# Deterring Wildlife Use of Road Right-of-Ways in Wyoming

WYDOT Project Champions

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## Problem Statement and Background

Need:

Wildlife occupy and are attracted to road right-of-ways (ROWs) particularly during dusk through nighttime hours (Huijser et al. 2007). As day-time gives way to night-time, vehicle operators have a much more difficult time seeing the roadway and visibility to the side of the roadway is greatly reduced. This situation results in negative interactions between wild ungulates and traveling vehicles (Donaldson and Elliott 2021). There are costs to wildlife, such as mortalities, and costs to the traveling public in vehicle damage and some bodily injury and fortunately very few deaths (Lehnert and Bissonette 1997, Riginos et al. 2018).

The Wyoming Department of Transportation (WYDOT) has worked with other interested parties such as the Wyoming Game and Fish Department (WGFD) to reduce wildlife vehicle collisions using various mitigation techniques. In the past, many efforts were randomly applied without much investigation or monitoring with the exception of some assessments such as utility of wildlife warning reflectors (Riginos et al. 2018). More recently, WYDOT has funded research to monitor and evaluate wildlife use of underpasses and overpasses (Sawyer et al 2012, Sawyer et al 2016, Specht et al 2022). WYDOT has further collaborated with WGFD and several non-governmental organizations and produced a wildlife mitigation priority list for Wyoming.

To minimize these human-wildlife conflicts, there is a great need to continue to find methods of providing a safe highway for public use and reduce vehicle-wildlife collisions. This proposal is designed to examine use of mitigation strategies through ROW management to provide future cost-effective responses for reducing wildlife-vehicle collisions across the state.

## Literature Search

Roadways have the potential to negatively impact wildlife populations through vehicle collision mortality (Lehnert and Bissonette 1997, Farrell et al. 2002, Litvaitis and Tash

2008, Barrientos et al. 2021) and indirectly through habitat fragmentation (Forman 2000, Lesbarreres and Fahrig 2012). To mitigate impacts to wildlife from roadways, and to make potential roadway barriers more permeable, transportation planning authorities and wildlife managers have constructed fencing, underpasses, and overpasses to reduce habitat fragmentation and vehicle collisions. Evidence has shown that these wildlife crossing features can help mitigate impacts to wildlife populations and improve safety for motorists (McCollister and van Manen 2010, Sawyer et al. 2012, Huijser et al. 2016, Denneboom et al. 2021).

Fencing has been implemented in an attempt to reduce wildlife-vehicle collision and has proven successful in some situations. In Banff National Park, Alberta, fencing of the Trans-Canada Highway resulted in nonrandom wildlife-vehicle collisions, but still resulted in an 80% reduction in wildlife-vehicle collisions (Clevenger et al. 2001). Proximity to major drainages also influenced the number of wildlife-vehicle accidents. However, most wildlife-vehicle collisions occurred within 1 km of fence ends (Clevenger et al. 2001). In Wyoming, Ward (1982) demonstrated how extending fencing along roads to a highway underpass significantly reduced collisions, especially for deer. Van der Ree et al. (2015) discuss the utility of fencing in mitigating vehicle-wildlife collisions and describe how different fence types are effective for different species. Vercauteren et al. (2006) reviewed the literature about different fence types and their efficacy in excluding deer in several situations. They concluded that few rigorous tests have been conducted of difference fence designs and most of what they recommend related to relatively confined areas. Thus, there is a great need for further assessment of the efficacy of fencing in mitigating vehicle-wildlife collisions.

Often an un-noticed but highly important consideration in roadway-wildlife interfaces is the role of the adjacent ROW (Gagnon et al. 2011). The vast majority of highways and roads have an associated ROW that can vary in width. From a vehicle safety standpoint, the ROW provides an “escape area” or a slowing vehicle catchment area for vehicles that leave the road surface. Typically, ROWs are designed with gradual slopes to reduce chances of roll overs and the ground is typically vegetated to prevent soil erosion. In Wyoming, ROWs are often vegetated with native plant species found on adjacent lands. In the past, ROWs were sometimes re-seeded with easily obtainable low cost non-native grasses such as smooth brome and crested wheatgrass. In either case, ROW vegetation can be an attractant to native (and sometimes non-native) ungulate species. Vegetation, especially when inclusive of native shrubs such as sagebrush and rabbitbrush, may also grow to heights that would inhibit driver visibility to the side of the road surface. Roadside vegetation near the shoulders is managed with mowing.

WYDOT's ROW maintenance program includes mowing ROWs to improve roadside visibility and also affect snow deposit during winter. Mowing the ROW may have an unwanted effect on vegetation from an attractiveness standpoint as there is some literature that has shown a resultant nutritional increase which may actually increase attraction of ungulates. For example, Willms and McLean (1978) demonstrated that spring green-up of non-natives such as crested wheat which can attract mule deer. In west-central Montana, Taylor et al. (2004) reported that moderate (50%) amounts of vegetation removal through mowing increased grass availability whereas cattle grazing removed more standing dead material, resulting in greater availability of nutritious forage in summer. Similarly, Kituku et al. (1992) noted that mowing increased phosphorus, digestibility, and crude protein in forage items of elk and mule deer in south-central Wyoming. This trend of increased forage quality owed to mowing can be important to herbivores on rangelands where vegetation quality is limiting (Clark et al. 1998). Importantly, mowing also helps remove dead vegetation without reducing biomass production during the growing season (Schacht et al. 1998).

This program affords the opportunity to assess how ROW maintenance influences wildlife use of these areas and wildlife collisions. WYDOT typically uses native plant species in reclamation seed mixes (last 20 or so years). With increased maintenance type projects reclamation efforts are generally restricted to the stripped areas next to the road surface or shoulder typically around 12 ft wide (equates to a road grader stripping back the soil). The remaining ROW may be untouched so whatever plants were there remain.

ROWs also encompass a variety of fence types delineating the WYDOT ROW from the adjoining landowner. Many of the adjacent lands are utilized for grazing whether managed by federal land management agencies, state or private landholders. The fence type used can be an issue for wildlife to cross or not cross often dependent upon the particular wildlife species. WYDOT has utilized stout and tall fencing along portions of Interstate 80 to essentially block wild ungulates from getting on to the highway surface. A series of wildlife jumpouts were placed to allow animals that did somehow get through a fence a means to get back out. Secondary roadways are more commonly fenced with livestock compatible fence type to restrict their access to the ROW. These fence types especially these with woven wire serve as barriers to pronghorn while mule deer and elk can jump over them. The WGFD has advocated for the use of wildlife friendly fencing enabling the crossing of wildlife over both sides of the ROW. The concept here is to not impede their passage and also enable the animals to more easily get out of the ROW. Wildlife overpasses and underpasses have incorporated fencing to help guide wildlife to these crossing areas.

The role that the ROW plays in affecting wildlife vehicle conflicts is poorly understood even though various mitigation strategies have been proposed and implemented. The influence of ROW vegetation and manipulating that vegetation through mowing on wildlife use has not been evaluated. The efficacy of other mitigation techniques, such as wildlife friendly fencing, although implemented in some areas have not been evaluated. Thus, there is a great need to understand whether these actions are meeting their intended outcomes.

**Study Objectives**

Our objectives are to evaluate the effectiveness of several ROW mitigation approaches to reduce wildlife-vehicle collisions and improve highway safety. These include vegetation management, fence-type, existing wildlife crossings, and features that could influence their efficacy such as road shoulder width, landscape conditions around sites, and other features.

## Study Approach

*Study Design*

Through the Wyoming Wildlife and Roadways Initiative, WYDOT and WGFD identified 240 project sites state-wide that were candidates for mitigation actions to reduce vehicle-wildlife collisions. From those 240 sites, 41 were identified as statewide priorities based on an objective scoring matrix. Further, previous research has determined "hotspots" of wildlife-vehicle collisions where mitigation procedures have been suggested. For example, Teton Science Schools (2016) identified 27 deer-vehicle collision sites which were "hotspots" where high numbers of wildlife-vehicle collisions occurred. For each site, mitigation measures that were most suitable at those "hotspots" were suggested. Various methods of ROW management ranging from mowing for wildlife visibility improvement to wildlife friendly fencing, fencing with jumpouts and wildlife crossings have been or plan to be implemented across these sites.

Our first task will involve working with WYDOT Districts to identify sites where mitigation actions have been taken, but not evaluated, or sites where actions will be implemented in the future. We will identify actions being taken, their location, timing, and future plans for implementation. At this time, we are not aware of how many actions have been or are planned to be implemented, which limits our ability to identify specific locations or number of sites. Ideally, we intend on monitoring several response variables (see below) using a BACI design (described below), so inclusion of sites where treatments have not been implemented will be prioritized. Once we identify the available sites, we will reduce the available sites to a manageable number representative of those actions being implemented. For example, we would identify several sites that are mowed to improve wildlife visibility, sites with wildlife friendly fencing and fencing with jumpouts, and wildlife crossing mitigation sites.

After identifying available sites, we will use a BACI (Before-After-Control-Impact) design where we have pre-action evaluation of responses of interest, an assessment of responses during and after treatments, while pairing treatment sites with similar sites that are not treated. This design yields robust inference and is considered the gold standard in impact designs (Conquest 2000). At sites where we do not have any pre-action data, we will utilize an Accident Assessment Design (Skalski and Robson 1992). This design enables analysis of an action that has already been taken without the benefit of collecting pre-treatment data. Consequently, this design involves pairing sites that have received treatment, with sites that are similar with respect to other features (e.g., vegetation, landscape attributes), to assess whether trends in the response variables are similar. These designs are commonly used in the case of accidents where assessment of wildlife and other responses are important, yet true experimental design involving data collected before treatment and randomization are not possible. Examples include wildfires, oil spills, and other unplanned events. However, through pairing of sites with similar attributes, robust inference is possible (Skalski and Robson 1992). In all cases "sites" refer to stretches of roads, not singular points along a road. Thus, whether we implement a BACI or an Accident Assessment Design, we will pair sites where mitigation actions have been or are planned to be taken with control sites that are similar, yet not treated with the mitigation action. We intend to include several different mitigation actions, depending on what our collaboration with WYDOT Districts reveals in terms of available mitigation sites that we can use in our study. Such a design will be efficient in terms of utilizing treatments already being conducted or planned by WYDOT. That is, we will not be asking WYDOT to perform mitigation actions they did not intend, rather we will use WYDOT actions as a natural experiment to be evaluated.

At each of these sites, we will record several response variables of interest which can be used to gauge effectiveness of the mitigation action. Vehicle collisions along stretches of roadway will serve as the most important response. Further, where appropriate, we will also conduct wildlife surveys by various means depending on suitability at a site. For example, road surveys conducted by technicians in vehicles, which involve counting wildlife numbers, species, and timing and duration of use of ROWs along with remote cameras or drones might be used. At sites where mitigation actions have not been implemented, we will conduct surveys before the action, during, and again after the treatment has been implemented. Ideally, we would pair each site with two control sites not receiving the treatment. In some cases, wildlife surveys or camera installation before, during, and after could be efficiently used. Once sites are identified, we will have a better understanding of methodology to use beyond vehicle collision data. We will follow appropriate safety recommendations for conducting any work along ROWs.

In all comparisons there are additional variables that will be measured and considered. For example, ROW vegetation species, structure, height, the ROW width, road shoulder width, fence type, terrain type, presence of streams or draws, existence of natural pathways, seasonality, weather (e.g., precipitation), time of day, road type (e.g., two lane, four lane, etc.), traffic density, wildlife species, and other similar factors will all be considered both in identifying appropriate control sites, but also in determining their influence on the response variables of interest. We intend to collaborate with WYDOT to secure traffic data (vehicle volume/use) and wildlife-vehicle collision data.

To better understand why wildlife might be using ROWs, we will test the hypothesis that forage in these areas is of higher nutritional value than adjacent, untreated sites. ROWs could serve as nutritional sinks for ungulates where wildlife are attracted to these sites for their biomass and nutritional quality in comparison to adjacent sites. Collection of vegetation data will occur during times of survey work to better understand if forage quality is a mechanism affecting wildlife use of ROWs. To estimate biomass, we will complete plot clipping and weigh vegetation to estimate productivity. To estimate species specific forage quality, we will collect forage species in each of the phenological stages to determine dry matter digestibility (DMD) using sequential detergent fiber analysis (Van Soest 1982, Robbins et al. 1987*a, b*). We will calculate digestible energy (DE), measured as kcal per gram of forage, from DMD (Cook et al. 2016). We will dry samples within 10 hours of collection at 55$^{o}$C for 36 hours and send samples to the

Wildlife Habitat and Nutrition Laboratory (Pullman, WA, USA). In all cases, vegetation collection will occur only at sites considered safe for technicians to collect data.

*Data Management and Analysis*

In all cases, trends in the responses identified above (number collisions and wildlife use of ROWs) will be assessed over time along stretches of highway where mitigation actions have been implemented and their paired controls. It is through an assessment and comparison of those trends that we can determine whether mitigation actions significantly affect wildlife-vehicle collisions and wildlife use of those areas. In some cases, we will compare within year influences of response variables, and in others, we will compare across years. Both have value in understanding the efficacy of these management strategies. Methods to analyze such trends are well-documented in several sources such as Conquest (2000) and Skalski and Robson (1992). Most of these analyses involve the use of general linear models. Some recent advancements involving the use of Bayesian hierarchical models might be considered if advantageous (Conner et al. 2016).

Collision data will be secured from WYDOT and summarized along stretches of road corresponding to treatments and controls. We will consider date of collisions and other pertinent information if available (e.g., species of wildlife, time of day of collision). We view collision data as the most important response variable assessing the efficacy of these treatments. For camera and wildlife observation data, we will upload data and pictures into software (eMammal.org or similar) that groups pictures taken <60 seconds apart into independent sequences. We will identify the number of unique individuals of each species in each sequence, then photo identifications will be reviewed by an independent party to ensure accuracy and pictures will be archived. Data will only be accessible to WYDOT and researchers at the University of Montana involved in this project. Pictures of humans will not be released to the public or put online. Human pictures will be available to researchers, but faces will be blurred to maintain privacy.

For camera data, we will use a Bayesian Poisson regression model to assess wildlife presence and use of ROWs. We will use relative abundance of each wildlife species (count/100 trap nights at structure) and whether they used the ROW (count/100 trap nights of those using structure) as a camera-level predictor of presence. Analyses will be done by species and we will include other covariates in models that may also influence species occurrence and use of ROW as identified above.

To monitor species changes in temporal activity patterns of ROWs, we will calculate probability density distributions of each species activity pattern using the non-parametric kernel density estimation procedure (Ridout and Linkie 2009). These functions will be estimated over time and comparisons by season will be made using a volume of intersection type analysis (Millspaugh et al. 2004) which will assess how temporal trends change over time and across seasons and years.

Vegetation data, including both biomass and quality, will be compared between treatment and control sites using general linear models. We will leverage the BACI or Accident Assessment Design to compare trends over time, both within seasons and across years.

**Study Benefits**

This study will provide WYDOT and its partners with an evaluation of potential wildlife-vehicle mitigations that can be applied to ROW management to improve highway safety and reduce wildlife mortalities. This study may also identify cost effective alternatives to mitigate wildlife-vehicle collision areas.

**Output and Output Measures**

Outputs of this study support WYDOT's strategic goal of exercising good stewardship of land resources. In addition, output will support measures to improve motorist safety, wildlife safety and minimize associated costs over the long term. Output measures include valuable information about wildlife use of ROW management applications. In addition, mitigation strategies evaluated gained will be applicable to other areas in the state and across similar habitat/roadway/ROW types throughout the West.

*Performance Measures*

Performance measures will be derived directly from data assessment to determine practices that improve motorist and wildlife safety in relation to wildlife collision sites.

**Applicable Questions**

Barriers to successful completion of this study will include maintaining support of a graduate level student and/or post-doctoral researcher. The Millspaugh laboratory at the University of Montana has successfully graduated over 12 graduate students and 7 postdoctoral scholars in the past 6 years and will continue to provide opportunities for future interested researchers. Barriers also include the location of appropriate study sites that meet acceptable safety standards for field sampling and we therefore intend to work closely with personnel at WYDOT to locate useful study sites. Camera failure (if used on this study) may be a barrier as well but the brand and model of camera have been used by both Dr. Millspaugh and WYDOT Environmental Services with high success. All sampling will occur within the ROW.

*Work Plan/Scope*

We will use WYDOT's wildlife collision data to determine potential study sites within the State. We will consider reclamation data and fencing information to select sites with and without collisions to help with variable comparisons. We will include other covariates in models that may also influence species occurrence and use of the ROW, vegetation, known migratory routes, road type, fence type, landscape permeability, precipitation, and other features which might influence use of ROWs. Statistical procedures are described in proposal methods.

**Deliverables**

1. Documentation of wildlife use of highway ROWs. Included will be timing of use by season, year, and species with a focus on ungulates.
2. Determination of factors affecting wildlife use of ROWs, including weather, vegetation influences, and other factors related to use.
3. Management recommendations regarding mitigating factors affecting wildlife use of ROWs.
4. Quarterly, annual, and final reports to WYDOT Environmental Services staff and district staff.
5. Presentation of major findings to WYDOT field staff and other interested personnel.
6. Publication in peer-reviewed scientific journals and presentations at scientific conferences such as regional or international meetings.

**Work Schedule**

We anticipate the budget timeline will encompass three years, beginning June 1, 2023 and a project end date in June 30, 2026 to allow time for analysis completion after data collection ends. It is anticipated at least two peer-reviewed publication would be developed at the conclusion of the work.

**Change Order Information and Agreements**

We understand that any changes in the duration of the contract, work plan, scope, schedule, or costs must be submitted in writing and approved by WYDOT.

**Budget**

We have included 2 months of postdoc time in each of the first two years and 8 months of postdoc time in the last year of the project for final analysis and write-up of two publications intended for a peer-reviewed journal. We have assumed that WYDOT personnel would summarize site treatment information. There is a total of 10 months of field technician time during the first two years (which could be divided among two technicians) to conduct field work. There are two weeks of faculty salary included. We included field travel costs for technicians, postdoc and faculty member. Millspaugh will provide cameras and associated supplies for this project at a value of $17,000 (30 cameras @ $500/each plus $2,000 in batteries used in cameras). This contribution is listed as a footnote in the budget below. Last, there are supply costs along with page charges for a publication.

**WY DOT Highway Crossing Structure Project**
**Project dates: July 1, 2023 - June 30, 2026**
**Fiscal year: July 1-June 30***

| **BUDGET** | FY2024 | FY2025 | FY2026 | Total |
|---|---|---|---|---|
| **Personnel Services Costs** | | | | |
| Postdoctoral Research Associate[1] | $ 11,625 | $ 11,794 | $ 47,176 | $70,595 |
| Insurance ($1,054/month + 5%/year) Benefits (31.5%) | $ 2,108 | $ 2,213 | $ 9,296 | $13,617 |
| Hourly student employees AY | $ 29,333 | $ 29,913 | $ 13,674 | $72,920 |
| Fringe student employees (6%) | $ 1,760 | $ 1,795 | $ 820 | $4,375 |
| Professor (Summer salary Millspaugh) | $ 6,750 | $ 6,750 | $ 8,540 | $22,040 |
| Fringe (35%) | $ 2,363 | $ 2,363 | $ 2,989 | $7,715 |
| **Travel and Transportation[6]** | | | | |
| Site visit for postdoc and faculty member | $ 15,000 | $ 15,000 | $ 5,000 | $35,000 |
| **Supplies** | | | | |
| Hard drives, software for photo processing | $ 7,500 | $ 7,500 | $ 7,500 | $22,500 |
| Page Charges | $ - | $ - | $ 2,500 | $2,500 |
| **Total (without indirect rate)** | $76,439 | $77,328 | $97,495 | $251,262 |
| Indirect costs (20%) | $15,288 | $15,466 | $19,499 | $50,252 |
| **Total** | $91,727 | $92,794 | $116,994 | $301,514 |

*Millspaugh will provide cameras and associated supplies for this project at a value of $17,000 (30 cameras @ $500/each plus $2,000 in batteries used in cameras).

**Implementation Process**

We will work closely with WYDOT representatives and other project partners including the WGFD and interested NGOs through the duration of the project to ensure our findings are relevant and useful. Our deliverables will provide valuable information and recommendations pertaining to the WYDOT ROW mitigation for wildlife. We anticipate results will advance understanding of how ROW mitigations facilitate reductions in wildlife collisions.

**Technology Transfer (including data management plan)**

Results from this project will be shared with WYDOT staff. WYDOT Environmental Services Manager Scott Gamo and Wildlife Specialist Tom Hart will be consulted and will participate throughout the project to ensure the project meets their needs and expectations. In addition, WYDOT will receive written and/or verbal (presentations) quarterly reports over the course of the project timeframe.

Data will be stored at the University of Montana in electronic and paper form (when applicable) for the duration of the project and backup data files will be maintained for several years. At the conclusion of the project, we will provide a comprehensive final report, including research results, conclusions and recommendations, raw data and metadata.

**Education, Outreach, and Scientific Products**

1. Presentations: We will provide presentations to interested members of the general public, WYDOT and professional societies.
2. Scientific journal articles: We will prepare and submit one or more manuscripts detailing the findings of the study to appropriate scientific journals.
3. Project evaluation: We will evaluate the outputs of the education phase to ensure project outcomes were achieved.

## Personnel

Dr. Joshua Millspaugh is a Professor and Boone and Crockett Chair in the Wildlife Biology Program at the University of Montana. He has over 30 years of experience in applied research in wildlife habitat, population, and wildlife impact research and has published over 300 peer-reviewed journal articles and book chapters and 5 books. He has extensive expertise in population and habitat ecology, statistical modeling, and wildlife response to human activities.

Dr. Scott Gamo is the Environmental Services Manager for WYDOT. He has served as a wildlife biologist and manager for over 30 years. Most of his research has involved wildlife habitats and populations. He also serves as co-chair of the Wyoming Wildlife and Roadways Initiative and Implementation Team (WWRIIT) which is a multi-agency, multi collaborator effort to implement wildlife crossing and human safety features along roadways across the state.

Tom Hart is the Environmental Services Wildlife Specialist. He has served in this capacity for nearly 20 years and has been involved with many of WYDOT's wildlife-vehicle mitigation efforts across the state. He also serves as a WYDOT representative to the WWRIIT.

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