US 93 Post-Construction Wildlife-Vehicle Collision and Wildlife Crossing Monitoring and Research on the Flathead Indian Reservation between Evaro and Polson, Montana

Annual Report 2010

by

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EXECUTIVE SUMMARY

This first annual report contains a preliminary summary for work conducted in 2007-2009 and related to the US 93 wildlife mitigation evaluation project. The mitigation measures along US 93 consist of wildlife fencing combined with wildlife underpasses and overpasses, jump-outs, and wildlife guards at access roads. The research objectives relate to investigating the effect of the mitigation measures on human safety (an expected reduction in wildlife-vehicle collisions), habitat connectivity for wildlife (wildlife use of the crossing structures), and a cost-benefit analysis for the mitigation measures which will be conducted in the following years.

At first glance the carcass removal and crash data suggest a 47-58% decline in the number of large mammal carcasses and the number of animal-vehicle crashes after the mitigation measures were implemented. In addition, the number of reported large mammal carcasses for the entire road section between Evaro and Polson dropped substantially in 2008 and 2009, perhaps suggesting effective mitigation measures. However, a closer review of the data, including reviewing data for unmitigated road sections, crash data and deer pellet group counts, suggested that the reduction is definitely not only the result of the implementation of the mitigation measures but likely partially caused by a reduced search and reporting effort for large mammal carcasses on and along US 93. Nonetheless, the crash data seems to have had consistent search and reporting efforts and these data do suggest that the number of crashes with large wild mammals was reduced by about 47% in the mitigated road sections of Ravalli Curves and Ravalli Hill combined. In the meantime data forms have been located at MDT maintenance offices that had not been entered in the database. At this time, it is unclear if the recovered data fully explains the patterns in the data or whether there may still be an indication of reduced search and reporting effort for animal carcasses in 2008 and 2009.

The wildlife crossing structures in Ravalli Curves and Ravalli Hill appear to receive substantial use by a wide variety of wildlife species, especially deer and coyotes. Humans and domestic species including cats, dogs, and horses also use the structures. Bobcats, raccoons, and black bears have been observed frequently using the structures. While wildlife use of the structures can be considered substantial, the term “success” is specifically defined based on consensus between MDT, CSKT and FHWA. Thus whether the wildlife crossing structures are considered “successful” or not can only be concluded after more data have been collected and after they have been analyzed in the context of the measures of effectiveness agreed upon by MDT, CSKT, and FHWA. The isolated crossing structures were used by a large variety of wildlife species, sometimes in great numbers. The Post Creek structures seem to be heavily used by white-tailed deer, and it is noteworthy that a grizzly bear was also observed using one of these structures.

Wildlife guards appear to be a substantial barrier to horses and mule deer. They do not appear to be a substantial barrier to coyotes, black bears, and domestic cats. The fact that the wildlife guards appear to be a substantial barrier to mule deer is encouraging and suggests that the wildlife guards largely function as intended.

The wildlife jump-outs have been used by a range of animal species to escape the fenced road corridor. However, relatively few of the individuals, including deer, which are of most concern (from a human safety perspective), jumped down. This suggests that many of the jump-outs in the Ravalli Curves and Ravalli Hills areas may be too high. There appears to be sufficient margin to lower the jump-outs as no species were found to jump up into the fenced road corridor.

1. INTRODUCTION

1.1. Background

The US Highway 93 (US 93) reconstruction project on the Flathead Indian Reservation in northwest Montana represents one of the most extensive wildlife-sensitive highway design efforts in North America. The reconstruction of the 56 mile (90 km) long road section includes the installation of 41 fish- and wildlife crossing structures, 2 underpasses for live-stock, 1 bicycle/pedestrian underpass, and approximately 8.3 miles (13.4 km) of road with wildlife exclusion fencing on both sides (excluding future mitigation measures in the Ninepipes wetland area) (Figures 1, 2, and 3). The mitigation measures are aimed at improving safety for the traveling public through reducing wildlife-vehicle collisions and allowing wildlife to continue to move across the landscape and the road. Other examples of relatively long road sections in North America with a high concentration of wildlife crossing structures and wildlife fencing are I-75 (alligator alley) in south Florida (24 crossing structures over 40 mi; Foster & Humphrey 1995), the Trans-Canada Highway in Banff National Park in Alberta, Canada (24 crossing structures over 28 mi (phase 1, 2 and 3A); Clevenger *et al.* 2002), State Route 260 in Arizona (17 crossing structures over 19 mi; Dodd *et al.* (2006)), and I-90 at Snoqualmie Pass East in Washington State (about 30 crossing structures planned over 15 mi; WSDOT 2007). Both the road length and number of wildlife crossing structures of US 93 on the Flathead Indian Reservation makes it the most extensive mitigation project of its kind in North America to date. If the section of US 93 south (south of Missoula, Bitterroot valley) is included, the mitigation measures along US 93 are even more substantial.

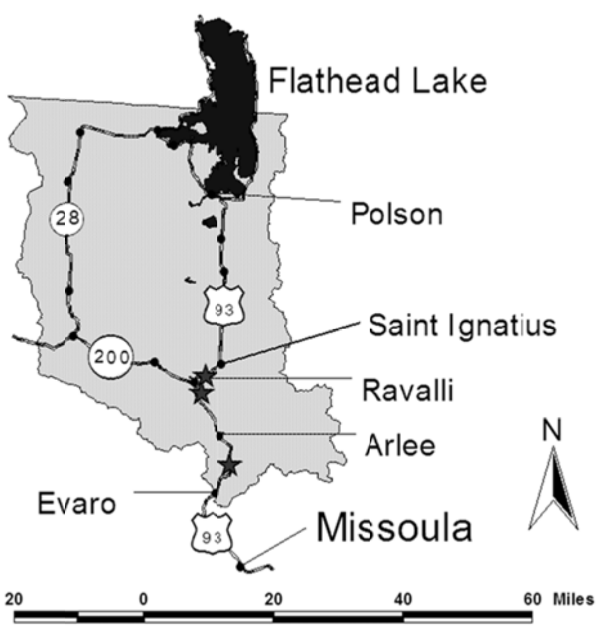

Figure 1: The Flathead Indian Reservation in northwestern Montana including major highway routes. The US 93 reconstruction effort and evaluation study area traverses 56 miles (90 km) from Evaro to Polson including the Evaro, Ravalli Curves, and Ravalli Hill study areas (indicated by stars).

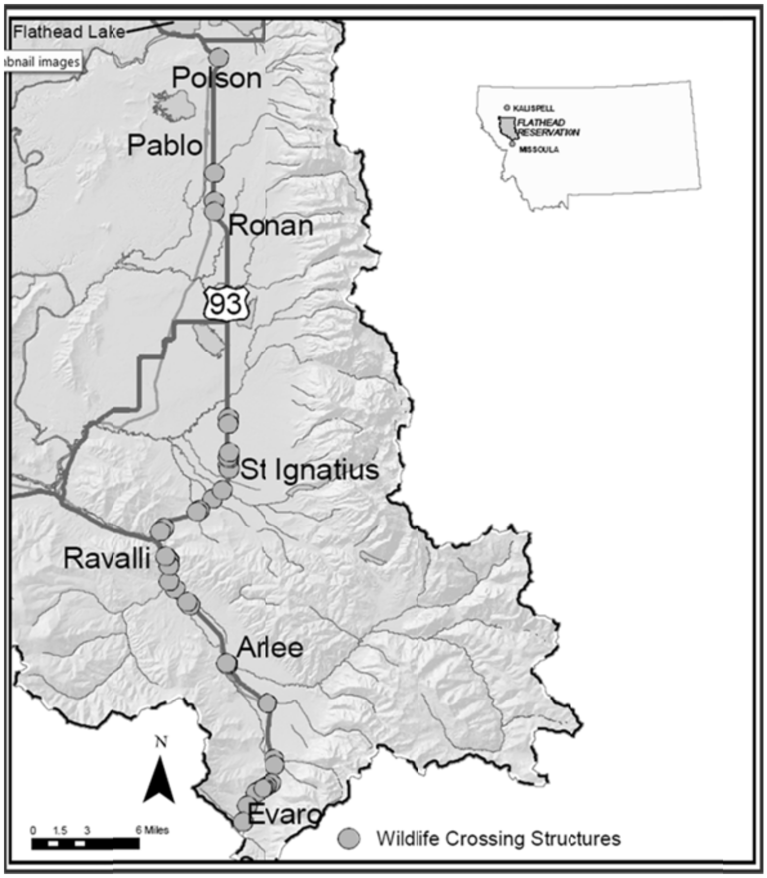

Figure 2: The approximate location of the 41 fish and wildlife crossing structures along US 93 on the Flathead Indian Reservation in northwestern Montana.

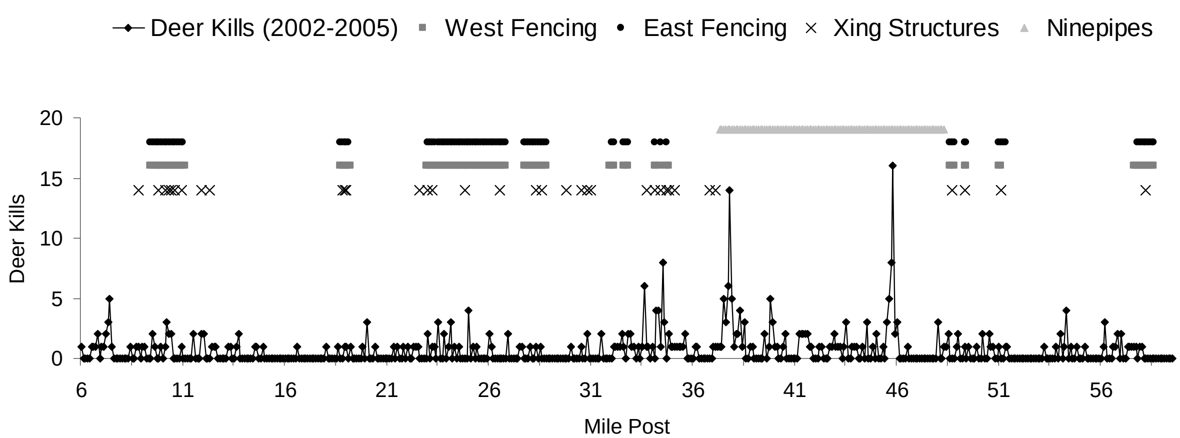

Figure 3: Total reported deer-vehicle collisions over 2002-2005, plotted by 1/10 mile along the US 93 study area, with corresponding mitigation measures across the same area (from Hardy *et al.* 2007).

The magnitude of the US 93 reconstruction project and associated mitigation measures provide an unprecedented opportunity to evaluate to what extent these mitigation measures help improve safety through a reduction in wildlife-vehicle collisions, maintain habitat connectivity for wildlife (especially deer (*Odocoileus* spp.) and black bear (*Ursus americanus*)), and what the monetary costs and benefits are for the mitigation measures. In addition, the landscape along US 93 is heavily influenced by human use. This is in contrast to the more natural vegetation along most of the other road sections that have large scale wildlife mitigation in North America. As the roads with most wildlife-vehicle collisions are in rural areas, the results from the US 93 project are expected to be of great interest to agencies throughout North America (Huijser *et al.* 2008).

In 2002, prior to US 93's reconstruction, the Western Transportation Institute at Montana State University-Bozeman (WTI-MSU) was funded by the Federal Highway Administration (FHWA) and the Montana Department of Transportation (MDT) to initiate a before-after field study to assess the effectiveness of the wildlife mitigation measures and to document events and decisions that shaped the process of planning and designing the mitigation measures. Preconstruction field data collection efforts were completed in the fall of 2005 and a final report on the preconstruction monitoring findings was published in January 2007 (Hardy *et al.* 2007). While the preconstruction monitoring and research efforts (Hardy *et al.* 2007) are valuable on their own, their main purpose is to provide a reference for a before-after comparison with the post-construction data.

In 2010 MDT contracted with WTI-MSU to conduct the post-construction research with regard to the effectiveness of the mitigation measures. For this project, the Confederated Salish and Kootenai Tribes (CSKT) act as a subcontractor to WTI-MSU.

1.2. Objectives

Consistent with the direction provided by MDT, the project has the following objectives:

- Investigate the effect of the mitigation measures on human safety through an anticipated reduction in wildlife-vehicle collisions;
- Investigate the effect of the mitigation measures on the ability to maintaining habitat connectivity for wildlife (especially for deer (white-tailed deer [*Odocoileus virginianus*] and mule deer [*Odocoileus hemionus*] combined) and black bear (*Ursus americanus*) through the use of the wildlife crossing structures; and
- Conduct cost-benefit analyses for the mitigation measures.

This document is the first in a series of annual reports detailing the progress on these tasks.

1.3. Post-Construction Research Activities Prior to 2010

CSKT and WTI-MSU conducted post-construction research prior to being contracted by MDT in 2010. A substantial part of the WTI-MSU efforts was made possible through a fellowship for Tiffany Allen, allowing her to pursue her M.Sc. degree at MSU. This first annual report summarizes the activities and results of these activities through December 2009.

2. MITIGATION MEASURES AND HUMAN SAFETY

2.1. 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 & Associates Inc. 2003, Huijser *et al.* 2008). These numbers have increased even further over the last decade (Tardif & Associates Inc. 2003, Huijser *et al.* 2008). 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.* 2008). In addition, some species also represent a monetary value that is lost once an individual animal dies (Romin and Bissonette 1996, Conover 1997).

While this chapter focuses on the reduction of collisions with large ungulates, this group is not necessarily the most abundant or the most important species group hit by vehicles. Large mammals (e.g. deer size and larger) receive most attention because of the following reasons:

- A collision with a large mammal can result in substantial vehicle damage and poses a threat to human safety;
- Large mammal carcasses on or adjacent to the road pose a safety hazard on their own as they can cause drivers to undertake evasive maneuvers, be a general distraction to drivers, and become an attractant to potential scavengers (e.g. bears and eagles) which may then be hit by vehicles also, resulting in multiple road-killed animals and species at a location; and
- Some large mammal species are threatened, endangered or considered charismatic.

The preconstruction research along US 93 found that deer (white-tailed deer [*Odocoileus virginianus*] and mule deer [*Odocoileus hemionus*] combined) were by far the most frequently recorded species group (Hardy *et al.* 2007). However, rare, threatened or endangered species may be removed illegally before agency personnel was able to record them, and small and medium sized species such as coyote and smaller are rarely reported. It is notable though that the western painted turtle is frequently hit by vehicles in the Ninepipes area (Griffin 2007).

This chapter focuses on the potential reduction in wildlife-vehicle collisions along US 93 as a result of the implementation of the mitigation measures described in Chapter 1. The results, discussion, and conclusion should all be considered preliminary as the final results will not be available until 2015. Previous research has shown that wildlife fencing in combination with wildlife under- and overpasses can reduce collisions with large wild ungulates by 79-97% (Reed *et al.* 1982, Ward 1982, Woods 1990, Clevenger *et al.* 2001, Dodd *et al.* 2007). However, specific measures of effectiveness (paramters and thresholds) were determined based on consensus by MDT, CSKT, and FHWA (Huijser *et al.* 2009).

2.2. Methods

2.2.1. Crash and Carcass Data

Crash report data and carcass removal data were obtained from MDT. The crash data ranged from 1 January 1998 through 31 December 2009, and the carcass removal data ranged from 1 January 2002 through 31 December 2009. The crash data selected for this analysis involve all crashes where the first or most harmful event involves animals. Note that neither the crash nor the carcass removal data are believed to include all crashes that occur or carcasses that are present (Huijser *et al.* 2007). There are thresholds for crash data (e.g. at least $1,000 in vehicle repair costs), carcasses of small or medium sized species (e.g. coyote [*Canis latrans*] and smaller) are not removed, and carcasses of larger species that are not on the actual road surface and not highly visible to drivers in the right-of-way are also not removed and remain unrecorded. However, both data sets can be very useful for the US 93 monitoring and research project as long as their search and reporting efforts are consistent. For example, it is not necessary to record all animal-vehicle collisions to detect potential changes in the number of collisions, as long as the search and reporting effort remains consistent.

For the purpose of this report the researchers did not combine the crash data and the carcass removal data. Instead, the researchers used the two separate data sets to investigate potential patterns in the individual data sets. Currently these efforts are mostly targeted at evaluating the data collection processes rather than conducting final analyses with regard to a potential reduction in wildlife-vehicle collisions. However, we do provide a preliminary summary of the number of wildlife-vehicle collisions, before and after completion of the mitigation measures in selected areas, and a comparison of the mitigated and unmitigated areas. For this purpose, the begin and end dates for construction in selected road sections with a concentration of mitigation measures are provided in Table 1. The researches distinguished 3 different time periods: before reconstruction, during reconstruction, and after reconstruction.

Table 1: Begin and end dates of the reconstruction of selected road sections with a concentration of mitigation measures.

Road Section (mile reference posts)	Begin Construction	End Construction
Evaro (9.4-11.1)	2009	May 2010
Jocko River (18.7-19.2)	2005	2006
Ravalli Curves (22.9-26.8)	January 2006	November 2007
Ravalli Hill (27.7-28.8)	January 2006	Spring 2007

2.2.1. Deer Pellet Group Surveys

If there are more deer in a certain year than in a previous year, more deer-vehicle collisions can be expected. Similarly, reduced deer population size may be expected to result in fewer deer-vehicle collisions. Therefore it is important to have a measure for potential changes in the deer population size.

Because there are no deer population estimates or hunting statistics available on the Flathead Indian Reservation, pellet group surveys were conducted in the Evaro, Ravalli Curves, and Ravalli Hill areas to provide a relative measure for potential changes in deer population size. Pellet group surveys can be useful to estimate ungulate population densities (Mandujano and Gallina 1995, White and Eberhardt 1980, McConnell and Smith 1970, Neff 1968, Eberhardt and Van Etten 1956). There were 25 transects perpendicular to the road. Each transect originated from the road and was 1640 ft. (500 m) long and 3.3 ft. (1 m) wide. The surveys were conducted in 2004, 2005, 2008, and 2009. However, the 2008 and 2009 surveys were only conducted in the Ravalli Curves and Ravalli Hill areas as construction was not completed yet in the Evaro area. If a deer pellet group was encountered it was classified as fresh black, old black, or brown. For the purpose of the current analyses only the fresh and old black pellet groups were included as brown pellets may be from a previous season.

2.3. Results

2.3.1. Crash and Carcass Data

The crash data do not specify the species, but the carcass removal data do contain species identification. The species involved with animal-vehicle collisions along US 93, based on carcass removal data, consist mostly of large mammals and are heavily dominated by white-tailed deer (Figure 4). The category "other (domestic)" was excluded from further analyses as domesticated species, in this case livestock and a mule, are controlled by people and livestock fences rather than mitigation measures aimed at wildlife. The "other (wild)" category was also excluded from further analyses as the species involved (red fox [*Vulpes vulpes*], raccoon [*Procyon lotor*], turkey [*Meleagris gallopavo*], and coyote [*Canis latrans*]) are too small to pose a substantial safety risk to humans (see paragraph 2.1) and their carcasses are not consistently recorded.

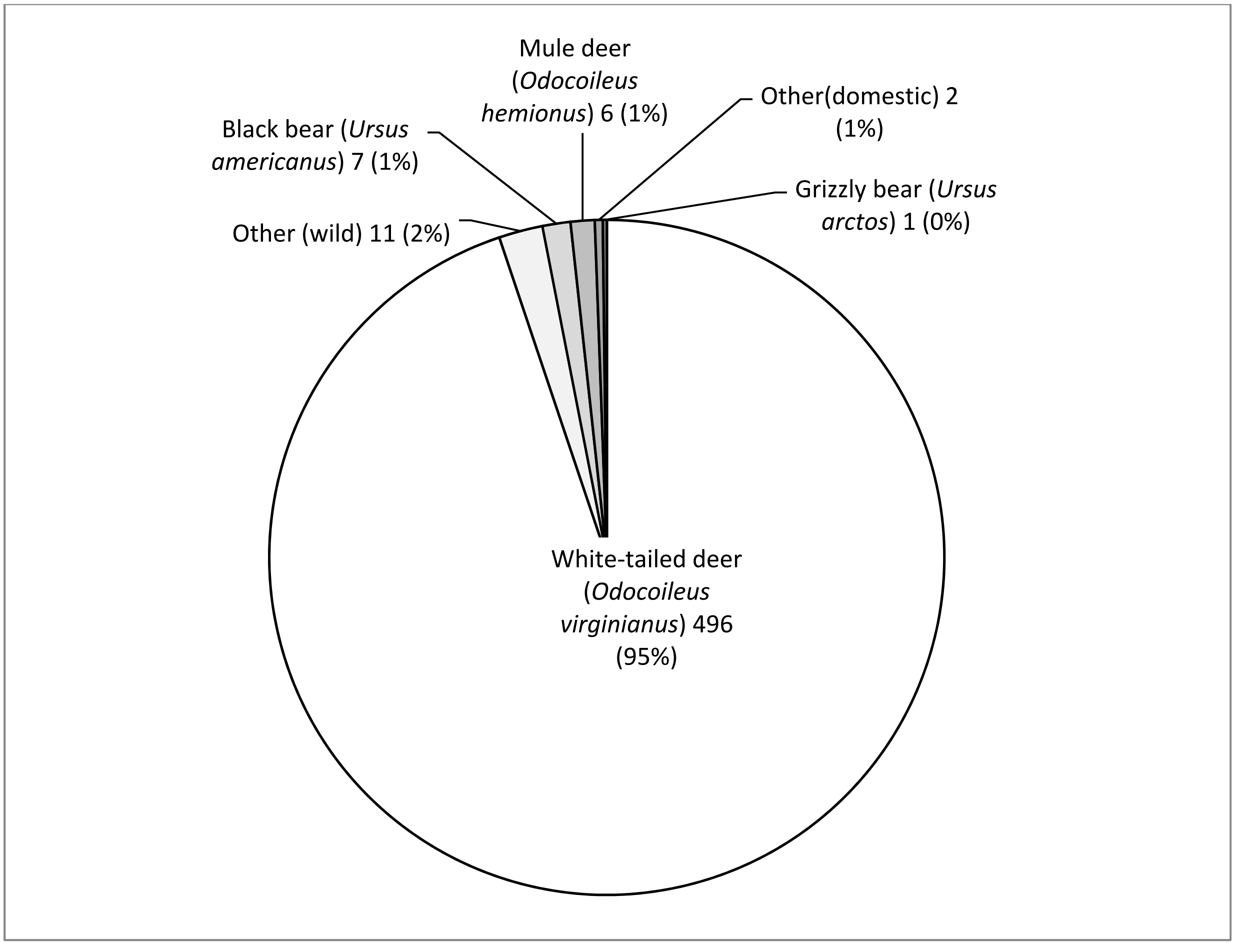

Figure 4: Species involved with animal-vehicle collisions based on carcass removal data (2002 through 2009) along US 93 between Evaro and Polson (N=523).

The number of large mammal carcasses reported in two road sections with a concentration of mitigation measures was lower during and after construction compared to before construction (Figure 5). The data suggest a decrease of 58% in the number of reported large wild mammal carcasses. The number of reported crashes with animals (47% reduction) suggests a similar reduction (Figure 6).

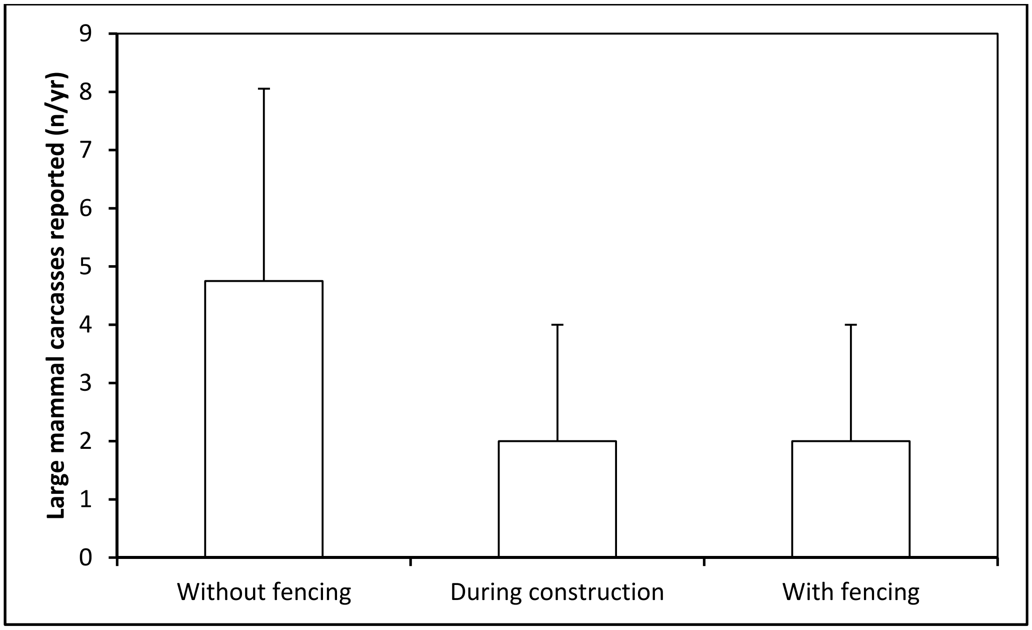

Figure 5: The number of wild large mammal carcasses that were reported before (without wildlife fencing or wildlife crossing structures (2002-2005)), during (2006-2007), and after construction (with wildlife fencing and wildlife crossing structures (2008-2009)) in the Ravalli Curves and Ravalli Hill area combined.

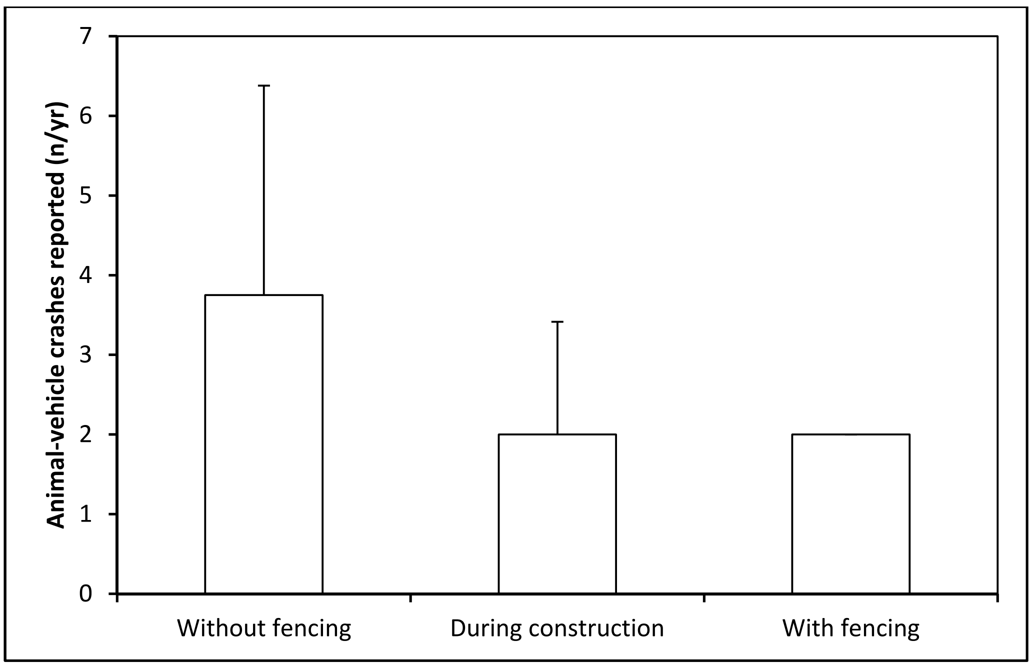

Figure 6: The number of animal-vehicle crashes reported before (without wildlife fencing or wildlife crossing structures (2002-2005)), during (2006-2007), and after construction (with wildlife fencing and wildlife crossing structures (2008-2009)) in the Ravalli Curves and Ravalli Hill area combined.

The overall number of reported large mammal carcasses between Evaro and Polson dropped substantially in 2008 and 2009 (Figure 7). However, a similar reduction occurred in the unmitigated road sections (Figure 7). Interestingly, the crash data do not show a drop in animal-vehicle crashes in 2008 and 2009; if anything there may be a slight increase, both for the entire road section between Evaro and Polson and the unmitigated road sections (Figure 8).

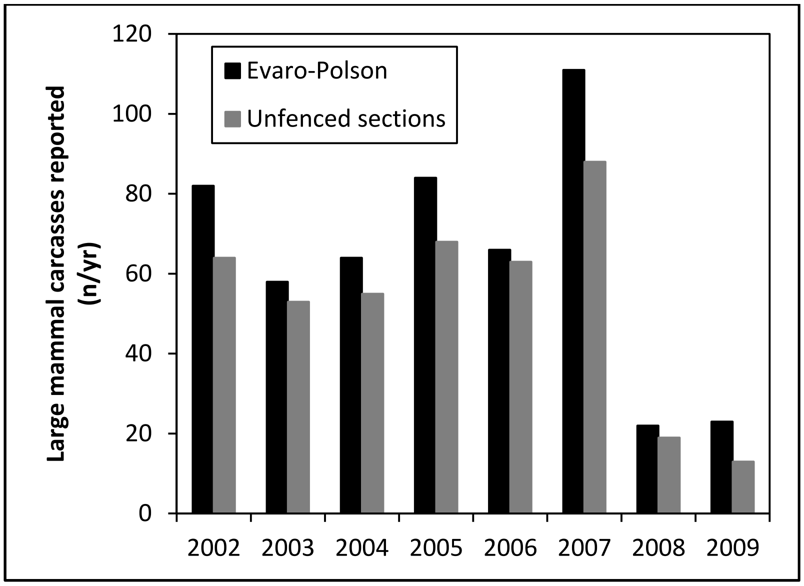

Figure 7: The number of wild large mammal carcasses that were reported between 2002 and 2009 for the entire 56 mi (90 km) between Evaro and Polson, and the road sections that do not have wildlife fencing or wildlife crossing structures.

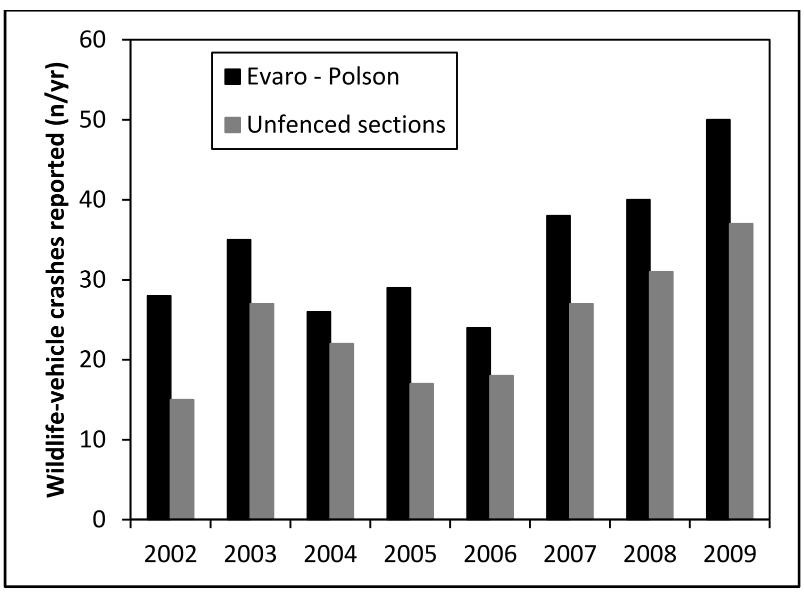

Figure 8: The number of animal-vehicle crashes that were reported between 2002 and 2009 for the entire 56 mi (90 km) between Evaro and Polson, and the road sections that do not have wildlife fencing or wildlife crossing structures.

2.3.1. Deer Pellet Group Surveys

The number of pellet groups was variable with relatively large standard deviations (Figure 9). However, there was no indication of fewer pellet groups, and thus fewer deer, in 2008 and 2009 compared to 2004 and 2005.

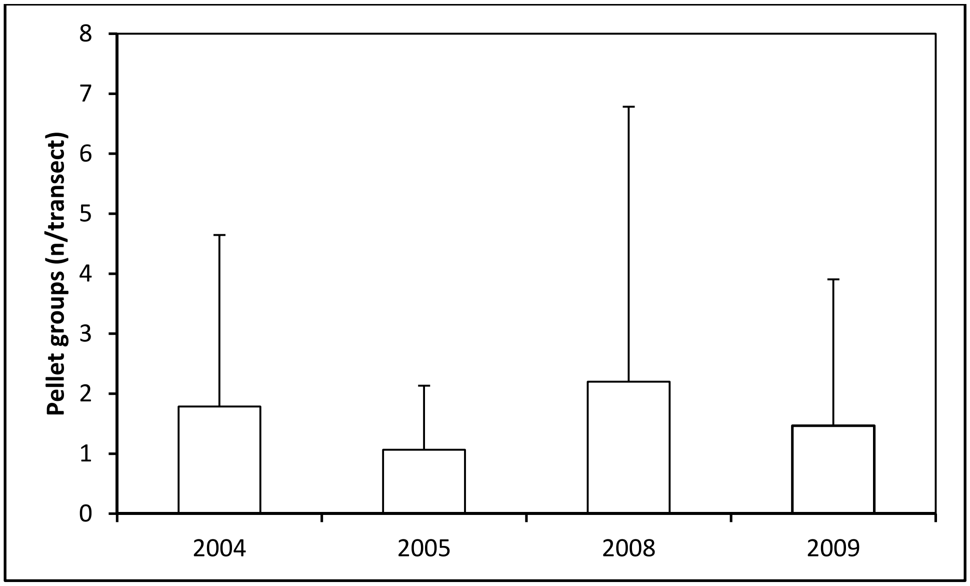

Figure 9: The average number of deer pellet groups (fresh and old black) per transect in Ravalli Curves and Ravalli Hill areas combined and associated standard deviations.

2.4. Discussion and Conclusion

At first glance the carcass removal and crash data suggest a 47-58% decline in the number of large mammal carcasses and the number of animal-vehicle crashes after the mitigation measures were implemented. In addition, the number of reported large mammal carcasses for the entire road section between Evaro and Polson dropped from about 70 to less than 20 per year in 2008 and 2009, perhaps suggesting effective mitigation measures. However, the number of reported large mammal carcasses dropped similarly for the unmitigated road sections between Evaro and Polson, suggesting that the reduction is definitely not only the result of the implementation of the mitigation measures. Alternative explanations for the drop in the number of reported large mammal carcasses are a potential reduction in the deer population size or a reduction in search and reporting effort. The number of reported animal-vehicle crashes did not decline in 2008 and 2009, neither for the entire road section between Evaro and Polson or the unmitigated road sections. This suggests that there was not a substantial reduction in the deer population size, at least not in the areas adjacent to US 93. Further evidence for the absence of a substantial reduction in the deer population comes from the deer pellet group counts in Ravalli Curves and Ravalli Hill. While there has been a substantial reduction in the deer population size after the winter of 2007-2008 in the wider region, the deer along US 93 may have had much better access to food, and the private lands along US 93 may also provide some refuge from hunters. In conclusion, the data suggest that there was a substantial reduction in search and reporting effort for the carcass removal data in 2008 and 2009. It is important that this is further investigated, and potentially corrected, as one of the three core research questions is at least partially based on these carcass removal data. Nonetheless, the crash data seem to have had consistent search and reporting effort and suggest that the number of crashes with large wild mammals was reduced by about 47% in the mitigated road sections of Ravalli Curves and Ravalli Hill combined. The absolute number of crashes is relatively low, both before and after the mitigation measures were implemented. This means that only one crash more or one crash less can have a substantial effect on the percentage reduction. Collecting data for longer and combining the data with those for other mitigated road sections will provide a more precise and robust estimate in the future.

Note: After the findings of this chapter were reported to MDT data sheets with carcass removal data were found that had not been entered in the database yet (Evaro section). In addition, other observations were not transferred to the reports yet and, consequently, had also not been sent in to MDT’s main office for entry into the central database (Ronan section). At this time it is unclear if the recovered data fully explain the patterns in the data or whether there may still be an indication of reduced search and reporting effort for animal carcasses in 2008 and 2009. The authors expect that such analyses will be conducted for the next annual report that is due in June 2011.

3. MITIGATION MEASURES AND HABITAT CONNECTIVITY FOR WILDLIFE

3.1. Introduction

The preconstruction research measured the number of animals, especially deer and black bear, that crossed the road before the road was widened and before the mitigation measures were put in place (Hardy *et al.* 2007). For this purpose 38 tracking beds (100 m long, 2 m wide) were installed along three road sections that would later have continuous wildlife fencing and wildlife crossing structures (Evaro, Ravalli Curves, and Ravalli Hill). The tracking beds covered about 30% of the road sections that would later be mitigated. Now that the road has been widened and the fences and crossing structures are in place in these three areas, the animals can only cross the road by using the underpasses (although some animals may cross wildlife guards or climb fences).

This chapter reports on the use of the wildlife crossing structures in Ravalli Curves and Ravalli Hill through 2009. The structures in Evaro were not completed until 2010. In addition this chapter reports on the use of more isolated crossing structures with no or only limited wildlife fencing (e.g. up to a few hundred yards (meters)). Furthermore this report includes data on the extent of the barrier effect of wildlife guards (similar to cattle guards) at access roads, and the functioning of wildlife jump-outs or escape ramps.

3.2. Methods

3.2.1. Structures in Evaro, Ravalli Curves, and Ravalli Hill

The wildlife use of the underpasses in the Ravalli Curves and Ravalli Hill was mostly measured through tracking beds (through 26 February 2010), and is currently measured through wildlife cameras (from 26 February 2010 onwards). Table 2 provides an overview of what structures were monitored through what means in the Ravalli Curves, and Ravalli Hill areas. The structures in the Evaro area were under construction in 2009 and part of 2010, and were not monitored before 2010.

The tracking beds were checked for tracks twice per week in summer in 2008 and 2009 (mid-May through mid-November). Checks took place once a week in the winter of 2008/2009 and 2009/2010 (mid November through mid-May). All of the structures in Ravalli Curves and Ravalli Hill were equipped with a wildlife camera (Reconyx RM35) from 26 February 2010 onwards, the need for frequent checks of the tracking beds disappeared. From 26 February 2010 onwards the tracking beds were only checked when the memory cards of the cameras were changed and when the battery status was checked. The camera checks take place about once a month. Before 26 February 2010 the few cameras that were in operation at that time were checked about twice per month as they operated on rechargeable batteries that did not last as long.

Some of the structures had a wildlife camera installed in 2008 (Table 2). Structure RC 377 (Schall Flats #1) is permanently inundated and did not allow for a tracking bed. Therefore a camera was installed from the start here, forming the only data source for this location. Other structures (RC 422 [Jocko Side Channel], RC 432 [Copper Creek], RH 459 [Ravalli Hill #1], and RH 463 [Ravalli Hill #2] had a camera installed to simply supplement data obtained through tracking.

During each check of the tracking beds the following parameters were recorded: species, certainty of species identification, whether a photo of the track was taken, behavior (crossing, parallel movement (> 16 ft. (5 m)), crossing and parallel movement, or presence), and direction of movement (going “east” or going “west”). For the purpose of this report, only data obtained through tracking were summarized, ignoring potential supplemental data from the cameras. The researchers only included records that related to actual crossings (rather than just parallel movements or presence), and species that the researchers were able to identify with certainty. However, if species identity was not certain, but the individuals did cross the structure, the observation was included in the category “other”.

Table 2: The 11 wildlife crossing structures in the Ravalli Curves and Ravalli Hill areas that were monitored for wildlife use between 2007 through 2009, methods of monitoring, and the time periods these methods were in effect.

Name structure	Method	Date or period monitored
RC 377 (Schall Flats #1)	a. Camera	a. August 2008 – present
RC 381 (Spring Creek)	a. Tracking bed b. 2 cameras	a. 23 May 2008 – present b. 26 February 2010 - present
RC 396 (Ravalli Curves #1)*	a. Tracking bed b. Camera	a. 23 May 2008 – present b. 26 February 2010 - present
RC 406 (Ravalli Curves #2)	a. Tracking bed b. Camera	a. 23 May 2008 – present b. 26 February 2010 - present
RC 422 (Jocko Side Channel)	a. Tracking bed b. Camera (center) c. 2 cameras (sides)	a. 23 May 2008 – present b. 20 November 2007-present c. 26 February 2010 - present
RC 426 (Ravalli Curves #3)	a. Tracking bed b. Camera	a. 23 May 2008 – present b. 26 February 2010 - present
RC427(Ravalli Curves #4)*	a. Tracking bed b. Camera	a. 23 May 2008 – present b. 26 February 2010 - present
RC 431(Ravalli Curves #5)	a. Tracking bed b. Camera	a. 23 May 2008 – present b. 26 February 2010 - present
RC 432 (Copper Creek)*	a. Tracking bed b. Camera	a. 23 May 2008 – present b. 24 July 2008 - present
RH 459 (Ravalli Hill #1)*	a. Tracking bed b. Camera	a. 23 May 2008 – present b. 4 January 2008 - present
RH 463 (Ravalli Hill #2)	a. Tracking bed b. Camera	a. 23 May 2008 – present b. 4 January 2008 - present

* = These four structures not only had a tracking bed inside the structure, but also one on the outside (see text).

Because sand tracking beds inside structures (sheltered) have a different detection probability for wildlife than sand tracking beds alongside the road (exposed to wind, precipitation etc.) a relationship between preconstruction road crossings on sand tracking beds alongside the road, and post construction sand tracking beds inside underpasses must be established. The same is true for detecting wildlife crossings with cameras compared to using tracking beds. Therefore four crossing structures currently have a tracking bed placed outside the structures (exposed to the elements, similar to pre-construction methods). These four tracking beds were installed on 20/21 July 2010. These four crossing structures have a relatively high use by deer and black bear, which should result in a high enough sample size to establish this relationship. The four tracking beds are located at RC 396 (Ravalli Curves #1), RC 427 (Ravalli Curves #3), RC432 (Copper Creek), and RH 459 (Ravalli Hill #1). These tracking beds, and the ones inside the four crossing structures, will be checked twice a week in summer (between mid-May and mid-November), and once a week in winter (between mid-November and mid-May).

Note: Only observations that relate to crossings and certain species identification were included in the analyses. However, "unknown" includes uncertain species identification. The data are based on tracking data only, except for structure RC377 which is based on camera images only because it is permanently inundated. The data exclude birds, mice, and voles.

3.2.2. Isolated Crossing Structures

While continuous fencing over relatively long road sections combined with wildlife crossing structures can result in a very substantial reduction in collisions with large mammals and substantial use by wildlife of the structures, such mitigation measures are not always possible or desirable. Much of the landscape in North America is heavily used by people (agriculture, houses, access roads etc.), resulting in a push towards more isolated crossing structures with no or limited wildlife fencing. However, the effectiveness of more isolated crossing structures is not known very well; not in terms of potential collision reduction and not in terms of wildlife use of the structures. Therefore this project also aims to measure wildlife use at a minimum of 10 more or less isolated wildlife crossing structures and analyze their use in relation to collisions in the immediate vicinity of the structure and potential short section of wildlife fence. For the purpose of this annual report the wildlife use data of the isolated crossing structures are summarized, but not analyzed in the context of the research question described above. The observations of the species are summarized, combining actual crossings with failed crossing attempts and presence without crossing. Data from Pistol Creek #1 and #2 were excluded as the cameras were only installed for a short period in 2007 through 2009.

Table 3: The isolated wildlife crossing structures that were monitored for wildlife use between 2007 through 2009, methods of monitoring, and the time periods these methods were in effect.

Name structure	Method	Date or period monitored
148 (North Evaro)	Camera	6 July 2010 - present
198 (Schley Creek)	Camera	29 June 2010 - present
499 (Pistol creek #1)	Camera	November 2007 - 1 January 2008 27 August 2009 - present
502 (Pistol creek #2)	Camera	27 August 2009 - present
529 (Mission Creek)	Camera (south side)	September 2009 - present
551 (Post Creek #1)	Camera	November 2007 - May 2009 29 June 2010 - present
555 (Post Creek #2)	Camera	November 2007 - October 2008 January 2009 - May 2009 August 2009 - present
560 (Post Creek #3)	Camera	November 2007 – present
774 (Spring Creek #1)	Camera	May 2009 - present
784 (Spring Creek #2)	Camera	11 March 2010 - present
810 (Mud Creek)	Camera	23 June 2009 – 23 July 2009

3.2.3. Wildlife Guards

In the areas with longer sections of fencing wildlife guards were installed at most of the access roads. Wildlife guards consist of modified bridge grating material (Peterson *et al.* 2003) and are designed to be a barrier for ungulates such as deer (*Odocoileus* spp.). The wildlife guards are not expected to be a barrier for bears (*Ursus* spp.). For the purpose of this annual report the behavior of the various wildlife species that approached the road was summarized. The wildlife guards are to keep animals from entering the roadway. While the wildlife guards represent the same physical barrier for animals that are caught in the fenced road corridor, it would be quite acceptable if those animals would cross the wildlife guard to reach the "safe side" of the fence. In addition, animals that were present on the "road side" of the fence may have been more motivated to cross the wildlife guard compared to animals present at the "safe side" of the fence. For these reasons the researchers only included animals in the analyses that were present, within the range of the cameras, on the "safe side" of the fence. This included animals that did not actually approach the wildlife guard but simply walked by the wildlife guard within range of the cameras. Furthermore the researchers only selected observations where the researchers were certain about the species identity.

Table 4: The wildlife guards that were monitored for wildlife approaches and crossing between 2007 through 2009, methods of monitoring, and the time periods these methods were in effect.

Name structure	Method	Date or period monitored
429 (Southern Guard)	Camera	8 July 2008 - present
433 (Northern Guard)	Camera	8 July 2008 - present

3.2.4. Wildlife Jump-outs

Wildlife jump-outs (or escape ramps) were installed near wildlife crossing structures as well as in between wildlife crossing structures in areas with continuous fencing. The purpose of the wildlife jump-outs is to allow animals that are caught in between the fences of the fenced road corridor to escape to the safe side of the fence. The ramps allow the wildlife to walk up to the top of the wildlife jump-out at or below the height of the fence (between 1.7 and 2.7 m high). The animals can then jump-down towards the safe side of the fence. Wildlife jump-outs should be low enough so that animals will readily jump down to safety, and high enough to discourage them from jumping up into the fenced road corridor. The appropriate height of jump-outs is unknown for most species. All 29 jump-outs in the Ravalli Curves and Ravalli Hill areas were monitored for wildlife presence and behavior at the top and bottom of the jump-outs. Sand tracking beds (each about 16 ft. (5 m) long, 6.5 ft. (2 m) wide) were installed at the top and bottom of each of the jump-outs. The tracking beds were checked about twice a week between 8 June 2008 – 24 July 2008 and 10 June 2009 - 17 August 2009. One of the jump-outs had a wildlife camera installed to obtain images of the wildlife at the jump-out allowing for more insight in their behavior than based on tracking data only. For the purpose of this annual report the behavior of the various wildlife species that were present at the jump-outs was summarized ignoring the differences in height between the jump-outs. The data summarized in this report are based on tracking data only, ignoring supplemental data from one camera at one of the jump-outs.

3.3. Results

3.3.1. Structures in Evaro, Ravalli Curves, and Ravalli Hill

Over 6,500 wildlife crossings were recorded in the 11 crossing structures in Ravalli Curves and Ravalli Hill between 23 May 2008 and 23 December 2009 (Figure 10; Table 5). Most of the crossings related to deer, followed by coyotes and domestic cats.

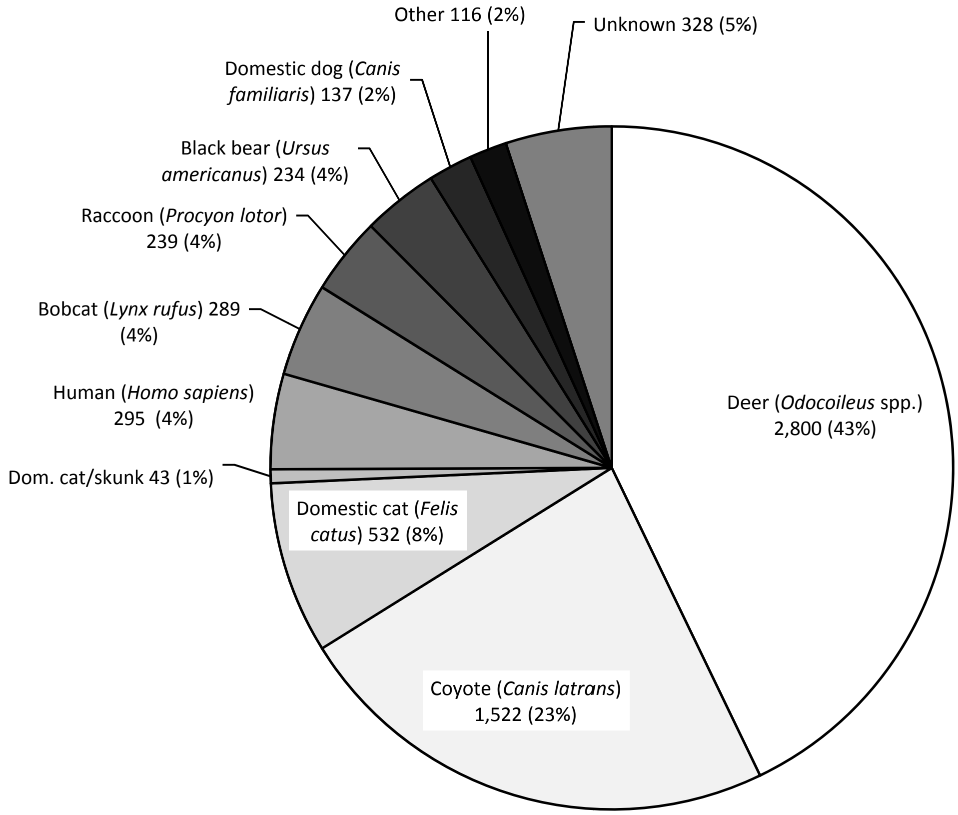

Figure 10: Wildlife use of the 11 crossing structures in Ravalli Hills and Ravalli Curves between 23 May 2008 and 23 December 2009 (N=6,535).

Table 5: The number and percentage of the crossing that related to the species that were grouped in the "other" category in Figure 10.

Species	**N**	**%**
Western striped skunk (*Mephitis mephitis*)	53	0.81
Domestic dog/wild canine	30	0.46
Mountain lion (*Felis concolor*)	19	0.29
Red fox (*Vulpes vulpes*)	6	0.09
Horse (*Equus ferus caballus*)	4	0.06
Elk (*Cervus elaphus*)	2	0.03
River otter (*Lutra canadensis*)	2	0.03

3.3.2. Isolated Crossing Structures

The observations of the species in the isolated crossing structures are summarized in Tables 6 and 7, combining actual crossings with failed crossing attempts and presence without crossing.

Table 6: The number of occurrences of wildlife species in the isolated crossing structures.

551 Post Creek #1	**2007(Nov-Dec)**	**2008 (Full Year)**	**2009 (Jan-May)**
White Tailed Deer	124	633	246
Misc.	2	24	18
555 Post Creek #2	**2007(Nov-Dec)**	**2008 (Jan-Oct)**	**2009 (Jan-May)**
White Tailed Deer	333	1,218	1,177
Black Bear	0	2	6
Coyote	0	0	1
Misc.	1	34	51
560 Post Creek #3	**2007 (Nov-Dec)**	**2008 (full year)**	**2009 (full year)**
White Tailed Deer	169	1,534	1,168
Black Bear	0	0	5
Grizzly Bear	0	0	1
Coyote	0	0	2
Misc.	0	41	22
529 Mission Creek	**2007 (no data)**	**2008 (no data)**	**2009 (Sept-Dec)**
Black bear	0	0	3
White tailed deer	0	0	34
774 Spring Creek #1	**2007 (no data)**	**2008 (no data)**	**2009 (May-Dec)**
White Tailed deer	0	0	2
Coyote	0	0	2
Misc.	0	0	8
Total Crossing by	**663**	**4,415**	**3,840**

Table 7: The number of occurrences of miscellaneous species (see Table 6) in the isolated crossing structures.

551 Post Creek #1	**2007(Nov-Dec)**	**2008 (Full**	**2009 (Jan-May)**
Raccoon	1	12	11
Magpie	1	2	0
Pheasant	0	8	5
Duck	0	1	0
Skunk	0	0	1
Fox	0	0	1
Unidentified bird	0	1	0
555 Post Creek #2	**2007(Nov-Dec)**	**2008 (Jan-Oct)**	**2009 (Jan-May)**
Pheasants	1	19	2
Hungarian partridge	0	6	0
Magpie	0	6	14
Skunk	0	1	0
Raccoon	1	1	29
Muskrat	0	1	0
Fox	0	0	4
Mouse	0	0	2
560 Post Creek #3	**2007(Nov-Dec)**	**2008 (full year)**	**2009 (full year)**
Canada goose	0	1	0
Magpie	0	5	0
Pheasant	0	18	2
Raccoon	0	12	1
Skunk	0	1	2
River otter	0	3	0
Bat	0	1	3
Fox	0	0	2
Mouse	0	0	1
Unidentified bird	0	0	11

Table 7 - Continued			
529 Mission Creek	**2007 (no data)**	**2008 (no data)**	**2009 (Sept-Dec)**
None	0	0	0
774 Spring Creek #1	**2007 (no data)**	**2008 (no data)**	**2009 (May-Dec)**
Bird	0	0	1
Pheasant	0	0	2
Porcupine	0	0	1
Raccoon	0	0	2
Skunk	0	0	2

3.3.3. Wildlife Guards

Twelve different species were detected on the safe side of the wildlife fence at the two wildlife guards (Table 8). Very few or one of the horses and mule deer crossed the wildlife guard, and most coyotes did not cross either. However, the guards were crossed more often than not by both black bears and domestic cats.

Table 8: The number of individuals of different species that were present at the "safe side" of the two wildlife guards and that either crossed or did not cross the wildlife guard.

Species	**Cross (N)**	**Not cross (N)**	**Cross (%)**	**Barrier effect (%)**	**Sample size (N)**
Sample size ≥10					
Horse (*Equus ferus caballus*)	0	10	0.00	100.00	10
Mule deer (*Odocoileus hemionus*)	1	38	2.56	97.44	39
Coyote (*Canis latrans*)	9	12	42.86	57.14	21
Black bear (*Ursus americanus*)	7	4	63.64	36.36	11
Domestic cat (*Felis catus*)	32	6	84.21	15.79	38
Sample size <10					
Wolf (*Canis lupus*)	1	0	100.00	0.00	1
Western striped skunk (*Mephitis mephitis*)	0	2	0.00	100.00	2
Red fox (*Vulpes vulpes*)	1	2	33.33	66.67	3
White-tailed deer (*Odocoileus virginianus*)	3	0	100.00	0.00	3
Deer (*Odocoileus* spp.)	0	4	0.00	100.00	4
Raccoon (*Procyon lotor*)	4	1	80.00	20.00	5
Bobcat (*Lynx rufus*)	4	4	50.00	50.00	8

3.3.4. Wildlife Jump-outs

Relatively few of the deer, domestic cats, and medium sized mammals that were present on top of the jump-outs actually used the jump-outs to jump down to safety on the safe side of the fence (Table 9). None of the deer, cattle, coyotes, and medium mammals that were present at the bottom of the jump-outs jumped into the road corridor (Table 10).

Table 9: The number of individuals of different species that were present on top of the jump-outs (caught in the fenced road corridor) and that jumped down to safety on the 29 jump-outs in Ravalli Curves and Ravalli Hill between 8 June 2008 – 24 July 2008 and 10 June 2009 - 17 August 2009.

Species	**On top (N)**	**Jumped down (N)**	**Jumped down (%)**
Sample size ≥10			
Deer (*Odocoileus* spp.)	36	4	10.00
Domestic cat (*Felis catus*)	18	1	5.26
Medium mammal	13	0	0.00
Sample size <10			
Coyote (*Canis latrans*)	8	1	11.11
Domestic cat/skunk	8	0	0.00
Medium / large mammal	4	0	0.00
Black bear (*Ursus americanus*)	2	0	0.00
Bobcat (*Lynx rufus*)	2	0	0.00
Coyote/domestic dog	2	0	0.00
Large mammal	2	0	0.00
Domestic dog (*Canis familiaris*)	1	0	0.00
Domestic dog/coyote	1	0	0.00
Elk (*Cervus elaphus*)	1	0	0.00

Table 10: The number of individuals of different species that were present at the bottom of the jump-outs (on the safe side of the fence) and that jumped up into the fenced road corridor on the 29 jump-outs in Ravalli Curves and Ravalli Hill between 8 June 2008 – 24 July 2008 and 10 June 2009 - 17 August 2009.

Species	On bottom (N)	Jumped up (N)	Jumped up (%)
Sample size ≥10			
Deer (*Odocoileus* spp.)	140	0	0.00
Cattle (*Bos primigenius*)	17	0	0.00
Medium mammal	11	0	0.00
Coyote (*Canis latrans*)	10	0	0.00
Sample size <10			
Black bear (*Ursus americanus*)	5	0	0.00
Large mammal	2	0	0.00
Horse (*Equus ferus caballus*)	2	0	0.00
Mountain lion (*Felis concolor*)	2	0	0.00
Raccoon (*Procyon lotor*)	2	0	0.00
Domestic cat/skunk	1	0	0.00
Medium/large mammal	1	0	0.00
Bobcat (*Lynx rufus*)	1	0	0.00
Elk (*Cervus elaphus*)	1	0	0.00
Snake	1	0	0.00

3.4. Discussion and Conclusion

The wildlife crossing structures in Ravalli Curves and Ravalli Hill appear to receive substantial use by a wide variety of wildlife species, especially deer and coyotes. Humans and domestic species including cats, dogs, and horses also use the structures. Bobcats, raccoons, and black bears have been observed frequently using the structures. The following species were observed less frequently using the structures: western striped skunk, mountain lion, red fox, elk, and river otter. While wildlife use of the structures can be considered substantial, the term “success” is specifically defined based on consensus between MDT, CSKT and FHWA. Thus whether the wildlife crossing structures are considered “successful” or not can only be concluded after more data have been collected and analyzed in the context of the measures of effectiveness agreed upon by MDT, CSKT, and FHWA.

The isolated crossing structures were used by a large variety of wildlife species, sometimes in great numbers. The Post Creek structures seem to be used extensively by white-tailed deer, and it is noteworthy that a grizzly bear was also observed using one of these structures.

Wildlife guards appear to be a substantial barrier to horses and mule deer. They do not appear to be a substantial barrier to coyotes, black bears, and domestic cats. Sample sizes are currently too low for a number of species to have a meaningful estimate of the potential barrier effect of the wildlife guard for these species. The sample sizes will increase over time, and the researchers also plan to increase the number of wildlife guards that are being monitored. Nonetheless, the fact that the wildlife guards appear to be a substantial barrier to mule deer is encouraging and suggests that the wildlife guards largely function as intended. The researchers do suggest blocking access to the concrete ledge on either side of the wildlife guards. Different species have used this ledge to access the fenced road corridor and have thus avoided walking on the modified bridge grating that should be more of a barrier.

The wildlife jump-outs have been used by a range of animal species to escape the fenced road corridor. However, relatively few of the individuals, including deer, which are of most concern (from a human safety perspective), jumped down. This suggests that many of the jump-outs in the Ravalli Curves and Ravalli Hills areas may be too high. There appears to be sufficient margin to lower the jump-outs as no species were found to jump up into the fenced road corridor. There appears to be sufficient margin to lower the jump-outs as no species were found to jump up into the fenced road corridor.

4. COST-BENEFIT ANALYSIS

No activities regarding cost-benefit analysis took place between 2007 and December 2009.

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