Road Ecology: Are We Taking The Right Turns?

Marcel P. Huijser, PhD
This talk

• Some observations of our practices

• Human safety and biological conservation
  US Hwy 93 North, Flathead Indian Reservation, Montana
What do we typically do?

- Reduce collisions with large mammals ... mostly human safety

- Safe crossing opportunities for wildlife: conservation
But… Road Ecology is much more!

Infrastructure

Organisms

Civil engineering

Traffic

Road Ecology

Physical Environment
“Transportation Ecology”

“Typical” Road Ecology Practice:
- Cars
- Highways
- Linear
- Terrestrial
- Biotic
- Safety
- Large mammals
- Mitigation
- Your wallet

Road/Transportation Ecology:
- Trains, Ships, Planes
- Dirt roads, trails
- 3-D landscape
- Aquatic, Air
- Abiotic
- Biological conservation
- Small species
- Avoidance, Compensation
- Your quality of life
Where do we typically take action?

Selection typically based on:
• Human safety
• Crash data, Carcass removal data
• Large common mammal species

Selection typically not based on:
• Biological conservation
• Habitat and corridors
• Small or rare species
## Example Carcass Removal Data

Hwy 2, NW Montana

### Table 1: The species included in the carcass removal database and their inclusion in the analyses based on human safety versus biological conservation.

<table>
<thead>
<tr>
<th>Species</th>
<th>n</th>
<th>%</th>
<th>Removed from data</th>
<th>Human health</th>
<th>Federal level</th>
<th>State level</th>
</tr>
</thead>
<tbody>
<tr>
<td>White-tailed deer (Odocoileus virginianus)</td>
<td>3936</td>
<td>90.28</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Stag deer (Odocoileus hemionus)</td>
<td>1672</td>
<td>4.13</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Elk (Cervus canadensis)</td>
<td>65</td>
<td>1.49</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Moose (Alces americana)</td>
<td>38</td>
<td>0.87</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Unknown or not sufficiently specified</td>
<td>35</td>
<td>0.80</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Black Bear (Ursus americanus)</td>
<td>14</td>
<td>0.32</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Deer spp. (Odocoileus spp.)</td>
<td>11</td>
<td>0.25</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Coyote (Canis latrans)</td>
<td>10</td>
<td>0.23</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
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<tr>
<td>Striped skunk (Mephitis mephitis)</td>
<td>9</td>
<td>0.21</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Domesticated cat (Felis catus)</td>
<td>8</td>
<td>0.18</td>
<td>x</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Domesticated dog (Canis lupus familiaris)</td>
<td>8</td>
<td>0.18</td>
<td>x</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Other wild species, unspecified</td>
<td>8</td>
<td>0.18</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Raccoon (Procyon lotor)</td>
<td>5</td>
<td>0.11</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Gray wolf (Canis lupus)</td>
<td>4</td>
<td>0.09</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Owl (Strigiformes)</td>
<td>3</td>
<td>0.07</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Painted turtle (Chrysemys picta)</td>
<td>3</td>
<td>0.07</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle (Bos taurus)</td>
<td>2</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grizzly bear (Ursus arctos)</td>
<td>2</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mountain Lion (Puma concolor)</td>
<td>2</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beaver (Castor canadensis)</td>
<td>2</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bobcat (Lynx rufus)</td>
<td>2</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common raven (Corvus corax)</td>
<td>2</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wild turkey (Meleagris gallopavo)</td>
<td>2</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pronghorn (Antilocapra americana)</td>
<td>1</td>
<td>0.02</td>
<td></td>
<td></td>
<td>x</td>
<td>n/a</td>
</tr>
<tr>
<td>Bighorn sheep (Ovis canadensis)</td>
<td>1</td>
<td>0.02</td>
<td></td>
<td></td>
<td>x</td>
<td>n/a</td>
</tr>
<tr>
<td>Horse (Equus ferus caballus)</td>
<td>1</td>
<td>0.02</td>
<td></td>
<td></td>
<td>x</td>
<td>n/a</td>
</tr>
<tr>
<td>Domestic, species not recorded</td>
<td>1</td>
<td>0.02</td>
<td></td>
<td></td>
<td>x</td>
<td>n/a</td>
</tr>
<tr>
<td>Badger (Taxidea taxus)</td>
<td>1</td>
<td>0.02</td>
<td></td>
<td></td>
<td>x</td>
<td>n/a</td>
</tr>
<tr>
<td>Bald eagle (Haliaeetus leucocephalus)</td>
<td>1</td>
<td>0.02</td>
<td></td>
<td></td>
<td>x</td>
<td>n/a</td>
</tr>
<tr>
<td>Golden eagle (Aquila chrysaetos)</td>
<td>1</td>
<td>0.02</td>
<td></td>
<td></td>
<td>x</td>
<td>n/a</td>
</tr>
<tr>
<td>Red fox (Vulpes vulpes)</td>
<td>1</td>
<td>0.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turkey vulture (Cathartes aura)</td>
<td>1</td>
<td>0.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>4360</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Common large mammals**
- **Threatened and Endangered, or rare Species**
- **Small species not Recorded at all**

Huijser & Begley, 2016
Departure Point Matters!

Table 11: Prioritization of the carcass removal hotspots based on human safety, biological conservation and economics. The raw data are in Appendix A.

<table>
<thead>
<tr>
<th>Departure point (primary)</th>
<th>Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Human safety</td>
</tr>
<tr>
<td>Human safety</td>
<td>8.0 (100%)</td>
</tr>
<tr>
<td>Biological conservation</td>
<td>5.2 (7%)</td>
</tr>
<tr>
<td>Economics</td>
<td>4.3 (9%)</td>
</tr>
</tbody>
</table>

- Human safety: 8.0 miles (6.6%) out of 121.0 miles
- Of the 8.0 miles, 5.2 miles (65%) were also concern to biological conservation

- Biological conservation: 76.8 miles (63.5%) out of 121.0 miles
- Of the 76.8 miles, 5.2 miles (7%) were also a concern to human safety

Includes habitat and successful wildlife movements

Huijser & Begley, 2016
Collision reduction for human safety vs. Mortality reduction for conservation

Population N=1000

† N=100

Population N=50

† N=10
Biological Conservation:

Some countries do it
So can you…
… if you want to!

1. Values vs. mandates
2. Voices
3. Allies
4. Action
How many collisions do you need to see before you take action?

Crash data thresholds

Carcass data misses animals that die off highway corridor

Carcasses taken by citizens

Huijser, in prep
Reconstructing a rural highway?

Historic Collision data not a good predictor: BACI design

Carcass data: -71%

Wildlife-crash data: -80%

Interaction P=0.036

Interaction P=0.026

Huijser et al. 2016
“We” Want ….

- Simple
- Inexpensive
- Fast implementation
- Implementation over long distances

- Warning signs
- Vehicle speed reduction
Wildlife Warning Signs

- Standard
- Enhanced
- Temporary
- Animal detection system

Huijser et al., 2015
Reduce Posted Speed Limit

• Design speed
  Lane and shoulder width, curvature, sight distance

• Posted speed limit
  Legal speed limit depicted on signs

• Operating speed
  The speed that drivers actually drive
Reduce Posted Speed Limit

Design speed = Posted speed limit  
Good practice

Design speed ≠ Posted speed limit  
Speed dispersion, increase in crashes
Stopping Distance – Maximum Vehicle Speed

Stopping distance =

Reaction time (distance) +
Braking distance

Not suitable for highways
Perhaps suitable for park roads
1. “High Volume Through Road”

Purpose: to get from A to B fast and safe
>10,000 – 15,000 vehicles/day
High design speed
High posted speed limit
Physical separation traffic and wildlife

Measures:
• Fences, underpasses, overpasses
Type of Road - Mitigation Approach

2. “Low volume through road”

Purpose: to get from A to B fast and safe
- <10,000 vehicles/day
- High design speed
- High posted speed limit
- Physical separation traffic and wildlife

Measures:
- Animal detection systems but doesn’t address barrier effect!
- Fences, underpasses, overpasses
Type of Road - Mitigation Approach

3. “Low Volume Park Road”

Purpose: to see and experience
- Low design speed
- Low posted speed limit
- Mitigation should not affect landscape aesthetics

Measures:
- Low design speed
- Low posted speed limit
- Night time closure
- Seasonal closure
- Gates (information, physical barrier)
- Law enforcement personnel present
Reduce Collisions: Effective Measures

Standard “ungulate” fence
Negative view of fences

- Landscape aesthetics

- Unpopular with landowners (gates, cattle guards at access roads)

- “Expensive”

- Fences hinder wildlife movements long distance seasonal migration

- Injuries/fatalities
Reducing Wildlife-Vehicle Collisions

Huijser et al., 2016, Biological Conservation

< 3 mi 52.7%
range 0-94%

> 3 mi: typically > 80%
Crossing Structures needed, especially at higher traffic volumes

Figure 6. At-grade and below-grade (through 6 wildlife underpass) elk passage rates at varying traffic volume levels along State Route 260, Arizona, USA (figure from Gagnon et al. 2007c). At-grade passage rates determined from GPS telemetry tracking of 44 elk from 2003-2006 (Gagnon et al. 2007a) and below-grade underpass passage rates determined from video surveillance of wildlife use of underpasses from 2002-2006 (Gagnon et al. 2007b).
Don’t Loose Track of Your Objectives
Fences need to cover hotspot and buffer zone

Figure 5. Kernel Density Analysis of AVC carcass data along US 93 South, mp 48 through 73. Darker spots reflect higher carcass counts at specific mile posts at six month intervals. Wildlife crossing structure type, location, date installed, and wildlife fencing are indicated.

Cramer et al. 2013
Needs – Design - Construction

Is anyone guiding the overall process?

Continued coordination in the different stages
Details Matter!
Construction Oversight
Maintenance is Critical! 

Include maintenance in responsibilities or contracts!
US93 N, Flathead Indian Reservation, Montana (2002-2015)

- "Road is a visitor"
- Respectful to land
- Respectful to "Spirit of the place"
- Cultural values
- Natural resources
29 Structures, 5 years

- 95,274 successful crossings
- 22,648 per year
- 20 wild medium-large mammal species
  - 1,531 black bear
  - 958 coyote
  - 568 bobcat
  - 227 mountain lion
  - 29 grizzly bear
  - 38 badger
  - 32 elk
  - 14 beaver
  - 13 otter
  - 3 moose

Huijser et al. 2016.
Learning Curve

Huijser et al. 2016
Ambition Levels

• Just build them, regardless of wildlife use
• “Substantial” wildlife use
• Viable wildlife populations
  – Migration routes
• Climate Change
Habitat Connectivity ???

Better
• Safe places to cross
• Less disturbance when crossing

Worse
• Wider road
• Higher design speed
• Increase traffic volume?
• Fewer places to cross
Deer and black bear crossings

Before

After
Correction Factor
Tracks – Camera Images

Deer: *1.623

Black bear: 1.088

Huijser et al. 2016
Habitat Connectivity

Huijser et al. 2016

P=0.049

P=0.139

Huijser et al. 2016
Concentration Of Movements in Crossing Structures?

**FIGURE 2** Camera placements in relation to a wildlife highway crossing structure (not to scale). Twelve HyperFire PC900 Reconyx™ trail cameras (dark blue squares indicate cameras, light blue cone indicates approximate 40° sampling window) were installed at each site for ~2 weeks at each site. Ten cameras were installed at randomly generated points at least 50 m apart within a 300 m by 300 m area adjacent to each side of the structure (red lines represent concrete retaining walls associated with all crossing structures). Two cameras were installed at each entrance to the structure. Cameras were installed ~3 m from the ground and a stake was placed to demarcate a 10 m viewing distance commensurate with the viewing distance of the cameras at the structure entrance.

Andis et al. 2017
Concentration Of Movements in Crossing Structures?

- 146% more large mammal movements at structures vs surroundings
- Full connectivity for large mammals? 40.7% road length permeable !!!

Andis et al. 2017
Cost-benefit analyses

• Costs:
  Equipment, installation, construction, operation, maintenance, removal

• Benefits:
  Reduced costs collisions

Huijser et al., 2009, Ecology & Society
Cost-benefit analyses
Large mammals

• Costs:
  Equipment, installation, construction, operation, maintenance, removal

• Benefits:
  Reduced costs of collisions
Benefits: Costs of collisions

<table>
<thead>
<tr>
<th>Description</th>
<th>Deer</th>
<th>Elk</th>
<th>Moose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle repair costs per collision</td>
<td>$2,622</td>
<td>$4,550</td>
<td>$5,600</td>
</tr>
<tr>
<td>Human injuries per collision</td>
<td>$2,702</td>
<td>$5,403</td>
<td>$10,807</td>
</tr>
<tr>
<td>Human fatalities per collision</td>
<td>$1,002</td>
<td>$6,683</td>
<td>$13,366</td>
</tr>
<tr>
<td>Towing, accident attendance and investigation</td>
<td>$125</td>
<td>$375</td>
<td>$500</td>
</tr>
<tr>
<td>Hunting value animal per collision</td>
<td>$116</td>
<td>$397</td>
<td>$387</td>
</tr>
<tr>
<td>Carcass removal and disposal per collision</td>
<td>$50</td>
<td>$75</td>
<td>$100</td>
</tr>
<tr>
<td>Total</td>
<td>$6,617</td>
<td>$17,483</td>
<td>$30,760</td>
</tr>
</tbody>
</table>

Huijser et al., Ecology and Society, 2009
Cost-benefit analyses

• 75 year long period
• Discount rate: 1%, 3%, 7%
Example road section
MT Hwy 83, Seeley-Swan Montana

Wildlife-vehicle collision costs (US$/km/yr)

- Threshold animal detection system
- Threshold fence, gap, animal detection system, jump-outs
- Threshold fence, under- and overpass, jump-outs
- Threshold fence, under pass, jump-outs

Huijser et al., 2009, Ecology & Society
Thank you!

Contact:
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406-543-2377
Reducing Wildlife-Vehicle Collisions

Why lower?

<5 km: under partial or full influence of fence end effects

Huijser et al. 2016

Huijser et al. 2016
False sense of spatial accuracy

- Not accurate to 0.1 mi
- Real accuracy 0.5 or 1.0 mi
- Base exact location of safe crossing opportunities on other data and field review
Correction Factor
Tracks – Camera Images

Deer: *1.623
Black bear: 1.088

Huijser et al. 2016
Fence End Treatments / Escape

• Especially important for short fenced sections

• Escape opportunities: Jump-outs

access roads/ bike paths
Conclusions

- Substantial use by wildlife of crossing structures
- Learning curve
- Upgraded mitigated highway did not reduce connectivity for deer and black bear
- Connectivity maintained (black bear) or improved (deer)
Conclusions

- Road length fences >5 km: 80-100% reduction in collisions with large mammals
- Road length fences ≤5 km: Lower effectiveness, more variable

- Substantial use by wildlife of crossing structures
- Learning curve
- Upgraded mitigated highway did not reduce connectivity for deer and black bear
- Connectivity maintained (black bear) or improved (deer)
Crossing Structure Types and Dimensions

Overpass
50-70 m wide

Over span bridge
>30 m wide
>4-5 m high

Large mammal
Underpass
7 m wide
4-5 m high

Medium mammal
Underpass
1.5-2 m diameter

Small-medium
Mammal pipe
30-60 cm diameter
Species specific preferences

<table>
<thead>
<tr>
<th></th>
<th>Wildlife overpass</th>
<th>Open-span bridge</th>
<th>Large-mammal underpass</th>
<th>Medium-mammal underpass</th>
<th>Small- to medium-mammal pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ungulates</strong></td>
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</tr>
<tr>
<td>Deer sp.</td>
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<td>●</td>
<td>●</td>
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</tr>
<tr>
<td>Elk</td>
<td>●</td>
<td>●</td>
<td>●</td>
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</tr>
<tr>
<td>Moose</td>
<td>●</td>
<td>●</td>
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<td>●</td>
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</tr>
<tr>
<td>Mountain goat</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
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</tr>
<tr>
<td>Bighorn sheep</td>
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<td>●</td>
<td>●</td>
<td>●</td>
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</tr>
<tr>
<td>Pronghorn</td>
<td>●</td>
<td>○</td>
<td>○</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td><strong>Carnivores</strong></td>
<td></td>
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</tr>
<tr>
<td>Weasel</td>
<td>●</td>
<td>●</td>
<td>○</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Pine marten</td>
<td>●</td>
<td>○</td>
<td>○</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Fisher</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Striped skunk</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Badger</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Wolverine</td>
<td>●</td>
<td>●</td>
<td>?</td>
<td>?</td>
<td>●</td>
</tr>
<tr>
<td>Bobcat</td>
<td>●</td>
<td>●</td>
<td>?</td>
<td>?</td>
<td>●</td>
</tr>
<tr>
<td>Canada lynx</td>
<td>●</td>
<td>●</td>
<td>?</td>
<td>?</td>
<td>●</td>
</tr>
<tr>
<td>Cougar</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Fox1 <em>(V. rupes, Urocyon)</em></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Fox2 <em>(V. macrotis, V. velox)</em></td>
<td>●</td>
<td>●</td>
<td>○</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Coyote</td>
<td>●</td>
<td>●</td>
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<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Wolf</td>
<td>●</td>
<td>●</td>
<td>○</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Black bear</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>○</td>
<td>●</td>
</tr>
<tr>
<td>Grizzly bear</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>○</td>
<td>●</td>
</tr>
</tbody>
</table>

- ● Recommended/Optimum solution
- ○ Possible if adapted to local conditions
- ☉ Not recommended
- ? Unknown, more data are required

Huijser et al. 2008
Reducing Wildlife-Vehicle Collisions

Why lower?

<5 km: under partial or full influence of fence end effects

Huijser et al. 2016

Huijser et al. 2016
Reducing Wildlife-Vehicle Collisions

Fence end effect is indeed present

Huijser et al. 2016
Reducing Wildlife-Vehicle Collisions

Why more variable?

Local situation fence ends always different

Short fences (<5 km):
Fence end effect immediately noticeable in overall effectiveness

Long fences (>5 km):
Fence end effect diluted
Unnatural Linear Landscape Elements

• Roads
• Powerlines
• Pipelines
• Canals
• Fences
Fences vs. Roads

Jakes et al, in prep.
Effect of the highway reconstruction (before-after) on the number of carcasses/crashes depended on the treatment (wildlife fences and wildlife crossing structures vs. no wildlife mitigation measures)

Carcass data: -71%

Wildlife-crash data: -80%

Interaction P=0.036

Interaction P=0.026

Huijser et al. 2016
Safe Crossing Opportunities for Wildlife

- Highly variable
- Short fences: can have high use
- Long fences: can have low use

Local situation very important
- Wildlife presence
- Habitat guides them to structure
- Factors that keep them away?

Huijser et al., 2016, Biological Conservation

Courtesy of MDT, CSKT & WTI

Montana State University | College of Engineering
Western Transportation Institute
Where Are We?

Positive

- Huge increase in knowledge
- Mitigation measures implemented

Reduced collisions, improved human safety
Safe crossing opportunities provided
Can make economic sense
Are we doing it all wrong?
US93 North, Flathead Indian Reservation, MT

- “Road is a visitor”
- Respectful to land
- Respectful to “Spirit of the place”
- Cultural values
- Natural resources

- Agreement reconstruction: 2000
- Research 2002-2016
Fences

8.71 road miles (14.01 km)

Crossing structures

39 locations
Fences

Functions:
1. Keep wildlife from accessing the highway
2. Help guide wildlife towards the safe crossing opportunities
Crossing Structure Types and Dimensions

Functions
1. Allow wildlife to safely cross the highway
2. Reduce wildlife intrusions into fenced road corridor
BACI Study Design

- Before-After
- Control-Impact
Effectiveness Fences

Effect of the highway reconstruction (before-after) on the number of carcasses/crashes depended on the treatment (wildlife fences and wildlife crossing structures vs. no wildlife mitigation measures)

Carcass data: -71%

Wildlife-crash data: -80%

Huijser et al. 2016
Reducing Wildlife-Vehicle Collisions

Huijser et al., 2016, Biological Conservation

< 5 km 52.7%
range 0-94%

> 5 km: typically > 80%
29 Structures, 5 years

- 95,274 successful crossings
- 22,648 per year
- 20 wild medium-large mammal species
  - 1,531 black bear
  - 958 coyote
  - 568 bobcat
  - 227 mountain lion
  - 29 grizzly bear
  - 38 badger
  - 32 elk
  - 14 beaver
  - 13 otter
  - 3 moose

Huijser et al. 2016
Sample Use Underpasses
Habitat Connectivity ???

Better
- Safe places to cross
- Less disturbance when crossing

Worse
- Wider road
- Higher design speed
- Increase traffic volume?
- Fewer places to cross
Before

38 Tracking beds
Random locations
Each 100 m long
5 double beds

Estimate based on a sample

Deer and black bear

© Marcel Huijser
Check and erase

Black bear

Twice a week

Jun-Oct

Deer
After Tracking beds (inside and outside)

Not an estimate but a measurement/census
Correction Factor
Tracks – Camera Images

Deer: *1.623

Black bear: 1.088

Huijser et al. 2016
Habitat Connectivity: Deer

Huijser et al. 2016
Habitat Connectivity: Black bear

P=0.197

P=0.139

Huijser et al. 2016
Conclusions

- Road length fences >5 km: 80-100% reduction in collisions with large mammals
- Road length fences ≤5 km: Lower effectiveness, more variable

- Substantial use by wildlife of crossing structures
- Learning curve
- Upgraded mitigated highway did not reduce connectivity for deer and black bear
- Connectivity maintained (black bear) or improved (deer)
Thanks!

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• Montana Department of Transportation
• Federal Highway Administration
• B and B Dawson Fund
• University Transportation Center program

Help:
• MDT: Access to the right of way
• Confederated Salish Kootenai Tribes: advocating for mitigation measures, permission to conduct research on tribal lands

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