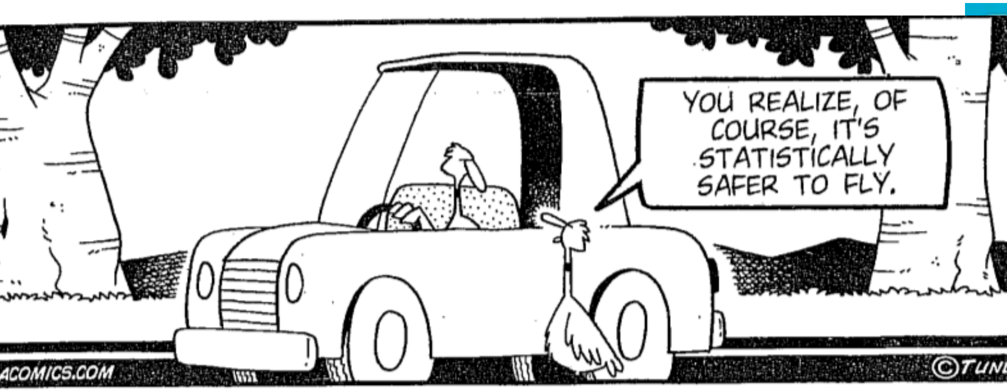
WTI
Transportation/Mobility
Road Ecology

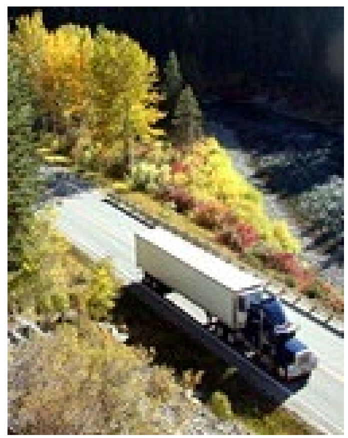
David Kack
Executive Director – WTI
Director – Small Urban, Rural and Tribal Center on Mobility (SURTCOM)

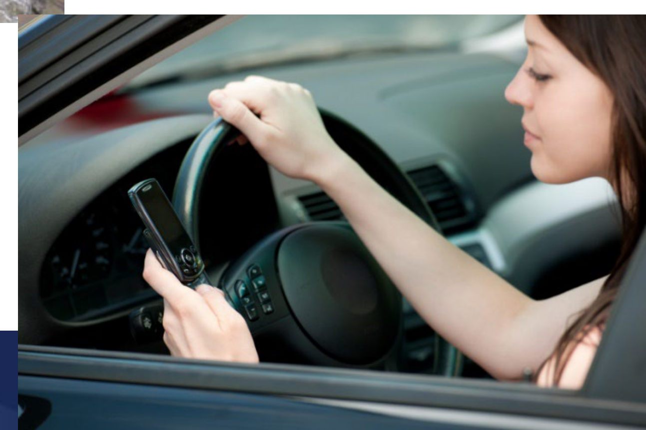
Tony Clevenger
Senior Research Ecologist



“Transportation”

WTI & Transportation

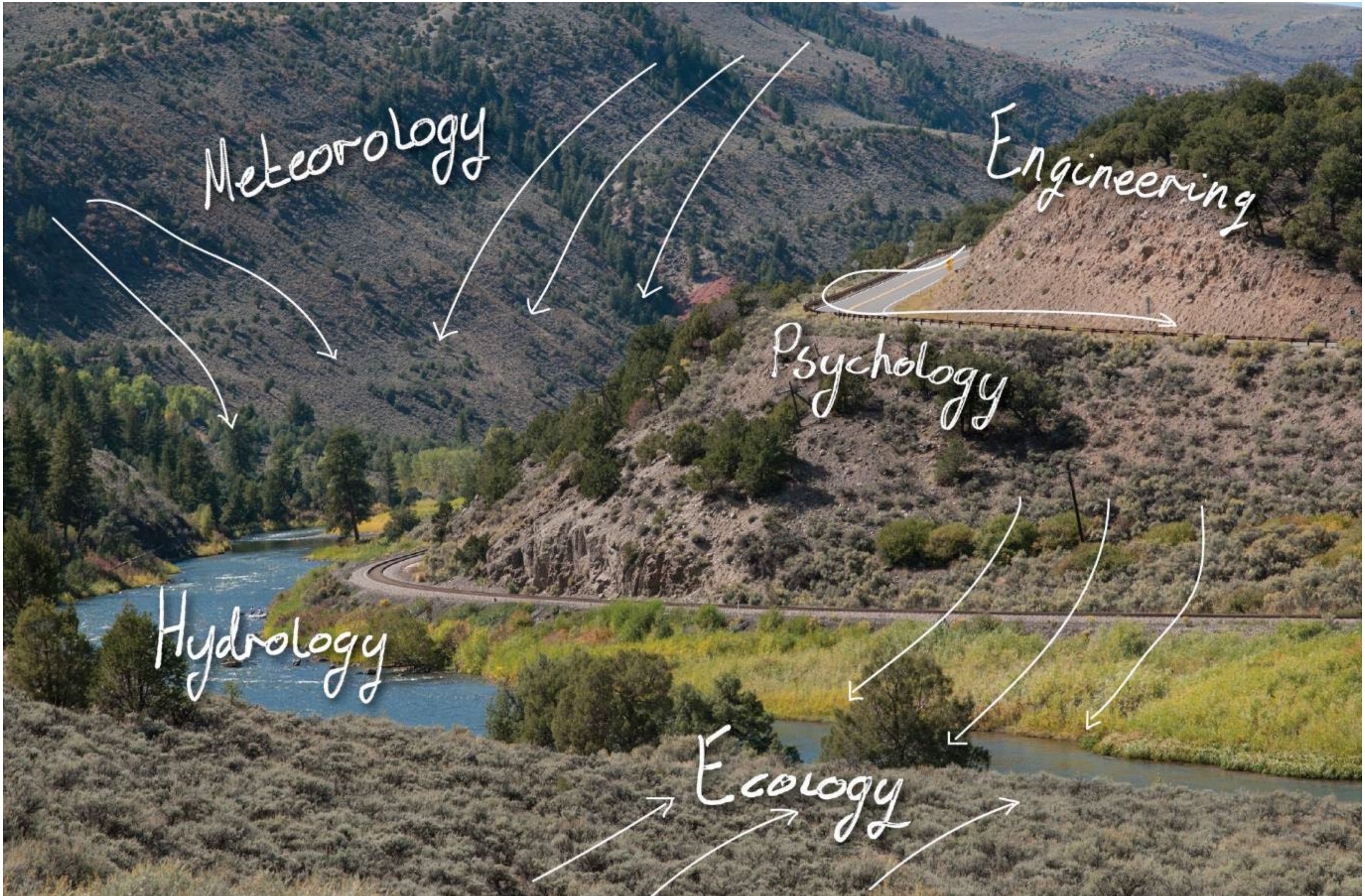




Our approach

multidisciplinary perspective

Considerations/Disciplines



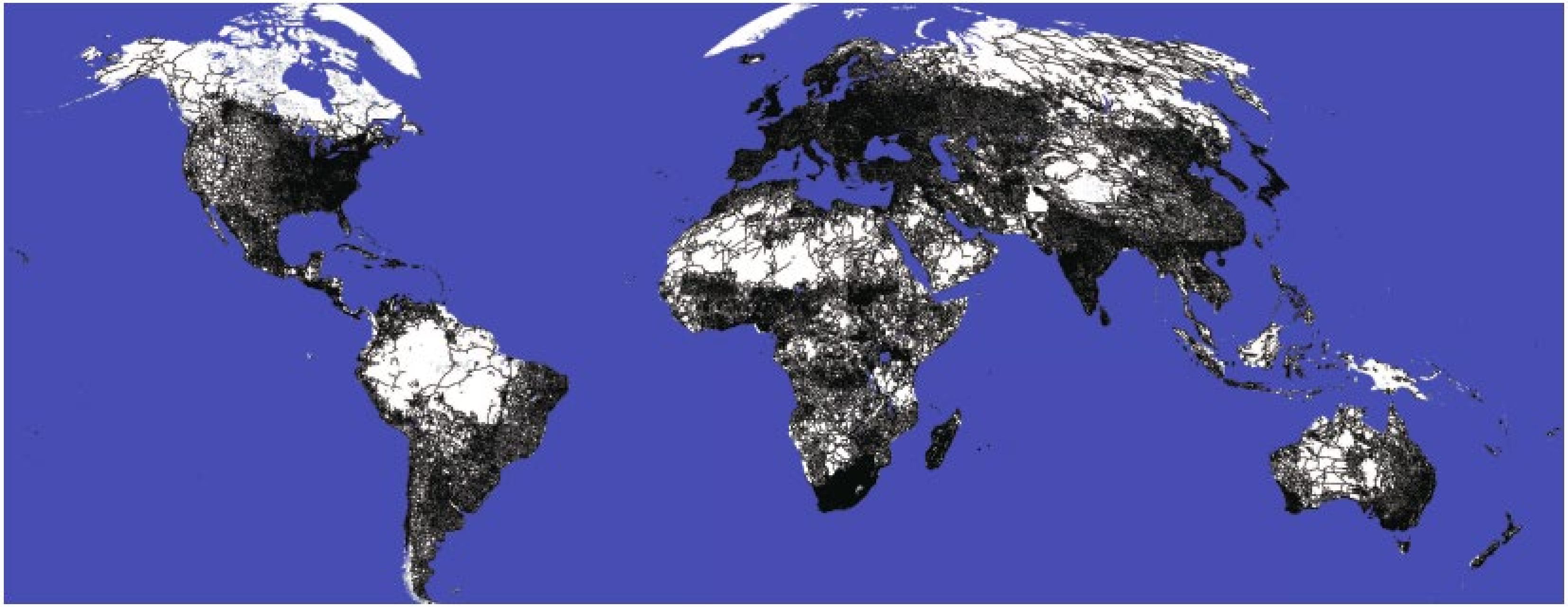
Road Ecology

Road Ecology:
Are We Taking the Right Turns?

Marcel P. Huijser, PhD
& dozens of colleagues…

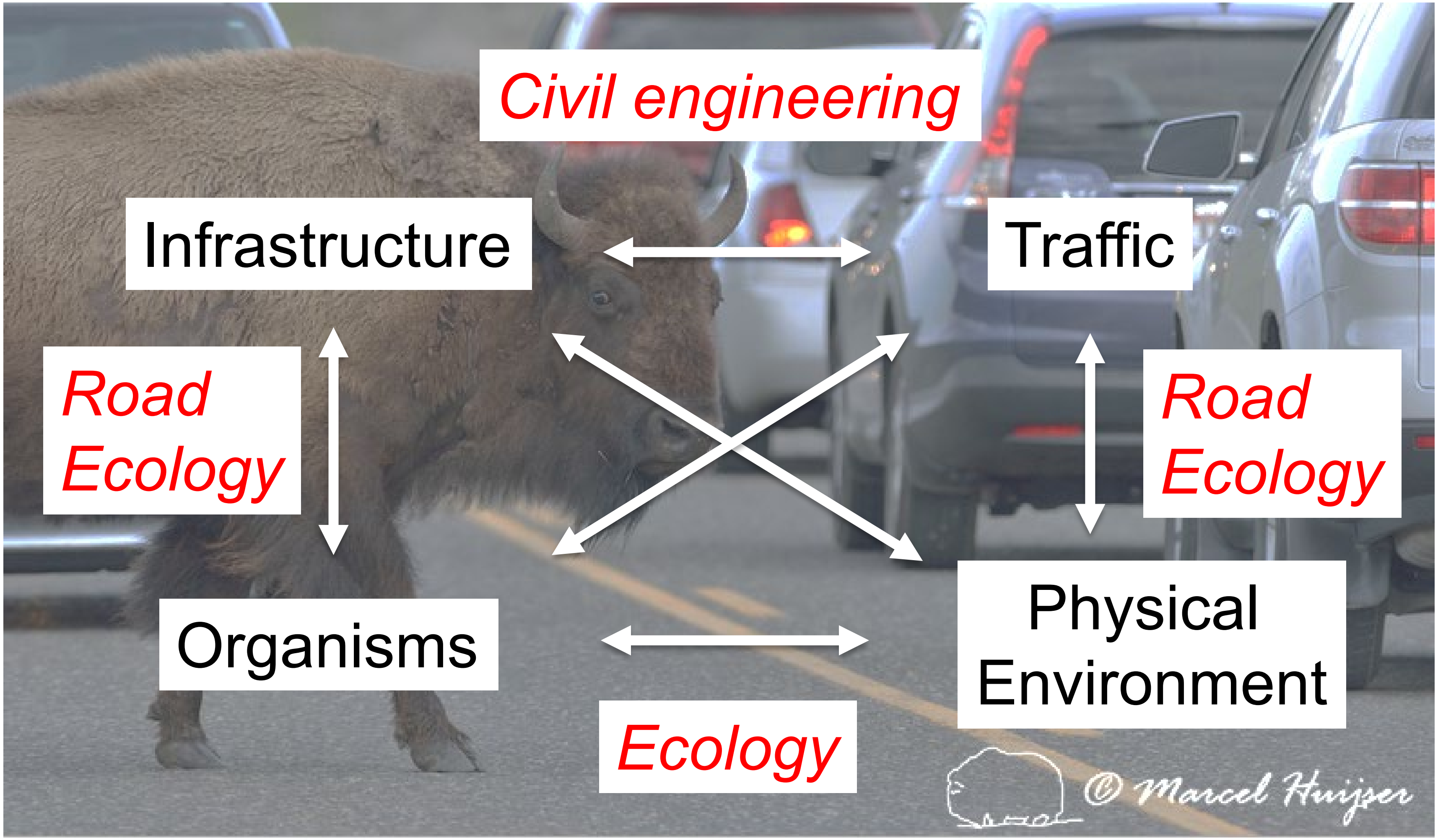
MONTANA STATE UNIVERSITY | College of ENGINEERING
Western Transportation Institute

Roads are (Almost) Everywhere

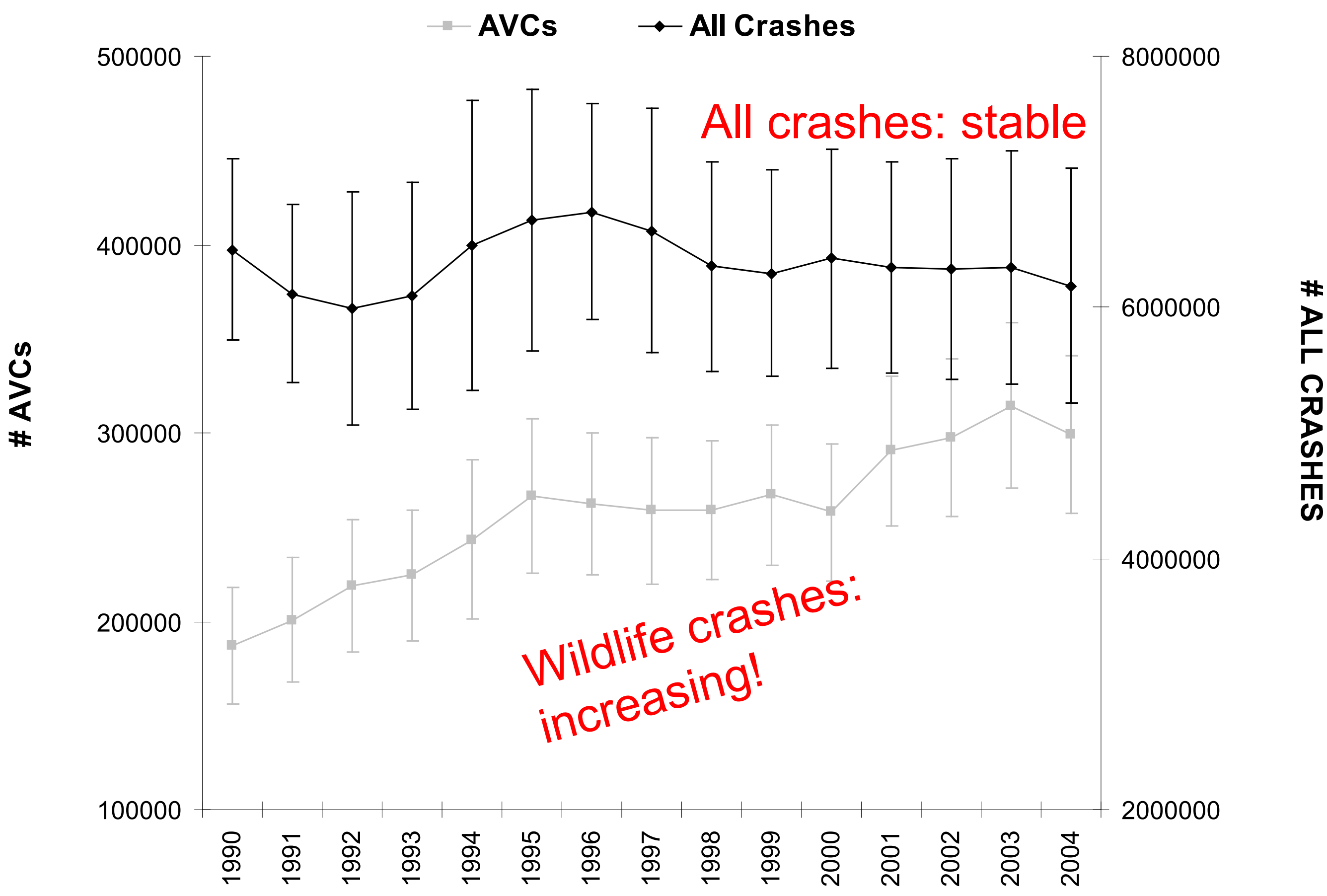


Laurence et al. 2014

What is Road Ecology?

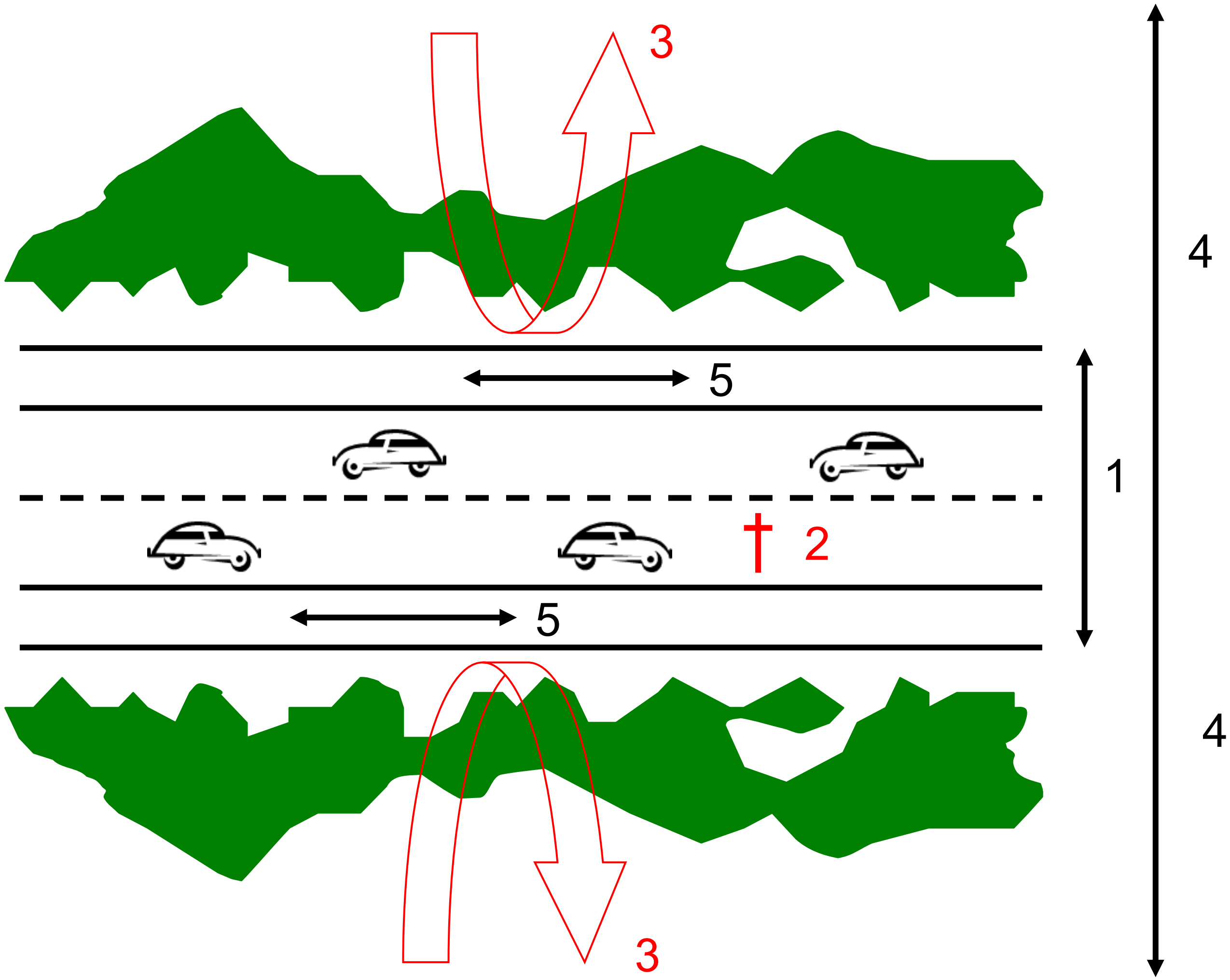


Trend animal-vehicle collisions



1-2 million ungulate-vehicle collisions / year in US (Huijser et al. 2008)

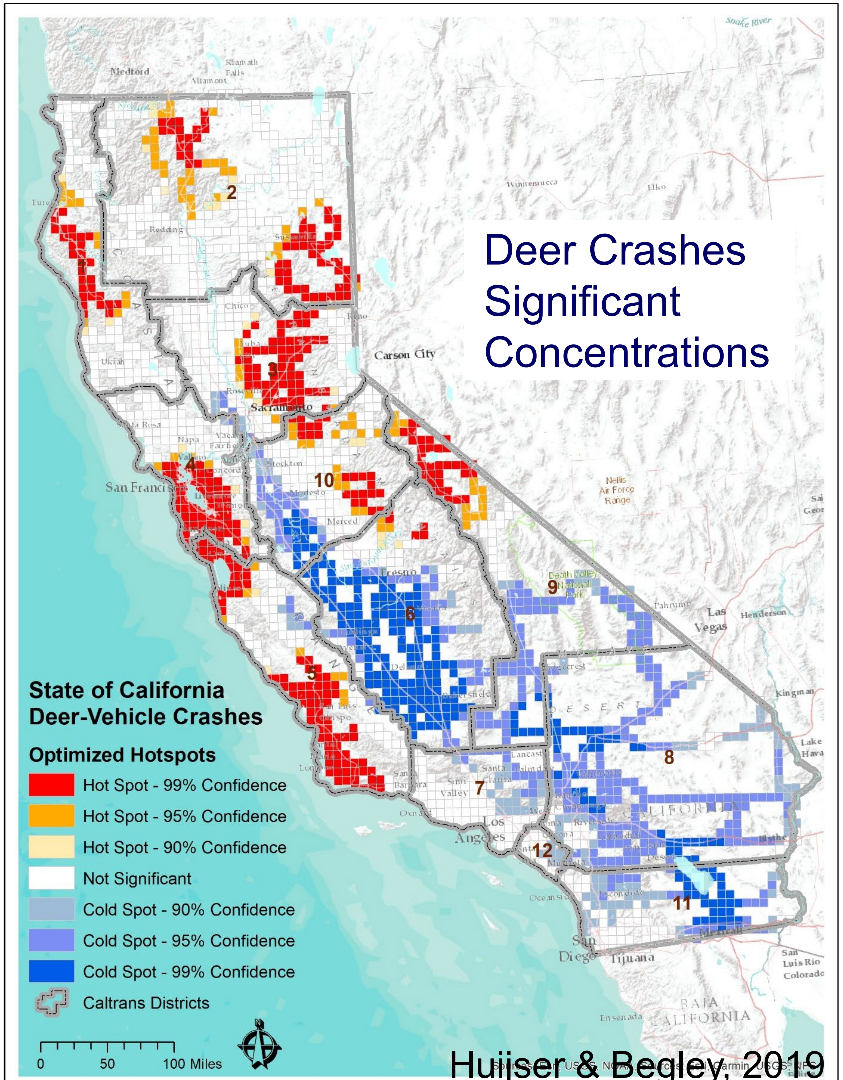
Ecological Impacts Roads and Traffic



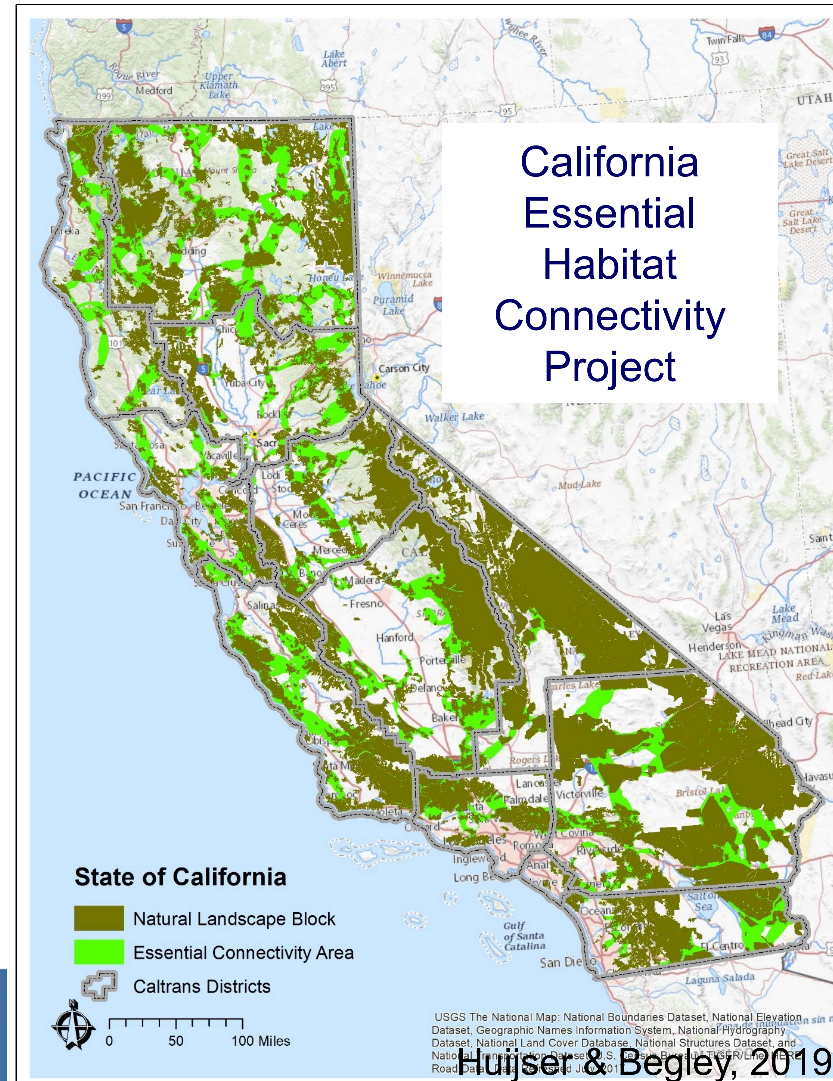
1. Loss of wildlife habitat
2. Road mortality
3. Barrier effect
4. Decrease in habitat quality (disturbance, pollution)
5. Ecological function of verges

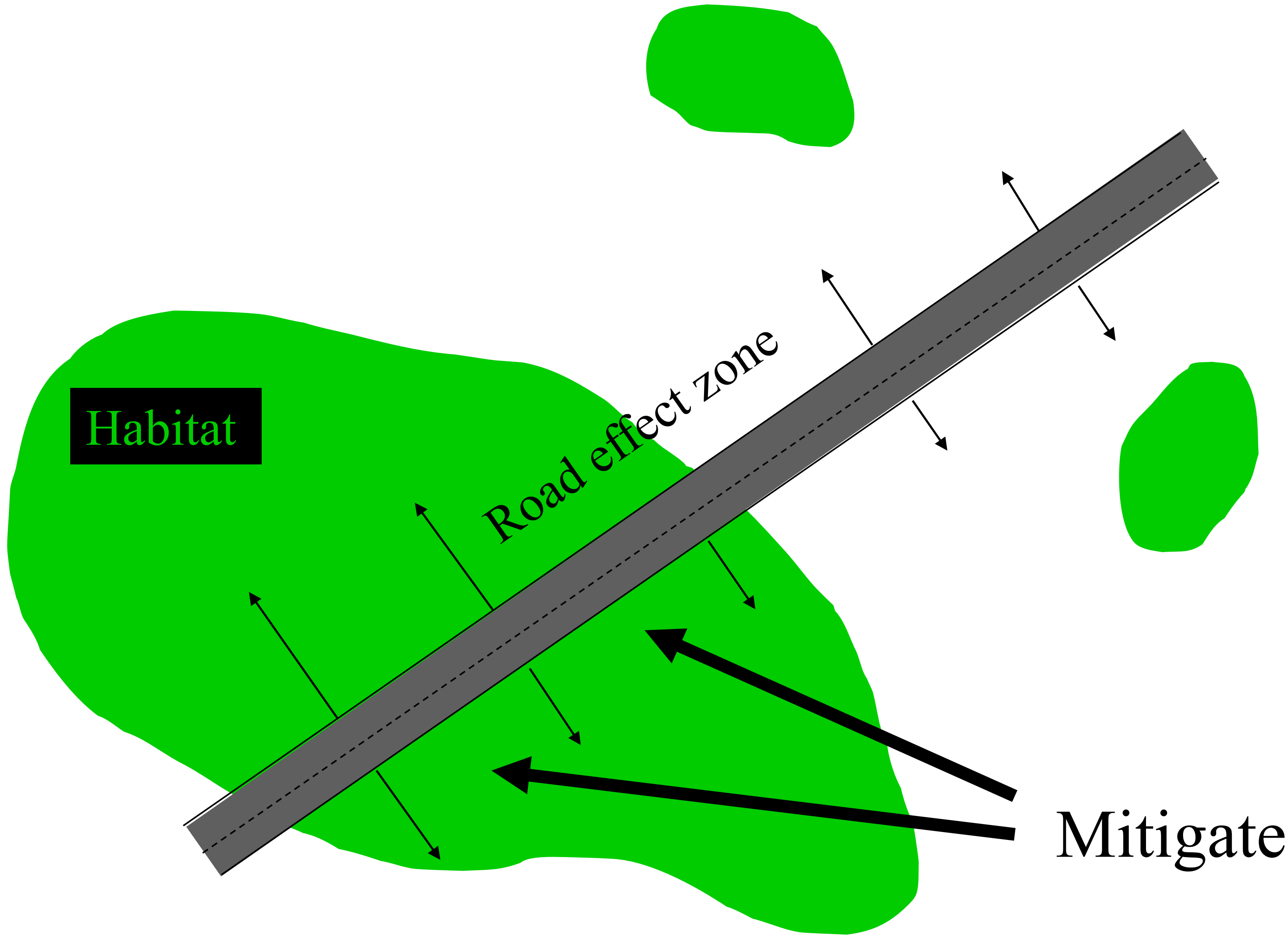
Departure Point

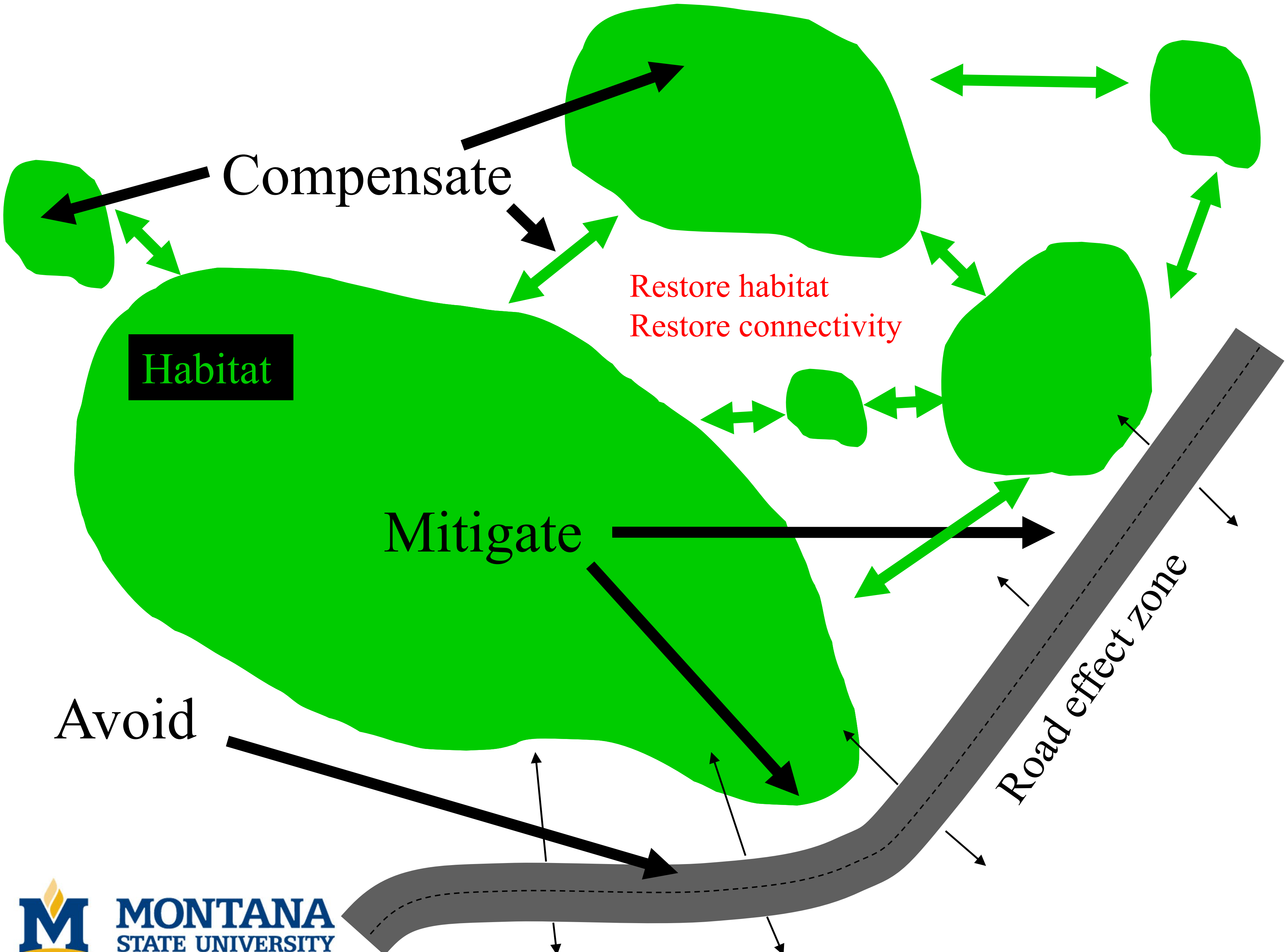
Human Safety



Biological Conservation




Habitat
Road effect zone
Mitigate



MONTANA STATE UNIVERSITY

Reducing Collisions Large Wild Mammals? We Want …

- Simple
- Inexpensive
- Fast implementation (tomorrow!)
- Implementation over long distances

- But… that doesn't mean it exists!

Wildlife Warning Signs

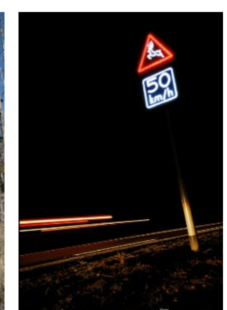
- Standard




- Enhanced

- Temporary

- Animal detection system

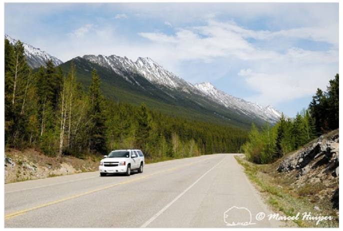
MONTANA STATE UNIVERSITY | College of ENGINEERING

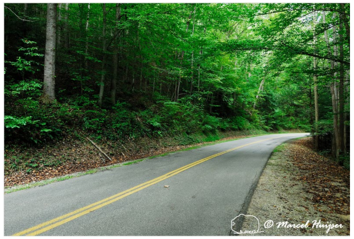
Huijser et al., 2015

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

Night Time
Reduction Posted Speed Limit

Winter ranges
Migration corridors

- 70 mph day / 55 mph night
- 3-5 mph reduction, not 15 mph
- No consistent/significant change in collisions

Riginos et al. 2019

Stopping Distance – Maximum Vehicle Speed

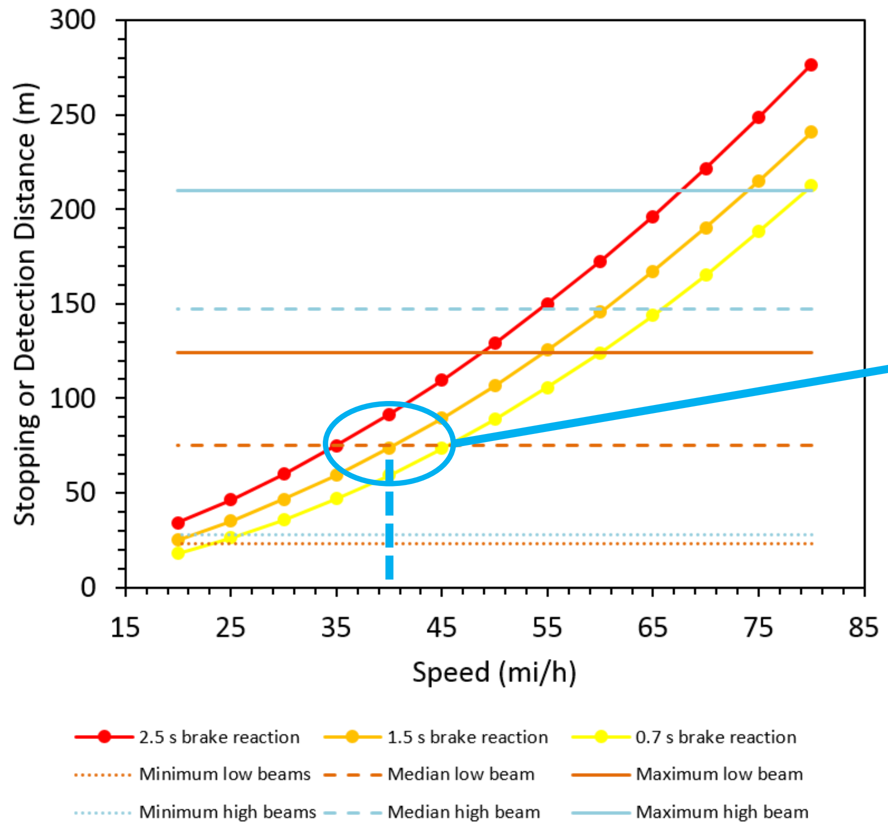


Figure 7. Stopping Distances and Detection Distances for Large Mammals (For more details on methods see Huijser et al., 2017)

Stopping distance = Reaction time (distance) + Braking distance

50% reduction?
Operation speed 40 MPH max!

Not suitable for highways
Perhaps suitable for park roads

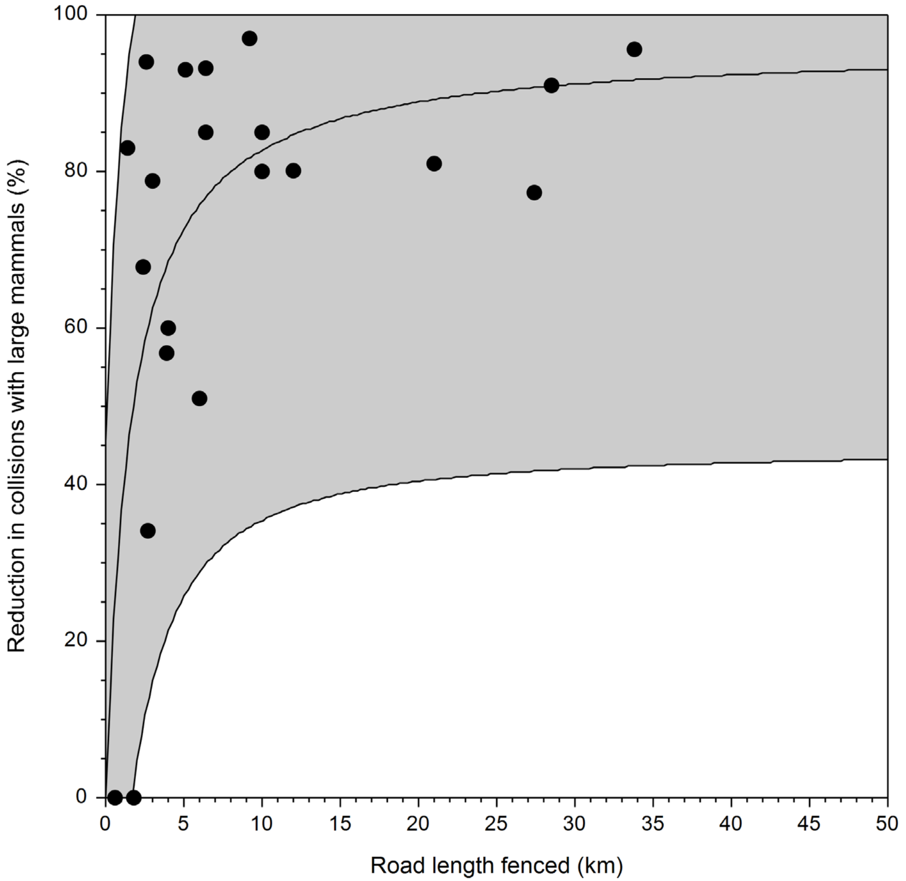
Huijser et al., 2017

Reduce Collisions: Barriers

Standard “ungulate” fence

Multi-species approach

Reducing Wildlife-Vehicle Collisions



Huijser et al., 2016, Biological Conservation

< 5 km 52.7%
range 0-94%

> 5 km: typically > 80%

Reduce barrier effect:
Crossing Structure Types and Dimensions

Overpass
50-70 m wide

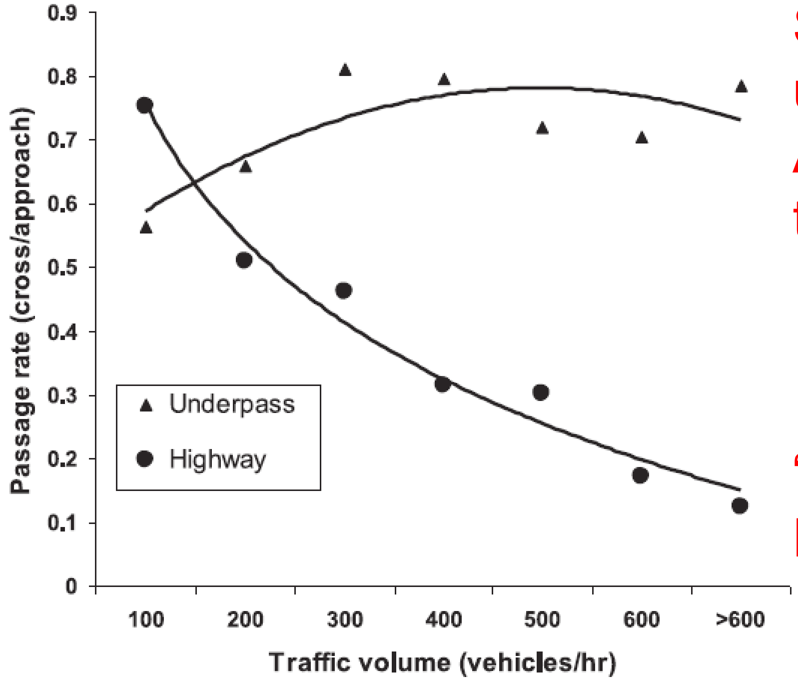
Medium mammal
Underpass
1.5-2 m diameter

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

Small-medium
Mammal pipe
30-60 cm diameter

Large mammal
Underpass
7 m wide
4-5 m high

Crossing Structures needed, especially at higher traffic volumes



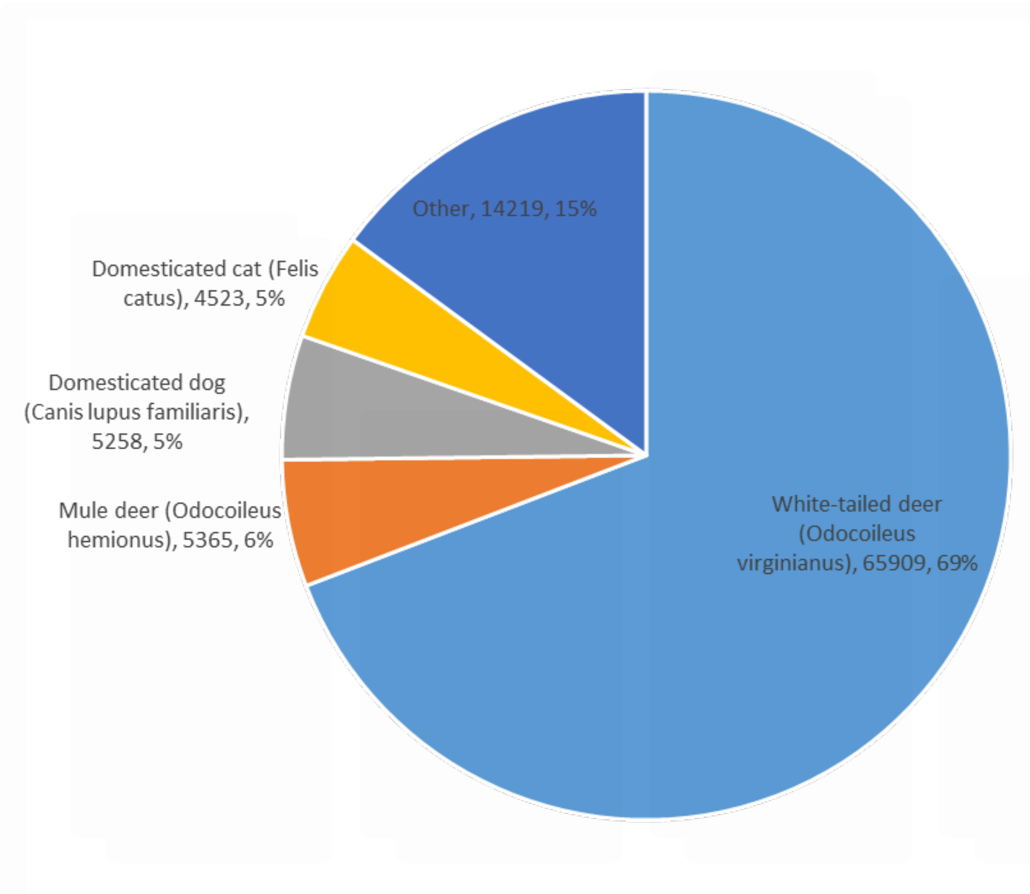
Safe crossing through under/overpasses?
Animals cross regardless of traffic volume!

"Safe crossing" on pavement?
No good for busy roads!

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).

Dodd et al., 2007

Use ≠ Effectiveness
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

Species specific design

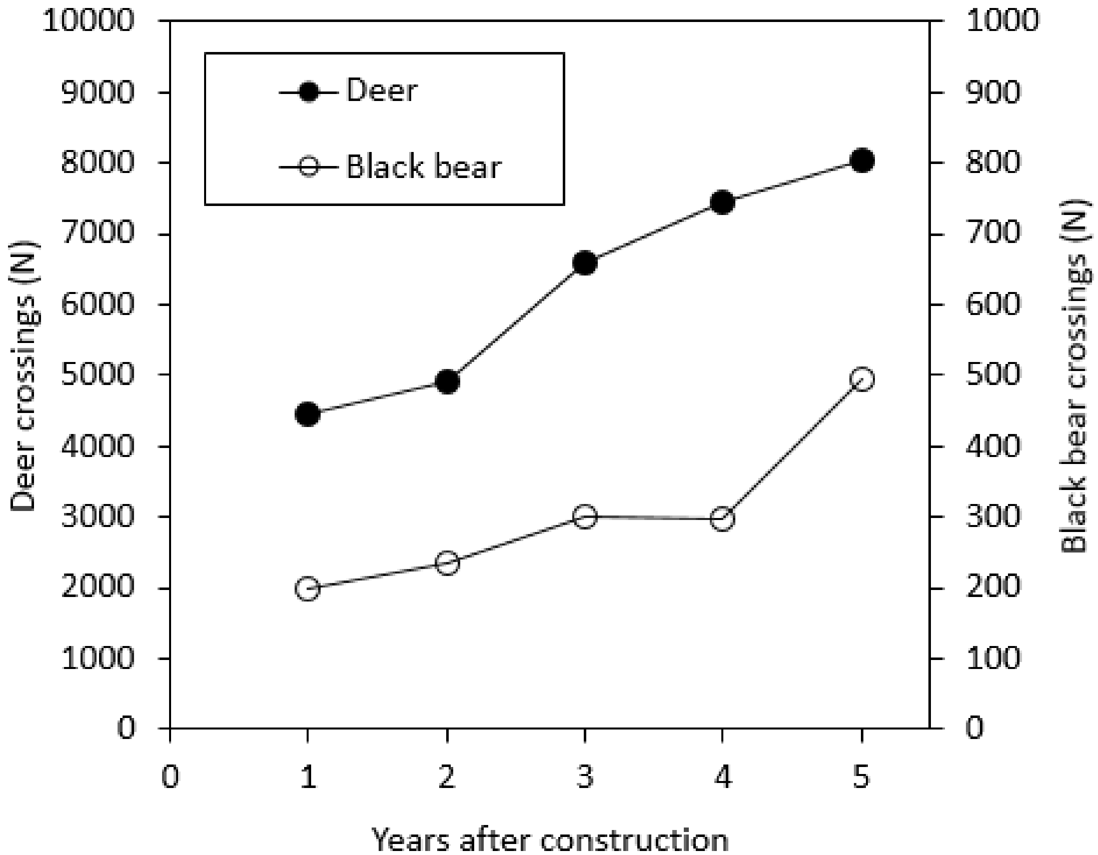
	Wildlife overpass	Open-span bridge	Large-mammal underpass	Medium-mammal underpass	Small- to medium-mammal pipe
Ungulates					
Deer sp.	●	●	●	⊗	⊗
Elk	●	●	●	⊗	⊗
Moose	●	●	○	⊗	⊗
Mountain goat	●	●	○	⊗	⊗
Bighorn sheep	●	●	○	⊗	⊗
Pronghorn	●	○	○	⊗	⊗
Carnivores					
Weasel	●	●	○	●	●
Pine marten	●	○	○	●	●
Fisher	●	●	○	⊗	⊗
Striped skunk	●	●	●	●	●
Badger	●	●	●	?	?
Wolverine	●	●	?	?	⊗
Bobcat	●	●	●	●	●
Canada lynx	●	●	?	?	⊗
Cougar	●	●	●	⊗	⊗
Fox1 (*V. vulpes, Urocyon*)	●	●	●	●	●
Fox2 (*V. macrotis, V. velox*)	●	●	○	?	?
Coyote	●	●	●	●	●
Wolf	●	●	○	⊗	⊗
Black bear	●	●	●	⊗	⊗
Grizzly bear	●	●	○	⊗	⊗

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

Huijser, Clevenger et al. 2008

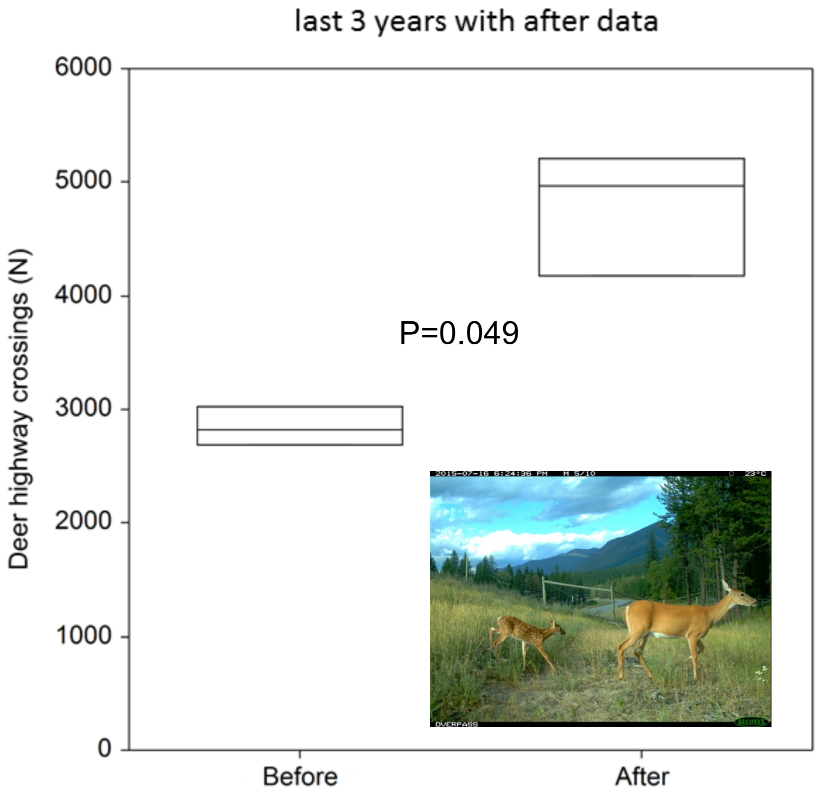
MONTANA STATE UNIVERSITY

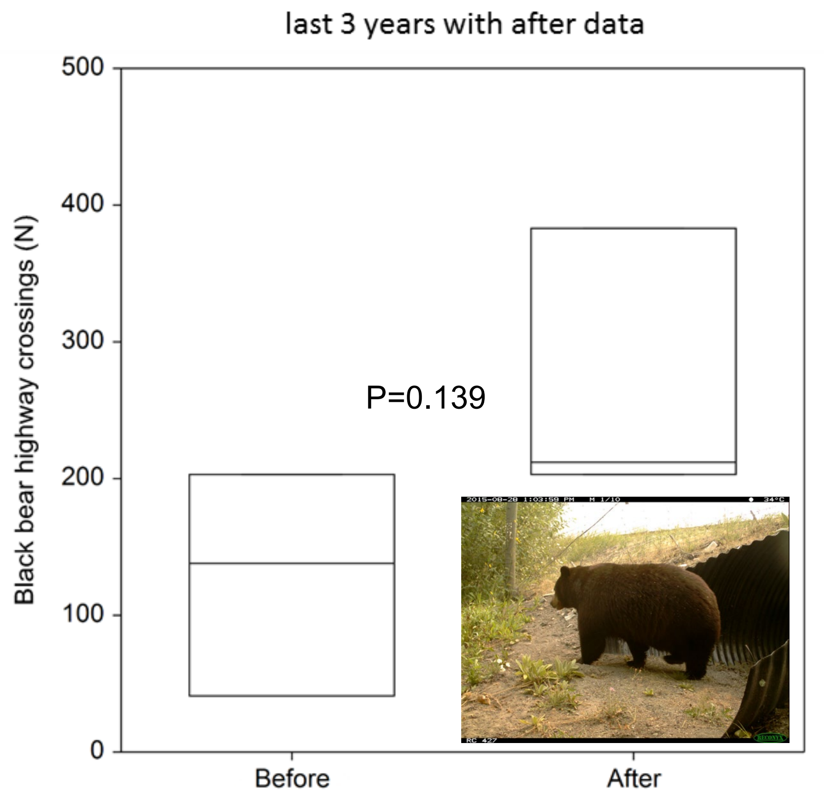
Long-term Perspective Learning Curve



Huijser et al. 2016

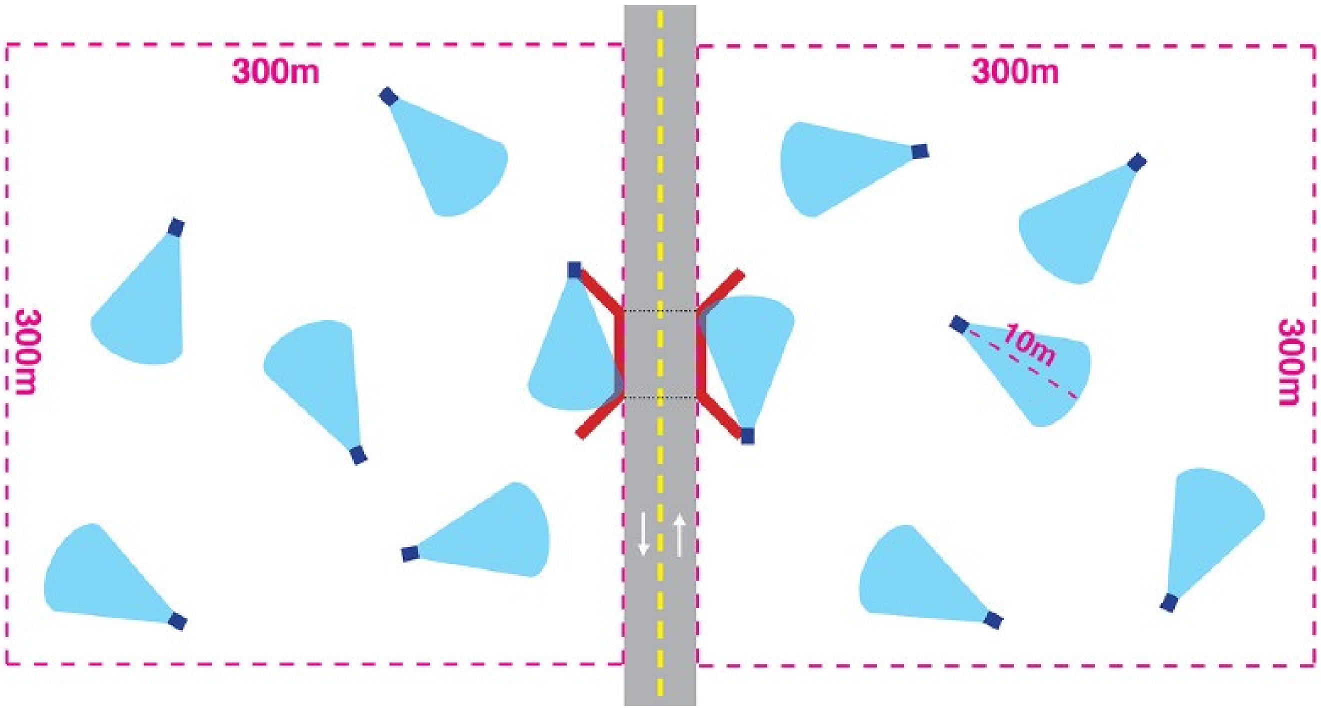
Habitat Connectivity





Huijser et al. 2016

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

Define Success!

No Definition?
Can’t have success!

Objectives <=> Measures

Set Higher Ambition Levels

- Just build them, regardless of wildlife use
- "Substantial" wildlife use
- Viable wildlife populations
- Ecosystem processes
  - Migration routes
- Climate Change

Cost-benefit analyses

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

- Benefits:
  Reduced costs collisions

Huijser, M. P., J. W. Duffield, A. P. Clevenger, R. J. Ament, and P. T. McGowen. 2009. Cost–benefit analyses of mitigation measures aimed at reducing collisions with large ungulates in the United States and Canada; a decision support tool. *Ecology and Society* **14**(2): 15. [online] URL: http://www.ecologyandsociety.org/vol14/iss2/art15/

E&S

Research, part of a Special Feature on Effects of Roads and Traffic on Wildlife Populations and Landscape Function

Cost–Benefit Analyses of Mitigation Measures Aimed at Reducing Collisions with Large Ungulates in the United States and Canada: a Decision Support Tool

Marcel P. Huijser [1], *John W. Duffield* [2], *Anthony P. Clevenger* [1], *Robert J. Ament* [1], and *Pat T. McGowen* [1]

ABSTRACT. Wildlife–vehicle collisions, especially with deer (*Odocoileus* spp.), elk (*Cervus elaphus*), and moose (*Alces alces*) are numerous and have shown an increasing trend over the last several decades in the United States and Canada. We calculated the costs associated with the average deer–, elk–, and moose–vehicle collision, including vehicle repair costs, human injuries and fatalities, towing, accident attendance and investigation, monetary value to hunters of the animal killed in the collision, and cost of disposal of the animal carcass. In addition, we reviewed the effectiveness and costs of 13 mitigation measures considered effective in reducing collisions with large ungulates. We conducted cost–benefit analyses over a 75-year period using discount rates of 1%, 3%, and 7% to identify the threshold values (in 2007 U.S. dollars) above which individual mitigation measures start generating benefits in excess of costs. These threshold values were translated into the number of deer–, elk–, or moose–vehicle collisions that need to occur per kilometer per year for a mitigation measure to start generating economic benefits in excess of costs. In addition, we calculated the costs associated with large ungulate–vehicle collisions on 10 road sections throughout the United States and Canada and compared these to the threshold values. Finally, we conducted a more detailed cost analysis for one of these road sections to illustrate that even though the average costs for large ungulate–vehicle collisions per kilometer per year may not meet the thresholds of many of the mitigation measures, specific locations on a road section can still exceed thresholds. We believe the cost–benefit model presented in this paper can be a valuable decision support tool for determining mitigation measures to reduce ungulate–vehicle collisions.

Key Words: *animal–vehicle collisions; cost–benefit analysis; deer; economic; effectiveness; elk; human injuries and fatalities; mitigation measures; moose; roadkill; ungulate; vehicle repair cost; wildlife–vehicle collision*

INTRODUCTION

Wildlife–vehicle collisions affect human safety, property and wildlife. The total number of large mammal–vehicle collisions has been estimated at one to two million in the United States and at 45 000 in Canada annually (Conover et al. 1995, Tardif and Associates Inc. 2003, Huijser et al. 2007b). These numbers have increased even further over the last decade (Tardif and Associates Inc. 2003, Huijser et al. 2007b). In the United States, these collisions were estimated to cause 211 human fatalities, 29 000 human injuries and over one billion US dollars in property damage annually (Conover et al. 1995). In most cases, the animals die immediately or shortly after the collision (Allen and McCullough 1976). In some cases, it is not just the individual animals that suffer. Road mortality may also affect some species on the population level (e. g., van der Zee et al. 1992, Huijser and Bergers 2000), and some species may even be faced with a serious reduction in population survival probability as a result of road mortality, habitat fragmentation, and other negative effects associated with roads and traffic (Proctor 2003, Huijser et al. 2007b). In addition, some species also represent a monetary value that is lost once an individual animal dies (Romin and Bissonette 1996, Conover 1997).

[1] Western Transportation Institute, Montana State University, [2] University of Montana, Department of Mathematical Sciences

Huijser et al., 2009, Ecology & Society

Benefits: Costs of collisions

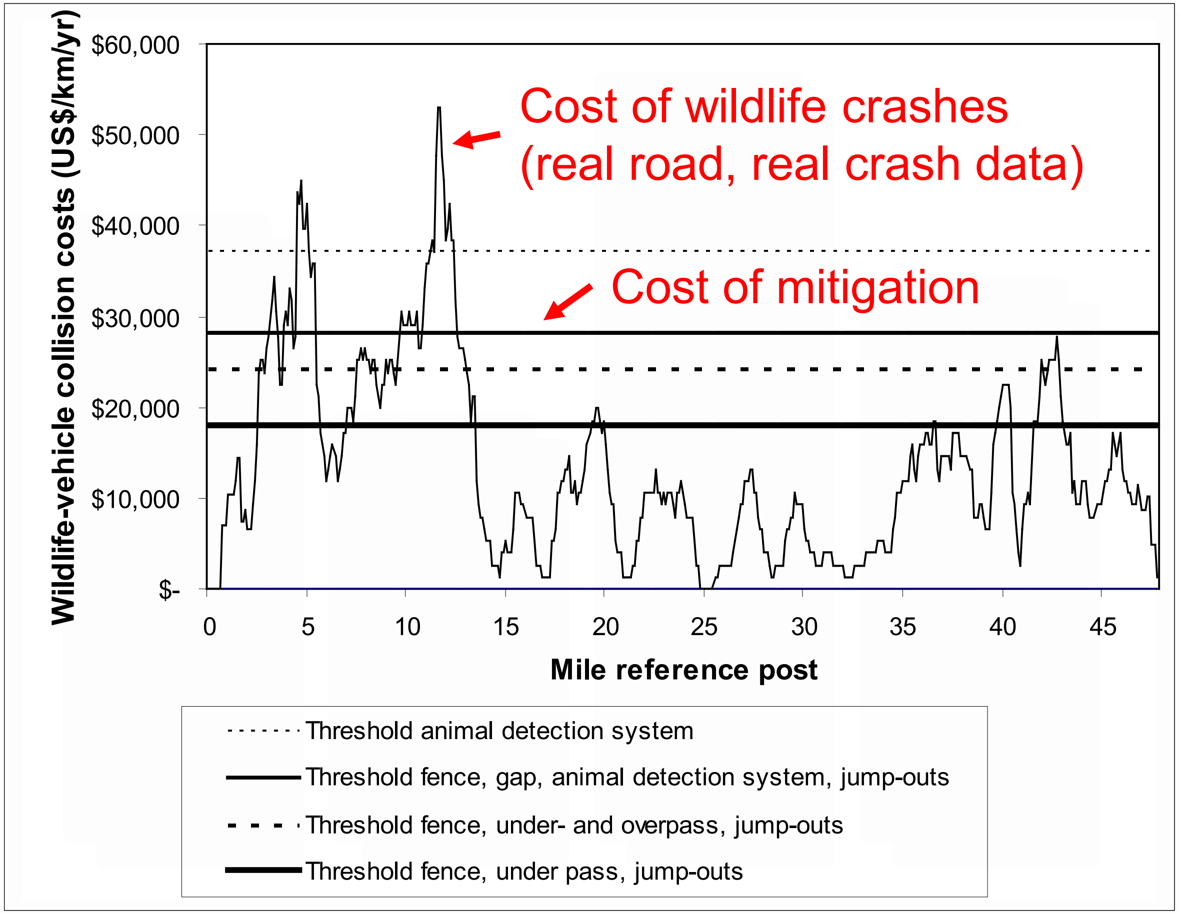
Description	Deer	Elk	Moose
Vehicle repair costs per collision	$2,622	$4,550	$5,600
Human injuries per collision	$2,702	$5,403	$10,807
Human fatalities per collision	$1,002	$6,683	$13,366
Towing, accident attendance and investigation	$125	$375	$500
Hunting value animal per collision	$116	$397	$387
Carcass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

Huijser et al., 2009, Ecology & Society

Cost-benefit analyses

- 75 year long period
- Discount rate: 1%, 3%, 7%

Example road section
MT Hwy 83, Seeley-Swan Montana



Not (yet) included:
Costs and benefits
Biological Conservation

Huijser et al., 2009, Ecology & Society

Opportunity & Optimism

Biological conservation

Human safety

Economic sense

Physical and mental health

Adapting for Climate change

Recreation

Thanks!

To you for tuning in
To Funders
To Practitioners

Contact:
Marcel Huijser
mhuijser@montana.edu
406-543-2377