<td>5</td>
<td>4</td>
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<tr>
<td>Big Creek Bridge</td>
<td>2769</td>
<td>237</td>
<td>317</td>
<td>3323</td>
<td>83</td>
<td>7</td>
<td>10</td>
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<tr>
<td>McCalla Creek North Bridge</td>
<td>2058</td>
<td>142</td>
<td>265</td>
<td>2465</td>
<td>83</td>
<td>6</td>
<td>11</td>
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<tr>
<td>Mill Creek Bridge</td>
<td>1036</td>
<td>117</td>
<td>283</td>
<td>1436</td>
<td>72</td>
<td>8</td>
<td>20</td>
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</tbody>
</table>
Results – High Performing, Bear Creek South Bridge
Results - No Use, Fun Park Culvert
Study Found:
Bridges and Large Culverts work best
for White-tailed Deer

Dimensions: Width most important
### Results - Relationships Between Usage Rates and Explanatory Variables

<table>
<thead>
<tr>
<th>Usage Rates</th>
<th>Explanatory Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Success Rate</td>
<td>Structure Type</td>
</tr>
<tr>
<td>Rate of Repellency</td>
<td>Structure Height</td>
</tr>
<tr>
<td>Parallel Rate</td>
<td>Structure Width</td>
</tr>
<tr>
<td>Success per Camera day</td>
<td>Structure Length</td>
</tr>
<tr>
<td></td>
<td>Structure Openness</td>
</tr>
<tr>
<td></td>
<td>Fence, Guardrail, Humans, Grass, Forbs, Shrubs, Trees, Bare Ground, Water, Fecal Pellets</td>
</tr>
</tbody>
</table>
Results and Methods

Generalized Linear Models were Used to Analyze Relationships

- Generalized Mix Linear Model with a binomial response for rates related to structure types
- One Way ANOVA was used for success per camera day
- Linear Regression for success rate and explanatory variables
- Two-sample test used for bridges vs culverts and explanatory variables
### Statistical Test Results

#### Green Boxes Show Strong Evidence of Relationship

- **Type of Structure**
  - B: bridge
  - C: culvert

<table>
<thead>
<tr>
<th></th>
<th>Success per Day</th>
<th>Success Rate</th>
<th>Rate of Repellency</th>
<th>Parallel Rate</th>
<th>Type of Structure</th>
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<tbody>
<tr>
<td><strong>Height</strong></td>
<td>p = 0.70</td>
<td>p = 0.20</td>
<td>p = 0.01</td>
<td>p = 0.28</td>
<td>p = 0.26</td>
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<tr>
<td><strong>Width</strong></td>
<td>p = 0.0008</td>
<td>p = 0.01</td>
<td>p = 0.10</td>
<td>p = 0.006</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td></td>
<td>Slope = 0.03</td>
<td>Slope = 0.08</td>
<td>Slope = -0.02</td>
<td>Slope = -0.09</td>
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<tr>
<td><strong>Length</strong></td>
<td>p = 0.09</td>
<td>p = 0.04</td>
<td>p = 0.25</td>
<td>p = 0.03</td>
<td>p &lt; 0.001</td>
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<tr>
<td></td>
<td>Slope = -0.02</td>
<td>Slope = -0.06</td>
<td></td>
<td>Slope = 0.06</td>
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<tr>
<td><strong>Openness</strong></td>
<td>p = 0.0007</td>
<td>p = 0.009</td>
<td>p = 0.009</td>
<td>p &lt; 0.001</td>
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<td>Slope = 0.24</td>
<td>Slope = 0.74</td>
<td>Slope = -0.28</td>
<td>B: 2.5</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>C: 0.2</td>
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<td><strong>Fence</strong></td>
<td>p = 0.45</td>
<td>p = 0.63</td>
<td>p = 0.98</td>
<td>p = 0.59</td>
<td>p = 0.56</td>
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<td><strong>Guard rail</strong></td>
<td>p = 0.21</td>
<td>p = 0.04</td>
<td>p = 0.02</td>
<td>p = 0.04</td>
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<tr>
<td></td>
<td>Slope = 0.04</td>
<td>Slope = -0.004</td>
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<tr>
<td><strong>Humans per day</strong></td>
<td>p = 0.54</td>
<td>p = 0.80</td>
<td>p = 0.63</td>
<td>p = 0.84</td>
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<td></td>
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<td>p = 0.10</td>
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<td></td>
<td></td>
<td>B: 0.15</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C: 0.06</td>
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</tr>
<tr>
<td><strong>Grass</strong></td>
<td>p = 0.37</td>
<td>p = 0.81</td>
<td>p = 0.39</td>
<td>p = 0.68</td>
<td>p = 0.74</td>
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<tr>
<td><strong>Forbs</strong></td>
<td>p = 0.15</td>
<td>p = 0.90</td>
<td>p = 0.95</td>
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<td><strong>Shrubs</strong></td>
<td>p = 0.21</td>
<td>p = 0.10</td>
<td>p = 0.04</td>
<td>p = 0.12</td>
<td>p = 0.53</td>
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<td></td>
<td>slope = 0.13</td>
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<td>Slope = -0.07</td>
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<tr>
<td><strong>Trees</strong></td>
<td>p = 0.99</td>
<td>p = 0.23</td>
<td>p = 0.38</td>
<td>p = 0.24</td>
<td>p = 0.62</td>
</tr>
</tbody>
</table>

#### Light Green Boxes Show Uncertain Evidence

- **Type of Structure**
  - B: bridge
  - C: culvert
White-Tailed Deer Success Rate with Openness

As Openness Increases, Success Rate Increases
White-Tailed Deer Success Rate Compared with Structure Width

The Wider the Structure, the Greater Success Rate
White-Tailed Deer Success Rate Compared with Length of Structure

The Longer the Structure, the Lower The Success Rate
White-Tailed Deer Success Rate with Bridges & Culverts

P-value-0.005 Extremely strong relationship that bridges have higher success rates than culverts, except for Largest Culvert - Bridges Worked Better Than Culverts for White-Tailed Deer.
Wildlife crossing structures should be designed with high openness ratios. High openness ratios are easier to achieve with bridges than with culverts.

Length should be minimized
Width (span) should be maximized and
Height should be maximized

These studies help design the most cost effective structures
What Was Learned About the Process of Researching Wildlife Along Transportation Corridors

New Approaches to Wildlife Movements and Roads

The Study helped establish
- That pre-construction monitoring is important to strength of science and recommendations
- Performance measures can be created with control and pre-construction monitoring
- Document pre-condition variables
What Was Learned About the Process of Researching Wildlife Along Transportation Corridors

Consistent strong scientific methods allow comparisons and application across states

Montana
Oregon
Utah
Colorado
Overall Lessons

- Monitor Pre-Construction
- Sound Scientific Study Design Supports Recommendations
- Standard Design for Different Locations Allows Comparisons for National Standards
- We Can Then Build Most Effective Wildlife Crossings and Mitigation for Multiple Species and Make Roads Safer for Motorists
Never doubt that a small group of thoughtful committed individuals can change the world. Indeed that is the only thing that ever has.

Margaret Mead