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 2013

by

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EXECUTIVE SUMMARY

This fourth annual report contains a preliminary summary for work conducted in 2012 for the US Highway 93 North wildlife mitigation evaluation project on the Flathead Indian Reservation, Montana, United States of America. The mitigation measures along this section of US Highway 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.

Carcass removal data and crash data suggest a substantial decrease in the number of wildlife-vehicle collisions in the Evaro, Ravalli Curves and Ravalli Hill areas after the mitigation measures were installed; 50% and 65% respectively. However, the absolute number of crashes was 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.

The number of fresh and old black pellet groups was variable through the years with high standard deviations. The data indicate that deer continue to be present in more or less similar numbers in the Evaro, Ravalli Curves and Ravalli Hill areas. However, the pellet group counts cannot detect subtle changes in population size as the standard deviations are high.

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 (at least 20 animal species in 2012), especially white-tailed deer, mule deer, and domesticated dogs and cats. It is noteworthy that the number of crossings by grizzly bears was down from 15 (in 2011) to 4 (in 2012). The number of elk crossings was down from 6 (in 2011) to 2 (in 2012). In addition, it is interesting that the 2 crossings by moose were both on the wildlife overpass. Moose crossings in previous years have also been exclusively on the overpass, suggesting a strong selection for the overpass versus the nearby underpasses for this species.

For the road sections with a concentration of mitigation measures (Evaro, Ravalli Curves and Ravalli Hill) the average number of deer (white-tailed deer and mule deer combined) that were estimated to cross the road before road reconstruction was estimated at 1,732 per year (2003 through 2005) while this number was 109 for black bears (Hardy *et al.* 2007). It appears that far more deer (n=9,084) and black bear (n=366) crossings occurred through the structures in these areas in 2012 than the pre-mitigation reference values, with no indication of a considerable increase in the deer population in 2012 compared to 2004 and 2005 (see pellet group counts in Chapter 2). However, a direct comparison of the pre-construction and post-construction deer and black bear crossings can only be made after several corrections have been made; the pre-construction data only relate to part of the year (May-October) while the current camera data relate to the full calendar year, and there are likely differences in the detection probability for sand tracking beds along the roadway, inside underpasses, and cameras at underpasses.

While wildlife use of the structures can be considered substantial, the term “success” is specifically defined based on consensus between Montana Department of Transportation (MDT), Confederated Salish and Kootenai Tribes (CSKT) and Federal Highway Administration (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 the stakeholders listed above.

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 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 miles (phase 1, 2 and 3A); Clevenger *et al.* 2002), State Route 260 in Arizona (17 crossing structures over 19 miles; Dodd *et al.* (2006)), and I-90 at Snoqualmie Pass East in Washington State (about 30 crossing structures planned over 15 miles; WSDOT 2007). Both the road length and number of wildlife crossing structures of US 93 North on the Flathead Indian Reservation makes it among the most extensive mitigation projects of this 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.

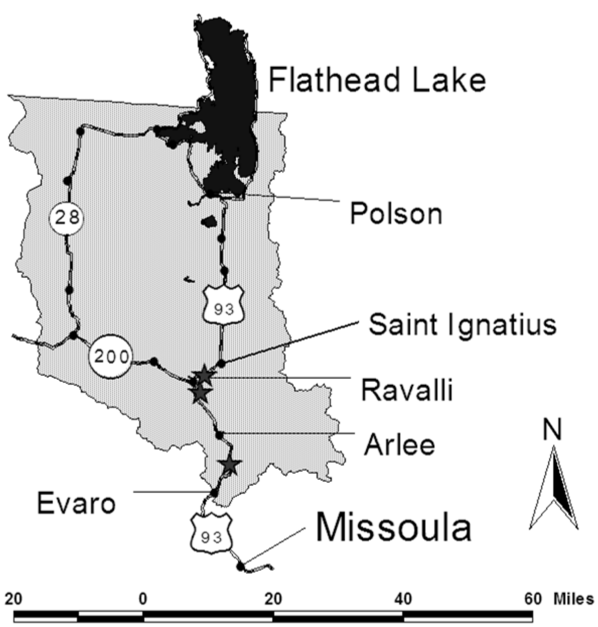

Figure 1: The Flathead Indian Reservation in northwestern Montana including major highways. The US 93 North reconstruction effort and evaluation study area relates to a 56 miles (90 km) road section from Evaro to Polson. Stars represent the Evaro, Ravalli Curves, and Ravalli Hill study areas from south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

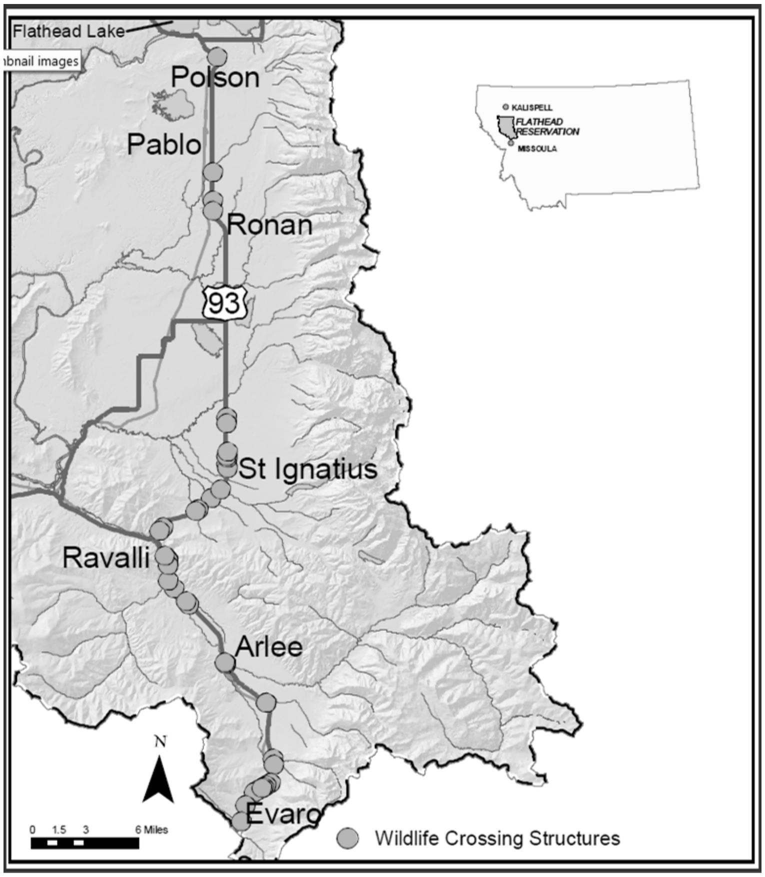

Figure 2: The location of the 41 fish and wildlife crossing structures along US 93 North on the Flathead Indian Reservation in northwestern Montana.

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, resulting in relatively short sections of wildlife fencing and gates or wildlife guards at access roads. This is in contrast to the more natural vegetation along most of the other road sections that have large scale wildlife mitigation including continuous wildlife fencing 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.

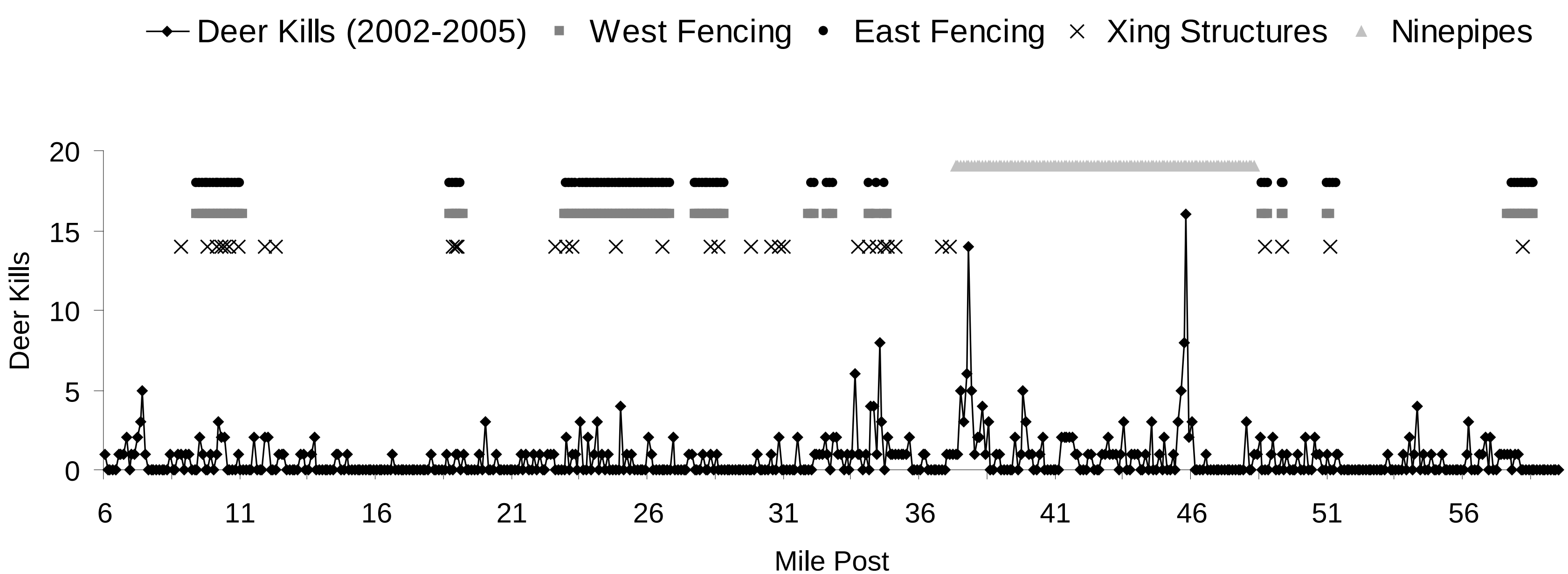

Figure 3: Total reported deer-vehicle collisions for each 0.1 mile between 2002-2005 along the US 93 North study area, including mitigation measures. Location of the following areas with continuous fencing and mitigation measures: Evaro (mile reference post 9.4-11.1), Ravalli Curves (22.9-26.8), and 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).

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 maintain 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 fourth in a series of annual reports detailing the progress on these tasks.

1.3. Post-Construction Research Activities Prior to 2012

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 fellowship for Tiffany Allen and Jeremiah Purdum, allowing them to pursue her M.Sc. degree at MSU and the University of Montana respectively. The previous three annual reports summarized the activities and results of these activities through December 2011 (Huijser et al., 2010; 2011; 2013). The current annual report summarizes the main results of data collected in 2012.

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 between 135 and 211 human fatalities, between 26,647 and 29,000 human injuries and over one billion US dollars in property damage annually (Conover *et al.* 1995; Khattak 2003; Centers for Disease Control and Prevention 2004). 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 substantial 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 not, inconsistently or rarely reported. It is notable though that the western painted turtle (*Chrysemys picta bellii*) 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 2012. 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 researchers distinguished three different time periods: before reconstruction, during reconstruction, and after reconstruction. The preliminary analyses for this report combined data for the three areas listed in Table 1, but, as a consequence only two year of post construction data were available (Evaro only had post-reconstruction data available for 2011 and 2012). Additional analyses for this report distinguished between Evaro and the other two areas (Ravalli Curves and Ravalli Hill) which allowed for the inclusion of five years with post reconstruction data from Ravalli Curves and Ravalli Hill (2008 through 2012).

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
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 around in a certain year than in a previous year, more deer-vehicle collisions can be expected. Similarly, reduced deer population size can 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 for the Flathead Indian Reservation, pellet group surveys were conducted in the Evaro and in the Ravalli Curves and Ravalli Hill areas to provide a relative measure for potential changes in deer population size. There were 24 transects perpendicular to the road; 11 in the Evaro area and 13 in the Ravalli Curves and Ravalli Hill areas. 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 and 2005, and 2008 through 2012. However, the 2008 through 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 identify the animal species. The species involved with animal-vehicle collisions along US 93 North between 1 January 1998 and 31 December 2012, based on carcass removal data, consist mostly of large mammals and are heavily dominated by white-tailed deer (Figure 4). The category “domestic” (n=12) 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. “Unknown” species (n=1) were excluded as well. Relatively small wild species (n=13) were 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) as it is unlikely that they were consistently recorded and they are too small to pose a substantial safety risk to humans.

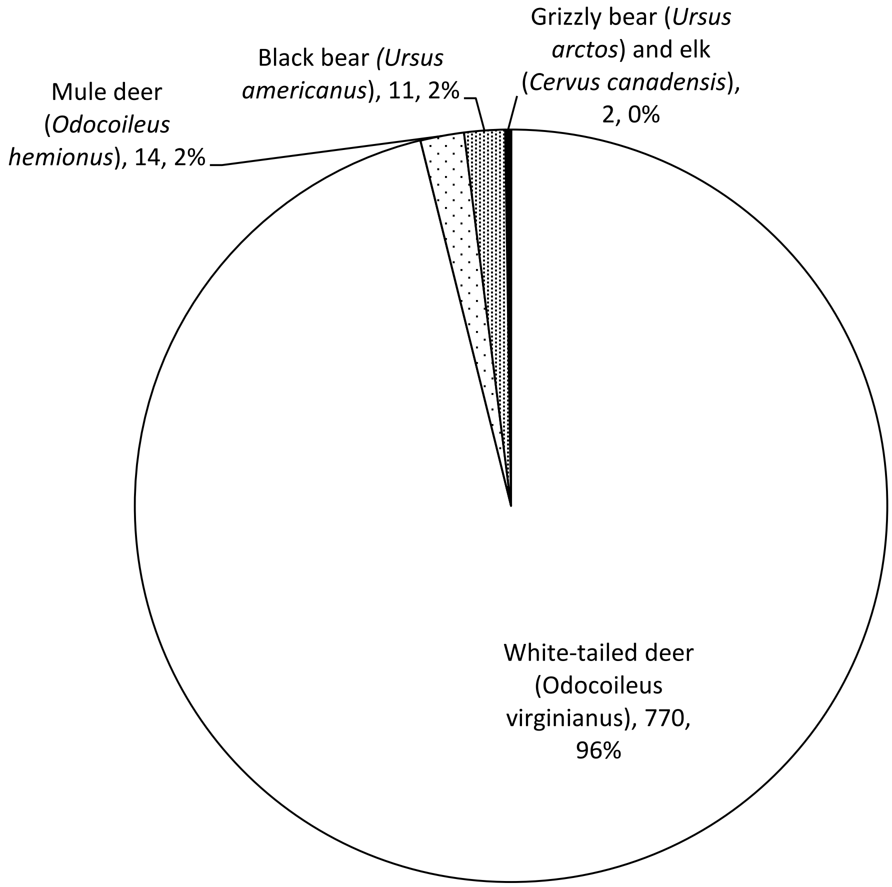

Figure 4: Species involved with animal-vehicle collisions based on carcass removal data (1998 through 2012) along US 93 North between Evaro and Polson (N=801).

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 average number of large mammal carcasses in the Evaro, Jocko River, and Ravalli Curves and Ravalli Hill areas is shown in Figures 5-7. The research concentrates on three road sections with a concentration of mitigation measures: Evaro, Ravalli Hills and Ravalli Curves.

The number of reported large wild mammal carcasses was lower during reconstruction and after the implementation of the mitigation measures than before reconstruction. For Evaro, Ravalli Curves and Ravalli Hill combined (two years of post mitigation data), there was a decrease of 50% in the average number of reported large mammal carcasses per year (Figure 5).

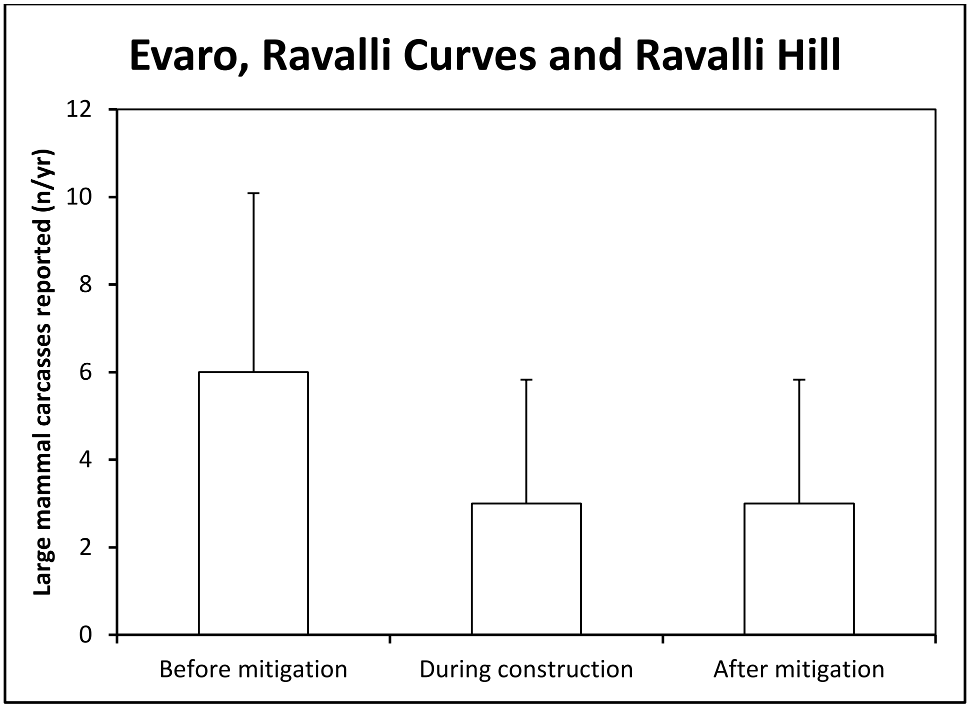

Figure 5: The number of wild large animal carcasses and associated standard deviation reported in Evaro, Ravalli Curves and Ravalli Hill.
The numbers relate to the four years before reconstruction (without mitigation), the two years during reconstruction, and one year after reconstruction (with mitigation) in the Evaro, Ravalli Curves, and Ravalli Hill areas combined. Note that the reconstruction for the areas took place in different years (see Table 1) and that there were only two years with post construction data available for the Evaro area (2011-2012).

The Evaro area, with only two years of post-reconstruction data, showed a decrease of 36.4% in the average number of reported large mammal carcasses per year (Figure 6) whereas Ravalli Curves and Ravalli Hill, with four years of post-reconstruction data combined showed a decrease of 32.7% (Figure 7).

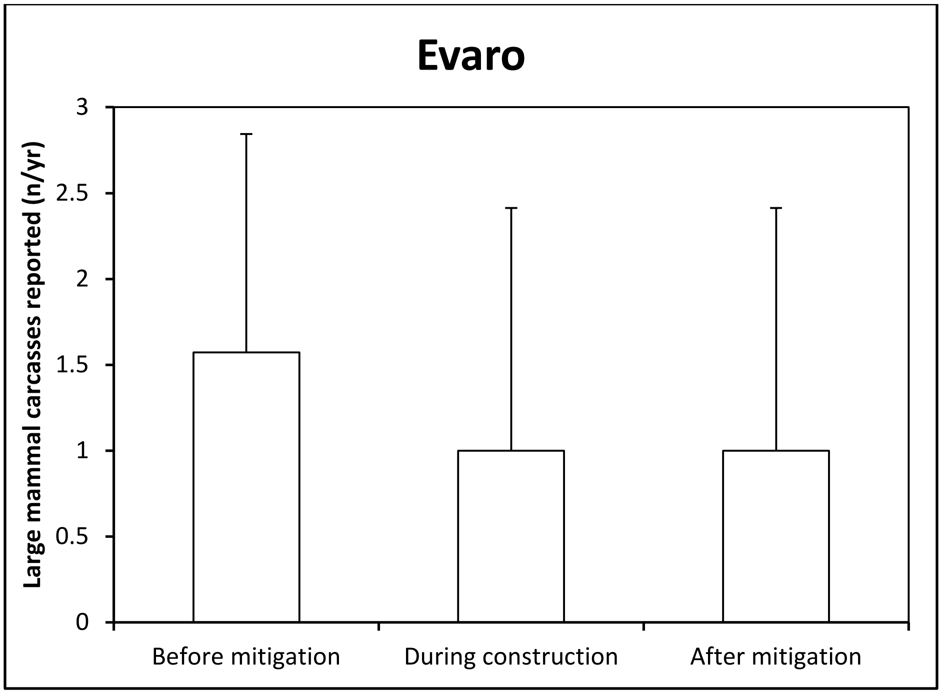

Figure 6: The number of wild large mammal carcasses and associated standard deviation that were reported in Evaro.
The numbers relate to the periods before (without mitigation), during, and after reconstruction (with mitigation) in the Evaro area. Before = 2002 through 2008, during = 2009 and 2010, after = 2011 and 2012.

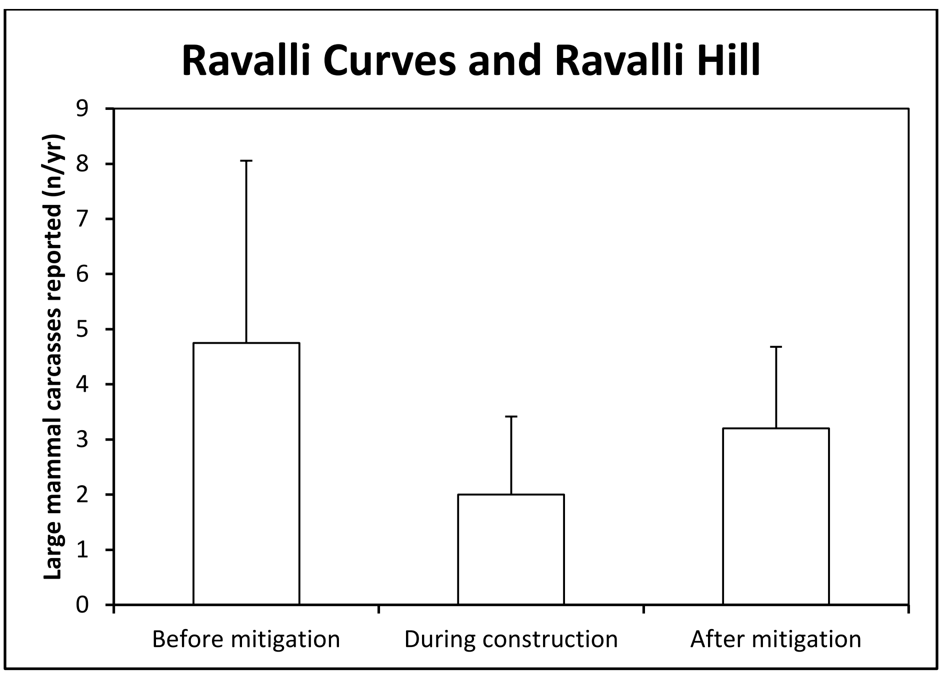

Figure 7: The number of wild large mammal carcasses and associated standard deviation that were reported in Ravalli Curves and Ravalli Hill.
The numbers relate to the periods before (without mitigation), during, and after reconstruction (with mitigation) in the Ravalli Curves and Ravalli Hill area combined. Before = 2002 through 2005, during = 2006 and 2007, after = 2008 through 2012.

The number of reported crashes with large wild mammals was lower during reconstruction and after the implementation of the mitigation measures than before reconstruction. For Evaro, Ravalli Curves and Ravalli Hill combined (two years of post-mitigation data), there was a decrease of 65.2% in the average number of reported large mammal carcasses per year when comparing the "after mitigation data" to the "before mitigation data" (Figure 8).

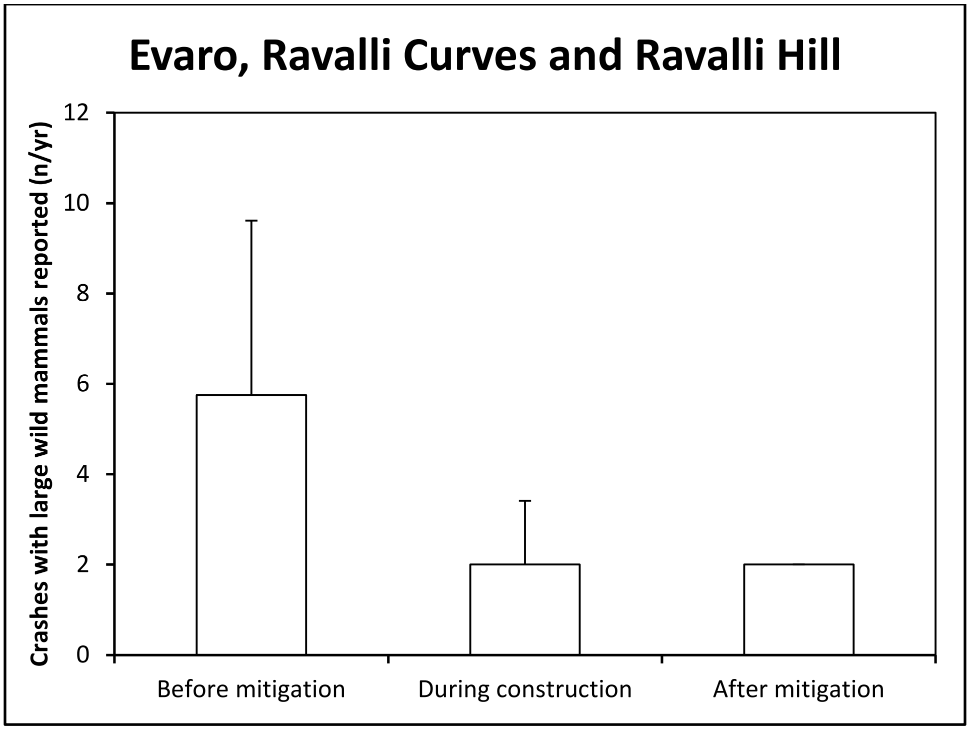

Figure 8: The number of crashes with large wild mammals and associated standard deviation that were reported in Evaro, Ravalli Curves and Ravalli Hill.
The numbers relate to the four years before reconstruction (without mitigation), the two years during reconstruction, and two years after reconstruction (with mitigation) in the Evaro, Ravalli Curves, and Ravalli Hill areas combined. Note that the reconstruction for the areas took place in different years (see Table 1) and that there were only two years with post construction data available for the Evaro area (2011 and 2012).

The Evaro area, with only two years of post-reconstruction data, showed a decrease of 68.2% in the average number of reported crashes with large wild mammals per year when comparing the "after mitigation data" to the "before mitigation data" (Figure 9) whereas Ravalli Curves and Ravalli Hill, with five years of post-reconstruction data combined showed a decrease of 71.7% (Figure 10).

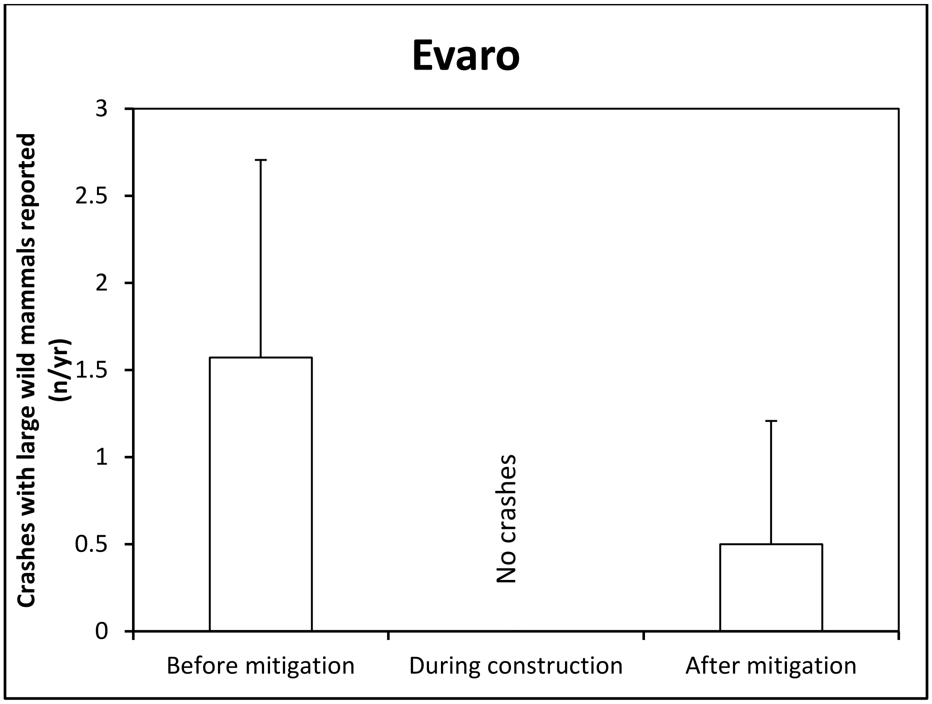

Figure 9: The number of crashes with large wild mammals and associated standard deviation that were reported in Evaro.
The numbers relate to the periods before (without mitigation), during, and after construction (with mitigations) in the Evaro area. Before = 2002 through 2008, during = 2009 and 2010, after = 2011 and 2012.

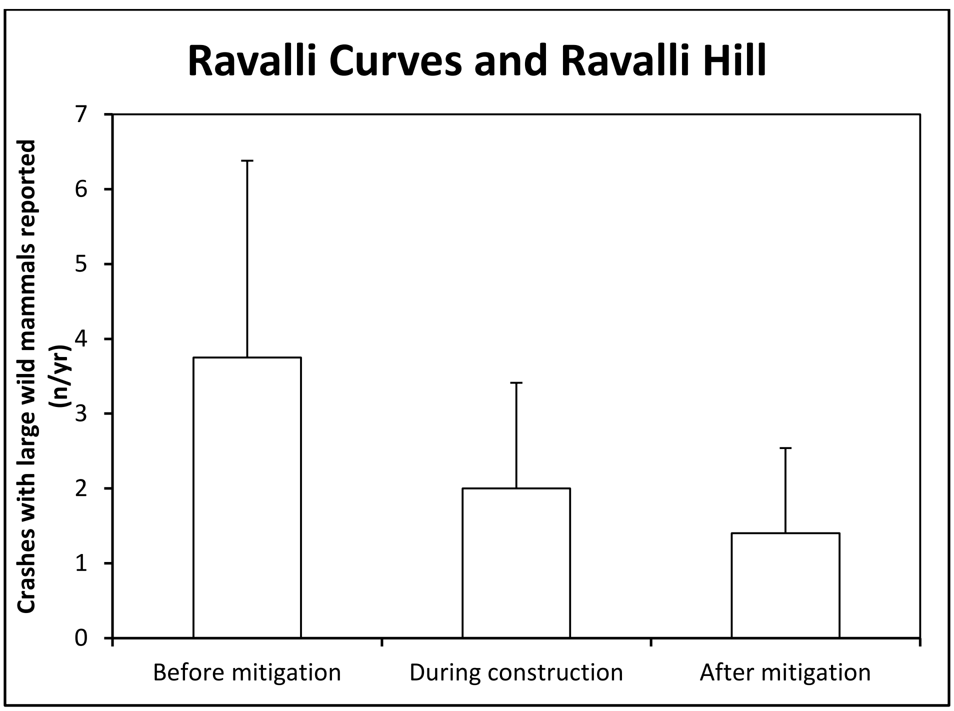

Figure 10: The number of crashes with large wild mammals and associated standard deviation that were reported in Ravalli Curves and Ravalli Hill.
The numbers relate to periods before (without mitigation), during, and after construction (with mitigation) in the Ravalli Curves and Ravalli Hill area combined. Before = 2002 through 2005, during = 2006 and 2007, after = 2008 through 2012.

The overall number of reported large mammal carcasses between Evaro and Polson dropped substantially in 2008 and 2009 with substantially higher numbers in 2010 through 2012 (Figure 11). However, a similar reduction occurred in the unmitigated road sections (Figure 11). 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 in crashes between 2007-2010, both for the entire road section between Evaro and Polson and the unmitigated road sections (Figure 12).

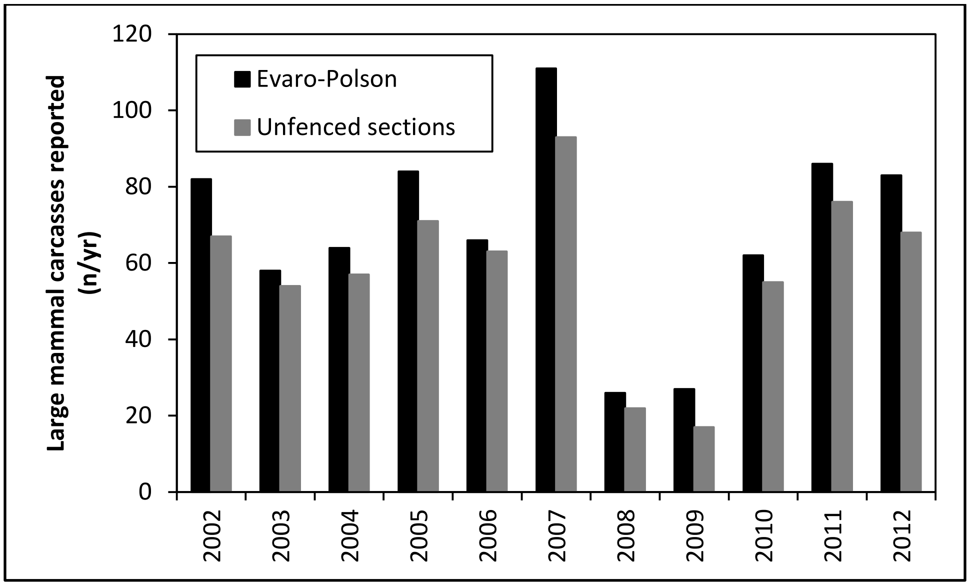

Figure 11: The number of wild large mammal carcasses that were reported between 2002 and 2012 for the entire 56 mile (90 km) between Evaro and Polson, and the road sections within this stretch that do not have wildlife fencing or wildlife crossing structures.

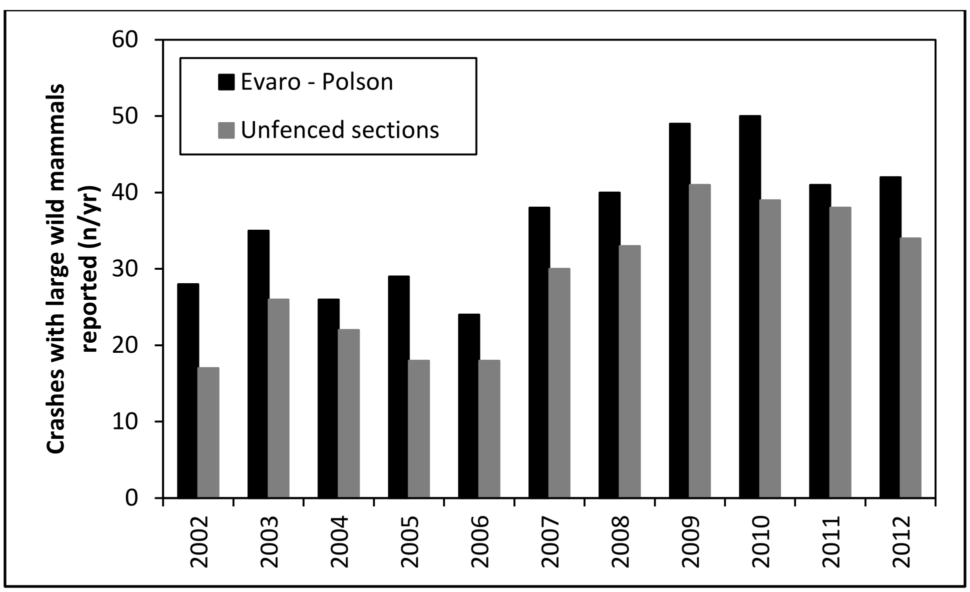

Figure 12: The number of animal-vehicle crashes that were reported between 2002 and 2012 for the entire 56 mile (90 km) between Evaro and Polson, and the road sections that do not have wildlife fencing or wildlife crossing structures.

2.3.1. Deer Pellet Group Surveys

The number of fresh and old black pellet groups in the Evaro, Ravalli Curves and Ravalli Hill areas combined was variable with relatively large standard deviations (Figure 13. However, if there is a change in the deer population before (2004-2005) and after mitigation (20112012) the data suggest a decline rather than an increase.

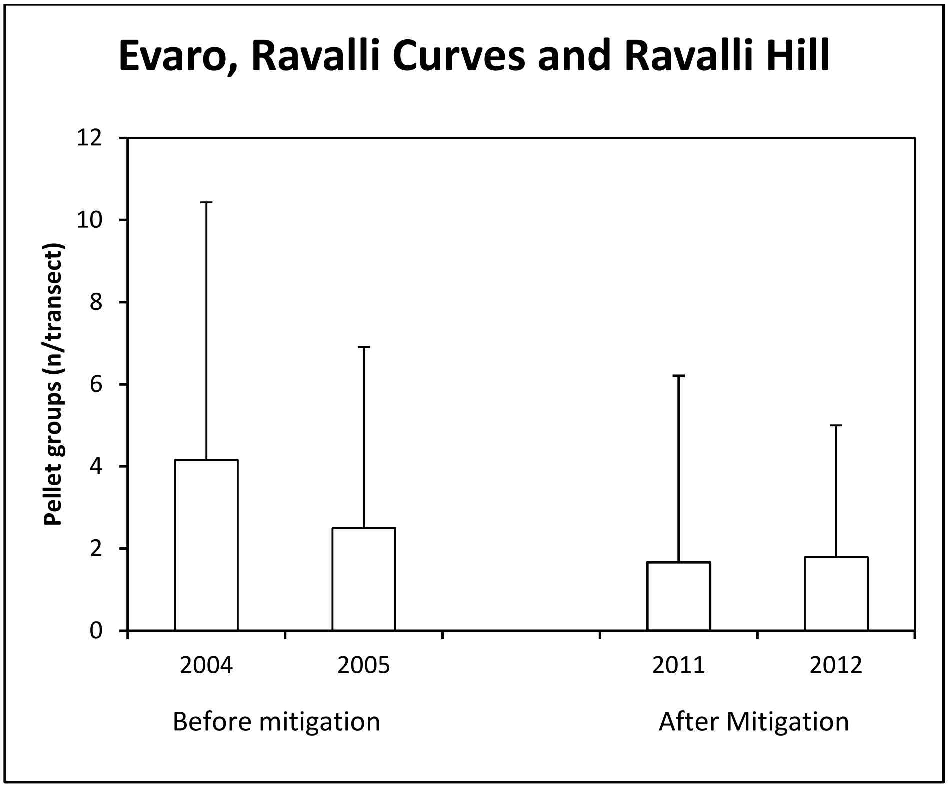

Figure 13: The average number of deer pellet groups (fresh and old black) per transect and associated standard deviations per year in the Evaro, Ravalli Curves and Ravalli Hill areas combined.

The pellet group data for the Evaro area are shown in Figure 14 whereas the data for the Ravalli Curves and Ravalli Hill data are shown in Figure 15.

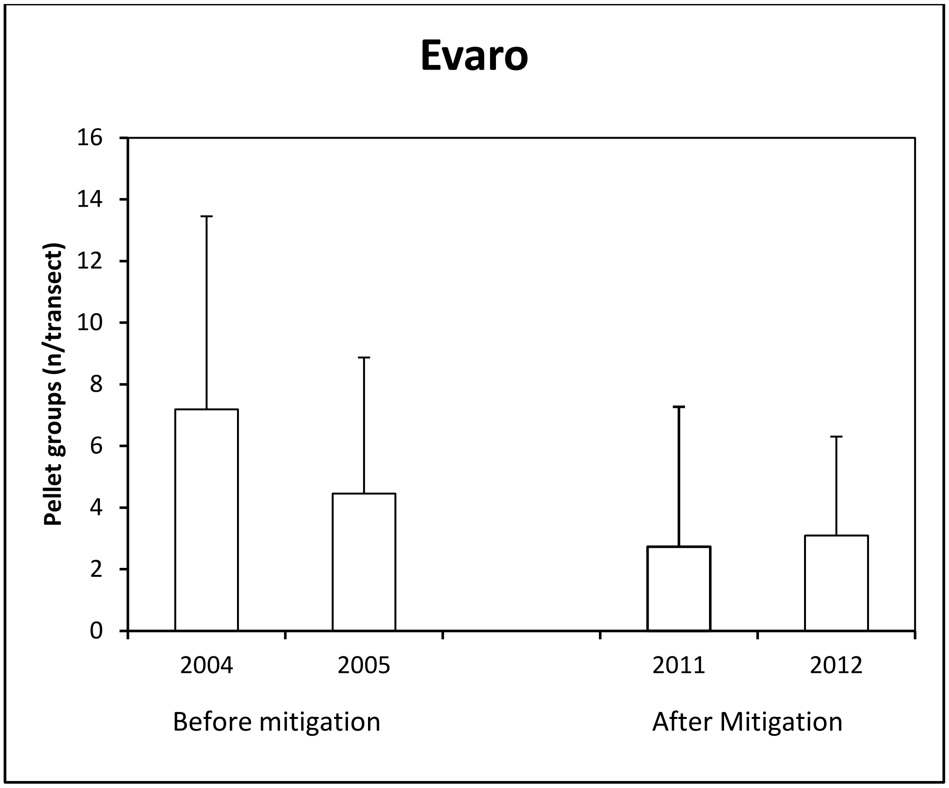

Figure 14: The average number of deer pellet groups (fresh and old black) per transect and associated standard deviations per year in the Evaro area.

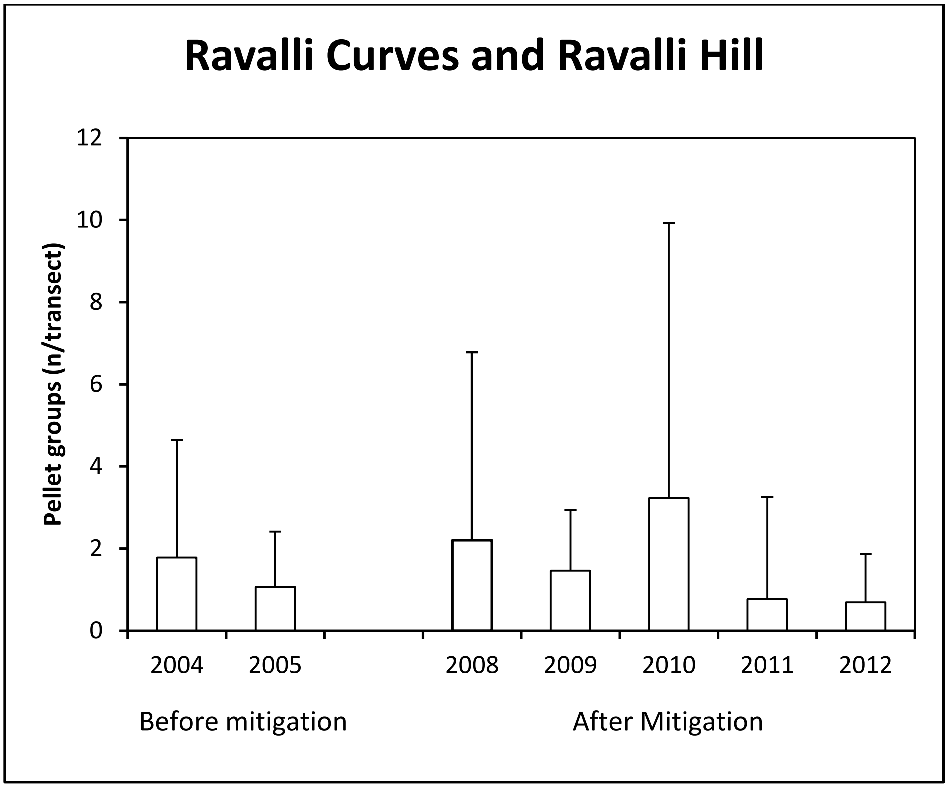

Figure 15: The average number of deer pellet groups (fresh and old black) per transect and associated standard deviations per year in the Ravalli Curves and Ravalli Hill areas.

2.4. Discussion and Conclusion

Based on the latest data the number of wildlife-vehicle collisions may have decreased by 50% (carcass removal data) or 65% (crash data). The absolute number of crashes was 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. As discussed previously (see Huijser et al., 2011), the carcass removal data collection effort may have been lower in 2008 and 2009 than in previous and later years. This may have resulted in underestimating the number of carcasses and overestimating the effectiveness of the mitigation measures in those years.

The number of fresh and old black pellet groups was variable through the years with high standard deviations. However, the data indicate that deer continue to be present in more or less similar numbers in the Evaro, Ravalli Curves and Ravalli Hill areas. However, the pellet group counts cannot detect subtle changes in population size as the standard deviations are high.

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 and the one overpass (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 the Evaro, Ravalli Curves and Ravalli Hill areas in 2012. 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)). For the effectiveness of wildlife guards the researchers refer to a recent publication in Wildlife Society Bulletin (Allen *et al*. 2013). The researcher will report on the effectiveness of the wildlife jump-outs in one of the following quarterly reports.

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. 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.

3.2. Methods

From 2008 until early 2010 the wildlife use of the structures was mostly monitored through sand tracking beds inside the structures. From early 2010 onwards, including 2012, the wildlife use of the crossing structures was measured through wildlife cameras that were placed inside the structures or at the approach of a structure. For the purpose of this report the researchers only included records that related to actual crossings (excluding animals that rejected the structure after approaching it, excluding animals walking by a structure). This included crossings by animals that were in a group with a “mixed response” where some of the animals in the group did not cross the road using the structure.

The researchers distinguished between the structures in the 1. Evaro area and 2. Ravalli Curves and Ravalli Hill areas (Table 2) as the structures in these areas were completed in different years. The structures in the Ravalli Curves and Ravalli Hill areas were completed in 2007 whereas the structures in Evaro were completed in 2010. This means that wildlife has had more time to learn about the location of the structures and that it is safe to use them in the Ravalli Curves and Ravalli Hill areas than in the Evaro area and that a separate analyses is appropriate for these areas for the 2012 data. The wildlife use of the “isolated” structures (Table 3) was summarized separately.

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 2012.

Area	Name structure
Evaro	EV 163 Montana Rail Link underpass
	EV 169 Finley creek 1
	EV 172 Finley creek 2
	EV 176 Finley creek 3
	EV 181 Finley creek 4
	EV 173 Wildlife Overpass:
Ravalli Curves	RC 377 (Schall Flats #1)
	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)
Ravalli Hill	RH 459 (Ravalli Hill #1) RH 463 (Ravalli Hill #2)

Table 3: The 12 isolated wildlife crossing structures that were monitored for wildlife use in 2012.

Name structure
148 (North Evaro)
198 (Schley Creek)
204 (North/East Fork Finley Creek)
499 (Pistol creek #1)
502 (Pistol creek #2)
529 (Mission Creek)
551 (Post Creek #1)
555 (Post Creek #2)
560 (Post Creek #3)
774 (Spring Creek #1)
784 (Spring Creek #2)
917 (Polson Hill)

The detection probability for deer and black bear is likely different for sand tracking beds outside the structures (pre-construction data) and inside structures (post-construction data 2008 through early 2010) as the tracking beds inside the structures were sheltered from wind and precipitation. In addition, the wildlife cameras are also likely to have a different detection probability for deer and black bear than the sand tracking beds. Therefore the relationship between pre-construction road crossings on sand tracking beds alongside the road, post-construction sand tracking beds inside underpasses, and post-construction wildlife cameras at the crossing structures must be established. Therefore four crossing structures had 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 and monitored, twice a week between 9 August 2010 and 2 November 2010, and between 27 May 2011 and 25 October 2011. 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 were located at RC 396 (Ravalli Curves #1), RC 427 (Ravalli Curves #3), RC432 (Copper Creek), and RH 459 (Ravalli Hill #1). The researchers will report on the calibration of the different monitoring techniques in one of the following quarterly reports.

3.3. Results

In 2012, 19,116 movements by animals (excluding movements that involved humans) representing at least 20 different animal species passed through the 29 structures listed in Tables 2 and 3 (Table 4). The animal crossings through the structures that were monitored were dominated by white-tailed deer, mule deer, domestic dogs and domestic cats (Table 4). The number of successful crossings per species for each structure are shown in the Appendix.

Table 4: The number of wildlife crossing through the 17 structures in Evaro, Ravalli Curves, and Ravalli Hill, and through the 12 isolated crossing structures. Preliminary data (N=20,435).
The species in the "other" category were bushy-tailed woodrat (*Neotoma cinerea*) (95%), unidentified bat species (<1%), great blue heron (*Ardea Herodias*) (<1%), wild turkey (*Meleagris gallopavo*) (<1%), and ring-necked pheasant (*Phasianus colchicus*) (<1%).

	Total passages (n)	Total passages (%)	Evaro (EV)	Ravalli Curves (RC)	Ravalli Hill (RH)	Combined (EV+RC+RH)	Isolated
White-tailed deer (*Odocoileus virginianus*)	13088	64.05	4289	3081	24	7394	5694
Mule deer (*Odocoileus hemionus*)	1656	8.10	9	485	1025	1519	137
Domesticated dog (*Canis lupus familiaris*)	1147	5.61	121	34	0	155	992
Domesticated cat (*Felis catus*)	1011	4.95	276	20	0	296	715
Human data collector	870	4.26	265	161	82	508	362
Black bear (*Ursus americanus*)	418	2.05	68	156	142	366	52
Raccoon (*Procyon lotor*)	377	1.84	32	34	2	68	309
Human	343	1.68	45	166	3	214	129
Birds (Aves)	317	1.55	61	2	145	208	109
Red fox (*Vulpes vulpes*)	247	1.21	3	1	0	4	243
Deer spp. (*Odocoileus* spp.)	186	0.91	9	155	7	171	15
Coyote (*Canis latrans*)	164	0.80	19	88	24	131	33
Western striped skunk (*Mephitis mephitis*)	142	0.69	0	47	20	67	75
Bobcat (*Lynx rufus*)	127	0.62	17	29	78	124	3
Mountain lion (*Felis concolor*)	104	0.51	14	54	34	102	2
Human and dog	97	0.47	6	59	0	65	32
Other	58	0.28	1	0	54	55	3
Rabbits and hares (Lagomorpha)	38	0.19	1	11	26	38	0
American badger (*Taxidea taxus*)	13	0.06	0	0	8	8	5
Unknown	7	0.03	0	0	0	0	7
Human and horse	5	0.02	0	0	0	0	5

Grizzly bear (*Ursus arctos*)	4	0.02		0	0	1	1		3
Bear spp. (*Ursus* spp.)	2	0.01		0	0	1	1		1
Elk (*Cervus canadensis*)	2	0.01		0	0	2	2		0
Human and ATV	2	0.01		0	0	0	0		2
Human and bicycle	2	0.01		2	0	0	2		0
Yellow-bellied marmot (*Marmota flaviventris*)	2	0.01		0	2	0	2		0
Moose (*Alces alces*)	2	0.01		2	0	0	2		0
Porcupine (*Erethizon dorsatum*)	2	0.01		0	0	0	0		2
Dog or Coyote (*Canis* spp.)	1	0.00		0	1	0	1		0
Long-tailed weasel (*Mustela frenata*)	1	0.00		0	0	0	0		1
Total	20435	100		5240	4586	1678	11504		8931

In 2012, 9,084 Deer (Odocoileus spp.) passed through the 17 structures in the Evaro, Ravalli Curves and Ravalli Hill area (Table 4). For black bear this number was 366. Other interesting observations are the 4 passages by grizzly bear (3 at Post Creek 3, 1 at Ravalli Hill 2), 2 passages by moose (both at the overpass), and 2 passages by elk (both at Ravalli Hill 2) (see Appendix).

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 (at least 20 animal species), especially white-tailed deer and mule deer, and domestic dogs and cats.

For the road sections with a concentration of mitigation measures (Evaro, Ravalli Curves and Ravalli Hill) the average number of deer (white-tailed deer and mule deer combined) that were estimated to cross the road before road reconstruction was estimated at 1,732 per year (2003 through 2005) while this number was 109 for black bears (Hardy *et al.* 2007). It appears that far more deer (n=9,084) and black bear (n=366) crossings occurred through the structures in these areas in 2012 than the pre-mitigation reference values, with no indication of a considerable increase in the deer population in 2012 compared to 2004 and 2005 (see pellet group counts in Chapter 2). However, a direct comparison of the pre-construction and post-construction deer and black bear crossings can only be made after several corrections have been made; the pre-construction data only relate to part of the year (May-October) while the current camera data relate to the full calendar year, and there are likely differences in the detection probability for sand tracking beds along the roadway, inside underpasses, and cameras at underpasses. Nonetheless, wildlife use of the structures, especially for deer and black bear, can be considered substantial. Note that 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 the number of crossings by grizzly bears was down from 15 (in 2011) to 4 (in 2012). The number of elk crossings was down from 6 (in 2011) to 2 (in 2012). In addition, the 2 crossings by moose were both on the wildlife overpass. Moose crossings in previous years have also been exclusively on the overpass, suggesting a strong selection for the overpass versus the nearby underpasses for this species.

4. COST-BENEFIT ANALYSIS

The cost-benefit data are projected to be analyzed in one of the following quarterly reports.

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6. APPENDIX

Successful wildlife crossings by species and structure for 2012.

Evaro area.
Note: The species in the "other" category was a wild turkey (*Meleagris gallopavo*).

Species	Railroad	Finley Creek 1	Finley Creek 2	Overpass	Finley Creek 3	Finley Creek 4
White-tailed deer (*Odocoileus virginianus*)	2186	758	62	981	172	130
Mule deer (*Odocoileus hemionus*)	4	0	0	2	3	0
Domesticated dog (*Canis lupus familiaris*)	1	16	16	1	1	86
Domesticated cat (*Felis catus*)	138	83	12	23	1	19
Human data collector	47	52	32	41	54	39
Black bear (*Ursus americanus*)	0	4	27	3	26	8
Raccoon (*Procyon lotor*)	26	1	2	2	1	0
Human	22	9	0	14	0	0
Birds (Aves)	49	2	0	10	0	0
Red fox (*Vulpes vulpes*)	0	0	0	3	0	0
Deer spp. (*Odocoileus* spp.)	7	1	0	0	0	1
Coyote (*Canis latrans*)	0	0	9	2	0	8
Western striped skunk (*Mephitis mephitis*)	0	0	0	0	0	0
Bobcat (*Lynx rufus*)	0	0	2	4	1	10
Mountain lion (*Felis concolor*)	2	4	1	2	3	2
Human and dog	6	0	0	0	0	0
Other	0	1	0	0	0	0
Rabbits and hares (Lagomorpha)	0	0	0	1	0	0
American badger (*Taxidea taxus*)	0	0	0	0	0	0
Unknown	0	0	0	0	0	0
Human and horse	0	0	0	0	0	0
Grizzly bear (*Ursus arctos*)	0	0	0	0	0	0
Bear spp. (*Ursus* spp.)	0	0	0	0	0	0
Elk (*Cervus canadensis*)	0	0	0	0	0	0
Human and ATV	0	0	0	0	0	0
Human and bicycle	2	0	0	0	0	0
Yellow-bellied marmot (*Marmota flaviventris*)	0	0	0	0	0	0
Moose (*Alces alces*)	0	0	0	2	0	0
Porcupine (*Erethizon dorsatum*)	0	0	0	0	0	0
Dog or Coyote (*Canis* spp.)	0	0	0	0	0	0
Long-tailed weasel (*Mustela frenata*)	0	0	0	0	0	0
Total	2490	931	163	1091	262	303

Ravalli Curves area
Note:

Species	RC 377	RC 381	RC 396	RC 406	RC 422	RC 426	RC 427	RC 431	RC 432
White-tailed deer (*Odocoileus virginianus*)	0	877	1604	51	61	3	0	7	478
Mule deer (*Odocoileus hemionus*)	0	9	115	147	193	0	0	0	21
Domesticated dog (*Canis lupus familiaris*)	0	4	11	14	2	0	0	0	3
Domesticated cat (*Felis catus*)	0	0	0	15	0	2	1	1	1
Human data collector	12	24	19	18	27	8	17	11	25
Black bear (*Ursus americanus*)	0	0	4	0	18	3	19	0	112
Raccoon (*Procyon lotor*)	0	1	0	1	0	17	6	5	4
Human	0	6	2	90	8	0	2	2	56
Birds (Aves)	0	0	2	0	0	0	0	0	0
Red fox (*Vulpes vulpes*)	0	0	0	0	0	0	0	1	0
Deer spp. (*Odocoileus* spp.)	0	28	80	12	33	0	0	0	2
Coyote (*Canis latrans*)	0	2	69	5	0	1	3	3	5
Western striped skunk (*Mephitis mephitis*)	0	0	0	2	0	0	1	0	44
Bobcat (*Lynx rufus*)	0	0	0	1	4	4	12	3	5
Mountain lion (*Felis concolor*)	0	0	0	0	25	1	2	0	26
Human and dog	0	2	0	55	0	0	0	0	2
Other	0	0	0	0	0	0	0	0	0
Rabbits and hares (Lagomorpha)	0	0	0	0	0	8	3	0	0
American badger (*Taxidea taxus*)	0	0	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	0	0	0
Human and horse	0	0	0	0	0	0	0	0	0
Grizzly bear (*Ursus arctos*)	0	0	0	0	0	0	0	0	0
Bear spp. (*Ursus* spp.)	0	0	0	0	0	0	0	0	0
Elk (*Cervus canadensis*)	0	0	0	0	0	0	0	0	0
Human and ATV	0	0	0	0	0	0	0	0	0

Human and bicycle	0	0	0	0	0	0	0	0	0
Yellow-bellied marmot (*Marmota flaviventris*)	0	0	0	0	2	0	0	0	0
Moose (*Alces alces*)	0	0	0	0	0	0	0	0	0
Porcupine (*Erethizon dorsatum*)	0	0	0	0	0	0	0	0	0
Dog or Coyote (*Canis* spp.)	0	0	1	0	0	0	0	0	0
Long-tailed weasel (*Mustela frenata*)	0	0	0	0	0	0	0	0	0
Total	12	953	1907	411	373	47	66	33	784

Ravalli Hill area
Note that the species in the "other" category was all bushy-tailed woodrat (*Neotoma cinerea*) (100%).

Species	Ravalli Hill 1	Ravalli Hill 2
White-tailed deer (*Odocoileus virginianus*)	21	3
Mule deer (*Odocoileus hemionus*)	426	599
Domesticated dog (*Canis lupus familiaris*)	0	0
Domesticated cat (*Felis catus*)	0	0
Human data collector	42	40
Black bear (*Ursus americanus*)	135	7
Raccoon (*Procyon lotor*)	2	0
Human	3	0
Birds (Aves)	143	2
Red fox (*Vulpes vulpes*)	0	0
Deer spp. (*Odocoileus* spp.)	6	1
Coyote (*Canis latrans*)	12	12
Western striped skunk (*Mephitis mephitis*)	9	11
Bobcat (*Lynx rufus*)	56	22
Mountain lion (*Felis concolor*)	29	5
Human and dog	0	0
Other	22	32
Rabbits and hares (Lagomorpha)	15	11
American badger (*Taxidea taxus*)	2	6
Unknown	0	0
Human and horse	0	0
Grizzly bear (*Ursus arctos*)	0	1
Bear spp. (*Ursus* spp.)	1	0
Elk (*Cervus canadensis*)	0	2
Human and ATV	0	0
Human and bicycle	0	0
Yellow-bellied marmot (*Marmota flaviventris*)	0	0
Moose (*Alces alces*)	0	0
Porcupine (*Erethizon dorsatum*)	0	0
Dog or Coyote (*Canis* spp.)	0	0
Long-tailed weasel (*Mustela frenata*)	0	0
Total	924	754

Isolated structures – part 1

The species in the "other" category were an unidentified bat species (n=1), a great blue heron (*Ardea Herodias*) (n=1), and a ring-necked pheasant (*Phasianus colchicus*) (n=1).

Species	North Evaro	Schley Creek	N Finley Creek	Pistol Creek 1	Pistol Creek 2	Mission Creek
White-tailed deer (*Odocoileus virginianus*)	26	4	0	62	132	219
Mule deer (*Odocoileus hemionus*)	0	0	0	6	0	0
Domesticated dog (*Canis lupus familiaris*)	279	186	13	6	0	487
Domesticated cat (*Felis catus*)	91	13	202	8	39	2
Human data collector	35	22	20	61	49	19
Black bear (*Ursus americanus*)	0	2	0	11	0	37
Raccoon (*Procyon lotor*)	0	3	103	17	9	37
Human	10	16	1	3	0	41
Birds (Aves)	0	0	1	18	2	8
Red fox (*Vulpes vulpes*)	0	0	0	0	0	42
Deer spp. (*Odocoileus* spp.)	0	0	0	0	1	1
Coyote (*Canis latrans*)	0	2	0	6	11	4
Western striped skunk (*Mephitis mephitis*)	0	0	0	4	0	3
Bobcat (*Lynx rufus*)	0	2	0	1	0	0
Mountain lion (*Felis concolor*)	0	1	0	0	0	0
Human and dog	16	2	1	0	0	1
Other	0	0	0	0	1	1
Rabbits and hares (Lagomorpha)	0	0	0	0	0	0
American badger (*Taxidea taxus*)	0	0	0	0	4	0
Unknown	0	0	0	2	0	3
Human and horse	0	0	0	0	5	0
Grizzly bear (*Ursus arctos*)	0	0	0	0	0	0
Bear spp. (*Ursus* spp.)	0	0	0	0	0	0

Elk (*Cervus canadensis*)	0	0	0	0	0	0
Human and ATV	0	0	0	1	0	0
Human and bicycle	0	0	0	0	0	0
Yellow-bellied marmot (*Marmota flaviventris*)	0	0	0	0	0	0
Moose (*Alces alces*)	0	0	0	0	0	0
Porcupine (*Erethizon dorsatum*)	0	0	0	0	0	0
Dog or Coyote (*Canis* spp.)	0	0	0	0	0	0
Long-tailed weasel (*Mustela frenata*)	0	1	0	0	0	0
Total	457	254	341	206	253	905

Isolated structures – part 2

The species in the “other” category were an unidentified bat species (n=1), a great blue heron (*Ardea Herodias*) (n=1), and a ring-necked pheasant (*Phasianus colchicus*) (n=1).

Species	Post Creek 1	Post Creek 2	Post Creek 3	Spring Creek 1	Spring Creek 2	Polson Hill
White-tailed deer (*Odocoileus virginianus*)	660	1992	2047	1	0	551
Mule deer (*Odocoileus hemionus*)	0	0	0	0	0	131
Domesticated dog (*Canis lupus familiaris*)	1	0	8	0	6	6
Domesticated cat (*Felis catus*)	3	32	132	92	51	50
Human data collector	25	36	74	5	5	11
Black bear (*Ursus americanus*)	0	0	1	0	0	1
Raccoon (*Procyon lotor*)	77	19	20	1	0	23
Human	0	4	36	0	0	18
Birds (Aves)	36	25	3	13	0	3
Red fox (*Vulpes vulpes*)	0	0	1	0	189	11
Deer spp. (*Odocoileus* spp.)	3	7	0	0	0	3
Coyote (*Canis latrans*)	0	0	0	0	0	10
Western striped skunk (*Mephitis mephitis*)	10	4	3	12	15	24
Bobcat (*Lynx rufus*)	0	0	0	0	0	0
Mountain lion (*Felis concolor*)	0	0	0	0	0	1
Human and dog	0	6	5	0	0	1
Other	1	0	0	0	0	0
Rabbits and hares (Lagomorpha)	0	0	0	0	0	0
American badger (*Taxidea taxus*)	0	0	0	0	0	1
Unknown	0	0	0	0	0	2
Human and horse	0	0	0	0	0	0
Grizzly bear (*Ursus arctos*)	0	0	3	0	0	0
Bear spp. (*Ursus* spp.)	0	0	1	0	0	0

Elk (*Cervus canadensis*)	0	0	0	0	0	0
Human and ATV	0	0	0	1	0	0
Human and bicycle	0	0	0	0	0	0
Yellow-bellied marmot (*Marmota flaviventris*)	0	0	0	0	0	0
Moose (*Alces alces*)	0	0	0	0	0	0
Porcupine (*Erethizon dorsatum*)	0	0	0	2	0	0
Dog or Coyote (*Canis* spp.)	0	0	0	0	0	0
Long-tailed weasel (*Mustela frenata*)	0	0	0	0	0	0
Total	816	2125	2334	127	266	847