BOZEMAN PASS WILDLIFE PRE-AND POST-FENCE MONITORING PROJECT

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ABSTRACT

Introduction

The Bozeman Pass transportation corridor between Bozeman and Livingston, Montana, includes Interstate-90, frontage roads, and a railroad. The highway supports 8,000-12,000 daily vehicles during the winter and 10,000 to 15,000 daily vehicles during the summer. The interstate has essentially become a barrier and hazard to animal movements in the Bozeman Pass area. To determine the extent of the animal-vehicle conflicts and where conflicts may best be mitigated, CERI began collecting field data on Bozeman Pass in 2001. Data analysis led to recommendations to incorporate approximately 2 miles of wildlife fencing, cattle guards and landscaping design modifications into the reconstruction of a Montana Rail Link (MRL) overpass. These recommendations were accepted by the Montana Department of Transportation (MDT) and MRL in 2005 and a wildlife fence and four jump-outs were constructed in 2007. Adding relatively low cost wildlife mitigation measures to existing highway projects are effective in increasing highway permeability and reducing animal mortality, and could be incorporated into the Obama infrastructure initiative.

Methods

Data on wildlife crossings and animal-vehicle collisions (AVC) were collected before and after installation of the fencing to evaluate if the fencing reduces animal-vehicle collisions, and to determine animal movements under the highway via existing culverts and the MRL overpass. Data collection includes seven tasks, as follows:

1. Road kill surveys between Bozeman and the Jackson Creek interchange.
2. Track bed monitoring of wildlife movements under the MRL bridge.
3. Remote camera monitoring of wildlife movements at fence ends
4. Infrared counter monitoring of wildlife movements at jump outs
5. Track bed monitoring of wildlife movements at fence ends and jump outs
6. Remote camera monitoring of wildlife movements in two culverts at east end of fence.
7. Opportunistic snow tracking under MRL bridge and in fenced area.

Power analyses (power = 0.8; $\alpha = 0.05$) indicated three to five years of post-fencing study would be optimal in order to make reasonable quantitative comparisons between the pre- and post-fencing ungulate-vehicle collision (UVC) data. This presentation reports on 2 years of data.

Results

Nearly 2000 animals have been killed along 23 miles of Interstate 90 from 2001-June 2009. Since the installation of the wildlife fence about 1.5 miles long, two white-tailed deer has been killed within the fenced area and three have been killed at the fence ends. There has not been an increase in AVC at the ends of the fence. Preliminary results indicate an increased use of underpasses and culverts by wildlife.

Discussion

Costs for this project were much lower than new wildlife crossing structures since the fencing was added on to a structure replacement project for an existing underpass. More wildlife appear to travel through the rebuilt underpass as well as through other existing crossing structures (culverts and county road bridge). This suggests that fencing alone can be added to help direct animals through existing structures.

Conclusion
Wildlife fencing leading to existing crossing structures is a cost-effective method of reducing AVC and thus reducing risk to motorists as well as increasing connectivity for wildlife.

Recommendations
Design improvements in jump-outs and fence-ends will be discussed.

INTRODUCTION

There is a wealth of evidence that details the mainly negative impacts that roads have on wildlife populations. When animals are confronted with roads, they potentially face direct mortality, habitat fragmentation, loss of habitat connectivity and genetic isolation (Clevenger and Wierzchowski 2006, Clevenger et.al. 2001, Corlatti et. al. Forman et. al. 2003, Forman and Alexander 1998). When humans encounter wildlife on roadways the effects can also be life-threatening. Every year approximately 200 people die from animal-vehicle collisions (AVC). The cost of wildlife related collisions are staggering with an estimated $1 billion yearly being paid out by insurance companies for automobile repairs (Robbins 2007). In an effort to decrease human and wildlife mortality, transportation planners within the past few decades began incorporating wildlife mitigation features in road construction and upgrades in the United States (Forman et. al. 2003). Methods typically include installing wildlife fencing and jump outs in conjunction with a variety of underpasses, overpasses or culverts that animals may use to traverse safely from one side of road to the other (Clevenger et. al. 2001, Forman et.al. 2003,). These structures target a wide variety of species depending on the size of the structure, ranging from amphibians, reptiles and small mammals to large ungulates and carnivores (Forman et. al. 2003) While many of these structures are effective in reducing road kill they can be very expensive, costing millions of dollars for a wildlife overpass. In some instances, the cost of mitigation can be lessened by incorporating the structures into planned upgrades and rebuilds of roads already scheduled by departments of transportation.

In 2001, the Craighead Environmental Research Institute (CERI) began the Bozeman Pass Wildlife Linkage and Highway Safety study to identify accurate road kill locations and actual wildlife movement along Interstate 90 (I-90) between Bozeman and Livingston Montana. Analysis from that project, highlighted areas of higher than average road kill within the study area near Bozeman and other areas closer to Livingston. One of these areas of high road kill was in the vicinity of the Montana Rail Link (MRL) bridge that was scheduled to be rebuilt in 2005. From this data, the Montana Department of Transportation (MDT) incorporated wildlife fencing into its bridge replacement plans. In 2003, MDT and the Western Transportation Institute (WTI) contracted with CERI to monitor the pre- and post-mitigation data that would be used to comparatively assess the effect of the mitigation (wildlife fencing, jump-outs and cattle guards) on AVC and wildlife movements from one side of the highway to another after the MRL bridge was rebuilt. The post fencing mitigation study area was limited to the area between Bozeman and Jackson Creek (milepost 309.5- 319.0). Road kill data continued to be collected throughout the entire study area to identify other areas that may serve as mitigation sites in the future.

THE STUDY AREA

Bozeman Pass on I-90 is located in southcentral Montana approximately 88 km (55 miles) north of Yellowstone National Park. The study area in and around Bozeman Pass encompasses approximately 908 km^2 and includes the cities of Bozeman and Livingston . Interstate 90 bisects the area between Bozeman on the western edge and Livingston on the eastern edge. The Montana Rail Link line runs parallel to the freeway crossing underneath at milepost 321 and 314. A frontage road also runs parallel to the freeway for a portion of that distance. The distance between Bozeman and Livingston is approximately 33.6 km (21 miles). The highway supports 8,000-12,000 daily vehicles during the winter and 10,000 to 15,000 daily vehicles during the summer. Railway traffic through this area is also a factor, with approximately 30 trains using the tracks daily, moving through the MRL underpass at approximately 48 kph (30 mph) (Dewey Lonnes, personal comm.). Figure 1.

Bozeman Pass is surrounded by a mosaic of residential, agricultural and public lands. The landscape varies from shrub-grassland communities near Bozeman and Livingston to coniferous forests in the middle section of Bozeman pass. Elevation varies from 1398 meters at its low point near Livingston to 1733 meters at the top of the pass.

Bozeman Pass supports a large amount of wildlife habitat on both public and private lands and serves as a wildlife connectivity link between the Gallatin and Absorka mountain ranges in the south and the Bridger and Bangtail Mountains in the north. The wildlife habitat in the area is somewhat fragmented by human development and transportation routes. Regionally, Bozeman Pass has been identified as an important wildlife corridor connecting wildlife habitat in the Greater Yellowstone Ecosystem in the south, through the Bridger and Big Belt Mountains, to the Northern Continental Divide Ecosystem in the north (Craighead et. al. 2001, Hardy et.al. 2006, Walker and Craighead 1997, Reudiger et. al. 1999). Interstate 90 is the most significant barrier to wildlife movement in the area and in the region.

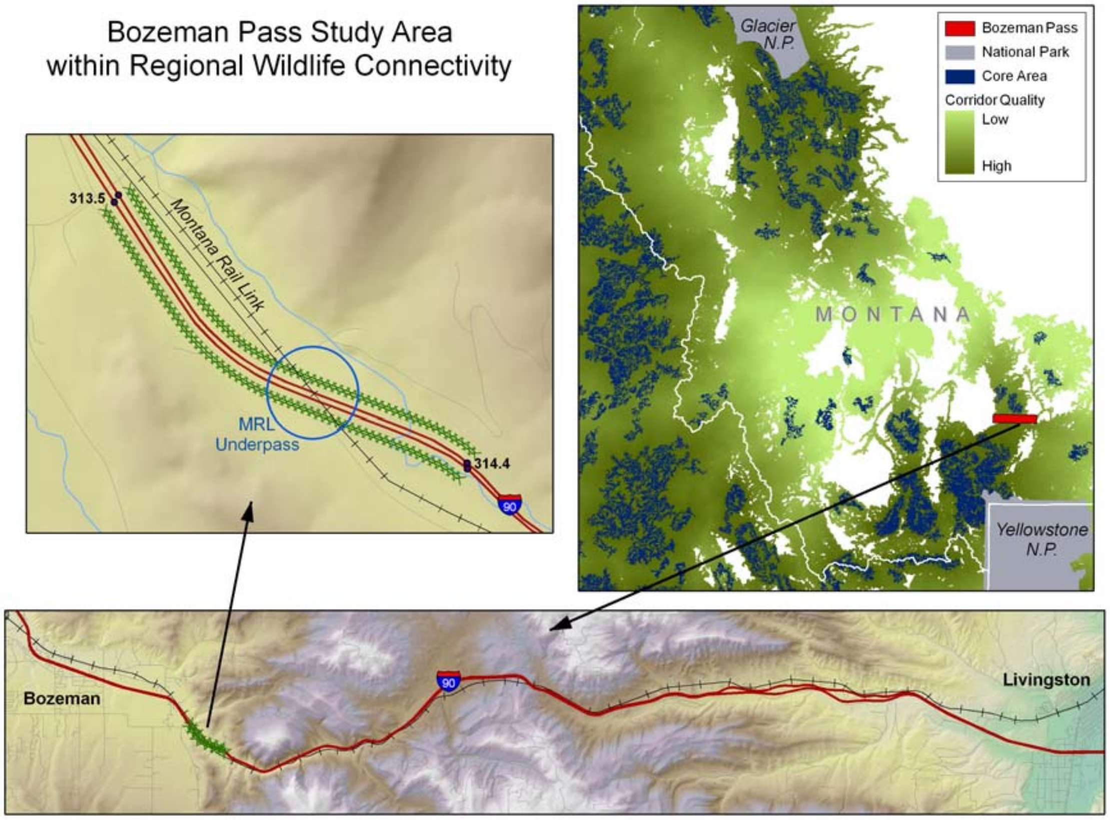

Figure 1. Bozeman Pass Study area

This area is rich in wildlife including: black bears (*Ursus americanus*), mountain lion (*Puma concolor*), bobcat (*Felis rufus*), elk (*Cervus elephas*), moose (*Alces alces*), mule deer (*Odocoileus hemionus*) and white-tailed deer (*O. virginianus*), red fox (*Vulpes vulpes*), coyote (*Canis latrans*) and a variety of smaller mammals, reptiles, and a diversity of bird species. Many of these species utilize this area on their seasonal and daily migration movements. Grizzly bears (*Ursus arctos horribilis*) are occasionally seen in the area but none have been documented crossing I-90 or recorded as road-kill.

The MRL bridge is located approximately at milepost 314.1 and spans the railroad and access right-of-ways underneath Interstate 90. After the bridge was rebuilt in 2005-2006 wildlife mitigation measures were installed, specifically wildlife fencing, jump outs, Texas or cattle guards and improved grading underneath the bridge to enhance wildlife movement. Wildlife exclusion fencing (1.2 meter (8 ft.) high) was installed along 1.44 km (.9 mile) of I-90, extending east and west from the bridge that crosses over the MRL railroad. The wildlife fencing is located between milepost 313.5-314.4 along both east and west bound lanes. Four jump outs were installed within the fenced areas to allow animals that became trapped on the freeway a place to 'jump out' to safety. These are constructed so that animals can jump away (exit) from the roadway but cannot walk back up onto the roadway (one-way). To discourage animals from making “end runs” around the end of the fences, modifications were made to include cattle guards and modified fence ends. Two sets of double cattle guards or Texas guards were installed at the western termini of the fence at the Bear Canyon interchange access ramps. These were installed to deter animals from walking to the end of the fence and then walking up the on-ramp to the freeway. The eastern wildlife fence ends encompass a large double culvert and a steep embankment before tying into the traditional barbed wire fence that runs the length of the right-of-way.

METHODS

Road kill data methods

Road-kill data collection began in 2001. Biologists at CERI and volunteers drove along Interstate 90 over Bozeman Pass between Bozeman and Livingston and recorded the date, location (to the closest 1/10th mile using mile markers), and species of road-kills observed. Sex was recorded for carnivores and ungulates if possible. Volunteers usually traveled Bozeman Pass during the five weekdays on their way to work, and CERI personnel drove the pass during the weekend in search of road-kills. Interesting or unusual road-kills were further investigated by CERI personnel. This survey methodology continued through 2002. A more standardized survey method began in 2003, with CERI personnel driving Interstate 90 between Bozeman and Livingston three times a week to collect road kill data. Driver speed for CERI personnel was kept between 88-105 kph (55-65 mph) during the surveys. Thru June 30, 2009, the pass has been surveyed 1066 times representing 80,631 km (50,102 miles) between milepost 309.5- 333.0. It is also important to note that many more animals are killed then ever get recorded; animals get hit and then die some distance from the roadway, people pick up road kill for personal uses and road kill become obscured by vegetation or topographical features. In some cases scavengers such as coyotes will drag carcasses away from the roadside. Road kill data from CERI and other agencies only represent an index of the actual number of animals hit. Data collection will continue until June 30, 2011 in accordance with the MDT contract.

Searches of agency records provided additional wildlife collision data. Road kill data were obtained from a variety of sources including Montana Fish Wildlife and Parks (MFWP) and Montana Department of Transportation (MDT). Typically, MDT removes dead animals from the right-of-way if the animal poses a threat to driver safety. These animals are usually picked very early in the morning before CERI personnel were able to record them. Species that fall into this category typically include moose, elk, deer and other large animals and are removed promptly. However not all species are picked up promptly and carcasses will lie on the side of the road for a period of days or weeks. Some carcasses are never picked up. Supplemental data from MDT Maintenance reports that were included in this project are: carnivores, moose and elk. Deer species (mule and white-tailed) from MDT maintenance records were not included due to the difficulty in trying to reconcile duplicate records. Accurate records contain the date, location and any other pertinent information such as sex of the animal. These data were also entered into the GIS database.

Track bed survey methods

To determine the number and species of animals crossing underneath the bridge, a sand track bed was constructed on the north side of the railroad tracks underneath the MRL bridge. The track bed is approximately 46 meters (150 ft) long and is 2.5 meters (8 ft) wide. Due to the configuration of the freeway and railroad passing beneath it, the track bed covers approximately two-thirds the width of the passage. Since it was not possible to census the entire area for animal movements, the track bed observations provide an index of crossing activity.

Track bed surveys began in October, 2003 and continued through April, 2005 when bridge reconstruction began. During the construction phase, equipment, materials and fill were present at the track bed site making it impossible to maintain and monitor the track bed until construction was completed. Accordingly, the track bed was rebuilt in the fall of 2006. However the fencing was not completed until the spring of 2007. Post-fencing track bed monitoring therefore commenced in May 2007.

Before construction the track bed was counted and then raked every 3-4 days on average. The number of tracks counted was then divided by the number of collection days to provide a count of tracks per day. Post-construction, an alternate method was used: surveys were conducted 4 consecutive days every other week; the bed was completely raked at the beginning of the week and then counted and raked every day for the next four days to provide a count of tracks per day. This was done to avoid any confusion due to large numbers of tracks after multiple days of collection (Hardy et. al. 2006). Due to the difficulties in conducting surveys in the winter with tracks being frozen and weather events confounding track identification, surveys were conducted between May 1- October 31, 2007 through the present.

Jump-out monitoring methods

Initially the jump-outs were monitored using small track beds constructed at the top of the jump-out and supplemented with trailmaster motion-sensor counters. The counters soon proved unreliable and were replaced with RECONYX motion-sensor cameras. Jump-out track beds were surveyed in conjunction with the main track bed survey (May 1- October 31). Jump-out cameras were downloaded periodically and batteries were replaced as needed.

Remote camera monitoring methods

Before construction, cameras were placed in culverts at MP 314.6, MP314.8 and MP315. Photo-monitoring was initiated in 1998. The eastern culvert at mile marker 314.6 was monitored from February 19, 1998 until January 23, 2005. The western culvert at mile marker 314.6 was monitored from January 1, 1998 until July 22, 2004. The eastern culvert at mile marker 314.8 was monitored from January 14, 2002 until November 21, 2005, but the western culvert was not monitored because it was full of deep, fast-moving water. The western culvert at mile marker 315 was monitored from July 21, 2003 until July 17, 2005. The eastern culvert was not monitored because it was full of deep, fast-moving water The MP315 culvert had a camera stolen in July 2004, whereupon a new camera was hidden outside the culvert, after which it did not work as well. On August 17, 2004, a camera was added below the Montana Rail Link bridge, where it was maintained until May 4, 2005. Trailmaster cameras were used with both passive IR beam or active IR beam triggers. A trial camera was also placed at the track bed to attempt to duplicate the results of track bed counts. Cameras were operated continually until the camera at MP 315 was stolen. At that point the other cameras were removed although a second camera at MP 314.6 in the easternmost culvert was also stolen before we could remove it.

After construction RECONYX digital motion-sensor cameras were used. Cameras were placed at the eastern fence ends attached to the guardrail with security boxes. At the western fence end a single camera was attached to the bridge supports at the county road underpass. Cameras were deployed in the culverts at MP 314.5 where they were attached to the ceiling of the culvert and secured with locking cables.

Cameras were maintained for constant monitoring. They were downloaded periodically and batteries were replaced as needed. In the case of the culvert cameras, maintenence could not be done during the periods of high water in spring runoff; however batteries were usually replaced just prior to high water so that they operated throughout.

ANALYSES

Road kill

Power analyses were applied to the pre-fencing Ungulate-Vehicle Collision (UVC) data to determine what degree of change in UVC rates would be statistically detectable when comparing rates before and after the mitigation fences were installed (Hardy et. al. 2006). Results from the power analyses (power = .8; a = 0.05) indicated a three to five year post-fencing study would be sufficient to allow quantitative comparisons to be made (Hardy et. al. 2006). The post construction monitoring period will include three years of data collection thru June 30, 2010. Data for this paper include road kill numbers thru June 30, 2009.

Research has indicated that while wildlife fencing decreases ungulate mortality within fenced areas, a majority of animals tend to get killed at the fence ends (Clevenger et. al. 2001). To accommodate this end run effect, a buffer of 0.2 miles (322 meters) of additional roadway were added to the analysis area considered as the fenced area (Hardy et. al. 2006). All data representing the fenced area thus includes the actual fenced section plus the buffered area (fence/buff).

Pre-fencing

Pre-mitigation data indicated that UVC rates were significantly higher within the proposed mitigation zone then elsewhere along the highway using 2001-2004 data (Hardy et. al. 2006). We further refined the analysis by including all pre-mitigation UVC data (2001- April 4, 2005) and compared UVC rates inside the proposed fence/buff area to those outside the fence/buff area.

Interim

Due to the longevity of this project, UVC numbers were broken into three separate categories within the mitigation zone; pre construction included 1544 days, interim (MRL bridge reconstruction and wildlife fencing installation) 819 days, and post construction 726 days (thru June 30, 2009). During the interim period, traffic patterns were restricted to two-lanes and speeds were reduced to 56 kph (35 mph). Recorded UVC numbers dropped sharply. To determine if the disruption and changes in traffic were affecting UVC rates, we ran a comparison of pre-fencing and interim UVC means both inside and outside the fence/buff zone. If there was a significant difference in UVC means then the data for the interim period would be omitted from further analysis.

Post-fencing

To determine what effect the fenced area was having on UVC within the mitigation zone, we ran a series of two- and one-tailed t-tests on UVC means both spatially and temporally. Spatial data were examined to see if the fencing was having an effect on UVC inside and outside of the fence. Temporal data were examined to see if UVC rates were different pre- and post-fencing. After the fencing was completed, we wanted to investigate these three research questions:

1) Did UVC rates significantly decrease within the fence/buff zone during the post-fence period compared with the pre-fence period.
2) Did UVC rates outside the fence/buff zone differ pre- and post-fencing.
3) Are UVC rates in the fence/buff zone different from those rates outside the fenced area during the post-fencing period.

To address these questions, we tested these three null hypotheses.

1) UVC rates post fencing in the fence/buff zone did not differ from those pre-fencing.
2) UVC rates outside the fence/buff zone did not differ pre- and post-fencing.
3) Post fencing, UVC rates in the fence/buff zone did not differ from those outside the fence/buff zone.

Track bed

In addition to reducing mortality caused by the highway, the mitigation project intended to ensure connectivity or passage across the highway corridor, allowing local and regional migration movement to continue. To test this, we analyzed the tracks per day observed in the track bed data to see if use had increased after fence installation. Track bed data were broken down into pre- and post-mitigation periods. Since the survey methods were slightly different between the pre- and post-fencing periods, only those data collected in a single 24 hour period were used to compare the pre-and post fencing means.

Fence ends, jump outs and Camera Data

Data for the fence ends and jump outs using remote cameras has only been collected during the post fencing period and will be summarized for animals in the vicinity of the fence ends and jump outs. There are hundreds of photos from remote cameras at the culverts at mile post 314.6

but due differences in camera type and survey effort we were not able to compare pre-and post-fencing images with any statistical confidence. The culvert photos are useful as an index of animals using the culverts. Species and numbers of animals utilizing these different areas are summarized in the results section.

Track bed data for jump outs

Track bed data for jump outs were only collected post fencing. Currently the numbers of animals utilizing the jump outs is limited. With another year of data collection, jump out data will provide additional information regarding animals attempting to exit the freeway. A list of species and numbers of tracks are summarized in the results section.

RESULTS

Since 2001, 1,997 animals, representing 49 different species of mammals, birds and reptiles, have been recorded as road kill on Bozeman Pass between Bozeman and Livingston, Montana. Table 1. The majority of animals killed were ungulates (45%, 901 animals), followed by small mammals (33%, 648 animals), birds (9.6%, 191 animals), carnivores (6.7%, 135 animals) and domestics and unknown (5.3%, 107 animals).

Table 1. Total number of road kills recorded between milepost 309.5-330.0 from January 01, 2001 thru June 30, 2009

SPECIES	TOTALS
Badger	**11**
Beaver	**9**
Bird (Other)[1]	**129**
Bird (Owl)[2]	**49**
Bird (Raptor)[3]	**13**
Black Bear	**25**
Bobcat	**4**
Cat (Domestic)	**35**
Coyote	**60**
Deer (Mule)	**181**
Deer (Unk)	**273**
Deer (Whitetail)	**389**
Dog (Domestic)	**4**
Elk	**49**
Fox	**23**
Marmot	**19**
Mink	**3**
Moose	**9**
Mountain Lion	**5**
Pine Marten	**1**
Porcupine	**35**
Raccoon	**174**
Skunk	**273**
Small Mammal[4]	**147**

Snake	**5**
Unidentifiable	**68**
Weasel	**3**
Wolf	**1**
TOTALS	**1997**

[1] Includes pheasant, Hungarian partridge, grouse, turkey, goose, duck, heron, raven, crow, magpie, cowbird, robin, pigeon, meadowlark, towhee, tanager, and unknown.

[2] Includes great horned, long-eared, and unknown species.

[3] Includes red-tailed hawk and northern harrier.

[4] Includes rabbit, ground squirrels, and gopher.

UVC totals across the entire study area fluctuate yearly over the span of the study with a peak in 2003 and a low in 2006. (Figure 2). Seasonally, the highest number of ungulates were killed in the fall (October) followed by a smaller summer peak (June). Winter tends to have much fewer road kills (Figure 3).

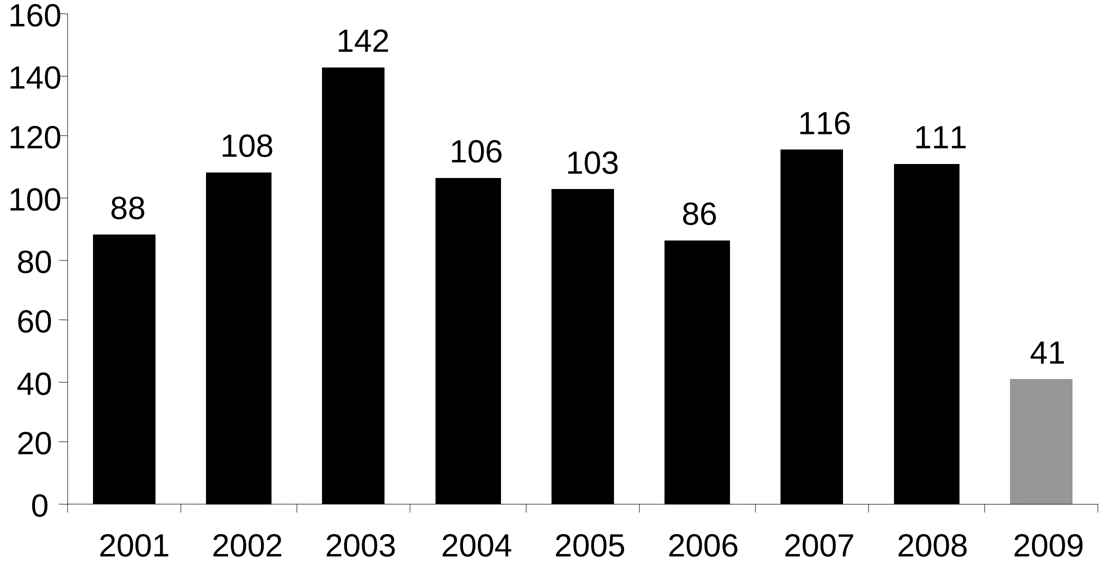

Figure 2. UVC by year (milepost 309.5-333.0) January, 2001- June 30, 2009.

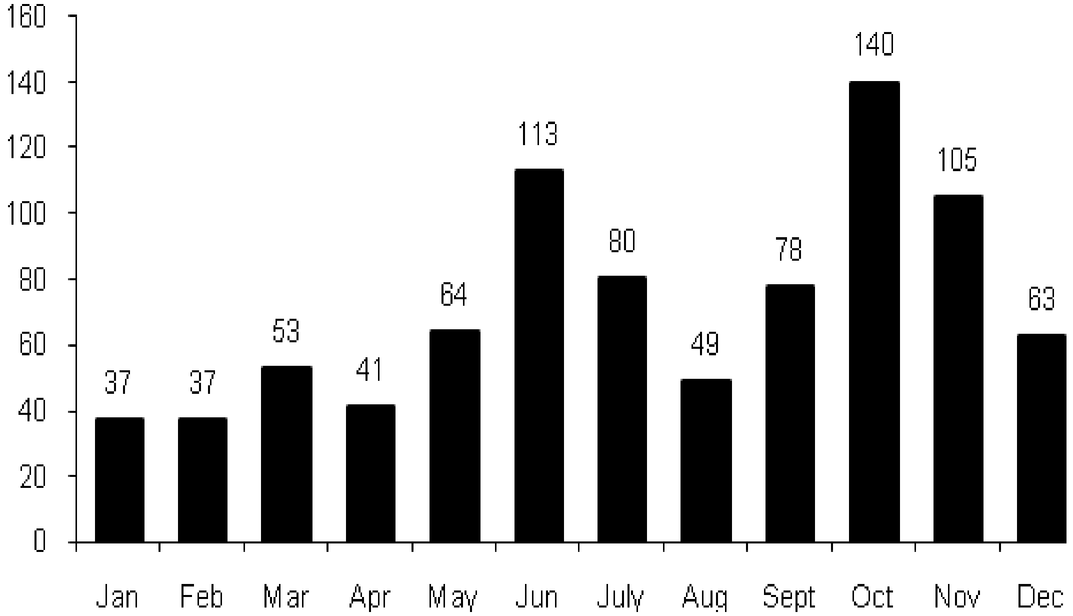

Figure 3. UVCs by month (milepost 309.5-333.0) January, 2001-December 31, 2008

Pre-fencing
Within the mitigation zone, there were significantly more UVCs within the proposed fence/buff area compared with the area outside (data set January 1, 2001-April 3, 2005; two-tailed T-test, P<.00). This finding justifies the placement of the mitigation fencing on this stretch of highway.

Interim
During the interim period of construction and fencing, UVC rates were greatly reduced in the mitigation zone due to lower traffic speeds and two-lane traffic patterns (Table 3). The reduction in mean number of UVCs was significant between the pre-fencing and the interim period both inside and outside the fence/buff zone (paired t-test, P < .01 (outside), P < .02 (inside)). All interim data were therefore omitted from further analyses.

Table 3. UVCs in mitigation zone calculated as UVC per mile per year

Stretch	Pre	Interim	Post
Fence/buff	10.9	3.8	4.3
Outside	6.9	4.8	7.4

Post-fencing
We found that the mitigation fencing significantly reduced the overall UVC rates in the fence/buff area from the pre- to post-fencing period (one-tailed t-test, P<.02). In the two years of post monitoring, UVC rates were reduced from pre-fencing high of 49 animals in the fenced area alone to only 5 animals in the fenced area. Three of the five animals killed in the fenced area

were killed at the fence ends. Figure 4. Additionally, the fencing had no significant effect on the UVC rates outside the fence/buff area (two-tailed t-test, P<.59). Finally, we found that post-fencing UVC rates within the fence/buff area were still higher than outside the fence/buff area within the mitigation zone, however the difference might be considered only marginally significant (two-tailed t-test, P>.11). There was no evidence of increased mortality at the fence ends however this is preliminary data and another full year of data collection may result in different conclusions.

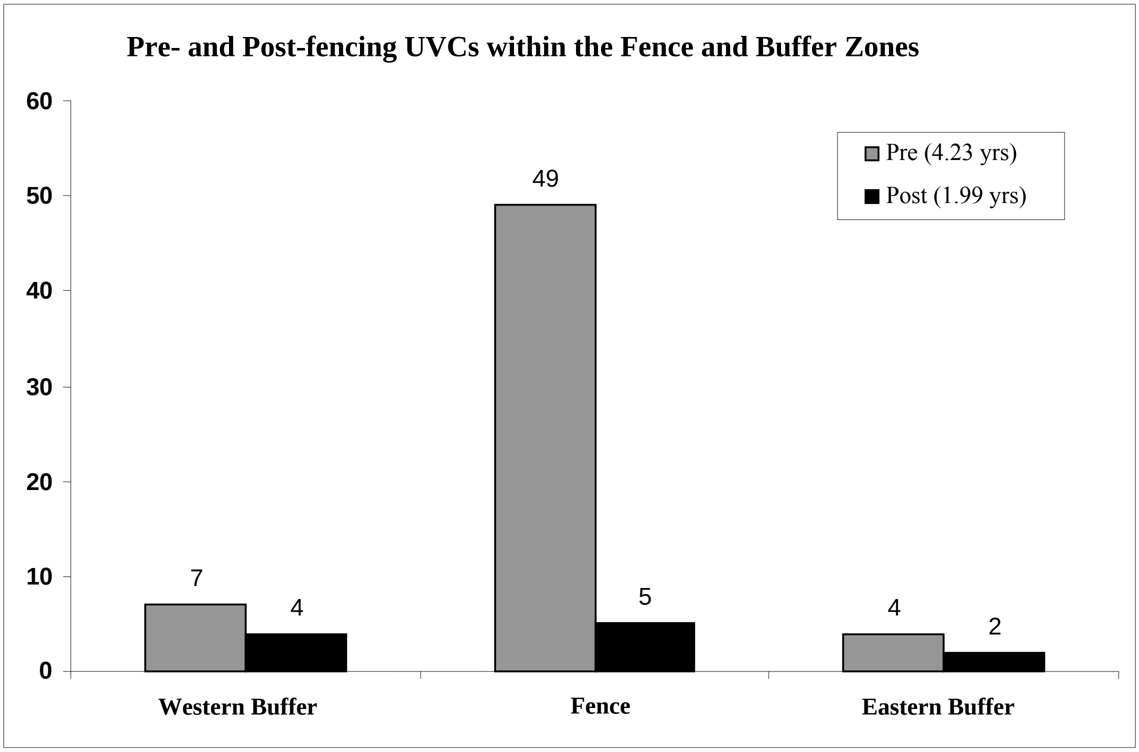

Figure 4. Pre- and post-fencing UVC's within the fence and buffer zone

Track Bed

After the mitigation fencing was installed, we found the number of daily ungulate crossings underneath the MRL bridge had significantly increased (two-tailed t-test, P< .01). This, along with the significant reduction in UVCs within the fence/buff area, indicates that this mitigation strategy is beneficial to ungulates in reducing road kill while maintaining connectivity of habitat.

Remote camera data for fence ends and jump outs and culverts

Post fencing data indicated that animals are reliably being photographed in the vicinity of the fence ends and jump outs. These monitoring techniques are limited in determining if animals successfully cross the freeway. Table 4. Preliminary data indicate that some mammals are trying to cross at the fence ends. In a few instances, animals are successful in finding and using the jump outs.

The majority of photos taken were birds including, magpies, ravens, crows and robins which tended to flock near the jump outs. A variety of other mammals were photographed at the fence ends or in the vicinity of the jump outs.

Table 4. Animal occurrences near fence ends and jump outs (January 1, 08 -March 30, 09) using remote cameras.

Species	Fence Ends	Jump outs			
		NE	NW	SE	SW
Birds	7	72	10	19	0
Deer	9	1	1	2	0
Coyotes	4	4	0	0	0
Marmot	1	0	0	0	0
Raccoons	0	7	0	4	0
Rabbits	3	2	0	6	0
Skunk	1	1	0	0	0
Weasel	1	0	0	0	0
Black Bear	0	1	0	1	0
Human	2	1	0	2	1
Total	28	89	11	34	1

Pre-and post fencing photograph comparisons in the culverts are not applicable in this study. However, preliminary data show that the same suite of species are utilizing the culverts to pass underneath the freeway. Animals associated with aquatic habitats tend to use the culverts more than other animals with the exception of the black bear. Table 5. The data also indicate that the eastern culvert (which has little or no water most times of the year) is used more heavily than the western culvert (which contains about 2 feet of water usually).

Table 5. Remote Camera Occurrences in Culverts (milepost 314.6)

	Pre-fencing		Post fencing	
Species	314.6 E	316.4 W	314.6 E	314.6 W
Beaver	5	0	2	0
Birds	9	0	7	0
Black bear	0	1	1	3
Domestic Dog	4	2	0	0
Duck	0	1	0	0
Frog	0	1	0	0
Mink	0	0	6	0
Mustelid	7	0	0	0
Nest	3	0	0	0
Raccoon	82	1	49	5
Unknown animal	4	0	0	0
Dipper	0	0	10	0
Human	8	0	3	2
Total	122	6	78	10

Track bed data for jump outs

Table 6. Track bed data for survey period (Aug. 2, 07 –June 20, 09)

	Jump outs			
Species	NE	NW	SE	SW
Black Bear	1	0	0	0
Cat (domestic)	0	1	2	1
Canid	2	0	2	0
Deer	1	1	2	0
Marmot	9	1	5	0
Rabbits	2	0	2	0
Small mammal	1	1	0	0
Snake	1	1	0	0
Total	17	5	13	1

During the post fencing monitoring period, there have been a total of 36 different tracks recorded representing a variety of mammals and reptiles at the jump outs. The majority of tracks have occurred at the NE and SE jump outs. We have found marmots living in the vicinity of the jump outs and using them as a latrine site, which over represents their presence.

DISCUSSION

Our preliminary findings indicate that the installation of wildlife fencing and jump outs has significantly reduced UVC's in the fence/buff area near the MRL bridge. Additional monitoring of the track bed underneath the bridge has shown an increased use by ungulates indicating the effectiveness of fencing in funneling animals away from the freeway and maintaining habitat connectivity. Over time, the area underneath the bridge may see increased use as animals discover it and become more accustomed to using it. Animals still try to cross at the fence ends as road kill data and photo monitoring document but our data do not indicate a significant increase of road kills at the fence ends. Data also indicate that animals are occasionally utilizing the jump outs as an effective means of exiting the freeway. Culvert monitoring has documented the long term use of a variety of animals and people utilizing the culvert as a means to cross underneath the freeway safely.

During the post-fencing monitoring period, there has been a total of five UVC's in the fenced area (2 within the fence, 3 at the fence ends). With another year of data collection, those numbers will change but the overall effectiveness of the fencing is clearly a benefit to animals and drivers. At this time, there has not been an overall increase in UVC's at the fence/buff zone.

While overall UVC rates are slightly higher within the fence/buff area than outside, some of those findings may be attributed to the overall distribution of ungulates in the vicinity of the MRL bridge. Initial analysis documented high UVC's towards the western edge of the fenced area and points further west. Therefore, the fencing seems to be only straddling this hotspot; not completely covering it. In the future, if the fence could be extended to the west then UVC rates inside the fence/buff area may be comparable with outside fence/buff area. Areas to the west and east already contain culverts that could be utilized by animals to cross if fencing were extended and ended at these culverts. The length of the fence could be effectively increased by installing a test section of electric fencing that continues eastward from the east end of the current fence. This electric fence could also tie into two more sets of culverts underneath the highway and thus deflect animals away from the highway and through the culverts. At the northeast end of the electric fencing it could tie into a steep hillside where end-runs of the fence would be minimal. At the southeast end it could stop in a section where the opposite side of the highway is steep hillside and cliff which would help discourage animals from attempting to cross there. Fence ends could be blocked more effectively with the use of an electrified mat that extends from one fence end to the other across the shoulders and the highway surface (East end of fencing project).

The Bozeman Pass project highlights the effectiveness of reducing UVC through wildlife mitigation strategies such as wildlife fencing, jump outs and modified earthwork. This suggests that fencing projects alone can be added to help direct animals through existing structures. It also highlights the need for innovative monitoring techniques pre- and post-mitigation to provide quantitative measures of effectiveness.

Costs for this project were much lower than new wildlife crossing structures since the fencing was added on to a structure replacement project for an existing underpass. While the cost of these mitigation techniques is not inexpensive, working with transportation managers and planners before planned rebuilds/upgrades can lessen the cost substantially. The cost of the planned MRL bridge rebuild in 2005-2006 was approximately six to eight million dollars (Deb Wambach, pers. comm.). The cost of the wildlife fencing and jump outs was approximately $100,000 which increased the cost of the re-build by only about 1.25%. While that may seem like a large expense, it is only a fraction of the cost that insurance companies pay out yearly for reported UVC. Taking into account the average cost of repairs to drivers of an ungulate collision ($6,000-$8,000), the costs of injury treatment, the indirect costs of accidents to police and medical personnel, and the ecological costs of highway barriers to wildlife populations, the overall benefits to society have already begun to be realized.

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