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

Annual Report 2011

by

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EXECUTIVE SUMMARY

This second annual report contains a preliminary summary for work conducted in 2010 for the US 93 wildlife mitigation evaluation project on the Flathead Indian Reservation, Montana, USA. The mitigation measures along this section of US 93 (US 93 North) consist of wildlife fencing combined with wildlife underpasses and an overpass, 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 22-41% 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 very substantially in 2008 and 2009, perhaps suggesting very effective mitigation measures. However, a closer review of the data, including reviewing data for unmitigated road section, crash data and deer pellet group counts, suggested that the reduction is 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 North or perhaps a side effect of large scale road reconstruction. Nonetheless, the crash data that do seem to have had consistent search and reporting effort suggest that the number of crashes with large wild mammals was reduced by about 22% in the mitigated road sections of Ravalli Curves and Ravalli Hill combined.

The wildlife crossing structures received substantial use by a wide variety of species, especially white-tailed deer, mule deer, and domestic dogs and cats. Coyotes, black bears, birds, yellow-bellied marmot, beaver, common porcupine, rabbits and hares, raccoon, long-tailed weasel, American badger, western striped skunk, bobcat, mountain lion, red fox, moose, horse, and grizzly bear were observed less frequently using the structures. It is noteworthy that there were three crossings by grizzly bears, and none by elk, although elk are known to occur in the Evaro and Ravalli areas on both sides of the road. The latter observations may lead to discussions about the location, type, dimensions and design of crossing structures in areas where elk is a target species.

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.

1. INTRODUCTION

1.1. Background

The US Highway 93 North (US 93 North) 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 Ninepipe 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 North 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 in Montana are even more substantial.

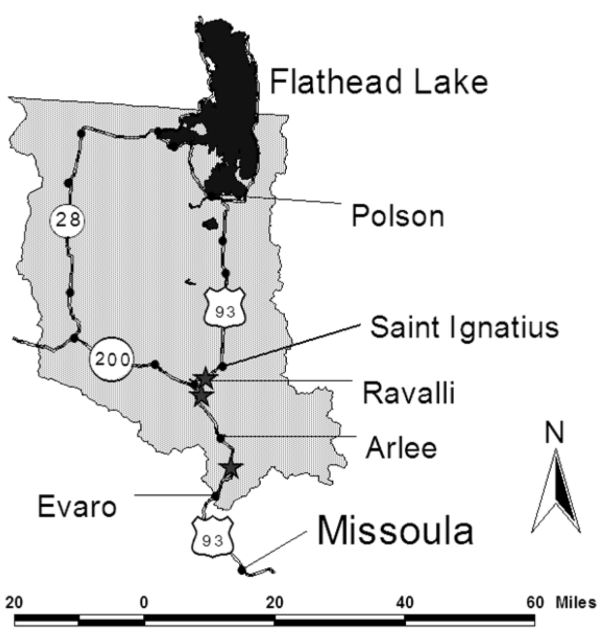

Figure 1: The Flathead Indian Reservation in northwestern Montana including major highway routes. The US 93 North reconstruction effort and evaluation study area traverses 56 miles (90 km) from Evaro to Polson. Stars represent the Evaro, Ravalli Curves, and Ravalli Hill study areas from south to north, respectively, where more intensive pre-construction sampling efforts were focused.

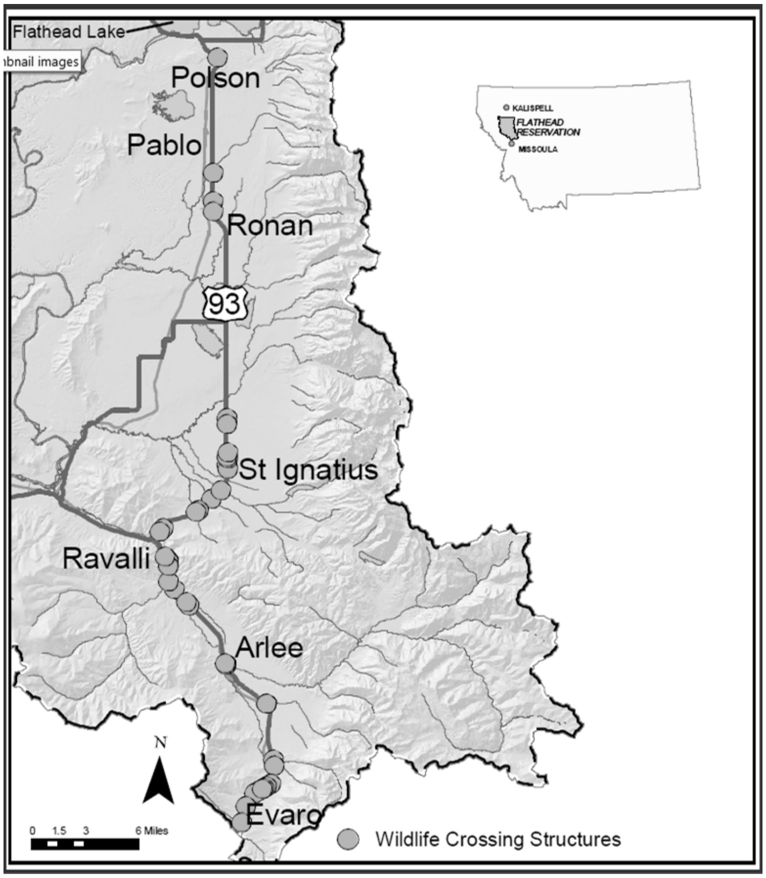

Figure 2: The location of the 41 fish and wildlife crossing structures along US 93 North on the Flathead Indian Reservation in northwestern Montana.

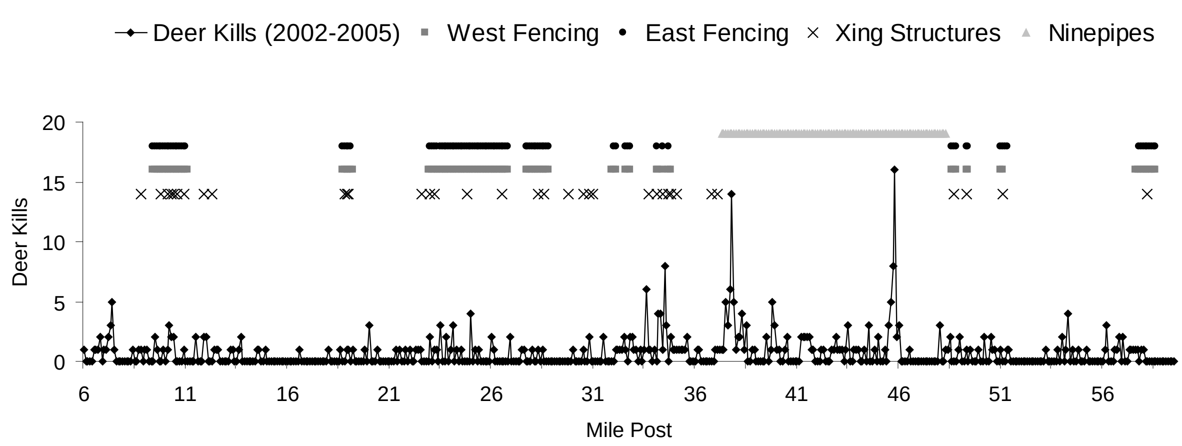

Figure 3: Total reported deer-vehicle collisions between 2002-2005, plotted by 1/10 mile along the US 93 North study area, with corresponding mitigation measures across the same area. Location of the following areas with continuous fencing and mitigation measures: Evaro (mile reference post 9.4-11.1), Ravalli Curves (22.9-26.8), and Ravalli Hill (27.7-28.8). The future mitigation measures for the Ninepipe section (mileposts 37-48) are not shown in this figure (from Hardy *et al.* 2007).

The magnitude of the US 93 North 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 North 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 North project are expected to be of great interest to agencies throughout North America (Huijser *et al.* 2008).

In 2002, prior to US 93 North'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 second 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. The previous annual report summarized the activities and results of these activities through December 2009 (Huijser et al., 2010). The current annual report summarizes the main results of data collected in 2010.

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; and
- Some large mammal species are threatened, endangered or considered charismatic.

The preconstruction research along US 93 North 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 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 Ninepipe area (Griffin 2007).

This chapter focuses on the potential reduction in wildlife-vehicle collisions along US 93 North 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 with 79-97% (Reed *et al.* 1982, Ward 1982, Woods 1990, Clevenger *et al.* 2001, Dodd *et al.* 2007). However, specific measures of effectiveness (parameters 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 two data sets ranged from 1 January 1998 through 31 December 2010. If more than one animal was recorded for one incident (either a crash or a carcass removal effort) each individual animal was counted and resulted in a separate record in one of the two databases. The crash data selected for this analysis involve all crashes where the first or most harmful event involves animals. Note that neither the crash data 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) and carcasses of small or medium sized species (e.g. coyote [*Canis latrans*] and smaller) may not be removed from the roadside, and carcasses of larger species that are not on the actual road surface and that are 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 North 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

Crash and carcass data were also analyzed for other roads on the reservation to investigate potential patterns in the search and reporting effort as well as potential fluctuations in the population size of the different wildlife species, particularly white-tailed deer and mule deer. The researchers used crash and carcass data from the following road sections:

- Hwy 200 from junction with US Hwy 93 in Ravalli (east end, mile reference post (RP) 88.859) to reservation boundary west of Perma (west end, RP 116.144).
- Hwy 382 from junction with Hwy 200 (south end, RP 0.000) to junction with Hwy 28 (north end, RP 15.766).
- Hwy 28 from reservation boundary (south end, RP 7.539) to junction with US Hwy 93 near Elmo (north end, RP 46.741).
- US Hwy 93 from junction with Hwy 35 in Polson (south end, RP 59.004) to reservation boundary south of Lakeside (north end, RP 86.424).
- Hwy 35 from junction with US Hwy 93 in Polson (south end, RP 0.000) to reservation boundary south of Bigfork (north end, RP 18.000).

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. 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, 2009, and 2010 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 North between 1 January 1998 and 31 December 2010, based on carcass removal data, consist mostly of large mammals and are heavily dominated by white-tailed deer (Figure 4). The category “other (domestic)” (n=6) was excluded from further analyses as domesticated species, in this case dogs, livestock and a mule, are controlled by people and livestock fences rather than mitigation measures aimed at wildlife. The “other (wild)” category (n=13) was also excluded from further analyses as the species involved bobcat [*Lynx rufus*] (n=1), red fox [*Vulpes vulpes*] (n=1), raccoon [*Procyon lotor*] (n=7), turkey [*Meleagris gallopavo*] (n=2), and coyote [*Canis latrans*] (n=2) were too small to pose a substantial safety risk to humans.

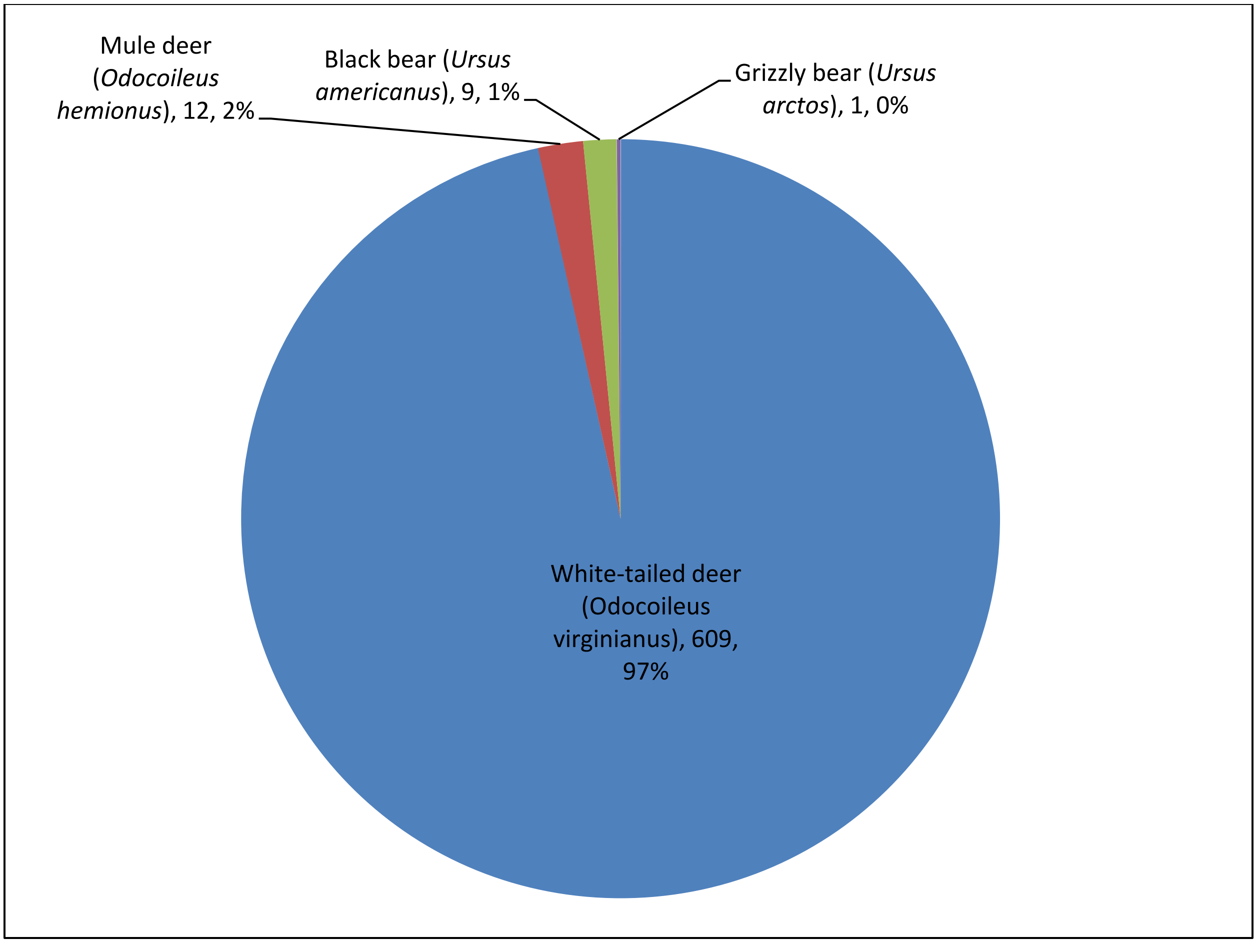

Figure 4: Species involved with animal-vehicle collisions based on carcass removal data (1998 through 2010) along US 93 North between Evaro and Polson (N=631).

The search and reporting effort was relatively low until 2002 (Hardy *et al.* 2007). MDT maintenance personnel were instructed to have better and more consistent reporting from 2002 onwards (Hardy *et al.* 2007). Therefore the researchers only included carcass data from 2002 onwards for the evaluation of the effectiveness of the mitigation measures in reducing the number of animal-vehicle collisions. 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 41% in the number of reported large wild mammal carcasses. A smaller reduction is suggested by the number of reported crashes with animals (22% reduction) (Figure 6).

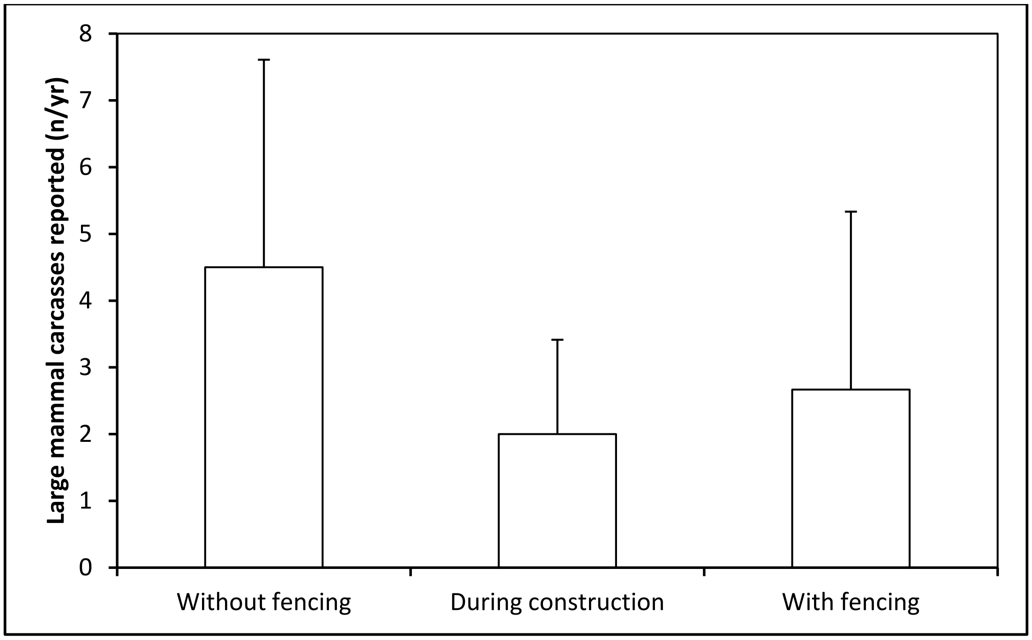

Figure 5: The number of wild large mammal carcasses that were reported before (without wildlife fencing or wildlife crossing structures), during, and after construction (with wildlife fencing and wildlife crossing structures) in the Ravalli Curves and Ravalli Hill area combined. The data are based on carcass removal data only. Before construction = 2002 through 2005, during construction is 2006 and 2007, after construction = 2008 through 2010.

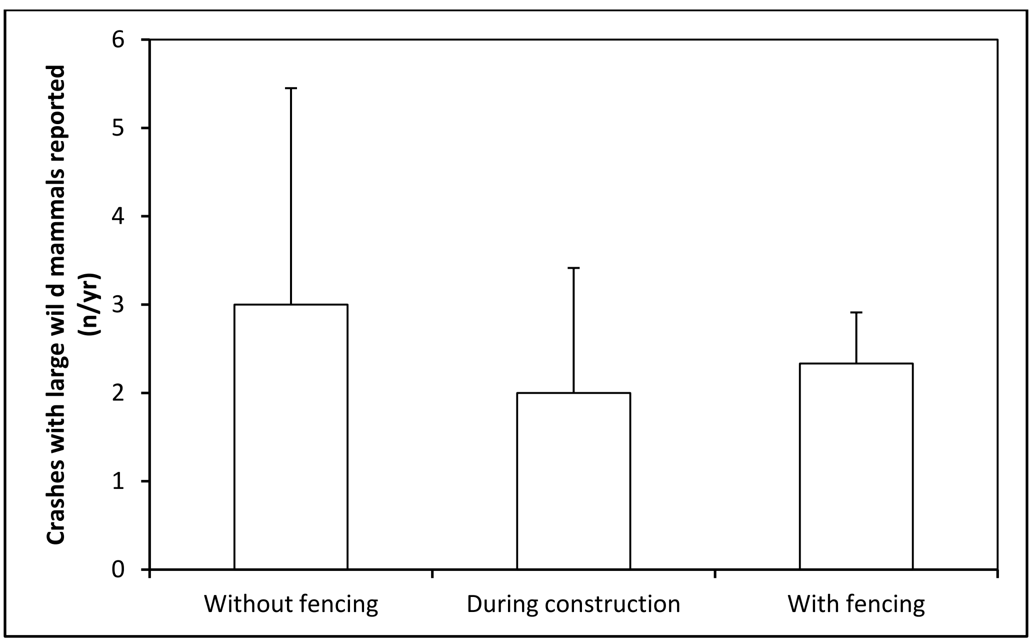

Figure 6: The number of animal-vehicle crashes reported before (without wildlife fencing or wildlife crossing structures), during, and after construction (with wildlife fencing and wildlife crossing structures) in the Ravalli Curves and Ravalli Hill area combined. The data are based on crash data only. Before construction = 2002 through 2005, during construction is 2006 and 2007, after construction = 2008 through 2010.

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 in recent years (Figure 8).

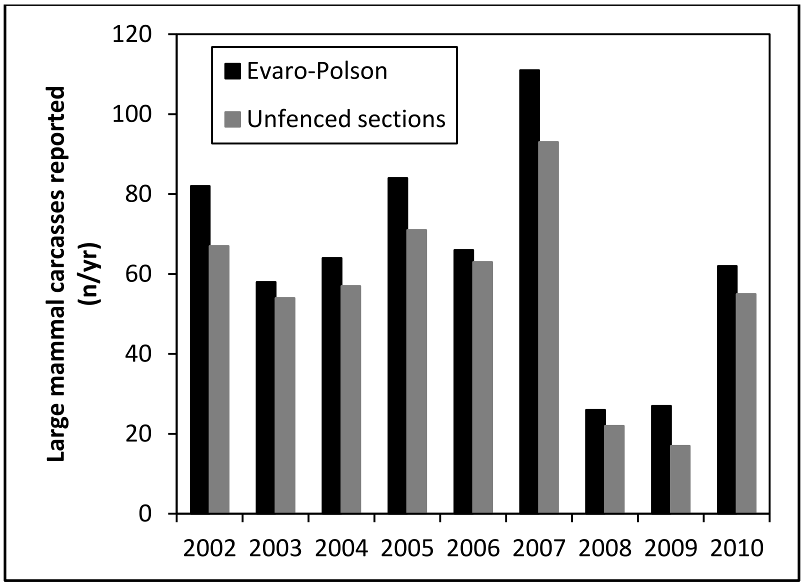

Figure 7: The number of wild large mammal carcasses that were reported between 2002 and 2010 for the entire 56 mi (90 km) between Evaro and Polson, and the road sections that do not have wildlife fencing or wildlife crossing structures.

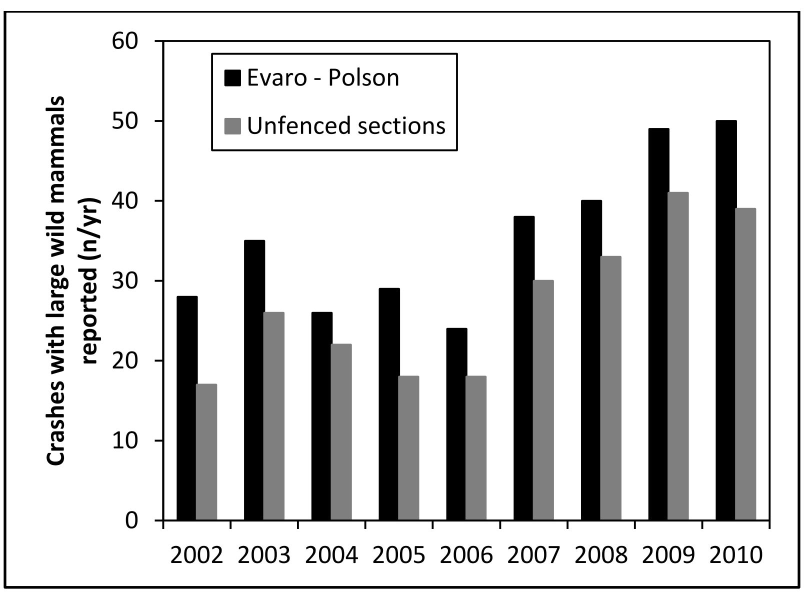

Figure 8: The number of animal-vehicle crashes that were reported between 2002 and 2010 for the entire 56 mi (90 km) between Evaro and Polson, and the road sections that do not have wildlife fencing or wildlife crossing structures.

The species involved with animal-vehicle collisions along other roads on the reservation (see paragraph 2.2.1) between 1 January 1998 and 31 December 2010, based on carcass removal data, consist mostly of large mammals and are heavily dominated by white-tailed deer (Figure 9). The category "other (domestic)" (n=5) was excluded from further analyses as domesticated species, in this case including a dog and two cows, are controlled by people and livestock fences rather than mitigation measures aimed at wildlife. The "other (wild)" category (n=8) was also excluded from further analyses as the species involved raccoon [*Procyon lotor*] (n=2) and coyote [*Canis latrans*] (n=3)) were too small to pose a substantial safety risk to humans.

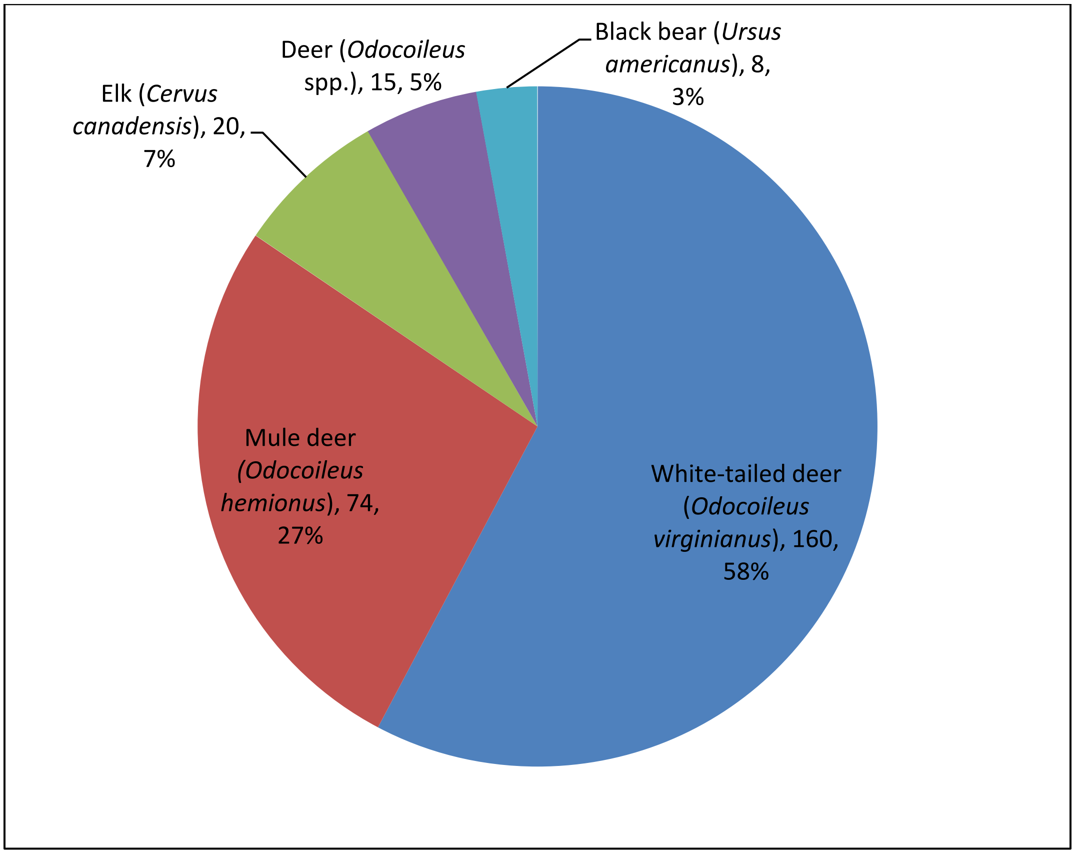

Figure 9: Species involved with animal-vehicle collisions based on carcass removal data (1998 through 2010) along other roads on the reservation (N=631).

The overall number of reported large mammal carcasses on other roads on the reservation increased substantially in 2009 and 2010 (Figure 10). Interestingly, the crash data show a different pattern with a spike in animal-vehicle crashes in 2008 (Figure 11).

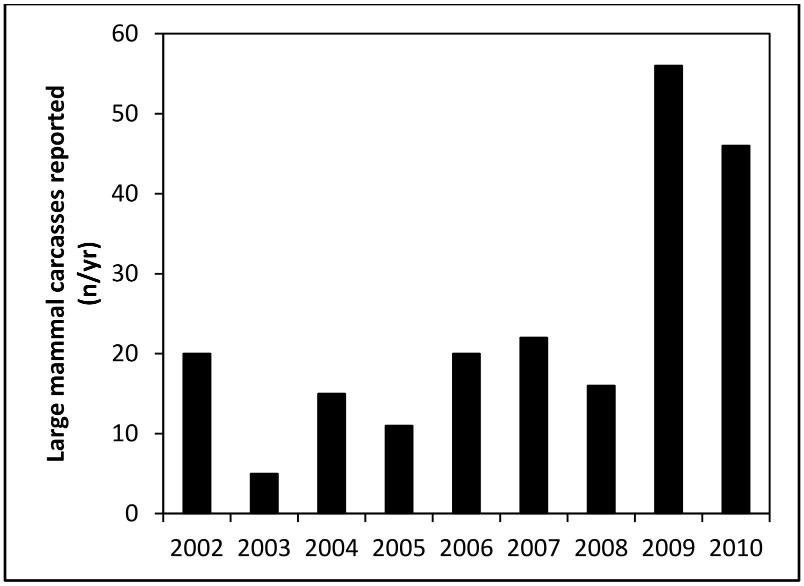

Figure 10: The number of wild large mammal carcasses that were reported between 2002 and 2010 for the other roads on the reservation.

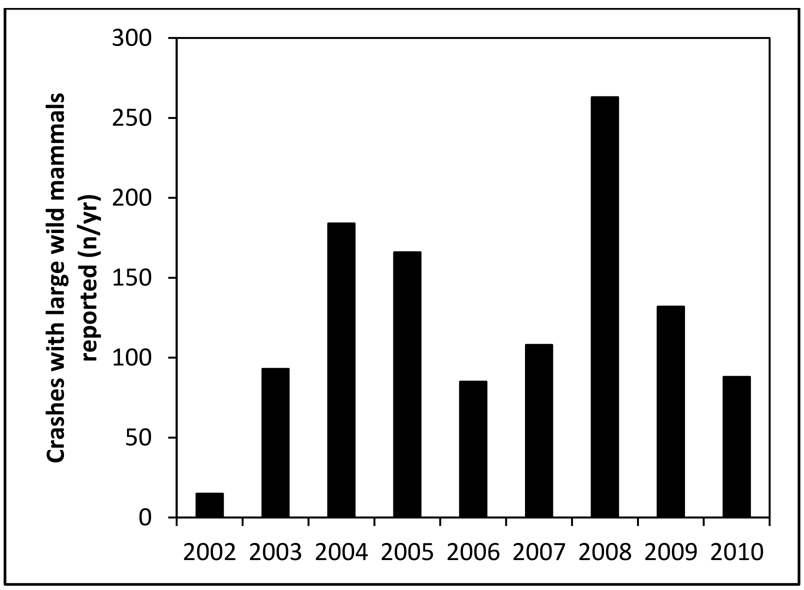

Figure 11: The number of animal-vehicle crashes that were reported between 2002 and 2010 for the other roads on the reservation.

2.3.1. Deer Pellet Group Surveys

The number of pellet groups was variable with relatively large standard deviations (Figure 12). However, there was no indication of fewer pellet groups, and thus fewer deer, in 2008 and 2009 compared to 2004 and 2005.

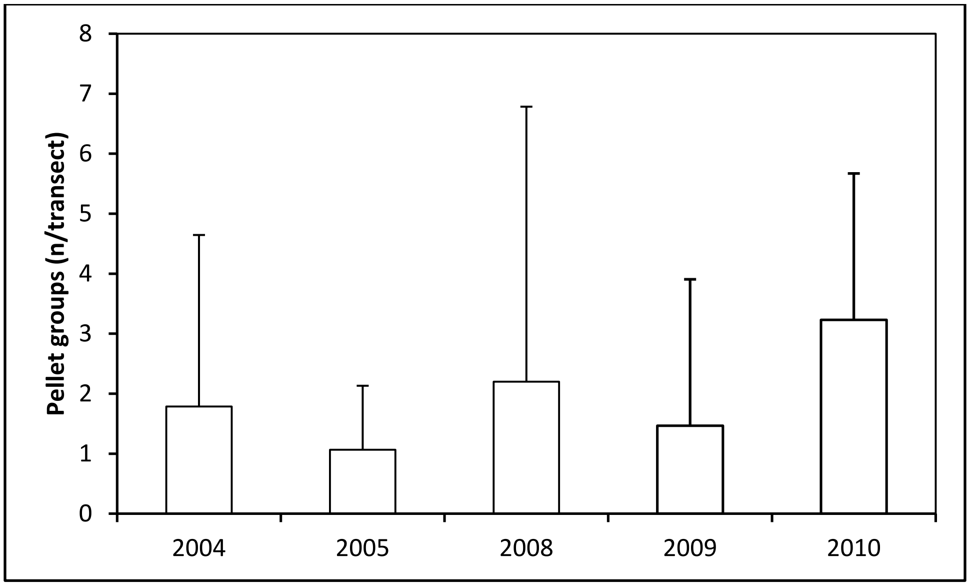

Figure 12: The average number of deer pellet groups (fresh and old black) per transect in Ravalli Curves and Ravalli Hill areas combined and associated standard deviations.

As an indication of potential population fluctuations of the deer (*Odocoileus* sp.) populations on the reservation, the researchers summarized the number of reported large animal carcasses (Figure 13) and the number of reported crashes with large animals (Figure 14) along the unmitigated sections of US Hwy 93 North and the other roads on the reservation. The number of carcasses was relatively low in 2008, but less so in 2009. The number of reported crashes with large wild mammals was relatively high however in 2008.

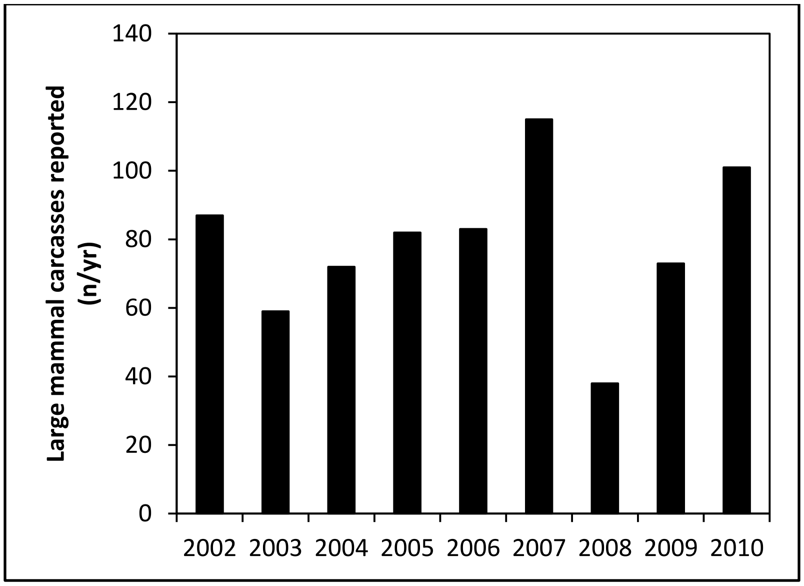

Figure 13: The number of wild large mammal carcasses that were reported between 2002 and 2010 for the unmitigated section of US Hwy 93 North and the other roads on the reservation combined.

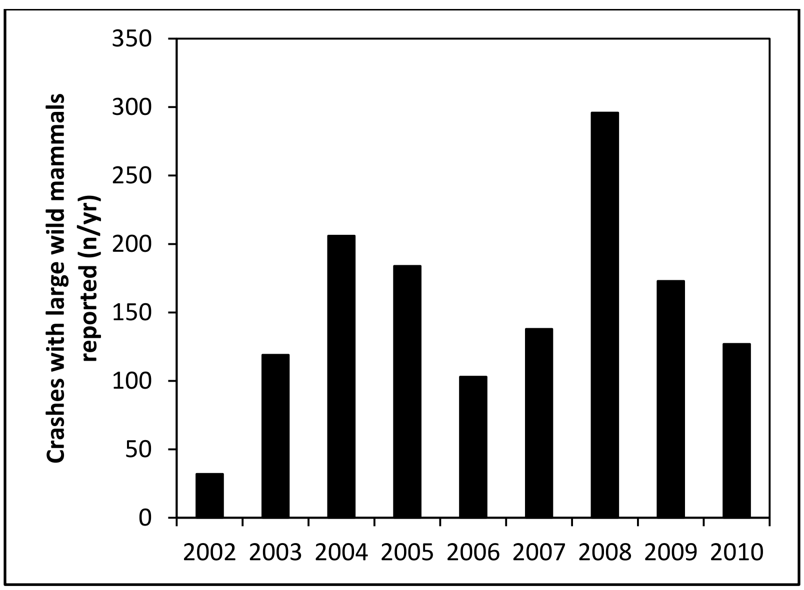

Figure 14: The number of animal-vehicle crashes that were reported between 2002 and 2010 for the unmitigated sections of US Hwy 93 North and the other roads on the reservation.

2.4. Discussion and Conclusion

At first glance the carcass removal and crash data suggest a 22-41% 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 very substantially in 2008 and 2009, perhaps suggesting very effective mitigation measures. However, the number of reported large mammal carcasses dropped similarly for the unmitigated road sections between Evaro and Polson, suggesting 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. There may also be a problem with the reporting system as a handful of observations from 2008 and 2009 were misplaced and then retrieved 2010. However, 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 North. For roads on the reservation as a whole, the number of carcasses was also low in 2008, but less so in 2009. The number of reported crashes with large wild mammals was relatively high however in 2008; a somewhat confusing result at this time. Nonetheless, 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 North may have had much better access to food, and the private lands along US 93 North may also provide some refuge from hunters.

In conclusion, the data suggest that there may have been substantial reduction in search and reporting effort for the carcass removal data in 2008 and 2009. Alternatively ongoing construction may have caused lower vehicle speeds and lower numbers of crashes in selected areas. This will be investigated in greater detail later on in the project. It is important that this issue is indeed further investigated, and potentially corrected, as one of the three core research questions is at least partially based on these carcass removal data. The 2010 carcass data suggest that if search and reporting effort may have been restored to its original levels from before 2008. Regardless, the crash data that do seem to have had consistent search and reporting effort suggest that the number of crashes with large wild mammals was reduced by about 22% 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.

3. MITIGATION MEASURES AND HABITAT CONNECTIVITY FOR WILDLIFE

3.1. Introduction

The preconstruction research measured the number of animals, especially deer and black bear, crossing 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 preliminary data for the use of the wildlife crossing structures in Ravalli Curves and Ravalli Hill in 2010. 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

In 2010 the wildlife use of the underpasses in the Ravalli Curves and Ravalli Hill was measured through tracking beds (1 January 2010 through 26 February 2010), and is currently measured through wildlife cameras (from 26 February 2010 onwards). The structures in the Evaro area were under construction in 2009 and part of 2010. Cameras were implemented at these crossing structures at different dates in 2010. Table 2 provides an overview of what structures were monitored through what means in the Evaro, Ravalli Curves, and Ravalli Hill areas.

The tracking beds in Ravalli Hill and Curves were checked for tracks once a week between 1 January 2010 and 26 February 2010. However, as all of the structures in Ravalli Curves and Ravalli Hill were equipped with a camera from 26 February 2010 onwards, the need for tracking 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.

Some of the structures had a wildlife camera installed in 2008. Structure RC 377 (Schall Flats #1) is permanently inundated (i.e. permanently filled with standing water) 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. However, for the purpose of consistency, the researchers only used tracking data for the structures in Ravalli Curves between 1 January 2010 and 26 February

2010. The researchers ignored potential supplemental data from the cameras for this period (1 January 2010 through 26 February 2010) and then relied on camera data only for the remainder of the year (26 February 2010 through 31 December 2010). For the structures in Ravalli Hill, the researchers used camera data only for 2010 (1 January 2010 through 31 December 2010). Human use of the structures was excluded for the purpose of this report.

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"). 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".

A variety of parameters were recorded. For the purpose of this report the researchers included all data on animals that the researchers believed actually crossed the structures. Animals that approached and then turned back were not included.

Table 2: The 17 wildlife crossing structures in road sections with continuous fencing in the Evaro, Ravalli Curves and Ravalli Hill areas that were monitored for wildlife use in 2010, and the methods of monitoring used for this report.

Area	**Name structure**	**Method**	**Period monitored for this report**
Evaro	EV 163 Montana Rail Link underpass (partial coverage with 2 cameras 8 September 2010) full coverage from 18 September 2010 onwards.	Camera	a. 18 September 2010 – 31 December 2010
	EV 169 Finley creek 1 EV 172 Finley creek 2 EV 176 Finley creek 3 EV 181 Finley creek 4 Cameras installed 3 September 2010 with full coverage from 8 September 2010 onwards	Camera	a. 8 September 2010 - 31 December 2010
	EV 173 Wildlife Overpass: Incidental cameras on overpass in June and early July, partial coverage wildlife overpass (partial coverage with 4 cameras; 6-29 July) (full coverage 1 approach with 7 cameras; 29 July- 18 August, full coverage both approaches 8 August-present).	Camera	a. June 2010 – 31 December 2010
Ravalli Curves	RC 377 (Schall Flats #1)	Camera	a. 1 January 2010 – 31 December 2010
	RC 381 (Spring Creek) RC 396 (Ravalli Curves #1) RC 406 (Ravalli Curves #2) RC 422 (Jocko Side Channel) RC 426 (Ravalli Curves #3) RC427(Ravalli Curves #4) RC 431(Ravalli Curves #5) RC 432 (Copper Creek)	a. Tracking bed b. 2 cameras	a. 1 January 2010 – 26 February 2010 b. 26 February 2010 - 31 December 2010
Ravalli Hill	RH 459 (Ravalli Hill #1) RH 463 (Ravalli Hill #2)	a. Tracking bed b. 2 cameras	a. 1 January 2010 – 26 February 2010 b. 26 February 2010 - 31 December 2010

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).

3.2.2. Isolated Crossing Structures

While continuous fencing over relatively long road sections combined with wildlife crossing structures can result in a substantial (>80%) 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 (Table 3). 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. Only actual crossings are included. Human use of the structures was excluded for the purpose of this report.

Table 3: The 12 isolated wildlife crossing structures that were monitored for wildlife use in 2010, and the methods of monitoring used for this report.

Name structure	Method	Date or period monitored
148 (North Evaro)	Camera	6 July 2010 – 31 December 2010
198 (Schley Creek)	Camera	29 June 2010 - 31 December 2010
204 (East Fork Finley Creek)	Camera	4 October 2010 – 31 December 2010
499 (Pistol creek #1)	Camera	1 January 2010 – 31 December 2010
502 (Pistol creek #2)	Camera	1 January 2010 – 31 December 2010
529 (Mission Creek)	a. Camera (south side) b. Camera (north side)	a. 1 January 2010 – 31 December 2010 b. 13 October 2010 -31 December 2010
551 (Post Creek #1)	Camera	29 June 2010 – 31 December 2010
555 (Post Creek #2)	Camera	1 January 2010 – 31 December 2010
560 (Post Creek #3)	Camera	1 January 2010 – 31 December 2010
774 (Spring Creek #1)	Camera	1 January 2010 – 31 December 2010
784 (Spring Creek #2)	Camera	11 March 2010 - 31 December 2010
917 (Polson Hill)	Camera	11 October 2010 - 31 December 2010

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. Currently, data are collected at four guards (Table 4). 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 distinguish between the direction of travel of the animals. Data through mid 2010 have been analyzed and have been reported by Allen (2011).

Table 4: The wildlife guards that were monitored for wildlife approaches and crossing between 2007 through 2010, 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
Guard north of RC 381	Camera	31 October 2010 - present
Guard just north of RC 396	Camera	20 October 2010- 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, 10 June 2009 - 17 August 2009, and 13 June 2010 – 2 November 2010. 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. There were an additional 23 jump-outs monitored in the Evaro area. These were monitored 4 August 2010 - 2 November 2010. For this annual report the jump-out data were not analyzed.

3.3. Results

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

For the purpose of this report the researchers provide data on wildlife crossings for the following road section or groups of structures (Table 5):

Table 5: The structures or groups of structures that the wildlife crossing data were summarized for in this report.

Area	Structure or group of structures	Period summarized	Comment
Evaro	Montana Rail link underpass	None	Data not entered yet
	Finley creek 1, 2, 3, and 4	8 September 2010 – 31 December 2010	
	Wildlife overpass	June 2010 – 31 July 2010	From August 2010 onwards data not entered yet
Ravalli Curves	9 structures in Ravalli Curves	1 January 2010 – 31 December 2010	
Ravalli Hill	2 structures in Ravalli Hill	1 January 2010 – 31 December 2010	
Different locations	Isolated crossing structures	Different starting times 2010 – 31 December 2010	See Table 3

In 2010 a minimum of 12,022 movements by animals passed through the structures listed in table 5 (Figure 15, Table 6). The preliminary estimate of the number of animal crossings through the structures that were monitored was dominated by white-tailed deer and mule deer and domestic dogs and cats (Figure 15). The estimate is reported as a minimum because not all structures were monitored for the entire year.

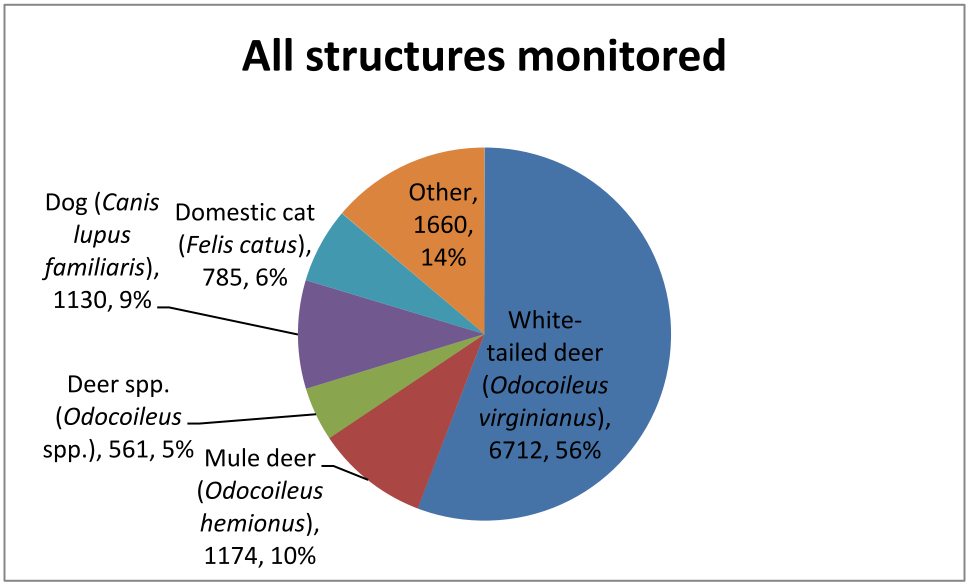

Figure 15: Wildlife use of all wildlife crossing structures monitored in 2010 with different start dates through 31 December 2010. Preliminary data (N=12022).

Table 6: The number and percentage of the crossing that related to the species that were grouped in the "other" category in Figure 15.

Species	N	%
Coyote (*Canis latrans*)	356	2.96
Black bear (*Ursus americanus*)	297	2.47
Raccoon (*Procyon lotor*)	281	2.34
Bobcat (*Lynx rufus*)	142	1.18
Birds (Aves)	125	1.04
Red fox (*Vulpes vulpes*)	95	0.79
Western striped skunk (*Mephitis mephitis*)	86	0.72
Dog or Coyote (*Canis* spp.)	73	0.61
Mountain lion (*Felis concolor*)	29	0.24
Rabbits and hares (Lagomorpha)	26	0.22
American badger (*Taxidea taxus*)	20	0.17
Beaver (*Castor canadensis*)	14	0.12
Bear spp. (*Ursus* spp.)	10	0.08
River otter (*Lutra canadensis*)	6	0.05
Grizzly bear (*Ursus arctos*)	3	0.02
Long-tailed weasel (*Mustela frenata*)	2	0.02
Horse (*Equus ferus*)	2	0.02
Yellow-bellied marmot (*Marmota flaviventris*)	2	0.02
Common porcupine (*Erethizon dorsatum*)	1	0.01
Moose (*Alces alces*)	1	0.01
Unknown	1	0.01
Other	66	0.55
Unknown	22	0.18

The number of crossings through the groups of crossing structures listed in Table 5 is shown in Figures 16 through 20 and Tables 7 through 11.

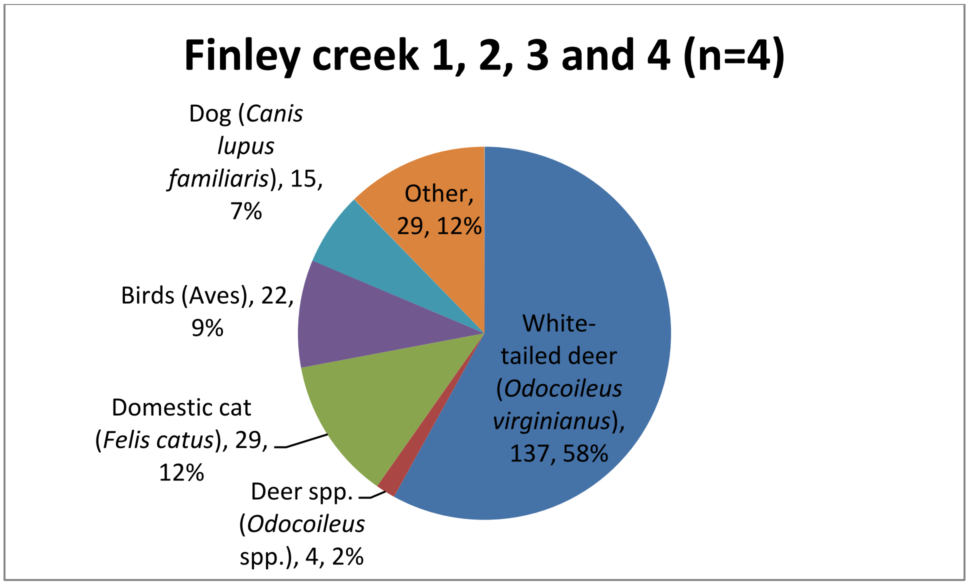

Figure 16: Wildlife use of the 4 Finley creek underpasses in Evaro between 8 September 2010 and 31 December 2010. Preliminary data (N=236).

Table 7: The number and percentage of the crossing that related to the species that were grouped in the "other" category in Figure 16.

Species	**N**	**%**
Black bear (*Ursus americanus*)	9	3.81
Bobcat (*Lynx rufus*)	9	3.81
Raccoon (*Procyon lotor*)	9	3.81
Coyote (*Canis latrans*)	1	0.42
Red fox (*Vulpes vulpes*)	1	0.42

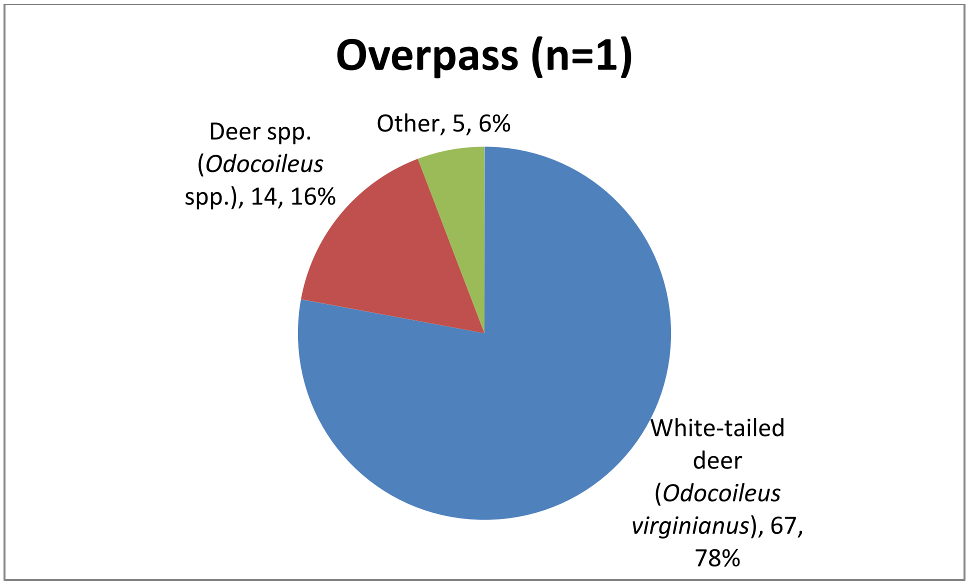

Figure 17: Wildlife use of the wildlife overpass in Evaro between June 2010 and 31 July 2010. Preliminary data (N=86).

Table 8: The number and percentage of the crossing that related to the species that were grouped in the "other" category in Figure 17.

Species	**N**	**%**
Black bear (*Ursus americanus*)	2	2.33
Domestic cat (*Felis catus*)	1	1.16
Moose (*Alces alces*)	1	1.16
Unknown	1	1.16

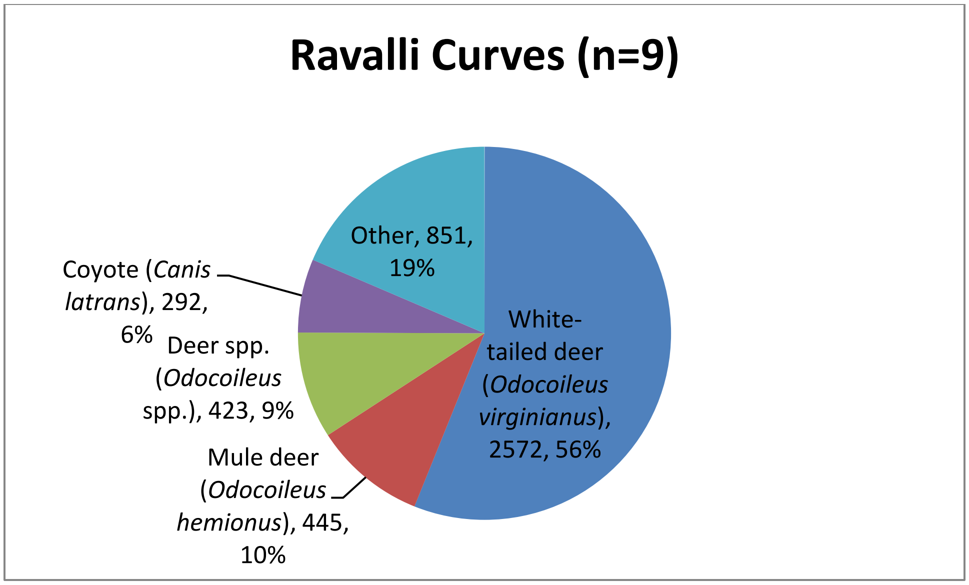

Figure 18: Wildlife use of the 9 underpasses in Ravalli Cures between 1 January 2010 and 31 December 2010. Preliminary data (N=4583).

Table 9: The number and percentage of the crossing that related to the species that were grouped in the "other" category in Figure 18.

Species	N	%
Domestic cat (*Felis catus*)	186	4.06
Raccoon (*Procyon lotor*)	169	3.69
Black bear (*Ursus americanus*)	162	3.53
Bear spp. (*Ursus* spp.)	10	0.22
Bobcat (*Lynx rufus*)	94	2.05
Dog or Coyote (*Canis* spp.)	69	1.51
Western striped skunk (*Mephitis mephitis*)	62	1.35
Birds (Aves)	26	0.57
Rabbits and hares (Lagomorpha)	26	0.57
Beaver (*Castor canadensis*)	14	0.31
River otter (*Lutra canadensis*)	6	0.13
Mountain lion (*Felis concolor*)	5	0.11
American badger (*Taxidea taxus*)	3	0.07
Red fox (*Vulpes vulpes*)	3	0.07
Long-tailed weasel (*Mustela frenata*)	2	0.04
Horse (*Equus ferus*)	2	0.04
Unknown	12	0.26

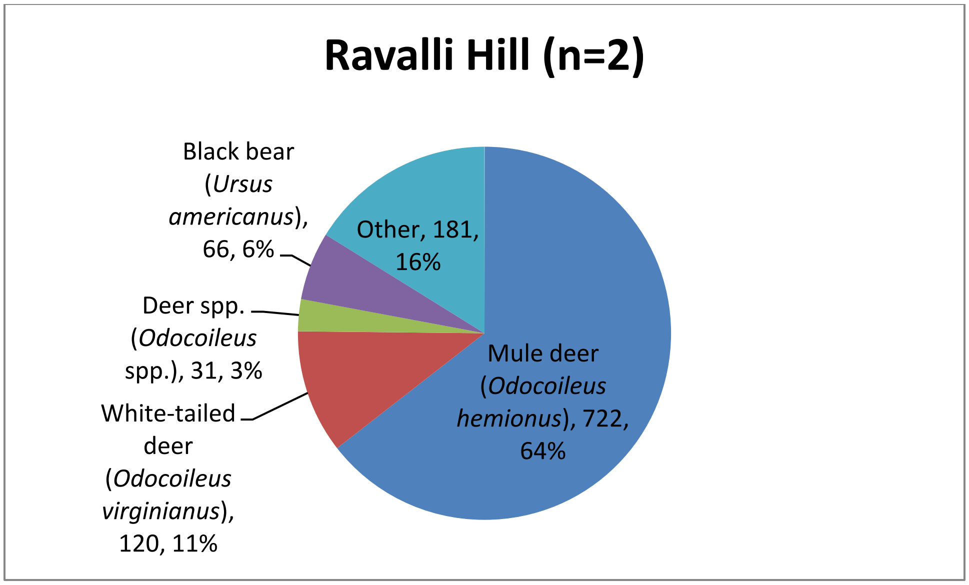

Figure 19: Wildlife use of the 2 underpasses in Ravalli Hill between 1 January 2010 and 31 December 2010. Preliminary data (N=2866).

Table 10: The number and percentage of the crossing that related to the species that were grouped in the "other" category in Figure 19.

Species	N	%
Coyote (*Canis latrans*)	49	4.38
Bobcat (*Lynx rufus*)	28	2.50
Mountain lion (*Felis concolor*)	22	1.96
Birds (Aves)	11	0.98
American badger (*Taxidea taxus*)	7	0.63
Domestic cat (*Felis catus*)	5	0.45
Western striped skunk (*Mephitis mephitis*)	6	0.54
Raccoon (*Procyon lotor*)	4	0.36
Dog or Coyote (*Canis* spp.)	3	0.27
Red fox (*Vulpes vulpes*)	1	0.09
Other	45	4.02

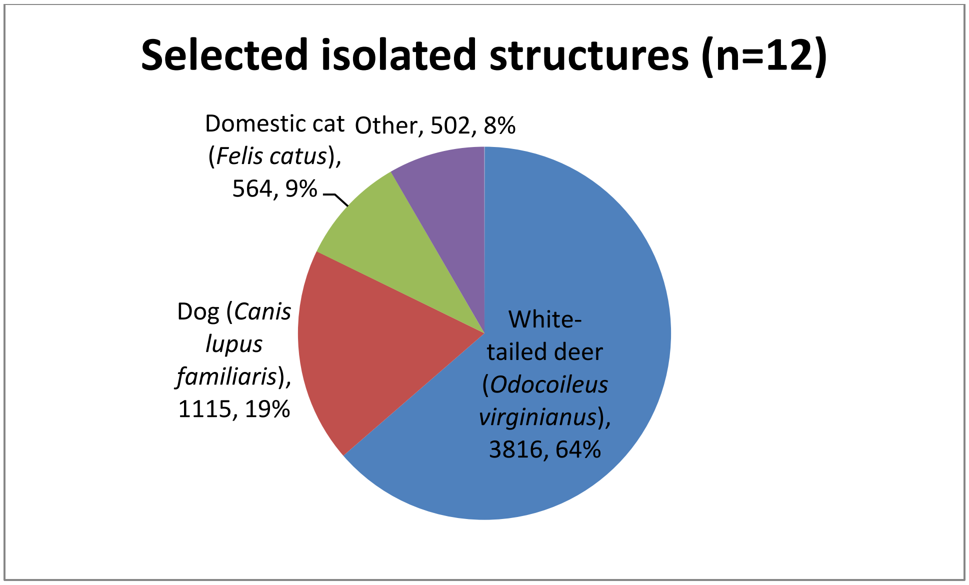

Figure 20: Wildlife use of the 12 isolated structures with varying start dates in 2010 through 31 December 2010. Preliminary data (N=5997).

Table 11: The number and percentage of the crossing that related to the species that were grouped in the "other" category in Figure 20.

Species	N	%
Raccoon (*Procyon lotor*)	99	1.65
Red fox (*Vulpes vulpes*)	90	1.50
Deer spp. (*Odocoileus* spp.)	89	1.48
Birds (Aves)	66	1.10
Black bear (*Ursus americanus*)	58	0.97
Grizzly bear (*Ursus arctos*)	3	0.05
Western striped skunk (*Mephitis mephitis*)	18	0.30
Coyote (*Canis latrans*)	14	0.23
Bobcat (*Lynx rufus*)	11	0.18
American badger (*Taxidea taxus*)	10	0.17
Mule deer (*Odocoileus hemionus*)	7	0.12
Yellow-bellied marmot (*Marmota flaviventris*)	2	0.03
Mountain lion (*Felis concolor*)	2	0.03
Dog or Coyote (*Canis* spp.)	1	0.02
Common porcupine (*Erethizon dorsatum*)	1	0.02
Other	21	0.35
Unknown	10	0.17

3.4. Discussion and Conclusion

The wildlife crossing structures in the road sections with continuous fencing in Evaro, Ravalli Curves and Ravalli Hill, as well as the selected isolated structures appear to receive substantial use by a wide variety of wildlife species, especially white-tailed deer and mule deer, and domestic dogs and cats. Coyotes, black bears, birds, yellow-bellied marmot, beaver, common porcupine, rabbits and hares, raccoon, long-tailed weasel, American badger, western striped skunk, bobcat, mountain lion, red fox, moose, horse, and grizzly bear were observed less 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.

It is noteworthy that there were three crossings by grizzly bears, and none by elk (*Cervus canadensis*), although elk are known to occur in the Evaro and Ravalli areas on both sides of the road. The latter observations may lead to discussions about the location, type, dimensions and design of crossing structures in areas where elk is a target species.

4. COST-BENEFIT ANALYSIS

No activities regarding cost-benefit analysis took place in 2010.

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