Electrified Barriers for Carnivore Species and Lowered Jump-Outs for Deer along US Hwy 93N, Montana

Solicitation Number 21-011

by

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A proposal prepared for the
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4 December, 2020

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PROBLEM STATEMENT

Wildlife fences in combination with wildlife crossing structures can improve human safety substantially through reducing Wildlife-Vehicle Collisions (WVCs) by 80-100% (Huijser et al., 2016a). However, in multi-functional landscapes there are typically gaps in the wildlife fence for side roads, access to agricultural fields, and dispersed houses. Gates are only suitable for very low traffic volume access points, but they are sometimes left open after use, jeopardizing the overall effectiveness of the mitigation measures. Wildlife guards (similar to cattle guards) at access roads provide easy access for vehicles and have proven to be an effective barrier to deer species along US Hwy 93N (about 80% to nearly 100% barrier) (Allen et al., 2013; Huijser et al., 2016b). Unfortunately, they are quite permeable to carnivores, including bear species. Large wild animals that do end up in the fenced road corridor must be able to escape quickly. Earthen mounds (jump-outs) within the fenced road corridor are designed to allow animals to walk up to the height of the fence. The height of the jump-outs should be low enough to allow animals to readily jump down to the safe side of the fence. At the same time, these jump-outs should still be tall enough to discourage animals from jumping up into the fenced road corridor. Deer (white-tailed deer and mule deer combined) were by far the most numerous large wild mammal species observed on top of the jump-outs trying to escape the fenced road corridor along US Hwy 93N (96.7%; 1,026 deer out of 1,062 large wild mammals). However, the use of the jump-outs by deer attempting to escape the fenced road corridor has been low (only 7 % of the white-tailed deer and only 32% of the mule deer that showed on top of the jump-outs ended up jumping down). The animals that did not jump down spent an increased amount of time inside the fenced road corridor before they were either able to exit, at one of the (other) jump-outs or at a fence-end, or before they were hit by a vehicle.

To further improve human safety, and to reduce direct road mortality of wildlife, additional mitigation measures are needed within fenced road sections. Specifically, additional barriers at access roads are needed to keep carnivores (including black bears and grizzly bears) out of the fenced road corridor. In addition, large mammals, especially deer species, need to be able to escape the fenced road corridor more readily through better designed jump-outs.

BACKGROUND SUMMARY

The reconstruction of 56 miles (90 km) of US Hwy 93N on the Flathead Indian Reservation included the installation of wildlife crossing structures at 39 locations and approximately 8.71 miles (14.01 km) of wildlife exclusion fence (Huijser et al., 2016b). Wildlife guards (similar to cattle guards) at access roads have proven to be an effective barrier to deer species (about 80% to nearly 100% barrier) but unfortunately, they are quite permeable to carnivore species, including bear species (Allen et al., 2013; Huijser et al., 2016b). Large wild animals that do end up in the fenced road corridor must be able to escape quickly. Earthen mounds (jump-outs) within the fenced road corridor are designed to allow animals to walk up to the height of the fence. The height of the jump-outs should be low enough to allow animals to readily jump down to the safe side of the fence. At the same time, these jump-outs should still be tall enough to discourage animals from jumping up into the fenced road corridor. Deer (white-tailed deer and mule deer combined) were by far the most numerous large wild mammal species observed on top of the jump-outs trying to escape the fenced road corridor along US Hwy 93N (96.7%; 1,026 deer out of 1,062 large wild mammals) (Huijser et al., 2016b). However, the use of the jump-outs by deer attempting to escape the fenced road corridor has been low (only 7 % of the white-tailed deer and only 32% of the mule deer that showed on top of the jump-outs ended up jumping down). The animals that did not jump down spent an increased amount of time inside the fenced road corridor before they were either able to exit, at one of the (other) jump-outs or at a fence-end, or before they were hit by a vehicle.

To further improve human safety, and to reduce direct road mortality of wildlife, additional mitigation measures are needed within fenced road sections. Specifically, additional barriers at access roads are needed to keep carnivores (including black bears and grizzly bears) out of the fenced road corridor. In addition, deer species need to be able to escape the fenced road corridor more readily through better designed jump-outs.

Electrified barriers have been implemented to keep large wild mammals out of fenced road corridors. These barriers have been mostly at high-volume access roads and at fence-ends along main highways (e.g. Gagnon et al, 2010; Huijser et al., 2015). However, electrified wildlife guards or electrified mats or electrified metal strips embedded in the main travel lanes and at high-volume access roads can cost tens of thousands up to hundreds of thousands of dollars per location. In practice, many access points along a fenced highway in a multi-functional landscape have very low traffic volume and very low traffic speed (e.g. access to an agricultural field). Relatively inexpensive electrified barriers (e.g. up to several thousands of dollars per location) may be suitable for such low traffic volume and low traffic speed access roads. Of course, these low-cost barriers must still be effective in keeping large mammals, including bear species, out of the fenced road corridor. The focus of this research project is on electrified barriers that are relatively low cost and that appear suited for low traffic volume and low traffic speed locations.

Historically, one-way escape gates have been implemented to allow large wild mammals to escape fenced road corridors (see review in Huijser et al., 2015). However, one-way gates are now rarely implemented because of low effectiveness, animal intrusions into the fenced road corridor, and injuries and death of animals using the one-way gates (see review in Huijser et al., 2015). Wildlife jump-outs or “escape ramps” are now widely used instead. The height of the jump-outs should be low enough for the target species to readily jump down to the safe side of the fence. At the same time, the jump-outs should be high enough to discourage animals that are on the safe side of the fence to jump up into the fenced road corridor. This implies that finding an optimum height for the target species, or multiple target species, is important. However, there is very little information available on the appropriate height of jump-outs for different species. Nonetheless, a height of about 5-5½ ft seems advisable for white-tailed deer and mule deer (review in Huijser et al., 2015). This is lower than the height of most of the jump-outs along US Hwy 93N (Huijser et al., 2016b). Unfortunately, lower jump-outs can also result in more animals jumping up into the fenced road corridor. A jump-out can be made to appear higher for animals that may be interested in jumping up into the fenced road corridor by adding a metal bar or wooden plank about 18 inches above the ground, close to the edge of the jump-out (Siemers et al., 2013). The focus of this research project is on the effectiveness of jump-outs that are about 5-5½ ft tall in combination with a bar or plank on top.

BENEFITS AND BUSINESS CASE

The results of this project will provide information on how to improve human safety and how to reduce direct mortality of wildlife within fenced road sections. The research focuses on how to better keep wildlife, specifically carnivores, out of fenced road corridors through electrified barriers at access roads, and on how to improve wildlife use, specifically deer, of jump-outs, should the animals still end up inside the fenced road corridor. Depending on the results of the project, and implementation of the recommendations, the improvements to the mitigation measures are expected to lead to fewer large wild animals on fenced roads, and reduced time spent by these animals inside fenced road corridors. This in turn is expected to improve human safety through a reduction in collisions with large wild mammals. At the same time, reduced collisions with wildlife would also result in reduced unnatural direct wildlife mortality. This not only relates to common ungulates such as white-tailed deer and mule deer, but also to carnivore species such as black bear and grizzly bear. The knowledge gained on the effectiveness of the mitigation measures associated with wildlife fences and modifications to these mitigation measures, is expected to have wide application for highways for which wildlife fences are considered. It may also prove to be particularly useful to US Hwy 93N for the adaptive management of the already mitigated road sections, and to help guide the design and future road reconstruction through the Ninepipe area. The Confederated Salish & Kootenai Tribes (CSKT) and the US Fish & Wildlife Service have expressed their interest and support for this project. The objectives of this project are also consistent with the Memorandum of Agreement between the Federal Highway Administration, the Montana Department of Transportation, and CSKT (FHWA, MDT & CSKT, 2000). Finally, the Montana Department of Transportation is already preparing to connect short sections of wildlife fence north of St. Ignatius, and this research will help inform the design of the mitigation measures in this area.

OBJECTIVES AND TASKS

The objectives of this project are:

1. Investigate the effectiveness of relatively low-cost electrified barriers that are aimed at keeping carnivore species, especially black bears and grizzly bears, out of fenced road corridors at access roads with very low traffic volume and very low traffic speeds. Note that the selected access points (see later) already have wildlife guards installed to discourage ungulates such as white-tailed deer and mule deer from entering the fenced road corridor.
2. Investigate the effectiveness of modifications to existing jump-outs in allowing white-tailed deer and mule deer to escape the fenced road corridor more readily, while continuing to discourage deer from jumping up into the fenced road corridor. Modifications will be made to existing jump-outs. These modifications include lowering their height to about 5-5½ ft and adding a horizontal bar (e.g. wood, metal) above the ground, on top of the jump-outs. The bar is aimed at continuing to discourage large animals from jumping up into the fenced road corridor.

The specific tasks for this project are:

1. Select study sites.
2. Select measures or modifications.
3. Contact stakeholders and agree on measures and research methods.
4. Purchase and install mitigation equipment.
5. Purchase and install research equipment.
6. Evaluate the effectiveness of the mitigation measures and the modifications to mitigation measures.
7. Submit a draft report, final report, and present remotely to MDT. Deliverables also include a project summary report, implementation report, and performance measures report.

RESEARCH PLAN

Electrified Barriers

Task 1: Select Study Sites

Based on field visits there are two suitable sites for electrified barriers (Figure 1, 2, 3). These two locations meet the following criteria:

1. They have an existing wildlife guard without additional barriers such as gates or fences across the wildlife guard.
2. They are connected to a wildlife fence on both sides.
3. They have very low traffic volume (estimate is single digits per day).
4. They have very low vehicle speeds (estimate is walking speed).
5. They have a known presence of large wild mammals in the surrounding area, both of ungulates (white-tailed deer, mule deer) and carnivore species (especially black bear) (Allen et al., 2013, Huijser et al., 2016b).
6. Adjacent tribal land without houses. Access is restricted to tribal members or people who purchase conservation permits.

Figure 1: The two locations that appear suitable for the installation of electrified barriers, just south of Ravalli. Note that these are the same two sites that were part of the study by Allen et al. (2013).

Figure 2: Candidate site 1, just north of underpass RC432 (Copper creek), east side of US Hwy 93N, just south of Ravalli and the Jct with MT Hwy 200. Occasional use by fire fighters, hunters, and locals exists (graffiti on the nearby underpass suggests people sometimes use the area) (Personal Comment Whisper Camel, CSKT).

Figure 3: Candidate site 2, just south of underpass RC432 (Copper creek), east side of US Hwy 93N, just south of Ravalli and the Jct with MT Hwy 200. This provides access to an old MDT gravel pit / storage area only, extremely low current use (Personal Comment Whisper Camel, CSKT).

Task 2: Select Measures or Modifications

The following requirements apply to the electrified barriers:

1. They must be suited for very low traffic volume, e.g. perhaps a dozen vehicles per day at a maximum (but they do not have to be suited for high traffic volume).
2. They must be suited for very low traffic speeds, e.g. perhaps 5-20 MPH at a maximum (but they do not have to be suited for high traffic speeds).
3. They must be able to be combined with existing wildlife guards.
4. They must be relatively low costs (e.g. several thousand US$ per location at a maximum).

Based on these criteria, we propose two designs that have already been installed at a private farm to keep black bears out of an agricultural crop (Figures 4, 5).

Figure 4: Electrified bump gate. The horizontal poles and the vertical strands are electrified. When a vehicle pushes on the two horizontal poles, the poles swing open and close automatically behind the vehicle.

Figure 5: Electrified wires above the ground. Note that a vehicle can drive over these wires.

Preliminary data on the barrier effect of these two gate designs at the farm suggest that both are a substantial barrier to black bears. While the unmodified bump gate was often passed by black bears, a recent modification to the bump gate with electrified netting in addition to the strands showed zero passages out of 11 approaches by black bears (100% barrier) (Unpublished data Marcel Huijser, WTI-MSU). The design with the electrified wires above the ground showed one passage out of about 25 approaches by black bears (about 96% barrier) (Unpublished data Marcel Huijser, WTI-MSU) (Figures 6, 7). Though the sample sizes are still limited, this is substantially better than the 45-52% barrier for black bear (based on 2-3 years of research and of the existing wildlife guards along US Hwy 93N (Allen et al., 2013; Huijser et al., 2016b).

Figure 6: Black bear investigates electrified bump gate.

Figure 7: Black bear investigates barrier with electrified wires above the ground.

Task 3: Contact stakeholders and agree on measures and research methods

The electrified barriers will be discussed in detail with the members of the Technical Panel. In addition, the electrified barriers have already been discussed with representatives of the Confederated Salish & Kootenai Tribes (CSKT). However, more detailed discussions with CSKT need to take place and formal approval from CSKT needs to be obtained before the electrified barriers can be installed.

Note that a research permit has been obtained already from CSKT (Attachment A). Topics that need to be discussed and agreed upon in more detail include human safety, damage to vehicles, and liability. Other potential stakeholders include (other) landowners or land users, locals (residents in nearby Ravalli), travelers, and law enforcement. US Fish & Wildlife Service has already determined that no “take” is involved and that no “recovery permit” is required as the measures are designed for carnivore species in general, rather than grizzly bears in specific (Attachment B). The information below is partly based on information obtained in phone interviews with “Jeff” (Koehn Marketing Inc.) and “Nicole” (Agratronix).

Human safety

In general, the electrical characteristics (Voltage, Amperage, pulsing nature) of the electrified barriers are similar to that of electric fences for livestock. These electrical features have been widely used for a long time, and they are generally considered safe. Depending on the type of electrified barrier, the voltage (compare this to “water pressure”) is between 5kV and 10kV; much higher than the electrical grid (110-120V). However, the Amperage (compare this to the “rate at which water flows”, the “electric current”) is very low; around 100-150 milliamps for electric fences and associated components, compared to about 13-20 Amps for common appliances directly connected to the electrical grid. Electric fence energizers put out high voltage, but very low amperage or current (around 120 milliamps) compared to the electrical grid. Unlike the current of the grid, the electrical current on electric fences and associated components is not constant. Fence energizers send electricity in pulses, about once every second for 1/300th of a second. The low Amperage in combination with the pulsing nature make electric fences and associated components “safe”. This means that there is a very low potential for permanent injuries or deaths for large mammals and healthy people. The pulsing nature allows healthy people and animals to detach themselves from electrified components whereas the electric grid has constant electric current which can cause muscles to contract which can make it hard for people or animals to detach themselves from the electrified components.
However, an electric fence and associated components do have these considerations:

1. While generally considered “safe” for animals and people, getting shocked is unpleasant and painful.
2. In very rare occasions, people or animals can get injured or die. The probability is extremely low, but not zero.
3. People should be advised not to touch electric fences or associated components. This is especially true for people with existing health problems, especially people with a heart condition, including implants that operate on a battery such as a pacemaker.
4. Wearing shoes with thick rubber soles can somewhat reduce the shock compared to being barefoot or wearing shoes with thin soles, but it can still hurt, and it can still be painful.

Wearing shoes does not protect people from getting shocked. From "Nicole": touching a 3kV electric fence while wearing shoes with rubber soles results in a "tingle" (i.e. low impact) whereas barefoot results in a "noticeable and unpleasant shock" (i.e. high impact).

5. Touching electrified components with your head should be especially avoided.
6. Entrapment of people or animals should be avoided; they should be able to detach themselves from the electrified components. Entrapment could potentially occur if people walk over wires above the ground, trip, and then get their legs or feet entangled in the wires, prolonging their exposure to electric shocks.
7. Vehicles (cars) can drive through electrified barriers without an issue (with closed windows) as the tires insulate the vehicle and the people inside a vehicle. Depending on how thick the tires are, motorcyclists and bicyclists may be shocked as they are not protected by a metal cage.
8. Tripping over electrified wires that are a few inches above the ground could cause a person to fall and remain in contact with the electrified wires for longer. Foot traffic over electrified wires should be discouraged (regardless of whether the electricity is switched on or off) and an alternative (e.g. a gate on a spring that closes automatically) should probably be provided for pedestrians and other non-motorized traffic.

Damage to vehicles
Bump gates: The arms of the bump-gates have a rubber end cap. When a vehicle pushes open the gate, the rubber end cap can rub against the side of the car. The rubber end cap itself will not scratch the paint. However, dirt on the car, or dirt on the rubber end cap can scratch the paint of a vehicle.
Drive-over electrified wires: The wires would be positioned a few inches above the modified bridge grate material of the wildlife guard. Unless a vehicle has exceptionally low clearance, it should be able to drive over these wires without an issue. However, it is unknown what the damage to the wires would be with snow chains or aggressive tire treads.

Liability
I (Marcel Huijser) am not a lawyer, but electric fences and gates and other barriers are in use throughout the world, including in the United States (e.g. Gagnon et al., 2010). Most applications are for agriculture to keep livestock in pastures. However, electric fences are also used along highways managed by departments of transportation, including in Montana, including along highways managed by MDT. This suggests that potential legal and liability issues associated with electric fences are surmountable to a DOT, including MDT. ZapCrete® (7,000-10,000 V) has already been installed by MDT at two locations along MT Hwy 200. Two more electrified barriers will be installed at Toston (Personal comment Joe Weigand, MDT). Based on this, liability is apparently acceptable to MDT (Personal comment Joe Weigand, MDT).
The following seems prudent:

1. Proper signage to warn people of the electrified barriers (human safety, property damage (e.g. scratches on paint because of bump-gate)).
2. An on/off switch (must be accessible from either side of the barrier), perhaps on a timer so that it cannot be left off.

3. Potentially a pedestrian gate on a spring next to the wildlife guard and electrified barrier, especially for the design with electrified wires above the ground.
4. Decide on whether to install electrified wires above ground at all. Potentially install two bump gates rather than one bump gate and one installation with electrified wires above ground.

Examples of existing signage on electrified fences and barriers are in the images below (Figures 8, 9, 10, 11, 12, 13).

Note that the electrified barriers may be switched off in winter months (e.g. November – March) because:

1. One of the main target species (black bear) will have much reduced activity.
2. The low light may result in insufficient power in winter if powered by solar panels.
3. The batteries may not be able to sustain very low temperatures.
4. Snow may build up causing the electrified barrier to short out.

Note that the electrified barriers will be installed to increase the barrier function already provided by wildlife guards. As such, the researchers expect fewer large wild mammals will enter the fenced road corridor if the electrified barriers increase the barrier effect of the guard that is already present. If the electrified barrier is not effective at all, the researchers expect a similar number of large wild animals to enter the fenced road corridor compared to the current situation. In the unlikely scenario that adding the electrified barriers to the wildlife guards results in more animals entering the fenced road corridor, human safety may be negatively affected.

Proposed actions:

1. Agreement needs to be reached between the key partners (MDT, CSKT and researchers). If no agreement between these key partners is reached, the project may need to be cancelled.
2. Put a management plan in place that includes safety precautions for potential technical problems, maintenance, emergencies, and other issues.
3. Inform locals (residents of Ravalli) (e.g. through flyers at shops (bakery, bar) in Ravalli), law enforcement, MDT personnel in the area.
4. Informational/warning signs at the electrified barriers.
5. An “Off switch”, potentially on a timer (electricity turns back on automatically), for pedestrians, cyclists, equestrian use.
6. Potentially install a pedestrian gate next to the electrified barrier (most needed if electrified wires above ground are installed).

Figure 8: "Caution Electrified Roadmat" sign along MT Hwy 200 near Thompson Falls, Montana.

Figure 9: Electric fence associated with an animal detection and driver warning system at a fence end, S.R. 260 east of Payson, Arizona (see Gagnon et al., 2010).

Figure 10: Electric fence associated with an animal detection and driver warning system at a fence end, S.R. 260 east of Payson, Arizona (see Gagnon et al., 2010).

Figure 11: Pedestrian gate at electric fence associated with an animal detection and driver warning system at a fence end, S.R. 260 east of Payson, Arizona.

Figure 12: Shut off switch at pedestrian gate at electric fence associated with an animal detection and driver warning system at a fence end, S.R. 260 east of Payson, Arizona.

Figure 13: Electrified wires on road surface at gate, South Africa.

Task 4: Purchase and install mitigation equipment

WTI-MSU will have a Contracted Services Agreement with the NGO "People and Carnivores" to purchase and install two electrified barriers (for the locations and types of barrier see earlier sections). The electrified barriers will be solar powered for the test. Should MDT decide to keep the barriers in place after the test, MDT can decide to hook up the barriers to the grid which would allow for year-round operation. People and Carnivores have extensive experience with electrified barriers to keep carnivores out of areas where they may come into conflict with people. Note that the electrified barriers may only be operational in summer months when bears are most active. Note that the electrified barriers may be set back, e.g. 1 ft, so that animals that approach are first exposed to the wildlife guard only. Note that vegetation growing at or in the wildlife guards will be removed before data collection starts. Vegetation maintenance will continue throughout the project. Note that the researchers and associated project funds will address operation and maintenance of the electrified guards throughout the project (as long as it fits within the designated $2000 maintenance budget).

Assistance from MDT is needed for the following:
Potentially install swing gates adjacent to the wildlife guards and electrified barriers (one gate per site). These gates could potentially be used by pedestrians as an alternative to tuning off the electrified barriers and crossing the electrified barriers. The swing gates would have to be on a spring mechanism that closes automatically. Note that the costs for these potential gates and their installation are not part of this research project.

Task 5: Purchase and install research equipment

WTI-MSU will refurbish, purchase and install wildlife cameras (Reconyx, no glow infrared flash) at the two electrified barriers (for the locations and types of barrier see earlier sections). These cameras will detect large wild mammals that approach the electrified barriers and record whether they cross the barrier into the fenced road corridor or not. The researchers will change memory cards and batteries (anticipated once per month), download memory cards onto a hard disk, and conduct vegetation management (cut tall grasses in front of cameras and vegetation growing in the pit under the wildlife guards).

Task 6: Evaluate the effectiveness of modified mitigation measures

The cameras will be recording wildlife that come within e.g. 2 m (about 7 ft) of the wildlife guards and electrified barriers, day and night, 24/7. The researchers will then calculate the barrier effect for each species based on the number of approaches, and the number of pass vs. no-pass events across each electrified barrier. Note that the electrified barriers may be switched off in winter months (e.g. November – March) because one of the main target species (black bear) will have much reduced activity, because the low light may result in insufficient power in winter, and because the batteries may not be able to sustain very low temperatures.

Task 7: Reporting

The researchers will submit quarterly reports, a draft final report, final report, and present remotely to MDT representatives. In addition, WTI-MSU will work with People and Carnivores on schematics or sketches of the electrified barriers. Research images of the equipment and images obtained through the wildlife cameras are also available to MDT.

The report will include quantitative information on the barrier effect of the electrified barriers (this is the primary performance parameter), the expected benefits to human safety, and an estimate on the financial costs of the measures vs. the benefits of reduced property damage and improved human safety, and reduced direct wildlife mortality. The report will also include data on the purchase and installation costs of the equipment, installation considerations (e.g. power, modifications to existing facilities), experience with operation and maintenance of the equipment, including with regard to human safety. Deliverables also include a project summary report, implementation report, and performance measures report.

Jump-outs

Task 1: Select Study Sites

Ten existing jump-outs were selected based on the following criteria:

1. Some of the jump-outs need to be in areas where we know there are white-tailed deer, and others need to be located in areas where we know there are mule deer (based on historic data, see Huijser et al., 2016b). This will allow the researchers to gather information on the two most frequently hit large ungulate species in the region.
2. The jump-outs need to have a history of white-tailed deer and mule deer showing up on top of the jump-out. Jump-outs that are not or barely used by deer do not or barely contribute data.
3. Landowners who allow the installation of the cameras (e.g. CSKT lands in the Evaro area, National Bison Range in the Ravalli Hill area).

The selected jump-outs and their heights are listed in Table 1. Their location is shown in Figures 4 and 15.

Table 1: The current height of the ten jump-outs selected for this project. EV=Evaro, HH= Ravalli Hill.

		Height	
Area	**#**	**ft**	**cm**
EV	14	6' 8.5"	204
EV	17	6' 0"	183
EV	19	6' 8"	203
EV	20	6' 0"	183
EV	21	6' 1.5"	187
EV	23	5' 6"	168
RH	26	5' 11"	180
RH	27	6' 0"	183
RH	28	5' 9"	175
RH	29	5' 11"	180

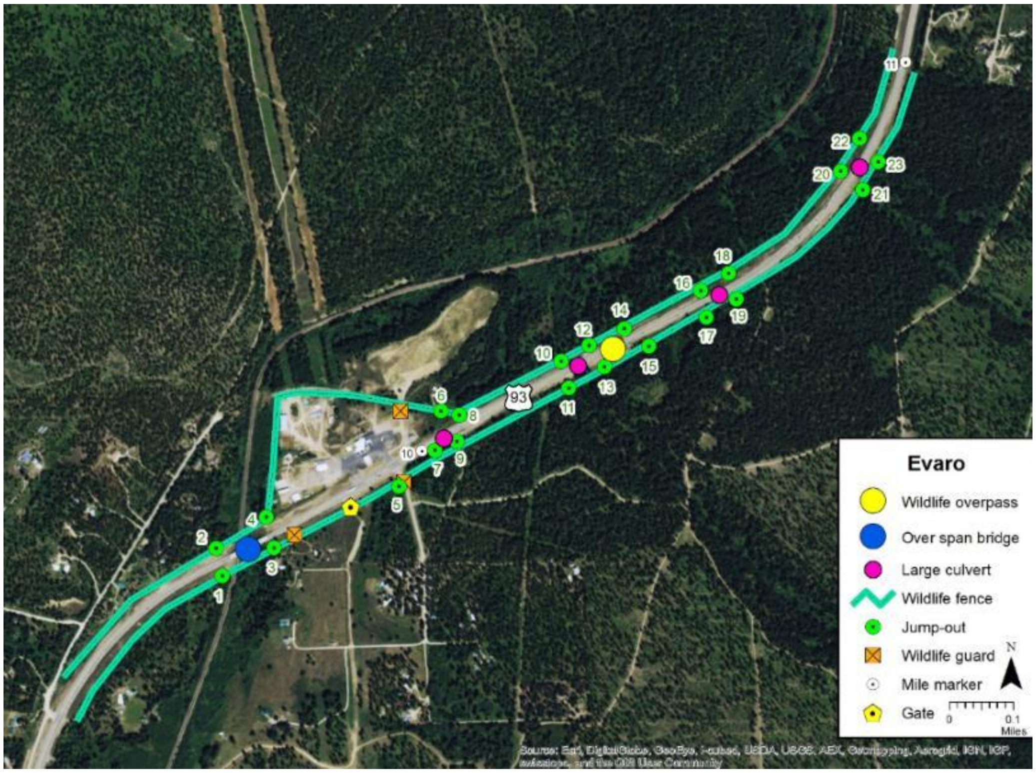

Figure 14: Location of the jump-outs in the Evaro area (green circles).

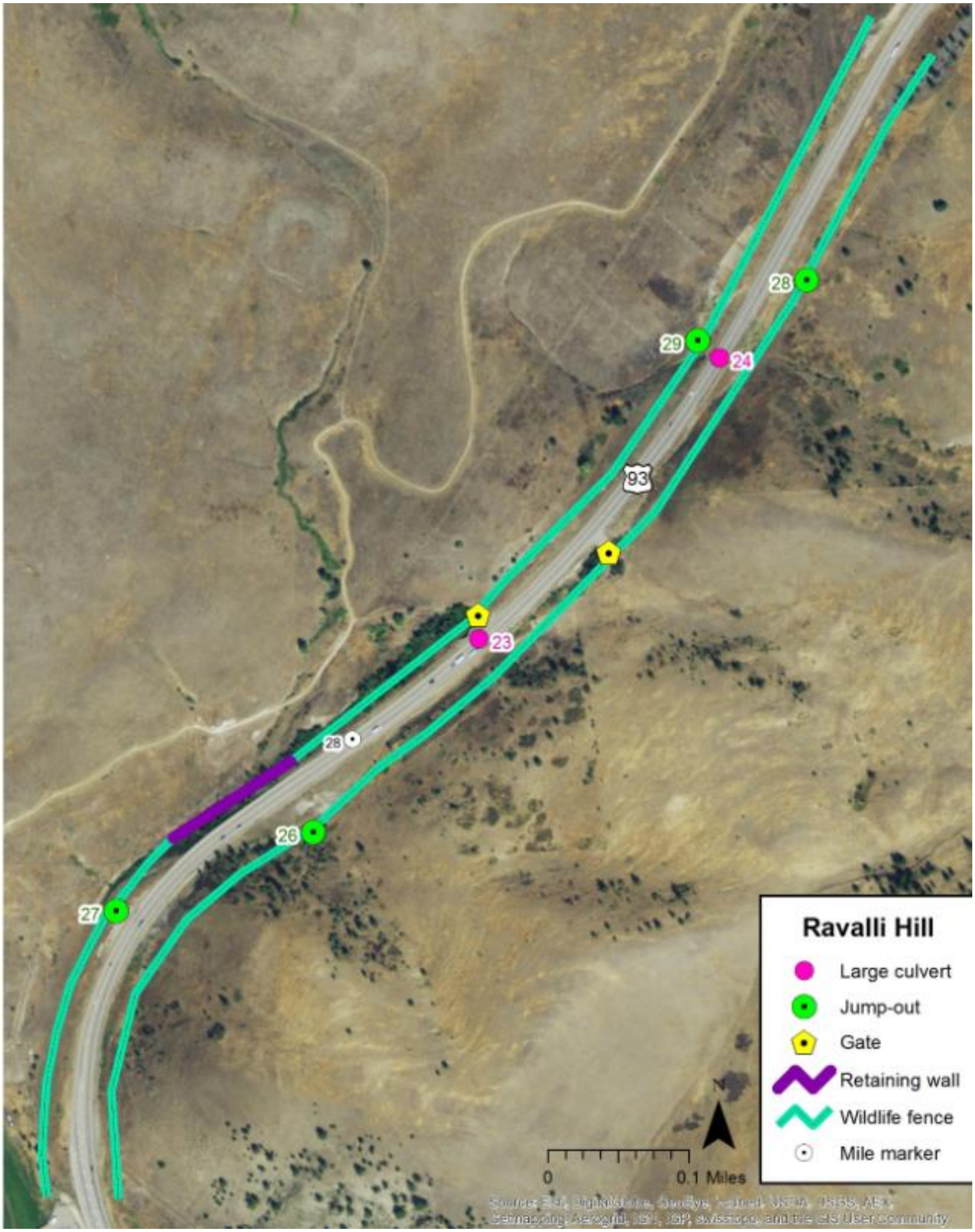

Figure 15: Location of the jump-outs in the Ravalli Hill area (green circles).

Task 2: Select Measures or Modifications

The ten jump-outs will have the following modifications:

1. Lower or standardized height (probably to either 5 ft or 5½ ft) by removing soil from the top and removing one or more rows of the concrete blocks from the face (the wall). The top blocks are 3 inches (7.6 cm) tall, and the standard blocks are 7 inches (17.8 cm) tall.
2. Standardize height by leveling the landing area up to about 6-7 ft out (2 m) to obtain consistent height of the jump-outs.
3. Remove tall vegetation on top, and on slopes of jump-outs, as well as the landing area.
4. Add a metal or wooden bar on top of the jump-out, about 12-18 inches (30.5-45.6 cm) above the ground level. This is aimed at continuing to discourage animals from jumping up into the fenced road corridor.

Task 3: Contact stakeholders and agree on measures and research methods

The modifications of the jump-outs have already been discussed with representatives of the Confederated Salish & Kootenai Tribes. Note that a research permit has been obtained already from CSKT (see attachment A).

Assistance by MDT is needed for the following:

1. MDT has already agreed to assist (e.g. with a bobcat or backhoe, or other appropriate equipment) to perform rough jump-out height adjustments. The height adjustment involves reducing the height from about 6-7 ft to about 5-5½ ft. Final height will be decided on later. Finer adjustments will be carried out by research personnel.
2. Stabilize the post of the short perpendicular fence on top of the jump-outs if needed (as the soil will be partially dug away around these posts).
3. Install wooden or metal bar on top of jump-outs about 12-18 inches (30.5-45.6 cm) above the ground level. Final height of the bars will be decided on later. This bar can be attached to stakes on either end, and potentially also on the existing post of the short perpendicular fence.

Task 4: Purchase and install mitigation equipment

The researchers will purchase metal or wooden bars and stakes to be installed on the top of the jump-outs.

Task 5: Purchase and install research equipment

The researchers will purchase (or refurbish) and install wildlife cameras (Reconyx, no glow IR flash) for the ten jump-outs. The wildlife cameras will point towards the face of the jump-out so that the cameras can record animals on the top of the jump-outs as well as animals at the bottom.

The researchers will change memory cards and batteries (anticipated once per month), download memory cards onto a hard disk, and conduct vegetation management (cut tall grasses in front of cameras).

Task 6: Evaluate the effectiveness of modified mitigation measures

The researchers will interpret the images and enter the data obtained from the images into a database. The effectiveness for animals jumping down is calculated (per species, potentially young of year vs. adult) as follows: the number of individuals that jump down divided by the number of individuals that show up on top (i.e. animals that jump down and that turn back combined). The effectiveness for animals jumping up is calculated (per species, potentially young of year vs. adult) as follows: the number of individuals that pass by at the bottom and that do not jump up divided by the number of individuals that show up on the bottom (i.e. those that jump up and those that do not jump up combined). Note that for the animals recorded at the bottom, different categories may be used based on proximity to the jump-out and behavioral parameters suggesting they are exploring the jump-out and are potentially interested in jumping up. Note: There are historic data for the jump-outs that the new data can be compared to (see Huijser et al., 2016b). Note: we will develop a protocol to define an observation and under what circumstances it will result in one record vs. multiple records (e.g. observations need to be at least 1 minute apart to result in separate records).

Task 7: Reporting

The researchers will submit quarterly reports, a draft final report, final report, and present remotely to MDT representatives. In addition, WTI-MSU will provide schematics or sketches of the modified jump-outs (i.e. suggestions for potential future modifications). Research images of the modifications and images obtained through the wildlife cameras are also available to MDT.

The report will include quantitative information on the barrier effect of the modified jump-outs (this is the primary performance parameter), the expected benefits to human safety, and an estimate on the financial costs of the measures vs. the benefits of reduced property damage and improved human safety, and reduced direct wildlife mortality. Careful monitoring and testing of the modifications is warranted as this design should not be allowed to result in an increase in animals jumping up into the fenced road corridor as that poses a human safety issue. The report will also include data on the purchase and installation costs of the equipment, installation considerations, experience with operation and maintenance of the jump-outs. Deliverables also include a project summary report, implementation report, and performance measures report.

INTELLECTUAL PROPERTY

There are no intellectual property issues related to the proposed activities.

MDT and Technical Panel Involvement

Bobbi deMontigny will be the research project manager. Joe Weigand, district biologist, is the champion, and Bob Vosen, Missoula District Administrator, is the sponsor of the project.

The technical panel members are:
Jason Allen / MDT Maintenance
Heidy Bruner /FHWA
Aaron Mason / Road Design MDT
Whisper Means / Natural Resources Department of the Confederated Salish and Kootenai Tribes
Larry Sickerson / MDT Environmental
Ivan Ulberg / MDT Traffic Safety
Nathaniel Walters / MDT Road Design
Darrell Williams / MDT Construction

Technical panel involvement:

1. Discuss and approve selected study sites and selected measures or modifications (note that CSKT also needs to be in agreement). Specific attention is needed for human safety aspects for electrified barriers, including warning signs.
2. Help write and approve a management plan including safety precautions for potential technical problems, maintenance, emergencies, and other issues.
3. Help write and approve outreach plan to inform locals (residents of Ravalli), law enforcement, MDT personnel in the area.
4. Help design, approve and create informational/warning signs at the electrified barriers.
5. Read and comment on reports and other deliverables.

On the ground assistance from MDT:

Electrified barriers:

1. Potentially install a pedestrian gate (automatic closure) next to each electrified barrier (most needed if electrified wires above ground are installed). These swing gates and their installation are not included in the research project.

Jump-outs:

2. MDT has already agreed to assist (e.g. with a bobcat or backhoe, or other appropriate equipment) to perform rough jump-out height adjustments. The height adjustment involves reducing the height from about 6-7 ft to about 5-5½ ft. Final height will be decided on later. Finer adjustments will be carried out by research personnel.
3. Stabilize the post of the short perpendicular fence on top of the jump-outs if needed (as the soil will be partially dug away around these posts).

OTHER COLLABORATORS, PARTNERS AND STAKEHOLDERS

Collaboration and approval from CSKT is critical. While a research permit has been obtained from CSKT already, the specific design of the electrified barriers needs to be discussed with and approved by CSKT.

The NGO “People and Carnivores” will be under a Contracted Services Agreement with WTI-MSU for the purchase and installation of the electrified barriers.

Other stakeholders include nearby residents of Ravalli and law enforcement.

PRODUCTS

- Quarterly reports throughout the duration of the project.
- Final Report, including technical sketches/drawings or images, design specifications, methods for evaluation performance (i.e. methods), images from research cameras that are particularly illustrating, implementation considerations etc.
- Performance measures report.
- Presentation to MDT through the internet (webinar)
- Project implementation report
- Project summary report

IMPLEMENTATION

If the proposed electrified barriers are effective in keeping wildlife, especially carnivore species such as black bear and grizzly bear, out of the fenced road corridors, potential implementation at these sites and other sites appears straightforward. The electrified barriers are potentially suitable for very low traffic volume and very low traffic speed access roads with single land users, e.g. access to an agricultural field. The modifications to the jump-outs, if effective, would be relevant along any road section with extensive wildlife fences as jump-outs are recommended for long sections of wildlife fence.

SCHEDULE

Assuming the project can start 1 December 2020, the researchers propose the following schedule (see table below).

Notes:
Jump-out modifications: If soil conditions and MDT maintenance personnel schedule allows, possible modifications in winter, otherwise in March/April 2021.
Electrified barrier installation: March/April 2021.

Draft final report: 30 Nov 2022
Review by MDT due: start 1 Dec 2022
Final report: 31 Mar 2023

Presentation to MDT in Dec 2022

End project: 31 Mar 2023

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<tr><td></td><td></td><td>2020</td><td>2021</td><td></td><td></td><td></td><td>2022</td><td></td><td></td><td></td><td>2023</td></tr>
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Note: Years in table are calendar years:
Q1 = Jan through Mar
Q2 = April through Jun
Q3 = July through Sep
Q4 = Oct through Dec

BUDGET

$ 62,000

STAFFING

Principal Investigator:
Dr. Marcel P. Huijser, Western Transportation Institute – Montana State University
https://westerntransportationinstitute.org/wti_people/marcel-huijser/

Students:
Samantha Getty, Gina Kuebelbeck, Alexa Morris

Subcontractor:
Bryce Andrews, People and Carnivores.
https://peopleandcarnivores.org/

FACILITIES

Electrified barriers:
The use of two study sites along US Hwy 93N south of Ravalli (see section on study sites).

Jump-outs:
The use of ten study sites along US Hwy 93N between Evaro and just north of Ravalli (see section on study sites).

REFERENCES

Allen, T.D.H, M.P. Huijser & D. Willey. 2013. Evaluation of wildlife guards at access roads. Effectiveness of wildlife guards at access roads. Wildlife Society Bulletin 37(2): 402–408.

FHWA, MDT & CSKT. 2000. Memorandum of Agreement. US 93 Evaro to Polson. December 20, 2000. Federal Highway Administration (FHWA), the Montana Department of Transportation (MDT), and the Confederated Salish and Kootenai Tribes (CSKT). Federal Highway Administration, Helena, Montana, USA. http://www.mdt.mt.gov/pubinvolve/polsoncorridorstudy/docs/moa.pdf

Gagnon, J.W., N.L. Dodd, S.C. Sprague, K. Ogren & R.E. Schweinsburg. 2010. Preacher Canyon wildlife fence and crosswalk enhancement project evaluation. State Route 260. Final Report — Project JPA 04-088. Arizona Game and Fish Department, Phoenix, Arizona, USA.

Huijser, M.P., A.V. Kociolek, T.D.H. Allen, P. McGowen, P.C. Cramer & M. Venner. 2015. Construction guidelines for wildlife fencing and associated escape and lateral access control measures. NCHRP Project 25-25, Task 84, National Cooperative Highway Research Program, Transportation Research Board of the National Academies, Washington D.C., USA.

Huijser, M.P., E.R. Fairbank, W. Camel-Means, J. Graham, V. Watson, P. Basting & D. Becker. 2016a. Effectiveness of short sections of wildlife fencing and crossing structures along highways in reducing wildlife-vehicle collisions and providing safe crossing opportunities for large mammals. Biological Conservation 197: 61-68.

Huijser, M.P., W. Camel-Means, E.R. Fairbank, J.P. Purdum, T.D.H. Allen, A.R. Hardy, J. Graham, J.S. Begley, P. Basting & D. Becker. 2016b. US 93 North post-construction wildlife-vehicle collision and wildlife crossing monitoring on the Flathead Indian Reservation between Evaro and Polson, Montana. FHWA/MT-16-009/8208. Western Transportation Institute – Montana State University, Bozeman, Montana, USA.

Siemers, J.L., K.R. Wilson & S. Baruch-Mordo. 2013. Wildlife fencing and escape ramp monitoring: Preliminary results for mule deer on southwest Colorado. Proceedings of the 2013 International Conference on Ecology and Transportation (ICOET 2013).

ATTACHMENT A: RESEARCH PERMIT CSKT

THE CONFEDERATED SALISH AND KOOTENAI TRIBES
OF THE FLATHEAD NATION
P.O. BOX 278
Pablo, Montana 59855
(406) 275-2700
FAX (406) 275-2806
www.cskt.org

A Confederation of the Salish, Pend d' Oreille and Kootenai Tribes

A People of Vision

April 14, 2020

Dr. Marcel Huijser:
636 Stoddard Street
Missoula, Montana 59802

Dear Marcel:

Attached you will find the signed copy of your Tribal Collecting Permit Renewal. In addition to the requirements listed on the second page, the following reporting requirements are also applicable.

1. **A study plan or proposal, listing goals and objectives of the project and a description of methodology to be used is required for each year of the fieldwork.**
2. **An annual progress report for the project must be received no later than December 31st of each year of the permitted activity.**
3. **A copy of any thesis, dissertation, report or publication arising from the project must be submitted upon completion or publication.**
4. **A copy of all data collected under this permit must be submitted with the annual progress report no late than December 31st of the year of the permitted activity.**

These documents may be sent to Dale Becker, Tribal Wildlfie Program Manager, Wildlife Management Program, Confederated Salish and Kootenai Tribes, P. O. Box 278, Pablo, Montana 59855. Failure to do so will result in a denial of any future permit requests. I appreciate your cooperation and I wish you well in your project. If it is possible, please try to stop by and discuss your project.

Sincerely,

Dale M. Becker

Dale M. Becker, Tribal Wildlife Program Manager

The Confederated Salish and Kootenai Tribes of the Flathead Reservation

Natural Resource Collecting Permit Application #____________

Date: 3 April 2020

NAME: Dr. Marcel Huijser (applicant, supervisor of the students)
Luca Guadagno (student, may also conduct field work)
Potential other students (names currently unknown)

ADDRESS: 636 Stoddard St, Missoula, MT 59802 (residence)

PHONE NUMBER: 406-543-2377

AGENCY OR AFFILIATION: Western Transportation Institute – Montana State University (WTI-MSU)

RESOURCE TYPE: Data collection using wildlife cameras at selected wildlife crossing structures, wildlife jump-outs, and wildlife guards and other barriers at access roads along US Hwy 93 North on the Flathead Indian Reservation, and potentially also at wildlife barriers at access roads on private land on the Flathead Indian Reservation (not in the right-of-way of a public road).

PURPOSE:

1. Investigate long-term wildlife use and acceptance of wildlife crossing structures (about 10-12 years after construction) to supplement the data collected between 2008 through 2015.
2. Investigate effectiveness of modifications of wildlife jump-outs to allow wildlife, specifically mule deer and white-tailed deer, to more readily escape from the fenced road corridor.
3. Investigate effectiveness of modifications to wildlife guards and adding physical barriers (gates) or electrified barriers (gates or "mats") at access roads to discourage wildlife, especially species with paws, from entering the fenced road corridor.

LOCATIONS (include township, section, and range, along with narrative description): Along US Hwy 93 North between Evaro (southern border of the Flathead Indian Reservation) and Polson. Private land may include the Dixon melon farm west of Ravalli, north of MT Hwy 200, south of the Bison Range.

COLLECTION METHODS: Wildlife cameras. Potential tracking

DATES OF COLLECTION: 1 May 2020 (or as soon as is possible/allowed) TO: 31 December 2021

DESCRIPTION OF VEHICLES, INCLUDING LICENSE NO:
VW Jetta, 4 50292B
Student vehicles
Rental vehicles (brand, model, license plate unknown)

NOTE: Please submit a workplan, schedule of activities and a location map to assist in the processing of your application.

Workplans

1. **TWG application (under development with Whisper Camel-Means)**
2. **Research Idea Montana Department of Transportation (attached)**
3. **Student Project Luca Guadagno (attached)**
4. **Access road and jump-out project NV DOT pooled fund (under development).**

Location map
See attachment.

Permit Terms:

I hereby apply for a permit to engage in specified activities on the Confederated Salish and Kootenai Tribes' Reservation and I agree, as partial consideration for the granting of such permit, that the following terms and conditions govern my use of the permit, and my use of Tribal resources and services:

1. I agree to obey all applicable Tribal and Federal laws and regulations and I understand that permission to enter the Flathead Reservation is conditioned on my compliance with same. I understand that any violation of such laws and regulations subjects me to Tribal civil penalties and/or any penalties proved by federal law.

2. I consent to the jurisdiction of the Confederated Salish and Kootenai Tribes over any dispute arising from my use of this Permit.

3. I agree to be bound by the civil sanction provisions of Tribal law in the event that I am found to have violated Tribal law while engaged in permitted activities.

4. I agree to save and hold harmless the Confederated Salish and Kootenai Tribes for any loss, damage or injury to any person or personal property that occurs from or arises out of activities engaged in under this Permit.

5. I understand that certain lands or waters may be closed to entry by the Tribes without prior notice.

6. I agree that any papers or reports utilizing data collected under this Permit will be provided to the CSKT as soon as they are completed and will cite the CSKT as a cooperator.

7. I understand that other Tribal or Federal permits may be required, and that these are my responsibility to obtain prior to any activity under this Permit.

3 April 2020

DATE Signature of Applicant

4/14/2020 Ellie Bundy McLeod

DATE Tribal Secretary

ATTACHMENT B: STATEMENT USF&WS

Re: draft proposal to study Wildlife Barriers at Fence Ends and at Access Roads

McGrath, Mike <mike_mcgrath@fws.gov>
Wed 4/22/2020 2:27 PM

To:

- Huijser, Marcel <mhuijser@montana.edu>

Cc:

- Bush, Jodi <jodi_bush@fws.gov>;
- Cooley, Hilary <hilary_cooley@fws.gov>

Hi Marcel,

I wanted to follow up with you on what I learned regarding your proposal to study wildlife barriers at fence ends and at access roads. Specifically, if there is a need for a recovery permit from the US Fish and Wildlife Service because of the occurrence of grizzly bears in the area and the use of electrified barriers. The study would occur along US Highway 93 North, and at a melon patch near Dixon, Montana. I ran your draft proposal past our Regional Office's recovery permits coordinator. Her response was that because your study is not targeting grizzly bears, but rather, trying to develop effective barriers for all pawed species, that there would be no "take" involved, and that a recovery permit from the Service **would not be required**. I hope that your study goes well, and I look forward to seeing your results. If you have any questions, don't hesitate to contact me. Thanks.

Mike

Mike McGrath
Montana Ecological Services Office
585 Shephard Way, Suite 1
Helena, MT 59601
406.449.5225 ext. 201
https://www.fws.gov/montanafieldoffice/