

Wildlife Game Trail Survey: US Highway 2 mileposts 193-209
Glacier National Park – South Boundary Area
Conducted by Becca Holdhusen, Summer 2016

Game trail data collection:

Study area: US 2 milepost 193 to 209 (East Glacier)

Methodology: I replicated the collection methodology from Mike Roesch's 2010 thesis identifying wildlife crossing zones. More detailed methodology can be found on pages 8 and 9 of his thesis. Broadly, this involved walking alongside the vegetative cover along both sides of US Hwy 2 and identifying major wildlife trails according to the description he used in his thesis (trails with vegetation almost or entirely worn away and extending at least 20 m into the vegetative cover). To maintain consistency between surveys, the GIS feature class I created for trails only includes major trails and didn't include minor trails identified during my survey.

Difficulties and differences in surveying:

- Dry, wide open spaces that is conducive to wildlife movement without the occurrence of game trails. Open grassland was common from ~milepost 201 to East Glacier.
- Fencing and private property extended from ~milepost 201 to East Glacier fairly consistently. This was often linked to the occurrence of open rangeland for livestock. Although livestock fence is likely not a complete barrier for wildlife (especially ungulates that can easily jump the fences), it could serve as a deterrent as found in the literature reviewed by Roesch in his thesis that suggested wildlife avoids barriers such as guardrails and fences when crossing highways. Fences also could make it more difficult to distinguish game trails due to the discontinuity created by having to jump over the fence rather than continue on an established game trail.
- Riparian areas along the highway are very dense. There often appeared to be multiple minor trails through the vegetation, but it was difficult to determine what would be considered a major trail. Roesch's thesis found that game trails were more likely to be in or close to riparian areas. Possibly riparian vegetation on the western stretch of Hwy 2 is less dense and more conducive to movement, or the trails are better defined. It is also possible that animals would access the riparian areas for water but wouldn't necessarily cross the highway at these areas. Many of the riparian areas on the stretch of Hwy 2 I surveyed extended, on average, 900m from the edge of the highway and would be difficult to move through, especially for larger mammals.
- Dry streambeds or areas where water drains could be perceived as game trails in dry summer months. On occasion, it was difficult to determine whether cleared vegetation was a result of wildlife movement or water drainage.
- Clearings conducive to movement can't be classified as trails as defined by Roesch's methodology but could facilitate wildlife movement.
 - o Camera monitoring of such area could provide better insight to the use of these areas.

- Trails that appear to cross the stream tend to be more pronounced on the farther side of the stream, away from the highway. It is difficult to determine how often animals cross the streams at these areas and if they should be considered highway crossings
- In 2 stretches on livestock land from milepost 207-209 there were a series of well-defined trails that crossed the creek. I monitored one of these trails with cameras and found they are primarily used by livestock and not wildlife (there was only one recorded incident of a deer using the trail in the 17 day monitoring session).

Results:

I identified 41 major trails in the US Hwy 2 stretch from mileposts 193-209 according to the methodology used for Roesch's study. Of these trails, 28 existed without the presence of a guardrail, 8 existed with the presence of a guardrail, and 5 existed at the ends of guardrails.

The highway stretch milepost 201-209 is composed of mainly farm and ranch land. Many of the major trails leading to the stream that appear to cross the highway could be a) created and used by cattle and b) used only to access the water and not for crossing purposes even if used by both livestock and wildlife. For the final game trail GIS layer, I excluded the trails that were likely created by livestock. I also made a separate GIS layer that includes these trails (*game_trails_plus_livestock*) in case further monitoring wants to be conducted to see if there are areas that receive similar livestock and wildlife use.

Maps:

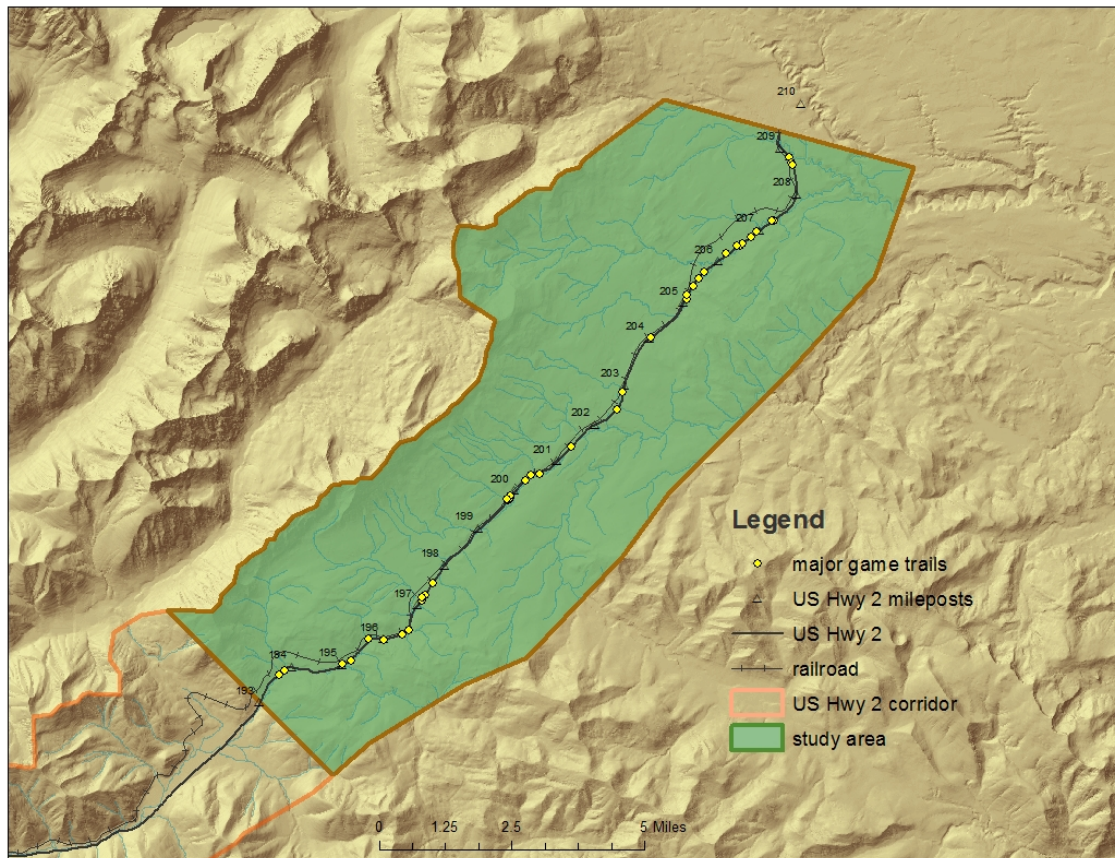


Figure 1. Map of game trail survey completed from milepost 193-209 on US Hwy 2. Wildlife crossing zones have been identified from mileposts 197-197.2 and 199.8-200.

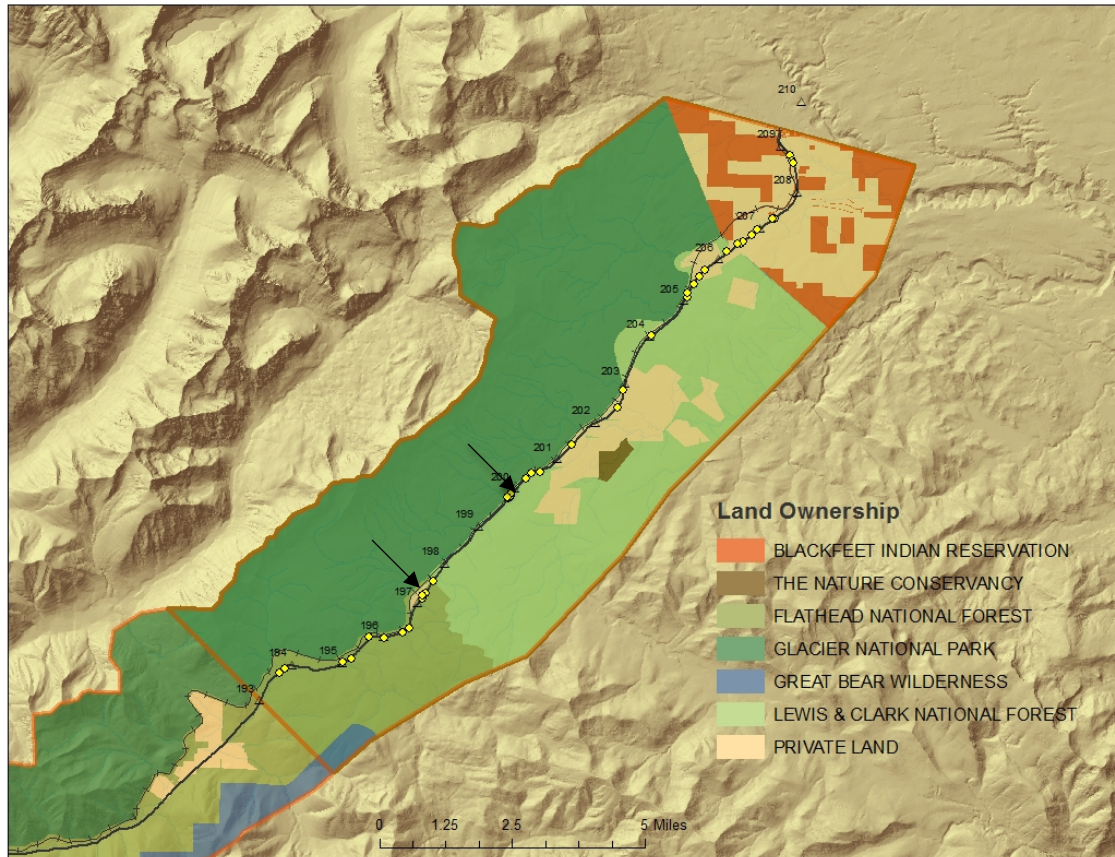


Figure 2. Land ownership of game trail survey study area. Black arrows indicate identified wildlife crossing zones.

Camera monitoring:

Major game trails were selected randomly for camera monitoring for the first and second rounds of camera monitoring. A trail couldn't be monitored in multiple camera sessions due to the limited time period and camera availability. The closest major or minor trail across the highway from the selected trail was also monitored. Only four cameras were available to be used during monitor sessions, so more extensive camera monitoring could provide a greater understanding of the game trail system on the eastern stretch of US Hwy 2.

One trail (360) was chosen intentionally in the third round of monitoring. This trail was very prominent on the southeastern side of a creek (farthest from the highway) and continued on the northwestern side (closest to the highway) after crossing the creek. The trail was also located somewhere that livestock could be using it to access water. The purpose of monitoring this trail was to see if a) wildlife used the trail along with livestock and b) if wildlife crossed the stream at this point and would likely continue to cross the highway.

Two of the trails that were identified as major and monitored during the second camera session and one during the third recorded no occurrences. One of these cameras (349) had a view of the highway and recorded mainly passing cars.

The other trail (camera 346) was in dense riparian vegetation and recorded vegetation movement from wind. There is a possibility that movement from animals was obscured in the dense vegetation or animal movement happened between picture sessions. For this reason, tracking beds or camera monitoring outside of the vegetation cover might be more effective for determining use of game trails in riparian areas where there is dense vegetation and common movement. The trail that recorded no incidents in the third monitoring session (camera 353) was a minor trail across from major trail 13.

The second monitoring session was 11 days shorter than the first, and the third monitoring session was 6 days shorter than the first, which could also be a factor in the lack of occurrences recorded on cameras 346, 349, and 353. Camera 348 (trail 147) recorded the greatest number of occurrences and was in the shortest monitoring session (12 days), which suggests that this area has high wildlife movement. Most occurrences were captured at dusk or dawn when traffic volumes were low, similar to Roesch's findings.

Camera incidents by species

Species	# of incidents	% of total incidents
Deer	30	91
Coyote	2	6
Rabbit	1	3

Camera incidents by trail

Camera # and Trail #	Total incidents	Days monitored
304, trail 29	1	23
305, trail 306	4	23
307, trail 108	4	23
308, trail 120	3	23
347, trail 298	1	12
348, trail 147	13	12
350, trail 360	2	17
351, across stream from 360	2	17
352, trail 13	3	17

Camera monitored trails with no incidents: 349, across highway from 147; 346, trail 329; 353, trail 32

GIS shapefile layers:

Game trail layers:

major_trails_mi193to209

- includes major trails identified from Roesch's methodology excluding those likely created by livestock

major_trails_plus_livestock_mi193to209

- includes all major trails identified from Roesch's methodology including livestock trails. Livestock trails include: 354, 357-360, 369, and 379-382. These trails could be continuously monitored by cameras if there is more interest in determining livestock usage of them

Highway feature layers:

culverts_mi193to209

- includes all culverts identified on this stretch of the highway. Existing culverts can be renovated to facilitate more effective wildlife movement (i.e. expanded for non-aquatic wildlife use, improved to facilitate fish movement). I added a field that specified which culverts were passages for streams identified from the "clean fish" layer of the FWP Fish GIS Database.

guardrails_mi193to209

- Polyline feature class outlining guardrails on Hwy 2 in my study area. This feature was used to analyze game trail presence in regard to potential guardrail avoidance by wildlife.

Statistical analysis (or lack thereof):

Although I didn't repeat the logistic regression analysis models that Roesch created in his analysis, if the results of his models hold true, trails are more likely to have a shorter distance to riparian areas and vegetative cover than random points. Roesch's findings support the lack of game trails I found in stretches of open fields. Continued monitoring of game trails emerging from riparian areas would offer insight into wildlife use of these passages through the dense riparian vegetation. The riparian areas monitored by my cameras didn't record any wildlife instances, but the constant movement of the vegetation could have masked any wildlife movement that occurred. Because many game trails on the eastern stretch of Hwy 2 were found in riparian areas, continued monitoring of these areas would be necessary to determine whether or not these trails are active.

Wildlife crossing zones identified:

The first wildlife-crossing zone I identified is from miles 197-197.2. This zone has high clustering of trails (5) and is located at Marias Pass where high wildlife movement was expected. The camera (307) monitoring trail 108 at the pass only recorded 4 wildlife occurrences, although this was the only camera that recorded occurrences that weren't deer (2 coyotes, 1 rabbit). The area being monitored also appeared to have a network of trails rather than a single obvious major trail. More extensive camera monitoring in this area could offer insight into how this network of trails is used. There is also a cluster of 4 trails that occurs before the parking lot at the pass. This area would also be a good candidate for camera monitoring. Overall, further camera monitoring or sand tracking should be done to gain a better understanding of the usage of this zone due to the probability of there being higher wildlife movement than recorded in the one camera monitoring session done on trail 108.

Another potential wildlife crossing is from miles 199.8-200. This zone contained clustered trails and the camera with the greatest wildlife occurrences

(camera 348, trail 147). The northern side of the road is in close proximity to the railroad, which usually is a deterrent to game crossing as seen in Roesch's thesis. If this area were selected for a location for wildlife crossing infrastructure, infrastructure spanning both the highway and railroad could be considered.

Comparison:

Roesch's thesis work was more complete than the data I collected this summer. Comparing game trail density, camera trap incidents, roadkill data, and GNESEA wildlife crossing areas, the crossing areas defined by Roesch were more active and would likely be better candidates for large scale wildlife crossing infrastructure, such as an overpass to be used by ungulates and large carnivores. Wildlife overpasses along Hwy 2 should be in areas that are most conducive to large mammal movement, specifically ungulates, and would likely be most beneficial in elk migration corridors that are also used by mule and white-tailed deer.

Depending on the scale of the wildlife-crossing project, wildlife zones identified from 193 to 209 could be candidates for connectivity infrastructure. Modification to existing culverts could benefit smaller riparian animals, such as beavers and small rodents, and fish. While conducting surveys, I encountered two beaver dams in riparian areas along Hwy 2, one past Firebrand Campground on the west and one past milepost 201 on the east side of the highway. Streams that are habitat for native fish and pass under the highway through culverts are good candidates for culvert modification to be more conducive to fish movement along with facilitating movement for terrestrial wildlife.

Further analysis and ideas:

Maxent modeling:

I created a Maximum Entropy (Maxent) species distribution model in an attempt to identify areas conducive to game trail occurrence. I used the major trail data I collected for the eastern stretch of Hwy 2 as occurrence data in the model along with environmental layers including climate, land cover, and topography data. The specific layers are listed in the table below.

Layer type	Layer name	Data source
Land cover	landcover	National Land Cover Dataset (NLCD)
Elevation	DEM, hillshade	GNESA GIS Database
Slope	slope	Calculated from DEM on ArcMap 10.2
Aspect	aspect	Calculated from DEM on ArcMap 10.2
Middle Fork vegetation survey	GNESA_veg	GNESA GIS Database
Climate data*	bio1-bio19, prec1-12, tmax1-12, tmean1-12	BioClim NADM 12 N
Land ownership	ownership	GNESA GIS Database

*for a complete list of bioclim layers, look here: <http://www.worldclim.org/bioclim>

I snapped game trails to the edge of the vegetative cover to account for a trail occurrence to mistakenly be placed on a “developed” road area on the NLCD land cover layer. The snap didn’t effectively move the trails far enough away from the road, so I created a 30m buffer around the US Hwy 2 shapefile from the GNESA GIS database and snapped the trails to the edge of this.

Outputs for Maxent didn’t show any highly suitable “habitat” for game trail occurrence and didn’t extend past milepost 185. I was unable to locate the original trail feature class from Roesch’s thesis, so the dataset was incomplete. The lack of projection onto the western half of the Hwy 2 corridor could be attributed to the differences in climate, topography, and vegetation across the continental divide. Overall, the use of Maxent to predict game trail occurrences appears ineffective, although a more detailed dataset and finer resolution could provide a more accurate output.

Currently, I believe the most effective use of Maxent in this study region would be to model the distribution of multiple target species (i.e. white-tailed and mule deer, elk, moose, grizzly and black bears, coyote, beaver, mountain lion, wolverine, etc.) in the corridor. These models could be used to identify habitat patches that are fragmented by the highway and used to locate specific areas where implementing connectivity infrastructure could connect these patches. More intensive ground truthing and monitoring could be done on areas identified as potential mitigation sites. These habitat patches, specifically for ungulates, should be compared to Mike Roesch and my game trail surveys to see if suitable habitat aligns with high density of game trails.

Land cover and climate must also be taken into account with this comparison. For example, an area on the eastern section of Hwy 2 could be highly suitable habitat for elk but defined game trails might not be present due to the area being dominated by flat, dry grassland which doesn't require game trails for efficient movement across the landscape. After identifying habitat patches through Maxent, a connectivity analysis of the corridor can be completed by using the software Conefor. This software will identify how patches on the landscape are fragmented or connected, and provide insight into how to restore connectivity to the landscape. Coarse-scale landscape analysis is important for identifying focal areas for this connectivity study, and software programs such as Maxent and Conefor are useful tools to conduct effective analyses of where wildlife crossing infrastructure would be most beneficial for connected fragmented habitat patches.

Highway 93 Case Study: Pre construction surveys, fencing and crossing design, post- construction maintenance

The wildlife crossing project (People's Way) completed on Hwy 63 offers insight into what preconstruction surveys should be done to identify the best areas to implement connectivity infrastructure. The People's Way project identifies tools to identify crossing zones:

- 1) coarse scale spatial analysis
- 2) expert opinion about corridor use and existing crossing zones
- 3) fine scale field research that examines areas identified by coarse scale analysis
- 4) animal vehicle collision data

The work conducted on Hwy 2 thus far consists of fine scale fieldwork that identifies game trails and camera trap data. Roesch also used animal vehicle collision (AVC) data and compared the distance of road kill incidents to existing game trails to see if there was a correlation. The road kill dataset didn't provide adequate occurrence data for miles 193-209 for me to do a similar analysis. The People's Way project employed graduate students to do species specific population and connectivity research in order to understand the effect the highway had on certain species and what the subsequent effect of crossing infrastructure had. The extensive research done on Hwy 93 found the most effective crossing structures for the focal species for the study. Many of these considerations could be used for crossing infrastructure on Hwy 2.

Recommendations about exclusion fencing for ungulates can also be found in the report. Fencing is necessary and effective for overpasses to be used by ungulates. Exclusion fencing is easier to build on public or federal land rather than private, which also makes the wildlife crossings that Roesch identified in the park more likely candidates for large scale wildlife crossing infrastructure than private land on the eastern stretch of the highway. The two wildlife crossing zones I identified are on national forest and national park land, which means they are also good candidates for wildlife crossing infrastructure.

A summary of the final report done on Hwy 93 is included in the last three pages of this report. I also included links to both reports for Hwy 93 and a link to

the Montana Department of Transportation website. These reports offer insight into methodology for preconstruction field methods, design ideas, and species specific crossing preferences.

Summary of Wildlife Crossing Project on Highway 93

Literature review

- Different methods for identifying optimal places for highway crossing
 - o Animal-vehicle collision sites and data
 - o Course-scale spatial analysis of landscape features using GIS
 - o Expert opinion on coarse-scale stretches used for wildlife migration (i.e. elk migration corridors or radio collar data)
 - o Intensive fine-scale analysis of optimal areas identified with coarse-scale analysis (i.e. game trail and scat surveys or camera monitoring)

Locations and design

- Optimal location for crossing: low human activity, suitable habitat on both sides
- Identify locations using coarse scale GIS outputs, suitable land ownership, and fine scale fieldwork
- Effective overpasses need exclusion fencing
 - o Need to accommodate for animal escape from breaching the exclusion fencing (i.e. one way exits)
- Design species specific crossings
- Locate crossing zones that are suitable for exclusion fencing to be built
- Appendix A (pg. 120) of the final Hwy 93 report includes diagrams of wildlife crossing designs
- Pg. 72 includes a table detailing culvert and highway feature renovation to better facilitate wildlife movement

Goals & Data Collection

- Define and identify specific goals for AVC mitigation, use of crossings, etc.
- Impossible for 100% effectiveness at reducing mortality
- Select methods to obtain relevant data
 - o Road-kill or vehicle collision data
 - o Snow tracking, tracking beds, tracking plates
 - o Camera and video monitoring
 - o Radio-monitoring animal movements
 - o DNA assignment testing
 - o Fecal stress measures
 - o Anecdotal information and observational data
 - o Accounting for confounding variables
 - Yearly fluctuations in animal populations
 - Seasonal fluctuations in populations and habitat use
 - Climatic effects
 - Habitat differences along the road corridor
 - Differences in human/building density
 - Traffic volume and speed
- DNA and fecal stress measures involve money, lab equipment, and qualified personnel

- AVC data, expert opinion and observational data, tracking beds, and camera monitoring are what would be used for preliminary data collection in this study
 - o Lab work and expertise could be used to employ graduate students conduct research about specific species and how they are connected on the landscape
- Evaluation of effectiveness of crossings requires data be collected pre and post mitigation
 - o Identify what baseline data should be collected
 - Models will show fragmented habitat patches
 - AVC and roadkill data can provide specific numbers to indicate reduced mortality after mitigation efforts are implemented
 - DNA testing could show separated populations and reduced gene flow (hypothetically)
 - o Small sampling period (only 1 or 2 years) can lead to skewed results, both before and after mitigation efforts
 - o Pg. 14 “Understanding the long-term and landscape-level effect of wildlife crossing structures in terms of communities, biodiversity, ecosystem processes, and landscape ecology may take many years (>10) before even beginning to suggest results”

Evaluation process, data quality, and data analysis

- Define research questions clearly
- Evaluate research goals to be sure they are obtainable given time and resources available
- Consult with a statistician early in the planning process
- Document standardized data collection procedures to ensure consistency of data over time
- Enter data into an electronic database promptly and back it up frequently

Project history and case study

- Challenges of deciding on highway plans; MDT, FHWA, CSKT
- CSKT emphasized “spirit of place,” approach established 6 goals
 - o Develop an understanding of the land and the relationship the Salish and Kootenai people have with the land
 - o Find ways the land can shape or influence the road
 - o Develop concepts that respect the integrity and character of the place, people, and wildlife
 - o Restore habitat areas that have been fragmented by the road and surrounding development
 - o Respect and restore the way of life in small communities along the road
 - o Create a better visitor understanding of the place that the Salish and Kootenai people call their homeland
- Had technical design committee

- o Consult with designers and literature to identify best construction for wildlife crossing infrastructure/exclusion fencing

Preconstruction data collection

Animal Vehicle Collisions

- AVC databases often inconsistent and incomplete
- Combine databases; screen for inconsistencies or redundant info
- Combined database should have
 - o Date of occurrence
 - o Mile marker (to the 0.1 mile)
 - o Species of animal
 - o Sex of animal (if identified)
 - o Age of animal (if identified)
 - o Data source
- Power analysis used for deer vehicle collisions (DVCs) due to high number of incidents, but not appropriate for bear vcs

Radio collars

- Radio collars used for difficult species to monitor (bears) or unknown spatial patterns

Tracking

- Tracking used when video monitoring prone to theft
- Track beds show gait and direction of animal movement as well as species
- Information gathered from track beds
 - o date
 - o precipitation (in mm) since last visit
 - o temperature
 - o bed condition (i.e. snowy, frozen, wet, dusty, normal)
 - o species and observer's certainty in identification (certain, probably, possible)
 - o behavior (crossing, parallel, presence)
 - o direction of travel (approaching or leaving highway)
 - o same track as: evidence of tracks approaching on one side of highway and leaving on the other
- Potential track bed avoidance is good case for more camera monitoring; a combination would be most effective
- *Details about track construction and placement found in case study*

Pellet group transects

- Used to estimate population densities of species
 - o specifically ungulates

Traffic monitoring

- Study found that there are more crossings at lower traffic volumes
- Linear regression used to compare crossings from photo data with traffic volumes

Measuring effectiveness

- Effectiveness assessment specific to project goals

- Pg. 79 of final Hwy 93 report contains table outline potential biological, economic, public safety, social, and political outcomes that would be considered “effective”

Links to reports about the Hwy 93 Wildlife Crossing Project:

Montana Department of Transportation website:

http://www.mdt.mt.gov/pubinvolve/us93info/post_construct.shtml

Preconstruction Wildlife Monitoring Field Methods Handbook:

http://www.mdt.mt.gov/other/webdata/external/research/docs/research_proj/wildlife_crossing/field_handbook.pdf

Final Report for Phase I of Wildlife Crossing Project:

http://www.mdt.mt.gov/other/webdata/external/research/docs/research_proj/wildlife_crossing/final_report.pdf