Road Ecology: What Do We Know?

Marcel P. Huijser, PhD
Human Safety

1-2 million large mammal-vehicle collisions/yr

Human injuries: N ~ 29,000/yr

Human fatalities: N ~211/yr

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
Habitat

Compensate

Mitigate

Avoid

Habitat connectivity

Road effect zone
Departure Point Matters!

Human safety

35%

65%

7%

Biological conservation

93%

Other species
Other habitat
Other effects
Other measures

Hwy 2, Montana (Huijser & Begley, 2016)
Collision reduction for human safety vs. Mortality reduction for conservation
... But we mostly focus on:
human safety / reducing collisions

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

“We” Want ....

- 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

- Reducing speed typically not suitable for highways
- Perhaps suitable for park roads

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

- Standard “ungulate” fence
- Animal detection systems
- Multi-species approach
Effectiveness of short sections of wildlife fencing and crossing structures along highways in reducing wildlife–vehicle collisions and providing safe crossing opportunities for large mammals


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ARTICLE INFO

Keywords: Fencing, fence, fencing

ABSTRACT

Wildlife fencing in combination with crossing structures is commonly regarded as a cost-effective and robust strategy to reduce large mammal–vehicle collisions while enhancing wildlife connectivity across roads. However, fencing and associated measures can affect landscape aesthetics and sometimes considered unsightly and unpopular. Therefore, fence length in km is minimized. We investigated (1) whether short fenced road sections were effective in reducing large mammal–vehicle collisions as long fenced road sections (literature review), and (2) whether fence length influenced large mammal use of underpasses (case-study analysis). We found that: 1) short fences (≤5 km road length) had lower (37.6%) and more variable (0-94%) effectiveness in reducing collisions than long fences (≥5 km) (typical 80% reduction); 2) wildlife use of underpasses was highly variable, regardless of fence length (first-field study); 3) in 305 km segments, crossings occurred through isolated underpasses (42%) rather than at fence ends (48%); and 4) the proportion of use of isolated underpasses (compared to crossings at fence ends) did not increase with longer fence lengths (up to 2100 m from underpasses). The primary success parameter is to improve highway safety for vehicles by reducing collisions with large ungulates, the data suggest fence length of at least 5 km. Longer fence lengths do not necessarily guarantee higher wildlife use of underpasses as use varies greatly between locations. Wildlife fencing can still improve wildlife use in an individual ecosystem.

Introduction

Large mammal–vehicle collisions are abundant in many parts of the world (e.g. Groves and Hadley, 1996; Comover et al., 1999). Collisions with large ungulates typically result in the injury or death of the animals involved, substantial vehicle damage, and, in some cases, human injuries and fatalities (Allen and Bush, 1979; Bieniek et al., 2008; Comover et al., 1999). Wildlife fencing in combination with wildlife crossing structures is commonly regarded as the most effective and robust strategy to reduce these types of collisions while also maintaining connectivity across highways for wildlife (review in Huijser et al., 2017). If wildlife fencing and crossing structures are designed based on the requirements of the target species, and if they are implemented and maintained correctly, the measures can reduce large mammal–vehicle collisions by 80–90% (Ceveringer et al., 2010; Eggers et al., 2015; Sawyer et al., 2013). In addition, the number of animal movements across overpasses or through underpasses, as well as the percentage of animals out of a local population that use the structures, can be substantial (Ceveringer and Holton, 2000; Sawyer et al., 2011; Sawyer et al., 2012). Despite the benefits described above, wildlife fences, wildlife crossing structures and associated measures can be controversial issues. Wildlife fences for large ungulates are typically 1.2 m high and can affect landscape aesthetics (Evans and Wood, 1980). In addition, some landowners may also object to associated measures such as gates, wildlife guards, or similar measures at access roads as they may be time consuming or unpleasant to drive across. Furthermore, despite the wildlife crossing structures that may be present, fences are sometimes a problem for wide ranging large mammal species such as mule deer (Odocoileus hemionus) and pronghorns (Antilocapra americana) (Coe et al., 2015; Poole et al., 2012; Seifert et al., 2015). They can even be a
Under- and overpasses 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).
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

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### Species specific design

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- **Recommended/Optimum solution**
- **Possible if adapted to local conditions**
- **Not recommended**
- **Unknown, more data are required**

Huijser et al. 2008
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
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

last 3 years with after data

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
Ambition level? ecological Processes?

- Entire ecosystems
- Soil
- Hydrology
- Plants
- Animals
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
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
Cost-benefit analyses

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

• Benefits:
  Reduced costs collisions

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 35-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 year per route 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 over two million in the United States and at 400,000 in Canada annually (Conover et al. 1995, Taroff and Associates Inc. 2003, Huerer et al. 2007b). These numbers have increased even further over the last decade (Taroff and Associates Inc. 2003, Huerer 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 Velden et al. 1992, Huerer 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 (Rood 2003, Huerer et al. 2007b). In addition, some species also represent a monetary value that is lost once an individual animal dies (Rood and Blustonette 1999, Conover 1997).

Huijser et al., 2009
Thanks!

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