Suggestions for the Modification of Existing Right-Of-Way Fences and Bridges to Reduce Mule Deer-Vehicle collisions and Maintain Habitat Connectivity for Large ungulates along I-25, Kaycee, Wyoming

By

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**Background**

A general decline in mule deer population size and an increase in unnatural mortality is associated with residential and energy development, highways, fences, and severe weather (Sawyer et al., 2016; Johnson et al., 2017). The decline of mule deer populations is a concern to the Wyoming Game and Fish Department (WGFD) (Pers. Com. Todd Caltrider, Terrestrial Habitat Biologist, WGFD). In addition, mule deer hunters in Wyoming have expressed concern about the decline in mule deer populations and hunting opportunities (Pers. Com. Todd Caltrider, Terrestrial Habitat Biologist, WGFD). Hunters are particularly concerned with the negative effects of predation, harvest management, climate and drought, habitat loss, and highways and other transportation infrastructure on mule deer hunting opportunities (Pers. Com. Todd Caltrider, Terrestrial Habitat Biologist, WGFD). WGFD is responsible for the management and conservation of wildlife in Wyoming. WGFD is sensitive to the concerns of hunters, especially issues related to hunting opportunities for game species, including mule deer. Therefore, WGFD is coordinating with Wyoming Department of Transportation (WYDOT) to reduce direct wildlife mortality along highways while maintaining or improving habitat connectivity.

**Proposed Project**

A section of I-25 near Kaycee (mile reference posts 253-268) has been identified as having high direct road mortality for mule deer (Pers. Com. Todd Caltrider, Terrestrial Habitat Biologist, WGFD) (Figure 1,2). Between 1 January 2006 and 31 December 2014 there were 1,111 large wild mammals removed (123.4 per year) along 60 miles of I-25 (between mile reference posts 240 and 300). Most of the carcasses related to mule deer (n=806, 72.55%). The remaining carcasses related to white-tailed deer (n=240, 21.60%), pronghorn (n=55, 4.95%), elk (n=5, 0.45%), and moose (n=5, 0.45%) (Figure 2). The road section has an average annual daily traffic volume of about 1,500-1,800 vehicles per day with about 18-20% truck traffic (Pers. Com. Mark Williams, WYDOT). This section of I-25 has relatively new right-of-way fences (Figure 3) and it has existing underpasses for streams, roads, livestock, and farm equipment (see images in Appendix 3). It has the preference of the Wyoming Department of Transportation (WYDOT) to modify the existing right-of-way fences and make them into an ungulate barrier rather than replacing the relatively new right-of-way fences with a standard wildlife fence (e.g. Gagnon et al., 2015). In addition, WYDOT and WGFD would like to explore the possibility of funneling large mammals, particularly mule deer and pronghorn, through the existing underpasses rather than building new underpasses specifically designed for wildlife. There is little information available on the effectiveness of modified right-of-way fences in reducing collisions with large ungulates and the level at which existing underpasses, originally built for other purposes, allow for wildlife crossings (e.g. Gagnon et al., 2015).
However, a cost-benefit analyses showed that the thresholds for wildlife fences (i.e. replacing right-of-way fences with 8 ft high standard ungulate proof fence, no new dedicated wildlife crossing structures) are easily met along substantial sections of I-25 (Figure 4; Huijser et al., 2009). In some areas, new dedicated wildlife underpasses and overpasses may even be attractive based on financial considerations alone (Figure 4). Both WGF and WYDOT would also like to learn about the actual effectiveness of this wildlife mitigation approach that uses the existing infrastructure (i.e. existing right-of-way fences and existing underpasses not built for wildlife) to reduce wildlife-vehicle collisions and provide wildlife safe crossing opportunities. The benefits of a mitigation approach that is based on existing infrastructure are:

1. Not wasting a perfectly good existing right-of-way fence. An existing right-of-way fence can remain in place and does not need to be replaced by a wildlife fence before the end of life of the right-of-way fence.

2. No travel delays and other issues associated with building new underpasses. The road surface and road bed can remain intact as the mitigation approach does not include new underpasses that are specifically designed for wildlife. Instead, the mitigation approach aims to funnel wildlife to existing underpasses built for other purposes (streams, roads, livestock, and farm equipment). This reduces the impact to travelers and adjacent landowners.

3. No funds required for wildlife underpasses. Instead, the mitigation approach aims to funnel wildlife to existing underpasses built for other purposes (streams, roads, livestock, and farm equipment).

4. Wildlife-vehicle collisions can be “immediately” addressed. A mitigation approach based on existing right-of-way fences and existing underpasses lends itself to a relatively swift implementation of mitigation measures aimed at reducing wildlife-vehicle collisions while maintaining habitat connectivity for wildlife. Replacing right-of-way fences with wildlife fences and constructing new crossing structures that are specifically designed for wildlife requires not only more time for construction. Wildlife fences and crossing structures specifically designed for wildlife are typically only implemented when the right-of-way fence needs to be replaced and when the highway requires major reconstruction. This means that such a “traditional” mitigation approach may not be implemented for multiple decades. Therefore, wildlife-vehicle collisions may not be addressed for decades as well. Instead, a mitigation approach based on the existing right-of-way fences and the existing underpasses can be implemented within a relatively short timeframe.
Figure 1. The section of I-25 (around mile reference posts 253-268) near Kaycee that has a concentration of mule deer-vehicle collisions (red oval).
Figure 2. The number of large wild mammal carcasses removed along I-25 between mile reference posts 240-300 between 1 January 2006 and 31 December 2014 (9 years) (Data provided by WYDOT through WGFD). Mile reference post 240 is south of Kaycee, 300 is near Buffalo.
Figure 3. The right-of-way fence along I-25 consists mostly of metal posts, woven wire fence (for domestic sheep) and three strands of barbed wire.
Figure 4. Cost-benefit analyses for selected mitigation measures aimed at reducing collisions with large wild ungulates along I-25 between mile reference posts 240 and 300 (Based on 3% discount rate) (For details on the methodology see Huijser et al. (2009)). The jagged line represents the costs associated with collisions with large wild ungulates based on historic data (2006-2014). The horizontal lines represent the thresholds for the different mitigation packages. Note: In the cost-benefit analyses, mule deer, white-tailed deer, and pronghorn were grouped into “deer”, while elk and moose were kept separate (see Huijser et al., 2009).
Tasks

The Wyoming Game and Fish Department approached Marcel Huijser (MPH:ETC) to conduct the following tasks:

1. Provide a presentation on the effectiveness of wildlife fences and wildlife crossing structures in reducing collisions with large ungulates and providing safe crossing opportunities for wildlife.
2. Conduct a field review of the road section near Kaycee, advise on the potential modifications of the existing infrastructure, and provide recommendations that would allow WGFD and WYDOT to learn about the effectiveness of this relatively new mitigation approach.

Presentation

Dr. Marcel Huijser provided a presentation with a question and answer session to WGFD and WYDOT personnel on Tuesday 11 April 2017 10:00 am - 12:00 pm at the WYDOT office in Casper Wyoming.

Field Review

The field review of the I-25 near Kaycee was conducted on Wednesday 12 April 2017 (Figure 5).

Figure 5. Representatives of the Wyoming Game and Fish Department, Wyoming Department of Transportation, and the Bureau of Land Management discussing wildlife-vehicle collisions and potential mitigation measures along I-25, north of Kaycee, Wyoming.
Requirements for the mitigation approach (formulated by WGFD and WYDOT):

1. The measures need to substantially reduce collisions with large wild ungulates (specifically mule deer) while not turning the transportation corridor into a (near) absolute barrier for wildlife (specifically mule deer).
2. The existing right-of-way fence needs to remain in place as it is relatively new. Therefore, instead of replacing the right-of-way fence with a wildlife fence, the existing right-of-way fence will be modified into a wildlife fence that is designed to be a near absolute barrier for mule deer.
3. The fence will connect to existing underpasses built for other purposes than wildlife. WGFD and WYDOT hope that large wild mammals, specifically mule deer, will then use these underpasses to access the other side of the highway. This mitigation approach does not include new crossing structures that are specifically designed for wildlife.
4. WYDOT and WGFD need to learn about the effectiveness of this approach in terms of wildlife-vehicle collision reduction and habitat connectivity for wildlife, specifically for mule deer. This will allow for an informed decision process when deciding on a broader application of a mitigation approach that is largely based on existing infrastructure (i.e. existing right-of-way fences and existing underpasses built for other purposes than wildlife).

General recommendations formulated by Marcel Huijser:

1. Implement wildlife fences in combination with crossing structures. Wildlife fences alone turn the transportation corridor into an absolute barrier for wildlife and can severely impact species that need relatively large and connected subpopulations to maintain viable metapopulations (Jaeger & Fahrig, 2004). Underpasses alone, without associated wildlife fences, are not an effective measure if the objective is to reduce wildlife-vehicle collisions (Rytwinski et al., 2016). In addition, fences can funnel wildlife to a crossing structure (e.g. Dodd et al., 2007; Gagnon et al., 2010).
2. Design the modifications to the existing right-of-way fence in such a way that it is a near absolute barrier to large ungulates, specifically mule deer (e.g. Knight et al., 2005; Gagnon et al., 2015; Huijser et al., 2015).
3. Limit the modification of the existing right-of-way fence to road sections that have existing underpasses which, based on their dimensions, can be considered suitable for large mammals, specifically mule deer (Clevenger & Huijser, 2011).
4. Fence road sections that are at least 3 miles in length as shorter fenced road sections are, on average, less effective and more variable in reducing collisions with large mammals (Huijser et al., 2016a).
5. Implement fence end treatments that reduce the likelihood of fence end runs (i.e. a concentration of wildlife crossing at or near a fence end), and that reduce the likelihood that wildlife ends up in the fenced road corridor (Huijser et al., 2016a).
6. To learn about the effectiveness of the mitigation approach, it is advisable to implement a BACI design (Before-After-Control-Impact) (Roedenbeck et al., 2007). This means it is essential to have replicates (i.e. multiple road sections with the wildlife fence connected to existing crossing structures). In addition, it is advisable to have designated “control” road sections where no changes are made to the existing right-of-way fences and the existing underpasses.
Furthermore, it is advisable to have at least two years with “before” data and two years with “after” data (Rytwinski et al., 2016). The construction year may have limited value for the analyses.

7. To learn about the effectiveness of this approach in terms of wildlife-vehicle collision reduction and habitat connectivity for wildlife, specifically for mule deer, it is essential to measure both wildlife-vehicle collisions and wildlife use of the existing underpasses.

*Specific recommendations formulated by Marcel Huijser:*

1. Select three road sections (each exactly three miles long) that will be fenced (i.e. modify existing right-of-way fence and make it into a barrier for large ungulates). In addition, select four road sections (also each exactly 3.0 miles long) that will not be changed. These are the “controls”. Multiple fenced sections and multiple control sections are the “sample size” (3 treatment sections, 4 control sections). The reason the sections are 3.0 miles long (not shorter) is because shorter fenced road sections have, on average, much lower and more variable effectiveness in reducing wildlife-vehicle collisions (Huijser et al., 2016a). Appendix 1 lists the fenced, control, and buffer zones, as well as all the culverts and bridges in these road sections. The reason the fenced sections are not longer than 3.0 miles is to avoid the transportation corridor turning into a complete barrier to wild ungulates should wildlife use of the existing underpasses be minimal.

2. There is a “buffer zone” of at least 0.25 miles between the individual control and fenced road sections. Should there be fence end runs (a concentration of wildlife crossing at or near a fence end), then this should keep the controls “pure” as fence end runs can extend about 0.2 mi beyond the fence end (see Huijser et al., 2016b).

3. Center the fenced sections on existing crossing structures that, based on the type and dimensions, should be suitable for mule deer. This is consistent with the principle that the barrier effect of the transportation corridor should not be increased without providing for safe and (potentially) effective crossing opportunities for wildlife.

4. For the sections that will be fenced:
   a. When the right-of-way fence is modified into a wildlife fence, install electric mats or electric concrete (at least 6.0 ft wide (Huijser et al., 2015)) at the fence ends (Figure 6, 7). Embed the mats or concrete in the paved surface. This reduces, perhaps even avoids, wildlife ending up in between the fences and reducing the effectiveness of the mitigation measures. Measures to reduce fence end effects and intrusions into the fenced road section are especially important if the fenced road sections are relatively short (Huijser et al., 2016a). Potential manufacturers: Crosstek (http://www.crosstekco.com/history.html) or Lampman Wildlife Services (http://www.lampmanwildlifeservices.com/). Reduce the length of the electric matt or concrete by bringing the wildlife fence close to the edge of the pavement and using wildlife fence in the median. If the fence enters the clear zone, consider using guardrails around the fences at fence ends to meet safety standards.
Figure 6. Example of suggested configuration for wildlife fences (modified right-of-way fences) and electric matts or concrete at a fence end (featured example: the north end of fenced section centered around Bridge across the North Fork Powder River, Fenced section 1).

Figure 7. Electric mat associated with an animal detection and driver warning system at a fence end, S.R. 260 east of Payson, Arizona, USA. Note: it is advisable to have the matt or concrete be at least 6.0 ft wide.
b. Make sure the wildlife fence fits snug to a crossing structure. If the fence parallels a wingwall, fit fence snug against wingwall everywhere (no wedges). Do not leave openings that would allow large wild ungulates to enter the fenced road corridor.

c. For structures deemed suitable for deer (>6 m wide, >3m high (animal’s perspective)), consider removing livestock fences at the entrances, or replace livestock fences at entrances with wildlife friendly livestock fences (e.g. Paige, 2012)). Consider designing it for mule deer, white-tailed deer and pronghorn as these appear the most common wild ungulates in the area. If crossing structures in the control and buffer road sections remain the same as they are now, consider wildlife friendly livestock fences or removal of livestock fences at the entrances of the crossing structures in the fences sections as an integral component of the mitigation package.

d. There is one fenced road section that includes an underpass with a road and on and off ramps to and from the interstate. There are currently cattle guards at the on and off ramps (Figure 8). Consistent with the philosophy to base the mitigation package on the existing infrastructure as much as possible, consider leaving the cattle guards in place and connect the wildlife fence to these cattle guards (Figure 9). Note that cattle guards are less effective of a barrier to deer than electric mats (Allen et al., 2013; Huijser et al., 2015). However, should the cattle guards allow many deer to enter the fenced right-of-way, replace the cattle guards with electric mats or electric concrete.

Figure 8. Suggested configuration of wildlife fences (modified right-of-way fences), existing cattle guards, and electric mats or concrete at Reno Junction.
Figure 9. Suggested configuration of wildlife fences (modified right-of-way fences), existing cattle guards, and electric matts or concrete at Reno Junction.

e. Include wildlife jump-outs or escape ramps inside the fenced sections (Figure 10). Include a jump-out every 300 m. Build them about 5.5-6.0 ft high to achieve use by mule deer (Huijser et al., 2015). White-tailed deer are likely to use the jump-outs less frequently (Huijser et al., 2016b) and pronghorn may not use them at all. Consider using a bar on top of the jump-out to make it more difficult for animals to jump up (Figure 11).
Figure 10. Wildlife jump-out for bighorn sheep (*Ovis canadensis*), near Thomspson Falls, Montana, USA.

Figure 11. Bar on top of wildlife jump-out for bighorn sheep (*Ovis canadensis*), near Thomspson Falls, Montana, USA.
5. To learn about the effectiveness of the mitigation approach in terms of reducing collisions with large wild ungulates, the following is recommended:

Carcass removal data:

a. Continue to collect carcass removal data. Note: Coordinate between the Kaycee and Buffalo WYDOT road maintenance crews to ensure similar search and reporting effort for all (future) fenced and control sections. While current historical data can be used as “before” data, it is best to ensure similar reporting effort between the road maintenance crews in all road sections that will later be fenced as well as the control road sections. This reduces variation in the “before” data. We would want at least 2 full calendar years with “before” data (e.g. 2018 and 2019).

b. While current historical data can be used as “before” data, it is best to mark the beginning and end of the individual (future) fenced and control road sections with a pole (e.g. with mile marker numbers visible on poles). Road maintenance crews can then note whether a carcass was located just inside or just outside a (future) fenced or control road section.

c. Add a column to the carcass removal data collection form to indicate if a carcass was inside a fenced road section, inside a control road section or in a buffer zone. This is especially important around the beginning and end of the fenced and control road sections.

Wildlife-vehicle crash data:

a. Coordinate with law enforcement personnel that reports on wildlife-vehicle crashes. It is assumed that the search and reporting effort of road maintenance crews is consistent throughout the road sections with the (future) fenced and control areas (e.g. an accident needs to be called in to law enforcement, there needs to be at least and estimated $1000 in vehicle repair costs to be included in the crash database, or there are human injuries or human fatalities associated with the crash).

b. It is assumed that law enforcement is very detailed in describing the location of a crash (e.g. with GPS). Nonetheless, if possible, ask law enforcement personnel to note whether a wildlife-vehicle crash was inside a fenced road section, inside a control road section or in a buffer zone. This is especially important around the beginning and end of the fenced and control road sections.

6. To learn about the effectiveness of the mitigation approach in terms of habitat connectivity for wildlife, the following is recommended:

a. Start monitoring large wild mammal use of the existing crossing structures. Collect at least 2 full calendar years of “before” data (2018 and 2019) and two full calendar years of “after” data (2021 and 2022).

b. Use wildlife cameras positioned in the structures to monitor wildlife movements. The use of Reconyx Hyperfire PC 900 is recommended. These cameras have a fast response time (low likelihood of not recording fast moving animals). The range (no glow IR flash) at night is 12
m. If a structure is more than 12 m wide, use multiple cameras (or make the area behind the camera inaccessible to wildlife (e.g. block the slope of an overpass with tall fences or branches so that large mammals cannot cross behind the camera).

c. Depending on the width of the crossing structures and whether fences or other barriers are implemented on the slopes inside the underpasses, the number of cameras per structure may vary between 1 and 6. Note that only one of the two structures at each location needs to be monitored (monitor either the northbound or southbound structure).

d. If budget is low or unavailable for the “before” data, prioritize the structures that are the principal structures in the three fenced sections and the four control sections (Appendix 1). Ideally all structures that are considered large enough to be suitable for deer (>6 m wide, >3 m high, from the animal’s perspective) should be monitored, especially after modifying the right-of-way fence.

e. Use steel boxes, thick steel cables, sturdy locks and, depending on the location, ground anchors to minimize theft and vandalism.

f. Program the cameras to take 20 images after having been triggered (2 per second, 20 images in 10 seconds). Program “no delay” so that a new trigger will cause another series of 20 images to be taken.

g. Use large (32GB) memory cards of a reliable brand (e.g. Sandisk or Lexar). There should be two cards per camera so that a new card can be inserted when a “full” card is removed.

h. Change the memory cards once per month.

i. Change the batteries once every 3 months (regardless of the indicated charge status of the batteries). Use “Energizer Ultimate Lithium” AA batteries. These are by far the best batteries. Use these batteries to avoid data loss and extra trips to replace depleted batteries.

j. Program the cameras so their name (based on location) is imprinted on each image. If there are multiple cameras at a structure, give them unique numbers in addition to the location name.

k. During the growing season, use a weedwhacker to mow grasses and herbs in a swath in from of the camera (e.g. 10 ft wide swath for at least 12 m (range of the camera at night) but preferable further. Mowing the vegetation reduces the likelihood that the memory cards will fill up before the month is up, it reduces battery drainage, and it greatly reduces download time of the memory cards and review time of the images.

l. Download the memory cards in the office after they have been removed from the cameras. Back the images up (e.g. hard disk in at least 2 different buildings (to protect against fire, theft)). The memory cards should be emptied and ready for reuse by the next month when the cameras are checked.

m. Use a select few people who manage the cameras and that get to know the cameras. This minimizes the risk that the cameras are programmed wrong, or are not set (i.e. not active). Avoid missing data.

n. Interpret the images only when budget is available as this is time consuming. Develop a consistent methodology (e.g. It is a successful crossing if the animal passes the center line from a camera and does not return for at least 5 minutes; Only include species of a certain minimum size (no mice) or only include species from certain species groups (mammals only)). Preferably, leave data interpretation and entry to dedicated research staff.
Timing

Before data: Two full calendar years, starting 1 January 2018. Before data related to 2018 and 2019.

Construction: Mitigation measures would be installed/constructed in calendar year 2020

After data: Two full calendar years, starting 1 January 2021. Before data related to 2021 and 2022.

References


APPENDIX 1

The fenced, control and buffer road sections.
<table>
<thead>
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<th>Fenced/Control</th>
<th>Mi reference post start-end</th>
<th>Road length (mi)</th>
<th>Existing (principal) underpass</th>
<th>Mi reference post principal feature</th>
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<td>267.85 Culvert (likely unsuitable) 268.06 Culvert (likely unsuitable) 268.28 Culvert (likely unsuitable) 268.48 Culvert (likely unsuitable) 269.22 Bridge (75 ft span incl. slopes): Farm equipment (suitable, no ungulate tracks found) 269.40 Culvert (likely unsuitable) 269.65 Possible culvert (likely unsuitable) 270.16 Culvert (likely unsuitable)</td>
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APPENDIX 2

Maps of the fenced and control sections
Suggestions Wildlife Mitigation I-25, Kaycee, Wyoming

Control 2: 267.23-270.23
Control 4: 277.97-280.97
APPENDIX 3

Images of selected crossing structures
Image below: Bridge across the Middle Fork Powder River (mile 253.96 along I-25)
Images below: Bridge across the North Fork Powder River (mile 258.98 along I-25)
Images below: Bridge across Old Hwy 87 (mile 261.43 along I-25)
Image below: Double culvert at Antelope Creek (mile 264.01 along I-25)
Image below: Bridge across Reno road interchange (mile 265.48 along I-25)
Image below: Underpass for farm vehicles (mile 269.22 along I-25)
Image below: Box culvert for livestock (mile 270.50 along I-25)
Image below: Underpass for farm vehicles (mile 271.88 along I-25)
Image below: Underpass for farm vehicles (mile 276.22 along I-25)
Image below: Bridge across South Fork Crazy Woman Creek (mile 278.26 along I-25)
Images below: Underpass for farm vehicles (mile 278.84 along I-25)
Image below: Bridge across Middle Fork Crazy Woman Creek (mile 279.56 along I-25)
Image below: Bridge across Middle Fork Road interchange (mile 280.18 along I-25)