EVALUATION OF AN ANIMAL-ACTIVATED HIGHWAY CROSSWALK INTEGRATED WITH RETROFIT FENCING

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PRESENTATION OBJECTIVES

• Discuss Why We Need Wildlife Crossings, Fencing and Detection Systems.
  ✓ The Problem – Motorist Safety and Habitat Fragmentation
  ✓ The Solution – Wildlife Crossings and Fencing
  ✓ Wildlife Detection Systems as an Alternative

• Describe the Preacher Canyon crosswalk and fencing project components.

• Present results of 3+ years research evaluation including motorist and wildlife response.

• Discuss Constraints of Wildlife Detection Systems.
Human Safety #1
Table 6: Summary of Estimated Costs of a Wildlife Vehicle Collision for a Deer, Elk, and Moose.

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Huijser et al. 2007 – Report to Congress
Cost of Wildlife-Vehicle Collisions to Society

....If No One is Sued

Booth VS State of Arizona = >$4,000,000!
Maintain Connectivity #2

Winter Range

Summer Range

Habitat Fragmentation
Maintain Connectivity #2

Winter Range

Summer Range

Habitat Fragmentation

H2O

FOOD

COVER

Migration Route
We Already Know How to Address These Issues

STATE ROUTE 260 - Arizona

Existing 2-lane highway

Reconstructed 4-lane highway

Reconstruction raises issues of highway safety with increased standard (e.g., speed) and maintenance of wildlife permeability across highway
STATE ROUTE 260 PROJECT
Wildlife Underpasses
(11 of 17 completed)

- Wildlife Underpasses (11)
- Bridges (6)
STATE ROUTE 260 PROJECT
Wildlife Underpasses
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- **Wildlife Underpasses (11)**
- **Bridges (6)**
STATE ROUTE 260 PROJECT
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STATE ROUTE 260 PROJECT
Wildlife Underpasses
(11 of 17 completed)

Legend
— HWY280

Wildlife Bridge

Wildlife Underpasses (11) Bridges (6)
Christopher Creek Section

2004 ELK-VEHICLE COLLISIONS (Before Fencing)

51 collisions
(11.3/km)
Christopher Creek Section
2005 ELK-VEHICLE COLLISIONS (After Fencing)

8 collisions (1.7/km)

84% reduction in collisions
CHRISTOPHER CREEK SECTION
Pre- and Post-Fencing Wildlife Use of Underpasses

Completion of Fencing

Total elk / deer

Mar-04  May-04  Jul-04  Sep-04  Nov-04  Jan-05  Mar-05  May-05

0  50  100  150  200  250  300  350  400  450
WILDLIFE UNDERPASS VIDEO MONITORING
State Route 260
FUNNEL CONCEPT

WILDLIFE

FENCES
FUNNEL CONCEPT

WILDLIFE

FENCES

CROSSING

STRUCTURE

HIGHWAY
We Know What Works……

Why Even Consider Wildlife Detection?
Wildlife Detection Systems in Lieu of Wildlife Passage Structures

Compromise –
• Topography - Cost
• Timeline of Construction

Complement -
• When used in conjunction with wildlife crossing structures
Wildlife Underpasses and Fencing Attempt to Modify Only Wildlife Behavior
Animal Detection Systems Attempt to Modify Only Driver Behavior
Animal Activated “Crosswalks” Attempt to Modify Both Wildlife and Motorist Behavior
Preacher Canyon wildlife fence and crosswalk enhancement project evaluation - State Route 260
AFTER-RECONSTRUCTION ELK-VEHICLE COLLISIONS
Preacher Canyon Section

2001-2006
Before-Reconstruction
Mean = 11.6
ELK CROSSINGS and INTERCEPTION BY FENCING

Preacher Canyon Section

- Original project fencing (24% crossing interception)
- TEA-21 enhancement fencing (75% crossing interception)

Weighted no. elk crossings

0.16-km highway segment

Bridge (1)
Underpass (2)
PREACHER CANYON FENCING TREATMENTS

ElectroBraid® Modified ROW Fence – 2.4m
(Electric and Barbed Wire)

2.4 m Wire Mesh Ungulate-Proof Fence

2.4 m ROW Fence and ROW Extensions
(Barbed wire)

2.4 m Wire Mesh Ungulate-Proof Fence (2001)

Project resulted in fencing entire 3-mile (5 km) corridor

Roadway Animal Detection System
(MP 259.9)

Preacher Canyon Bridge
(MP 261.0)

West Underpass
(MP 262.8)

East Underpass
(MP 262.9)
PREACHER CANYON FENCING TREATMENTS

West Underpass (MP 262.8)

East Underpass (MP 262.9)
PREACHER CANYON FENCING TREATMENTS

Raised fence with new T-posts

Raised fence with T-post extensions

8' ROW Fence and ROW Extensions
(Barbed wire)

Applied 2 right-of-way (ROW) barbed-wire fence retrofit treatments
PREACHER CANYON FENCING TREATMENTS

8’ Wire Mesh Ungulate-Proof Fence

Wildlife Escape Ramp at Preacher Canyon Bridge

Preacher Canyon Bridge

(MP 261.0)
PREACHER CANYON FENCING TREATMENTS

ElectroBraid® Modified ROW Fence – 2.4 m
(Electric and Barbed Wire)

Applied right-of-way (ROW) electric fence retrofit treatment

- Solar powered on north side
- AC powered on south side
PREACHER CANYON FENCING TREATMENTS

- ElectroBraid® Modified ROW Fence – 2.4 m (Electric and Barbed Wire)
- 2.4 m Wire Mesh Ungulate-Proof Fence
- 2.4 m ROW Fence and ROW Extensions (Barbed wire)
- 2.4 m Wire Mesh Ungulate-Proof Fence (2001)

Animal Detection System at Crosswalk (MP 259.9) Needed to address potential “end run” effect at the western terminus of the fencing
PREACHER CANYON CROSSWALK CONFIGURATION

Defined “crosswalk”

Defined Crosswalk Zone
CROSSWALK ANIMAL DETECTION SYSTEM

- Infrared cameras detect animal movement within detection zones.
- Integrated with target acquisition software to analyze movement and size of objects (to minimize “false positives”).
- If “target” acquired, radio signals sent to warning signs.
THERMAL IMAGING CAMERA INTEGRATED WITH TARGET ACQUISITION SOFTWARE
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PREACHER CANYON ENHANCEMENT PROJECT

Motorist Alert Signs

TEST AREA
ELK CROSSING
1500 FEET AHEAD
Variable Message Sign
PREACHER CANYON ENHANCEMENT PROJECT

Motorist Alert Signs

Variable Sign

Crosswalk warning sign
INDEPENDENT PROJECT EVALUATION

System performance and reliability
  • Animal Detection System and Signage
  • Fencing and other components

Motorist response to warning signage
  • Vehicle speed
  • Alertness

Wildlife-Vehicle Collisions
  • Preacher Canyon Section
  • Adjacent unfenced section

Highway permeability
SYSTEM PERFORMANCE AND RELIABILITY

• We assessed animal detection system reliability by making periodic status checks at crosswalk
  ▪ 275 status checks made
  ▪ System **operational 98%** of the time (269 visits)
  ▪ System **inoperable 2%** of time (6 visits)
  ▪ False positives occurred 4% of the time (12 visits)
    ▪ **Functioning Properly 93.4%**
CROSSWALK VIDEO CAMERA SURVEILLANCE

Independent Infrared Video Camera Systems

- Pole-mounted cameras
- Infrared Illuminators
- Triggers
- Recording Devices
Testing System Performance and Reliability

8' fence

50'

8' fence
Testing System Performance and Reliability

Is The System Activated When Wildlife Are Within 50 ft Of Roadway?

Lighted Indicator Lets Us Know When The Signs Are On?
801 total animals of 8 species were recorded at the crosswalk by video surveillance

<table>
<thead>
<tr>
<th>Species</th>
<th>Groups (≥1) approaching w/in 50’ roadway</th>
<th>Times signs activated before 50ft of roadway</th>
<th>Times signs activated after 50ft of roadway</th>
<th>No sign activation (false negatives)</th>
<th>Percentage of time signs activated</th>
</tr>
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<tbody>
<tr>
<td>Elk</td>
<td>168</td>
<td>137</td>
<td>28</td>
<td>3</td>
<td>97%</td>
</tr>
<tr>
<td>White-tailed Deer</td>
<td>65</td>
<td>59</td>
<td>5</td>
<td>1</td>
<td>97%</td>
</tr>
<tr>
<td>Total</td>
<td>233</td>
<td>196</td>
<td>33</td>
<td>4</td>
<td>97%</td>
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Modifying Driver Behavior – How Did We Do?
MOTORIST RESPONSE TO WARNING SIGNAGE

- Reliable warning signals
  - Increased driver awareness; large animals may be on or near the road
    - Lower vehicle speed
    - Increased driver alertness
      - Reduced reaction time when confronted with a large animal ahead
      - Shorter stopping distance
        - Vehicle may hit animal at lower speed
        - Vehicle may not hit animal

(From Huijser et al. 2006)
MOTORIST RESPONSE TO WARNING SIGNAGE

Reliable warning signals

Increased driver awareness; large animals may be on or near the road

Increased driver alertness

Reduced reaction time when confronted with a large animal ahead

Shorter stopping distance

Vehicle may hit animal at lower speed

Vehicle may not hit animal

(From Huijser et al. 2006)
ASSESSING MOTORIST SPEED RESPONSE

- Installed permanent traffic counters
- Conducted 256 paired 15-min samples
- Compared average speeds with and without signs activated to assess motorist response
- Compared average speeds by year to assess motorist habituation
- 22,064 total vehicles counted

Installing Piezo Strip traffic counter at crosswalk
A significant 17% reduction in average speed occurred when signs were activated

\( t = 1.97, \text{ df } = 256, P < 0.001 \)
ASSESSING MOTORIST ALERTNESS RESPONSE

• Hid and counted vehicles approaching crosswalk and assessed if motorists applied brakes

• Conducted 286 paired 15-min samples with and without warning signs activated

• Compared the proportion of braking vehicles with and without signs activated

• 8,089 total vehicles counted
MOTORIST RESPONSE TO SIGNS - ALERTNESS

<table>
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<th>Warning sign status</th>
<th>Vehicles counted</th>
<th>Proportion braking</th>
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<td>Not activated (off)</td>
<td>3,941</td>
<td>0.08</td>
</tr>
<tr>
<td>Activated (on)</td>
<td>4,157</td>
<td>0.68</td>
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Odds of motorists exhibiting a braking response were **21:1** with warning signs activated compared to when they were not activated ($\chi^2=3206$, df = 1, $P < 0.001$)

There was no difference between years (2007 and 2008)
ELK-VEHICLE COLLISIONS WITH FENCING AND CROSSWALK
Preacher Canyon Section

97% reduction in elk-vehicle collisions
(not including 2009 with no collisions)
There was NO significant change in elk-vehicle collisions on the adjacent Lion Springs Section—thus there was no “displacement” in collisions from the Preacher Canyon Section (not including 2009 with no collisions).
Cost of Wildlife-Vehicle Collisions to Society

Elk-Vehicle Collisions =

Table 6: Summary of Estimated Costs of a Wildlife Vehicle Collision for a Deer, Elk, and Moose.

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Cost of Wildlife-Vehicle Collisions to Society

Elk-Vehicle Collisions = $18,561/ Collision

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Cost of Wildlife-Vehicle Collisions to Society

Elk-Vehicle Collisions = $18,561/ Collision

$220,000/ Year on Average in Study Area

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CROSSWALK VIDEO CAMERA SURVEILLANCE

Independent Infrared Video Camera Systems

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- Recording Devices
What Happened Once Animals Approached the Road?
What Happened Once Animals Approached the Road?
Elk (N=523)
Enter Highway R-W at Detection Zone
Elk (N=523) Enter Highway R-W at Detection Zone

Successful Crossing 32%
CROSSWALK CROSSINGS
BY TIME AND TRAFFIC VOLUME

Time of Day

Number of Highway Crossings

Traffic (vehicles/hr)

- Crossings
- Vehicles/hr
86% of crossings occurred when traffic volumes averaged 32 vehicles/hour.

Traffic volumes averaged 308 vehicles/hour over 24 hours for the same time period.
PROBABILITY OF CROSSWALK CROSSING BY TRAFFIC VOLUME

![Graph showing the probability of successful crossing for elk and white-tailed deer as a function of traffic volume. The x-axis represents vehicles per minute, and the y-axis represents the probability of successful crossing. The graph shows a downward trend for both species as traffic volume increases.]
Elk (N=523) Enter Highway R-W at Detection Zone

Successful Crossing 32%

Unsuccessful Crossing 68%
Elk (N=523)
Enter Highway R-W at Detection Zone

Successfully Crossing 32%

Unsuccessfully Crossing 68%

Left R-W via same path 48%
Unsuccessful Crossings

Detection Zone

8’ fence

Detection Zone

8’ fence
Unsuccessful Crossings

Detection Zone

Detection Zone

8' fence

8' fence
Elk (N=523) Enter Highway R-W at Detection Zone

Successful Crossing 32%

Unsuccessful Crossing 68%

Left R-W via same path 48%

Entered R-W via Gap in Fence 20%
Wildlife Entering R-W Via Gap at Roadway

Detection Zone

Dangerous Situation – Motorists Can Encounter Wildlife Without Warning

8’ fence
Wildlife Entering R-W Via Gap at Roadway

Detection Zone

Dangerous Situation – Motorists Can Encounter Wildlife Without Warning

8’ fence
Wildlife Entering R-W Via Gap at Roadway

Detection Zone

Dangerous Situation – Motorists Can Encounter Wildlife Without Warning

8’ fence
ElectroMat Installation in July 2010
Gap at Road Closed With ElectroMat

Detection Zone

Detection Zone

EVALUATION THROUGH 2015
Gap at Road Closed With ElectroMat

Detection Zone

Detection Zone

EVALUATION THROUGH 2015
Gap at Road Closed With ElectroMat

Detected Zone

Detection Zone

EVALUATION THROUGH 2015

8’ fence
ELK HIGHWAY PERMEABILITY COMPARISON
Preacher Canyon Section

• Permeability determined from GPS telemetry

Passage rate = \frac{\text{no. highway crossings}}{\text{no. approaches to within 0.25 mi}}

Before Fencing and Crosswalk

Mean passage rate = 0.35 crossings/approach

After Fencing and Crosswalk

0.09 crossings/approach (-73%)
ELK HIGHWAY PERMEABILITY COMPARISON

Preacher Canyon Section

- Permeability determined from GPS telemetry

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<th>Mean spacing between passage structures</th>
<th>= 1.5 mi (2.4 km)</th>
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<td>2.5 times greater spacing than</td>
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Mean passage rate =

0.35 crossings/approach

After Fencing and Crosswalk

0.09 crossings/approach (-73%)
Before Fencing and Crosswalk ($n = 35$ elk)

After Fencing and Crosswalk ($n = 17$ elk)

CHANGE IN DISTRIBUTION OF GPS ELK CROSSINGS

Preacher Canyon Section

Unfenced section
CROSSWALK ARE A COST-EFFECTIVE ALTERNATIVE TO A PASSAGE STRUCTURE
CONTRAINTS

• Effectiveness of Animal Detection Systems Constrained by (assuming a fully functioning system?):

1. Traffic Volumes
2. Vehicle Speeds
3. Individual Species
4. Spacing (Full RADS VS Xwalk)
More information on the research Evaluation:


…..OR Google “Arizona Elk Crosswalk”

More information on the Project Components: Visit the ElectroBraid Booth