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Safe Passages for Wildlife in the Southern Canadian Rockies

2022-23 Final Report

Prepared for: Fish & Wildlife Compensation Program

Prepared by:

Emily Chow and Dr. Clayton Lamb

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Executive Summary

Highway 3 in southeast British Columbia (BC) is an obstacle for wildlife connectivity and a hotspot of wildlife-vehicle collisions. Southeast BC is home to one of the largest assemblages of large mammal species in North America. However, the highway fracture zone adversely affects these species at local (Elk Valley) and continental scales (Canada/USA), leading to numerous conservation challenges. These challenges include fragmenting crucial habitats and populations, and causing direct mortality due to collisions. Many species impacted by the highway, such as grizzly bears, wolverines, bighorn sheep, American badgers, elk, and mule deer, are of local conservation concern and hold high cultural values. More than a decade of research has contributed to our knowledge and proposed solutions to mitigate the impacts of Highway 3 on human and wildlife safety.

Here we report on a project to reduce wildlife-vehicle collisions and promote safe connectivity through exclusion fencing and wildlife crossing structures. The Reconnecting the Rockies: BC project proposes to fence 27 km of Highway 3 from Olsen Crossing east of Hosmer to the BC-Alberta border. On average, 41 roadkill are reported in this stretch each year, and this number may be as high as 124 after accounting for unreported roadkill. These collisions cost society at least 1.6 million per year, but the cost could be as high as 4.8 million. Similar mitigation projects in neighboring jurisdictions (AB, MT, WA, CO, etc.) have successfully reduced collisions with wildlife by >80%.

Guided by an abundance of past research and stakeholder engagement to identify key areas and best approaches, we broke ground on the project in 2020. We began retrofitting existing bridges to serve as underpasses, preparing the ground work for a large wildlife overpass, and future fencing. Between in 2020-2022 we constructed 4 km of wildlife exclusion fencing (2 highway km's) and retrofitted 4 underpasses. The effectiveness monitoring program has had continued success with over 35 cameras deployed with nearly a million photos classified, and ongoing grizzly bear collaring. Early results show wildlife are readily using the underpasses adjacent to the fenced sections. Because the fence was installed in Nov 2022 it is too early to assess effectiveness at reducing collisions, but that will be a priority in future years and as more fencing is installed. We provide a summary of project progress, data collected to date, and recommendations to ensure project effectiveness.

This project aligns with the Fish and Wildlife Compensation Program's Columbia Upland and Dryland Action Plan, focusing on habitat-based actions with the priority action of improvement of connectivity habitats (COLUPD.ECO.HB.13.01 Improvement of connectivity habitats-P1) habitats as the work we are doing directly increases safe connectivity across a major highway and reduces mortality caused by vehicle collisions.

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Introduction

The Flathead and Elk Valleys of southeast British Columbia currently safeguard one of the greatest assemblages of large mammal species in North America (Laliberte and Ripple 2004; Dirzo et al. 2014; Wolf and Ripple 2017). Decades of research has highlighted the immense value of this landscape for transboundary wildlife populations, and the potential challenges as human impacts intensify (Lamb et al. 2020; Proctor et al. 2012), (Poole et al. 2016; McLellan 2015; Benz et al. 2016; Mowat et al. 2020). While there is growing appreciation of the recreational and resource extraction opportunities on this landscape, the combined impact of increased traffic volumes, growing housing developments, recreation use, and expanding coal and timber extraction have the potential to profoundly influence the shared wildlife and habitat corridors in the region.

Highway 3, which bisects southern British Columbia (BC) east to west, has been identified as a barrier to wildlife connectivity, and a source of direct mortality (Apps and Wildlife Conservation Society Canada 2007; Lamb et al. 2017; Proctor et al. 2015). Highway 3 creates a fracture zone for many large mammals that impacts their movement and dispersal at local and continental scales (Canada/USA) (Proctor et al. 2012). Multiple conservation threats stem from this fracture such as disconnecting important habitats, fragmenting populations, and direct mortality from collisions. Many of the species that are impacted by the highway are species of local conservation concern and hold high cultural values, such as grizzly bear, wolverine, bighorn sheep, American badger, elk and mule deer.

The current rate of wildlife-vehicle collisions has raised concerns among the public, conservation groups, and First Nations. On average, nearly half of all reported vehicle collisions with animals (primarily wildlife, but also domestic) occur in the Southern Interior of BC (average 4,700/year in the Interior, 11, 000/year in the province, ICBC). In the Interior, those collisions result in an average of 370 human injuries and 2 fatalities per year. Wildlife-vehicle collisions are especially high in southeast British Columbia's Kootenay region. Within the East Kootenay service area approximately 1,200 to 1,600 road killed animals are collected per year (Mainroads Group 2019). Along Highway 3 from the Alberta border to Jaffray area, BC Ministry of Transportation and Infrastructure's (MOTI) Wildlife Accident Reporting System (WARS) reports 1,443 animal carcasses were collected from 2012-2017, the majority being deer (~175/year) and elk (~55/year). However, the true number of animals killed is likely much greater. For example, three collared grizzly bears were killed by collisions on Highway 3, and none were recorded in any government databases because the animals died off the highway edge. Similarly, neither of the two collared elk killed by vehicles on numbered highways in the Elk Valley were recorded in government databases. Most vehicle strikes are likely unreported, due to the nature of these collisions.

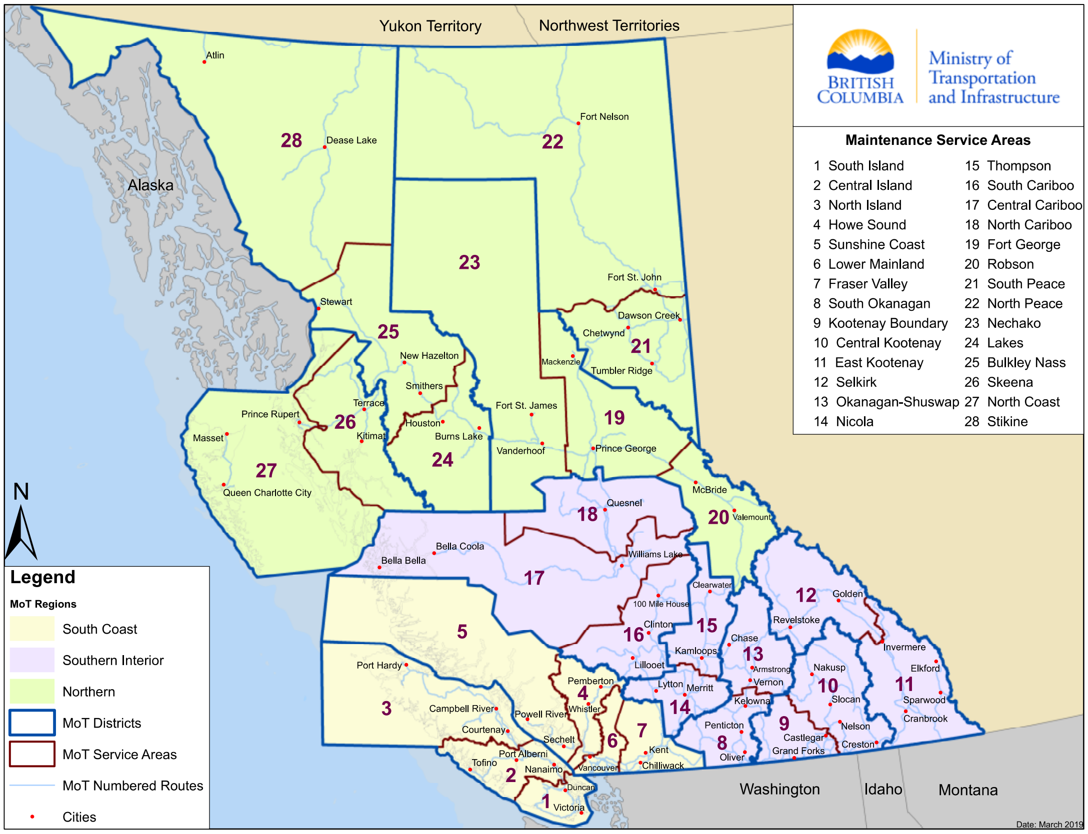

Image 1. Ministry of Transportation and Infrastructure Regions and Service Areas.

There has been over two decades of research contributing to knowledge and proposing solutions to mitigate impacts of Highway 3 to animals and human safety. In 2009, local and regional experts, stakeholders and the public convened on this issue focusing on Highway 3 (Ament et al. 2008). Subsequently, a report was released in 2010 which summarized existing knowledge about landscape suitability and species' vulnerability to Highway 3. The report evaluated key linkage corridors and conflict zones (Clevenger et al. 2010). As part of the 2010 report, 22 sites along Highway 3 were identified as mitigation emphasis sites (MES) based on a number of criteria, such as local conservation significance, mitigation options, and land use security. In 2019, these sites were re-evaluated and four additional sites were identified (Lee et al. 2019). Based on site visits, local landscape attributes, and target species, mitigation strategies to best facilitate movement of large carnivores and ungulates and reduce wildlife-vehicle collisions were identified at key mitigation sites.

In 2020, the research and concerted knowledge mobilization by multiple groups sparked action. A series of meetings focused on the Lee et al. (2019) work and the conclusion of the Roadwatch program were held to provide updates on the latest state of information and discuss next steps. Following these meetings, an innovative partnership formed to begin acting on the recommendations in the report. The group was lead by two government ministries (MOTI and the Ministry of Forests (MOF)), and supported by non-government organizations (Wildsight, Y2Y), and wildlife scientists from Miistakis Institute, Biodiversity Pathways, and the Wildlife Transportation Institute. The government ministries decided to pilot the work by focusing on a 27 km stretch of Highway 3, that extends west from the BC-AB border to Olsen crossing between Sparwood and Hosmer. This section of highway included a number of the highest ranked mitigation sites in the Lee et al. (2019) report, a critical elk migration route, numerous roadkill hotspots, and an internationally significant connectivity corridor—the Alexander-Michel valley.

Multiple jurisdictions in western North America have implemented wildlife crossing structures and fencing, including Alberta, British Columbia, Montana, Washington, Colorado, Wyoming, and Arizona. The effectiveness of these measures in reducing wildlife-vehicle collisions has been extensively studied. Results suggest these systems are generally >80% effective at reducing collisions with common wildlife species while providing safe passages for motorists. Projects are most effective when applied over sufficient distances (>5 highway km, Huijser et al. 2016), fences remain impermeable, and crossing structures are of sufficient dimension (Brennan, Chow, and Lamb, 2022). For example, in Banff, wildlife crossings, including underpasses and overpasses, have reduced wildlife-vehicle collisions by 80% overall, and ungulate-vehicle collisions by 89% (Clevenger and Barrueto 2014). Similarly, in Wyoming the installation of wildlife fencing, overpasses, and underpasses have reduced collisions with deer by 81% (Center for Large Landscape Conservation 2020). In Colorado, fencing between seven large underpasses has reduced collisions by 87% (Center for Large Landscape Conservation 2020). Overall, these studies demonstrate that wildlife crossing structures and fencing can be effective tools for reducing wildlife-vehicle collisions in western North America.

Despite wildlife-vehicle collisions threat to human and wildlife safety, the responsibility for implementing the well-tested solutions often falls in a grey area between government agencies, hindering progress. In British Columbia there is currently no law or policy that requires MOTI to undertake projects specifically for wildlife, nor does the mandate of MOF include road mitigation. This project, known as the Reconnecting the Rockies:BC (RTR:BC, formerly "Safe Passages for Wildlife in the Southern Canadian Rockies"), is exceptional as it's lead by an innovative partnership that includes multiple government agencies that each have an interest in aspects of wildlife-vehicle collisions, and is also supported by partnerships with Ktunaxa First Nation, industry (Teck), elected officials, the highway contractor, and broad community support (including a transportation solutions working group formed in response to the Roadwatch project). These strong partnerships are expanding as the project moves forward. The goal of this project is to implement the highway mitigation actions that have been supported by decades of research. Further, we intend to use a rigorous before-after-control-impact design (Wauchope et al. 2021) to assess the efficacy of the highway mitigation, both in terms of reducing vehicle-wildlife collisions and supporting population connectivity. Generating evidence on the project efficacy will provide critical information for future mitigation investments in other parts of British Columbia and the development of policy to support such actions.

Goals and Objectives and Linkage of FWCP Actions Plans

This work directly supports Action 6 of the Upland and Dryland Action Plan around conservation and improvement of connectivity habitats as well as Action 13 aiming to improve connectivity (e.g. increased wildlife movement between mountain ranges and drainages) in upland and dryland habitats. We accomplish this by fencing off the highway corridor to reduce mortality in this section of highway and creating effective crossing structure to maintain safe passage from one side of the highway to another.

Furthermore, it also supports Action 18 to monitor and evaluate the effectiveness of previous FWCP upland and dryland ecosystems projects. We have a rigorous monitoring project to evaluate effectiveness of the mitigation work that will be ongoing to support and inform future highway mitigation projects.

Study Area

The RTR:BC project area is located in the southern Canadian Rockies, also known as the northwest portion of the Crown of the Continent Ecosystem. The Crown of the Continent Ecosystem sits atop the Continental Divide in the transboundary region of the Rocky Mountains. Because of its geographic position, this Canada-US transborder region represents one of the most strategically important regions in maintaining ecological connectivity on the North American continent. The Crown of the Continent currently safeguards the greatest diversity of ungulate and carnivore species in North America and is recognized to be of global conservation significance.

Much of the Crown is situated between two core protected area complexes. The southern complex is composed of Waterton Lakes, Akamina-Kishinena, and Castle protected areas, while the northern complex is made up of Glacier and Banff-Yoho-Kootenay-Jasper National Parks. The largely unprotected lands stretching between are a vital land bridge connecting these refugia complexes. Once an intact landscape teeming with wildlife from Elk Pass to the US-Canadian border, currently these unprotected lands represent a multi-use landscape characterized by a matrix of towns, highways, resource extraction (logging and mining), and recreational activities (skiing, mountain biking, fishing, and hunting). Over 20 years ago, this land bridge for wildlife across the Crown was considered the most important transboundary conservation issue in North America (M. Soulé, pers. comm.). Indeed, recent connectivity models empirically support Dr. Soulé's assertions of this north-south corridors' importance at national and continental scales (Pither et al. 2023). However, habitat degradation has continued over the last two decades resulting in increasing bottlenecks and constricted movement corridors that impact connectivity.

Past research has highlighted the immense value of this landscape for wildlife populations, and the potential challenges as human impacts intensify. Today, the north-south Alexander-Michel corridor, located within the RTR:BC project in southeast BC is an important transboundary connection. Losing this connection, among others, will have lasting and irreparable effects on the ecological integrity and function of the Crown. The long-term survival of this vast assemblage of large mammals in this transboundary landscape depends on successful management that reconnects populations with these larger areas of secure habitat. Dozens of large mammals are killed each year in the Alexander-Michel corridor and beyond as they attempt to cross Highway 3. The RTR:BC project aims to substantially reduce the mortality from WVC's and improve connectivity in the Alexander-Michel corridor and adjacent habitats in southeast British Columbia.

The RTR:BC project area is located along Highway 3, with an eastern boundary near the Alberta border, and a western boundary between Sparwood and Hosmer (Figure 1). Within the 27 km project area there are ten proposed wildlife crossing structures. Of these ten structures, one is a large overpass (~50 m wide) in the Alexander-Michel corridor, two are purpose-built wildlife underpasses, and seven are existing open-span bridges over creeks (5) or railway tracks (2) that will be retrofitted to facilitate wildlife passage. Wildlife exclusion fencing will be erected along the 27 km project area to exclude wildlife from the highway and direct them towards the crossing structures.

The project is broken into six phases. We are striving to complete one phase per year between 2022-2027, but progress may be expedited or delayed depending on available funding.

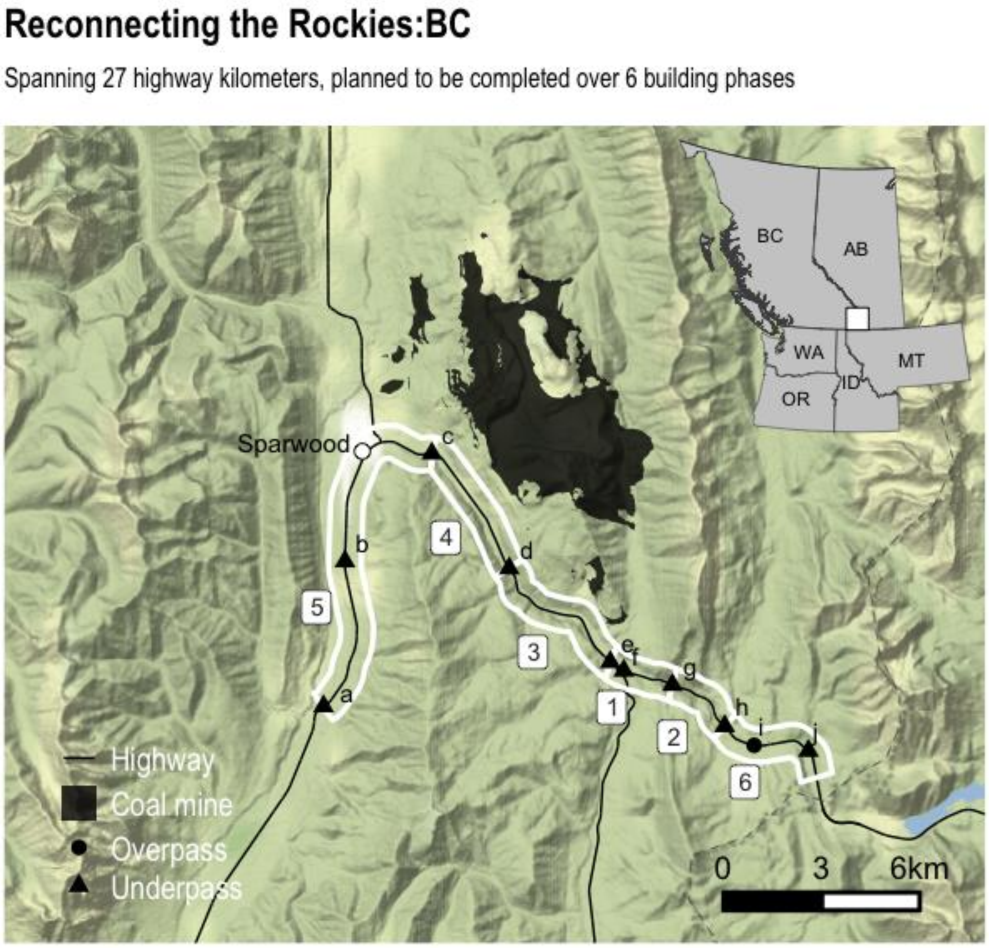

Figure 1: Project location along Highway 3 in southeast British Columbia, Canada. The project is proceeding in 6 phases (depicted as number in white squares), which correspond to the following years: 1=2022, 2=2023, 3-6=2023-2027. Crossing structures are as follows: a) Olsen Overhead, b) Sparwood West, c) Michel, d) Old Town, e) Loop, f) Loop Overhead, g) Carbon, h) Alexander, i) Alexander-Michel, and j) Crowsnest.

Methods and Results

Crossing Structure & Fencing Work

To date we have completed Phase 1, and are on track to complete Phase 2, and potentially Phase 4, for 2023. We have constructed 4 km of fencing (2 highway km's) in 2020-2022 and retrofitted 4 underpasses (Loop, Loop Overhead, Carbon, Alexander).

In 2021, we targeted two sites for mitigation, Loop Bridge and Carbon Creek Bridge. These sites were selected as they offered an opportunity to improve wildlife movement at minimal cost and have completed geotechnical surveys. We determined that Loop Overhead, just east of Loop Bridge, did not need any additional work to function as a underpass. In 2022, we targeted the structure east of Loop and Carbon, Alexander Creek Bridge, for wildlife trail creation. Trails were manually created under these structures to facilitate movement underneath, therefore acting as an underpass for wildlife to safely cross the highway. We erected wildlife exclusion fence on both sides of the highway between Loop and Carbon Bridges in 2022 to connect the two structures that were completed the year prior.

Alexander Bridge was the focus for work in 2021-22. Complications began early when the surveys came back and indicated the bridge works would cost around $200,000 due to structural needs of the bridge and additional materials and design needed. This was substantially more than we initially had forecasted. We also faced some complications around permitting. We put in the application based on the approval of the engineered drawings which were approved. However, the engineered drawings changed after the approval with some extra material needed along the creek, which required us to resubmit for a new permit. There were concerns with the new drawings in relation to restriction of fish passage, which required extra time and engagement with the biologists to be approved. This pushed our timeline back to complete the trail creation directly under the bridge. MOTI found additional funds to be able to complete this work, and ground-work began in early September 2021 and continued through to mid-October. Though we encountered many complications, all materials were delivered to site, the work at Alexander was substantially completed in 2021.

Originally, we had planned to begin work on Old Town bridge and Michel Mouth in 2022, but priorities shifted to focus efforts and funding on completing the work at Alexander and on the fencing between Loop and Carbon bridges, which took more funding and design effort than initially planned. For example, the fence runs under a high voltage powerline, which required additional design work to make the fence safe to run under the line, and the quote to finish Alexander was more than anticipated due to engineering complications. In the end, we successfully installed the fence, and completed Alexander, both to a high standard.

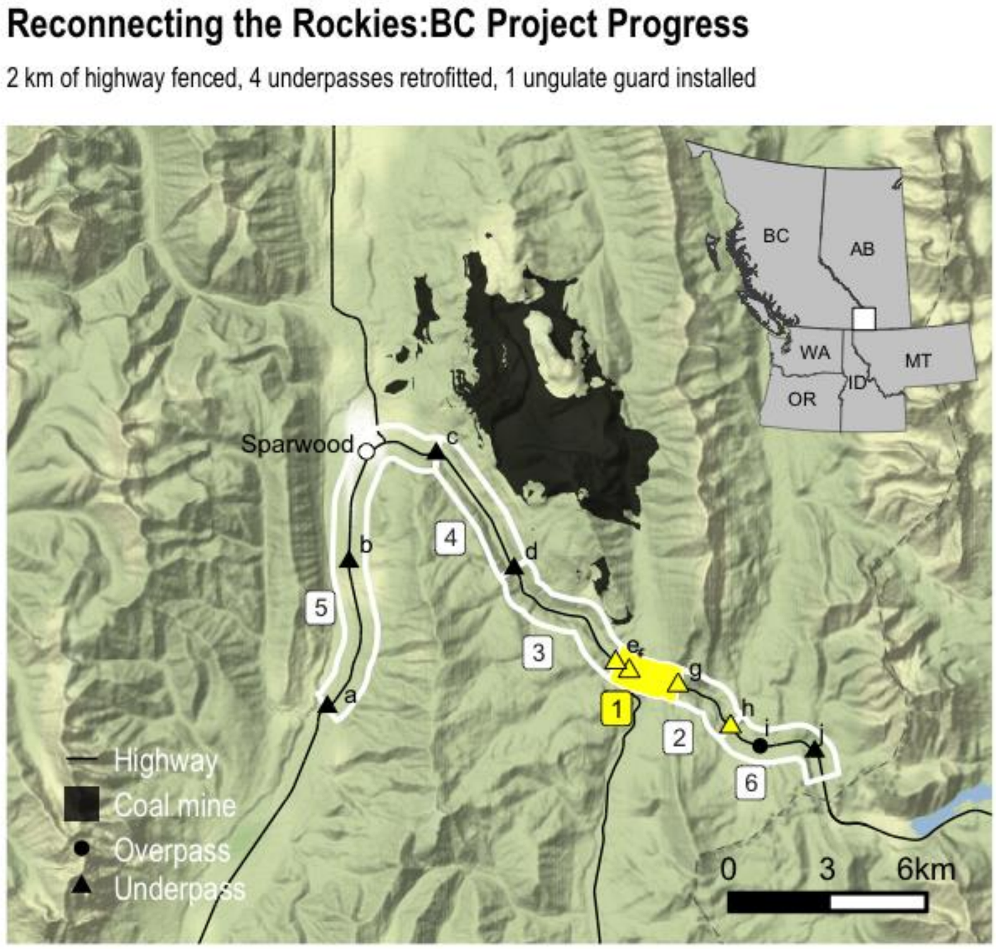

Figure 2: Progress on fencing and crossing structures to date. Completed structures and sections of fence highlighted in yellow. Phase 1 structures are Loop Bridge, Loop CP overhead, and Carbon Bridge, from left to right. Alexander bridge was retrofitted in 2022 to prepare for Phase 2 fencing in 2023.

Loop Bridge

BEFORE

AFTER

Image 2. Example of an underpass retrofit at Loop Bridge. Here a large open span bridge had the potential to provide an effective underpass below the highway, but rip rap and an old abutment blocked animals from easily entering the river edge. We removed a portion of this abutment and created a 10 ft wide path down to the underpass that makes the structure more enticing and safer for wildlife.

Alexander Bridge

BEFORE

AFTER

Image 3. Example of an underpass retrofit at Alexander Bridge. Here a large open span bridge is in an ideal crossing location, but due to the rip rap right up to the creek there was limited opportunity for wildlife to cross under the bridge unless they went in the creek. While the creek is passable for some of the year, its is challenging to cross in the spring during high water, and during the winter when the creek is partially frozen. We engineered a solution that allowed a 1.5 m wildlife path through the rip rap while still protecting the infrastructure. In some high water years the smaller gravel from this path will be washed away but it can be replaced by hand when needed.

Image 4. Phase one wildlife exclusion fencing between Loop Bridge and Carbon Bridge.

*Image 5. A jumpout along the Phase one fence. The jumpout was designed based on extensive testing from Arizona using elk, bighorn sheep, and deer (Gagnon et al. 2020). This design is simple and allows animals to safely exit the highway if needed, while precluding animals from jumping into the highway right of way in reverse. Where sheep are a concern the grooves between the blocks should be filled. *This image does not show the horizontal bar at 45 cm that was installed after this photo was taken.*

Image 6. An elk herd using the retrofitted Loop Bridge underpass following fence construction.

Effectiveness Monitoring

Methods

The effectiveness monitoring is designed to assess the projects' effectiveness in increasing human and wildlife safety and improving wildlife connectivity. We are monitoring project effectiveness using remote cameras, wildlife telemetry, and MOTI's WARS database on wildlife collisions. These data will provide us with insights into the projects' effects on wildlife use of crossings, wildlife movement, as well as human and wildlife safety. The effectiveness monitoring is designed to determine if animals are using the structures to cross Highway 3, and determine if mitigations result in a collision reduction that improves motorist and animal safety. Ensuring mitigations positively influence wildlife crossing and safety is important because we want to reduce collisions with the fencing, while still ensuring animals can cross the highway. We will assess successful crossings and collision reductions before and after road mitigation efforts, with comparison to adjacent control sites in nearby areas (a before-after-control-impact design). Overall, the work is designed to inform adaptive changes to the project as lessons are learned in each years' assessment, provide BC and partners with a rigorous assessment of the projects' short term and long term effectiveness, and inform future collision reduction efforts elsewhere.

At existing structures, two cameras have been deployed under the structure on each side to capture the animals that cross before bridge retrofitting and fencing (i.e. the "treatment"). Monitoring then continues after treatment to assess changes. Paired control cameras (2 per site) are placed up to 1 km from the road crossing in a representative habitat on a wildlife trail to capture what animals are present in the area surrounding the crossing that we would expect to also be represented in similar frequency at the crossing structure. On sites that do not have an existing structure, control cameras are deployed in standard fashion and the treatment cameras and deployed on an existing wildlife trail near the highway (within 400 m). When the crossing structure is installed, a camera will be mounted to capture which animals use the crossing structure. Once images are collected, they are uploaded to Alberta Biodiversity Monitoring Institute's WildTrax portal, where a program coordinator assigns wildlife technicians to classify images recording species, sex, age, and where appropriate, whether they successfully crossed the structure.

Telemetry data for elk and grizzly bear provide insights into individual animal responses to highways, fencing, and crossing structures, as well as fine scale movement data. We are leveraging previously collected elk telemetry data (2016-2022) and ongoing grizzly bear telemetry monitoring (2016-current) to assess animal use of the area before the project, and for grizzly bears, during and after the project.

In addition to the remote camera monitoring and telemetry data, MOTI is providing roadkill data from the WARS database on how many road-killed animals are picked up to so we can assess reductions in collisions following mitigation. Roadkill records from WARS represent our best estimate of animal vehicle collisions (and therefore risks to motorist safety) occurring along Highway 3. Currently, only 2 km of highway has been protected by fencing and not enough time passed since it's construction (finished Nov 2022), to begin assessing roadkill reductions. In addition, the WARS data is not in a state where it can be used for such analyses but we expect more WARS data to become available for our next report. We will begin analyzing these reductions following the construction of Phase 2 fencing in 2023. We will compare roadkill rates before and after mitigation within the fenced area and adjacent unfenced areas to assess the effect of fencing on reducing collisions while controlling for changes in collision rates due to changing animal population abundance, annual behaviour due to weather, etc.

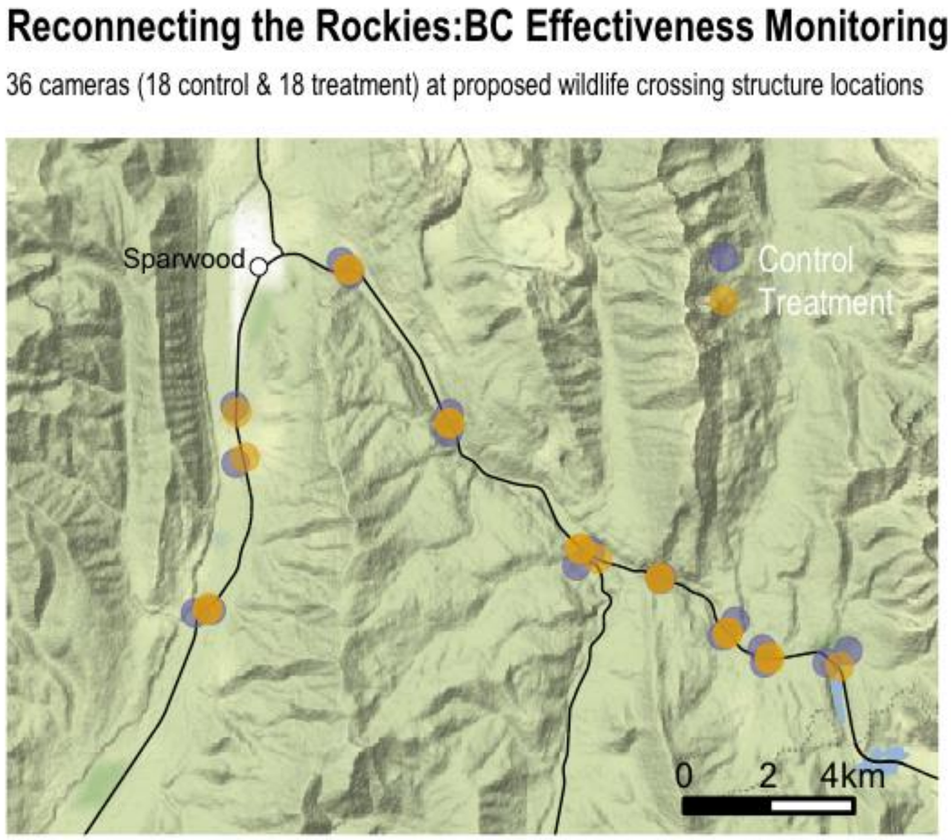

Figure 3: Cameras monitoring crossing structures (Treatment) and adjacent wildlife trails within 500 m of highway (Control).

Results

Between 2020-2022 we collected a total of 788,404 photos from the pre-treatment and control cameras in the RTR:BC project. After removing false triggers from wind, 638,770 photos have been captured of wildlife, people, and vehicles (Figure 4). The total number of photos increased each year since 2020, mostly due to an increase in camera deployment, and addition monitoring sites at railway underpasses (Figure 5). Average monthly detection rates for wildlife varied by structure (Figure 6) and by location type (pre-treatment vs control, Figure 8. Notable structures with abundant wildlife using the structure or nearby controls were Alexander Creek Bridge, Alexander-Michel Overpass, Crowsnest Underpass, and Sparwood West (Figure 6 & Figure 8).

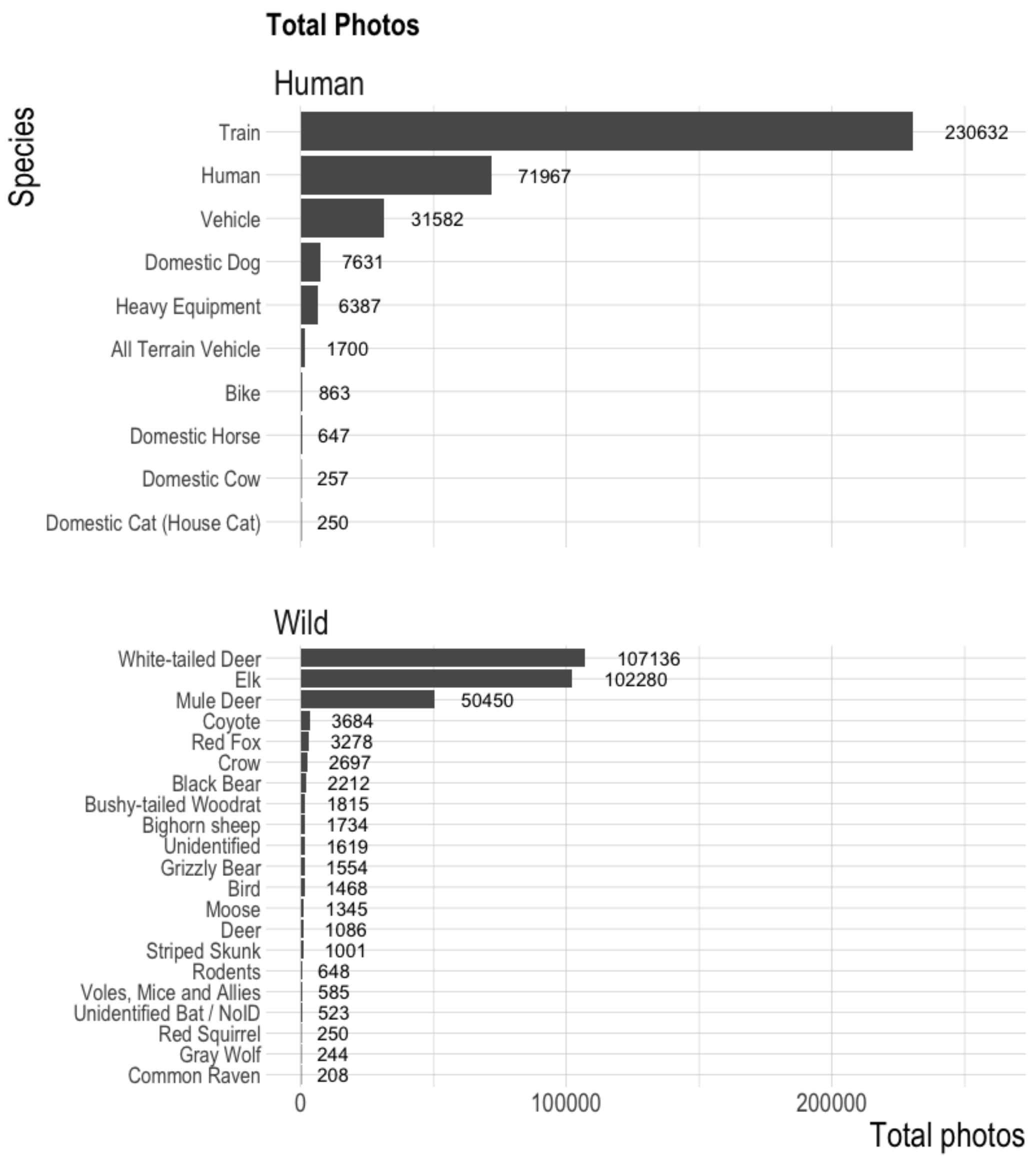

Figure 4: Total photo count across cameras by species and type.

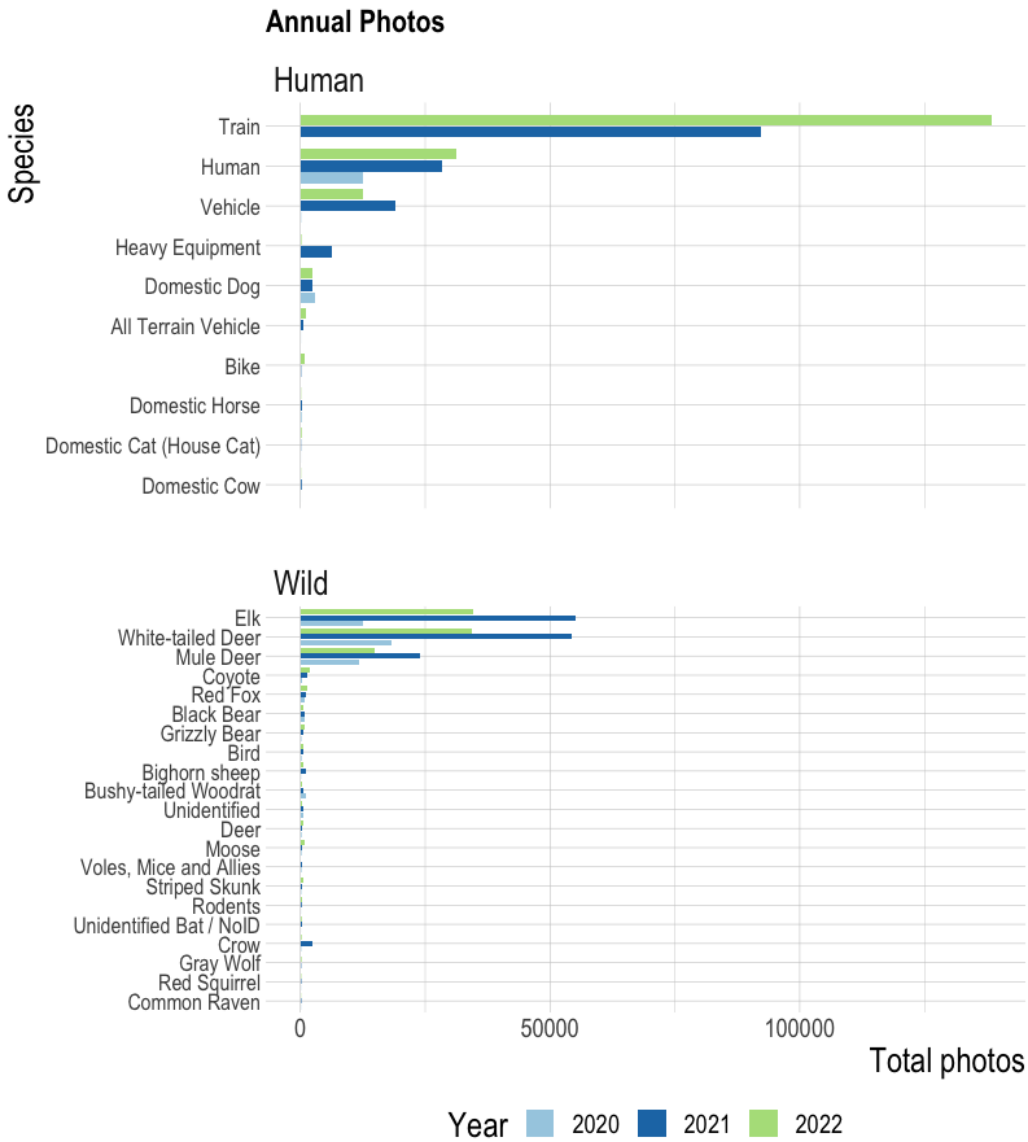

Figure 5: Annual photo count across cameras by species and type.

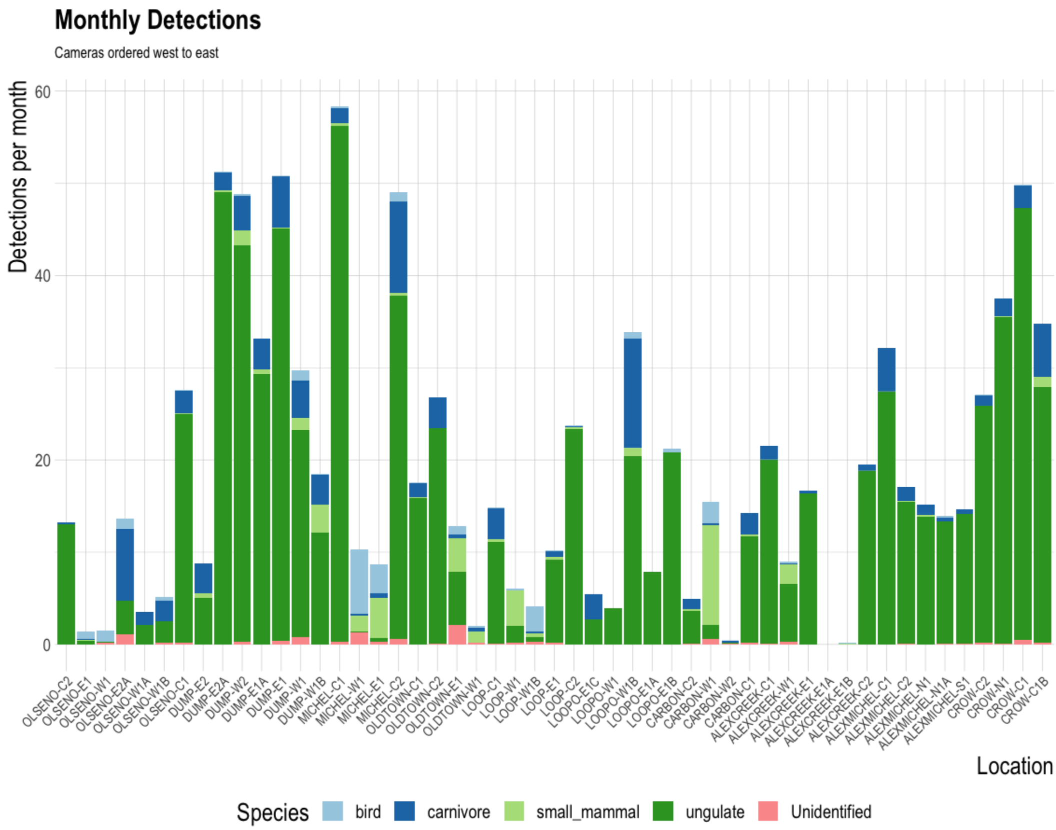

Figure 6: Average monthly detection rate for each camera.

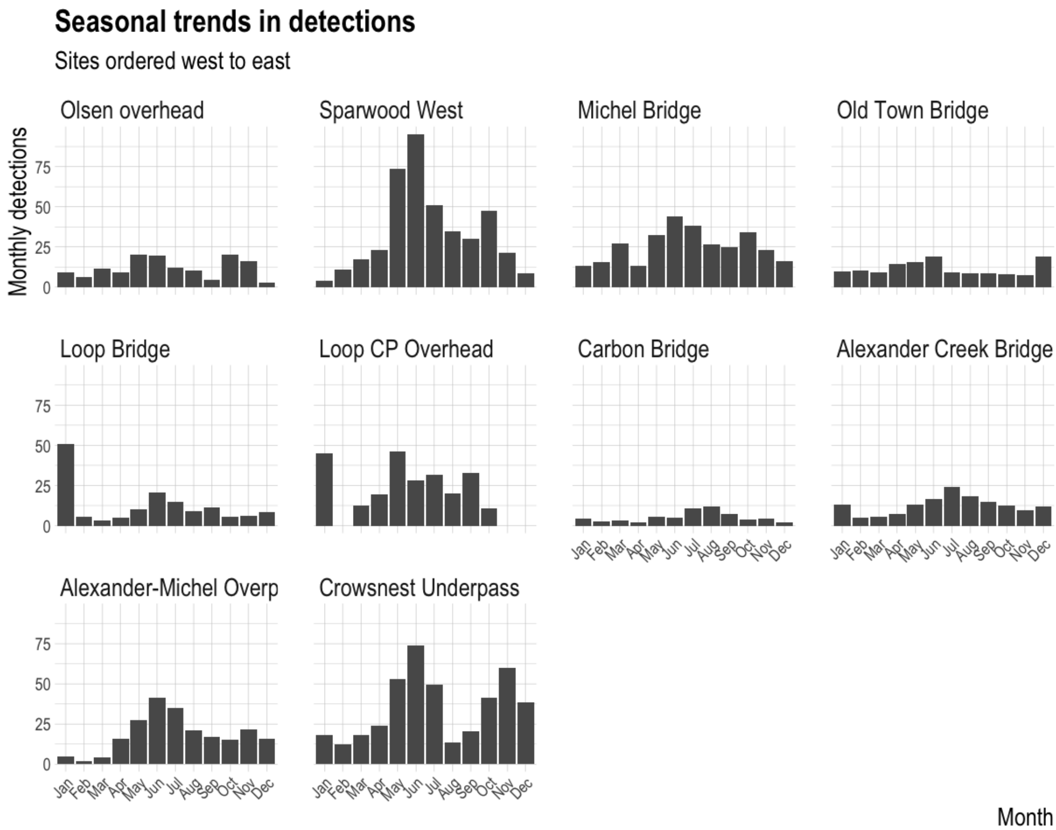

Figure 7: Seasonal trends in monthly detections for each site.

Wildlife were observed crossing under all existing bridges even before fencing guided them towards it. Excluding Alexander-Michel Overpass, Crowsnest Underpass, and Sparwood West, which didn't have infrastructure in place yet, the average monthly wildlife detection rate for control cameras was 22.6 and 8.5 for pre-treatment cameras (Figure 8). In one case, Loop CP Overhead near Corbin Road, wildlife were crossing at higher rates than at adjacent control cameras, suggesting this open-span bridge is serving as an effective structure already.

We monitored crossing success as the proportion of wildlife that entered each structure and crossed through to the other side (Figure 9). Crossing rates were highest for Loop CP Overhead and

Loop Bridge, and lowest for Alexander Creek Bridge and Michel Bridge. Bighorn sheep had the lowest rates of successful crossings, while black and grizzly bear, and elk, had the highest rates of successful crossing. The limited sheep crossings were in line with extensive telemetry data that suggested sheep rarely cross Highway 3.

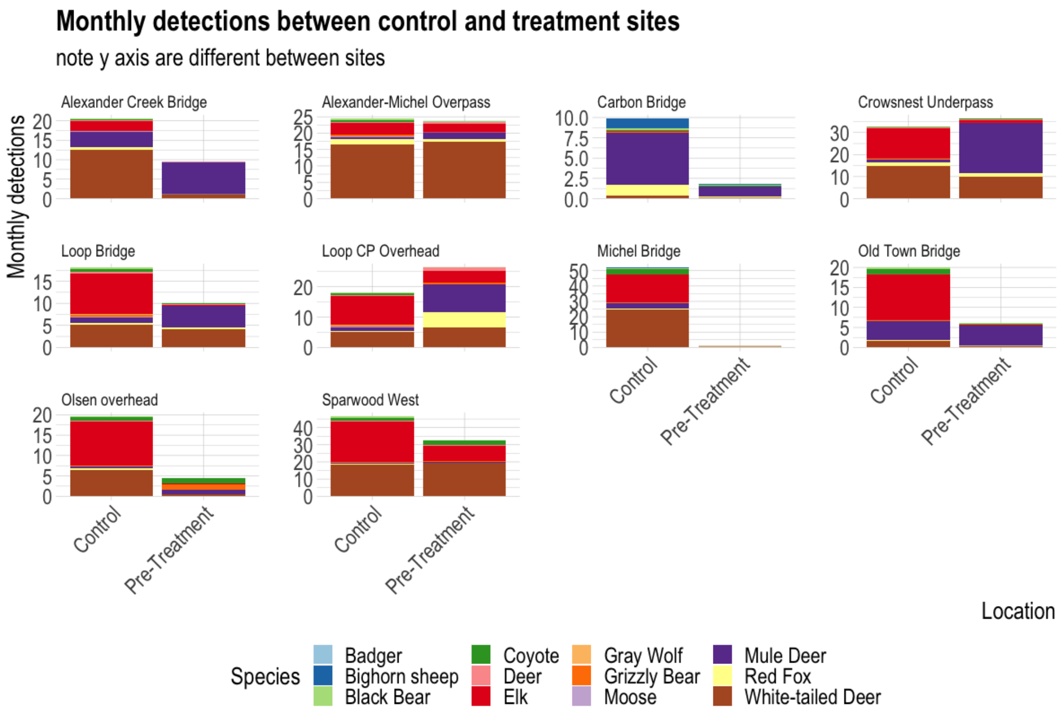

Figure 8: Detection rate comparison between treatment and control cameras.

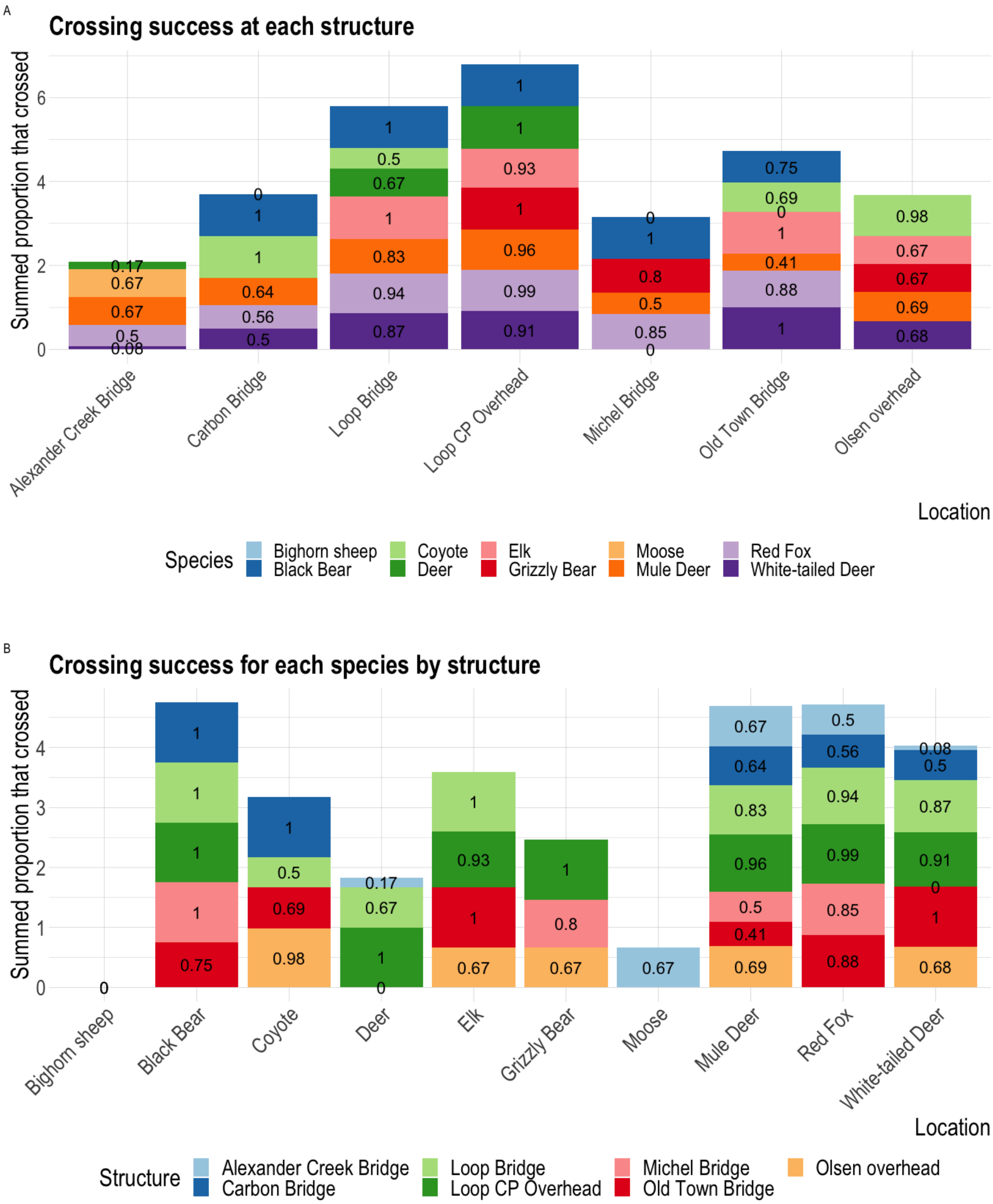

Figure 9: Proportion of successful crossings observed (crossing success) at each site (A) and by species (B). A value of 1 means all individuals of that species who entered the structure were observed crossing through the camera field of view. A value of 0.5 would mean that only half the animals successfully crossed, while the other half turned back the way they came and did not cross.

We assessed monthly detection rates spatially by species and for control and treatment cameras (Figure 10 & Figure 11). Monthly detection rates varied between species due to their differing abundance on the landscape. Detections were greatest in the Alexander-Michel corridor, near the Corbin Road junction, and west of Elkview mine to Olsen Crossing.

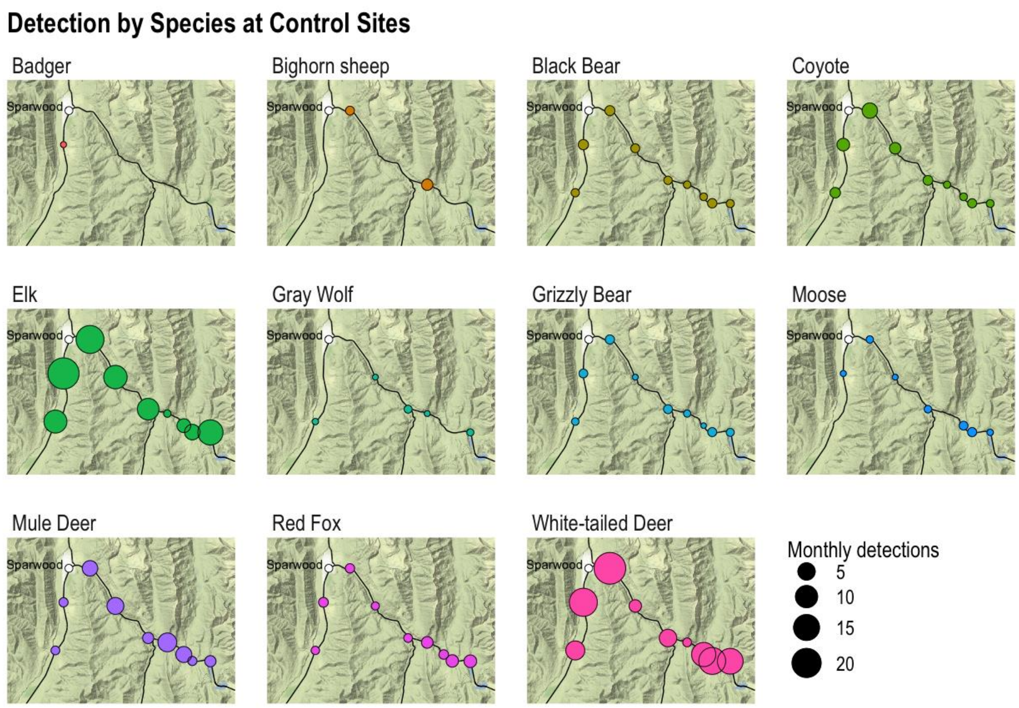

Figure 10: Detections by species across control cameras only.

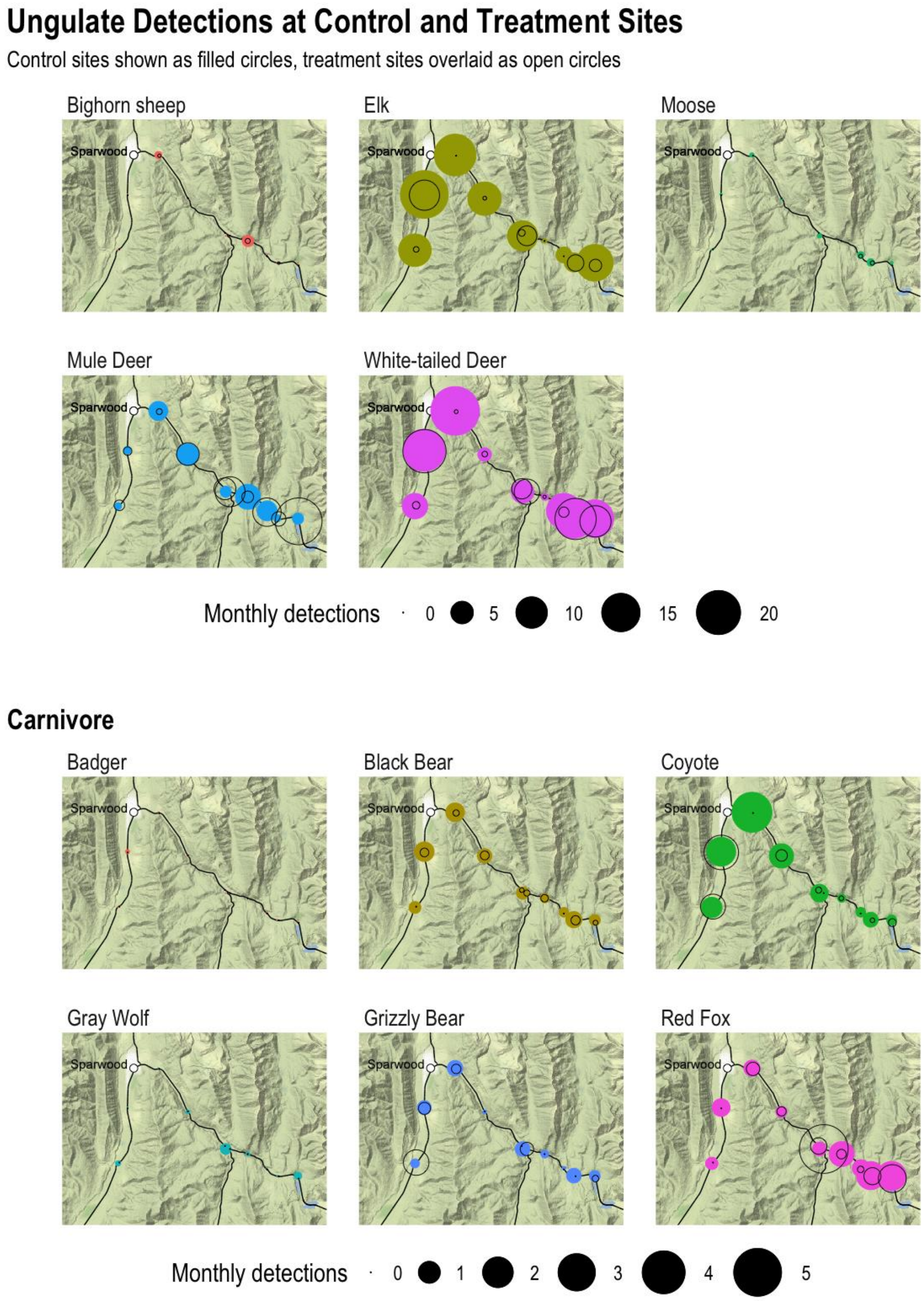

Figure 11: Detections by species across cameras for ungulates (top) and carnivores (bottom). Colored circles are control cameras, black outline are treatment cameras. Circle size indicates average monthly detection rate.

In Phase 5 we intend to install a wildlife underpass west of Sparwood, before Olsen Crossing (Figure 1). Two possible locations for the underpass have been identified. We installed wildlife cameras adjacent to these possible locations to assess wildlife use at these sites (Figure 12). The northern location is preferable from an engineering perspective, but we wanted to compare wildlife use of each site. Wildlife detection rates from the cameras suggested the northern site is also preferable from a wildlife use perspective. Land tenure, specifically future development that could alter wildlife use remains a concern here and agreements with the City of Sparwood should be made before construction to reduce future impacts to wildlife connectivity around crossing structures.

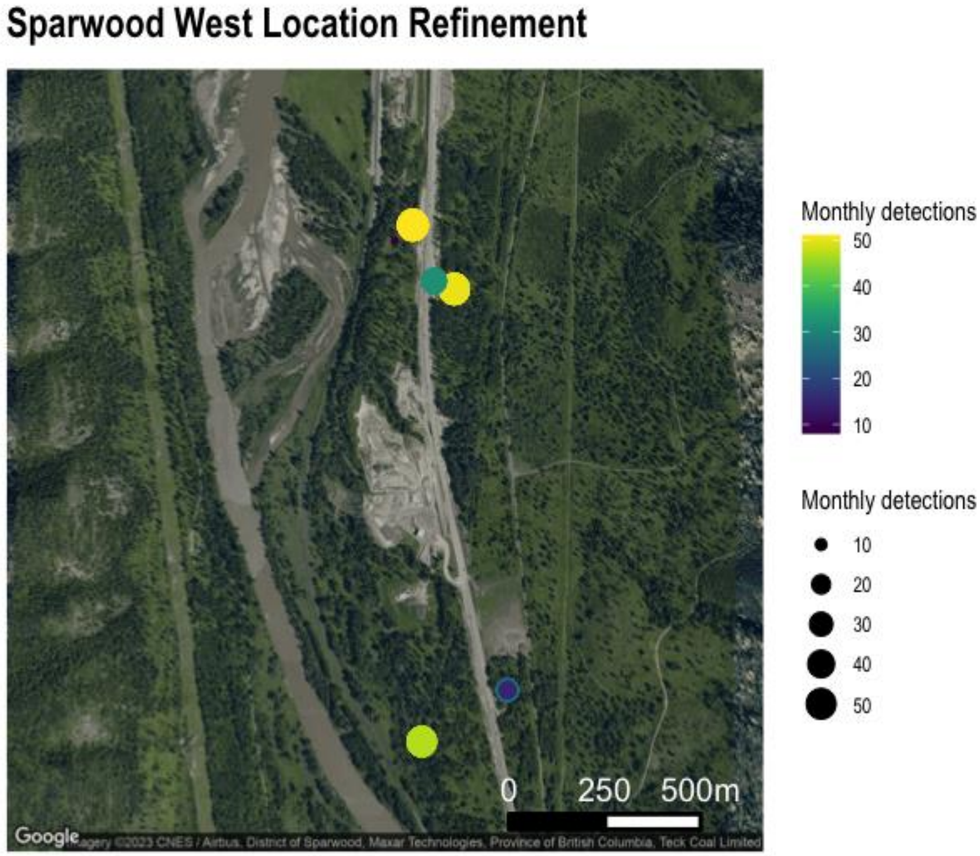

Figure 12: Average monthly detection rates for proposed north and south Sparwood West underpass sites. The north site is preferred from an engineering perspective, and appears to have higher wildlife detection too. Future land use on the east side of the highway needs to be considered.

We are fortunate to have access to telemetry data from past (elk and sheep) and ongoing (grizzly bear) collaring projects that overlap with the RTR:BC project area. We have previously used some of these data to optimize the location of crossing structures (Lee, Clevenger, and Lamb 2019), and we continue to use these data to inform structure location and fencing considerations. The location of current structures appear to be well placed to facilitate north-south grizzly bear movement in the Alexander-Michel corridor (Figure 13), and key crossing areas for grizzly bear and elk throughout the 27 km including west of Sparwood, near Elkview mine, and Corbin area (Figure 14). The project will also safeguard an elk migration route between reclaimed portions of Elkview mine, Corbin, and Alberta (Figure 15). As the fence progresses we will assess grizzly bear responses to this new barrier and the safer crossings afforded by the crossing structures. Elk should be collared again once more fence phases are complete to assess elk migrations and movements in response to the project.

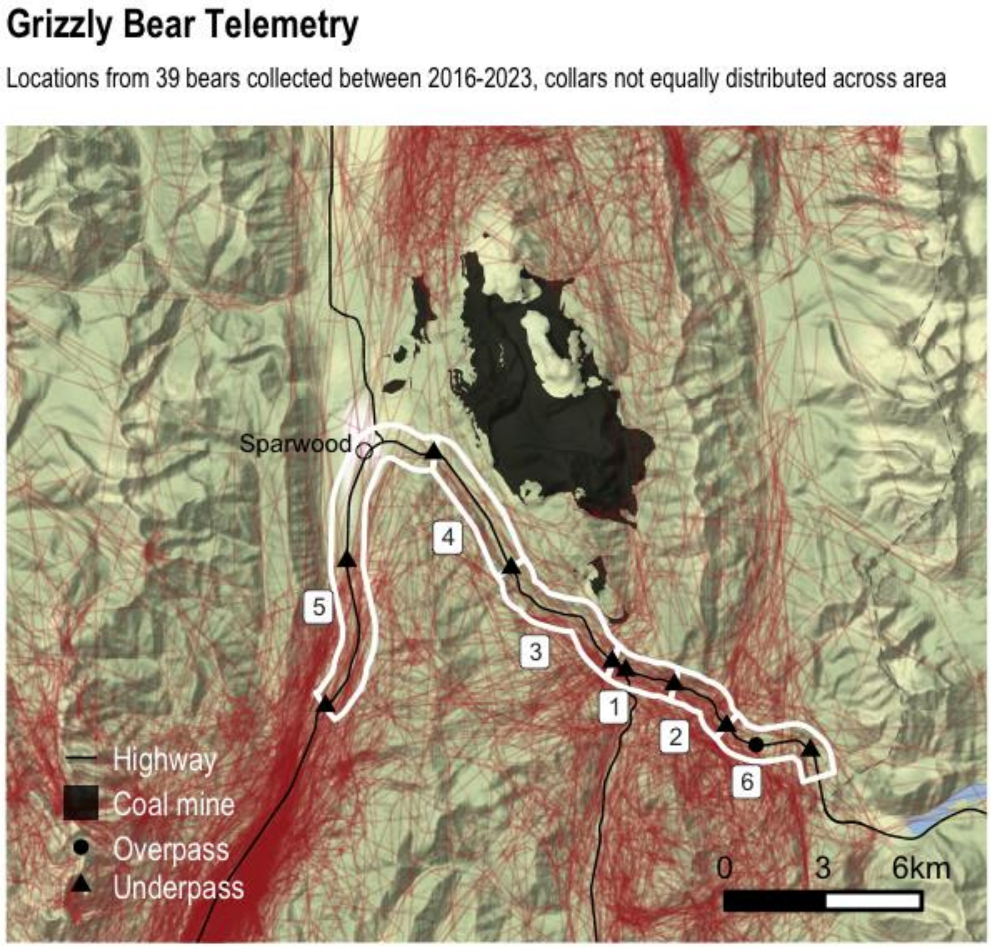

Figure 13: Grizzly bear telemetry data collected between 2016-2023 in the Elk Valley. These data have been used to inform placement of crossing structures. As the fencing continues, collared bears will be monitored to assess crossing rates and habitat use before and after fencing. Note that the map does not accurately display the intensity of bear use/crossings because collars are not randomly distributed in relation to animal density. Lamb et al. (in review) has more details on this collaring project.

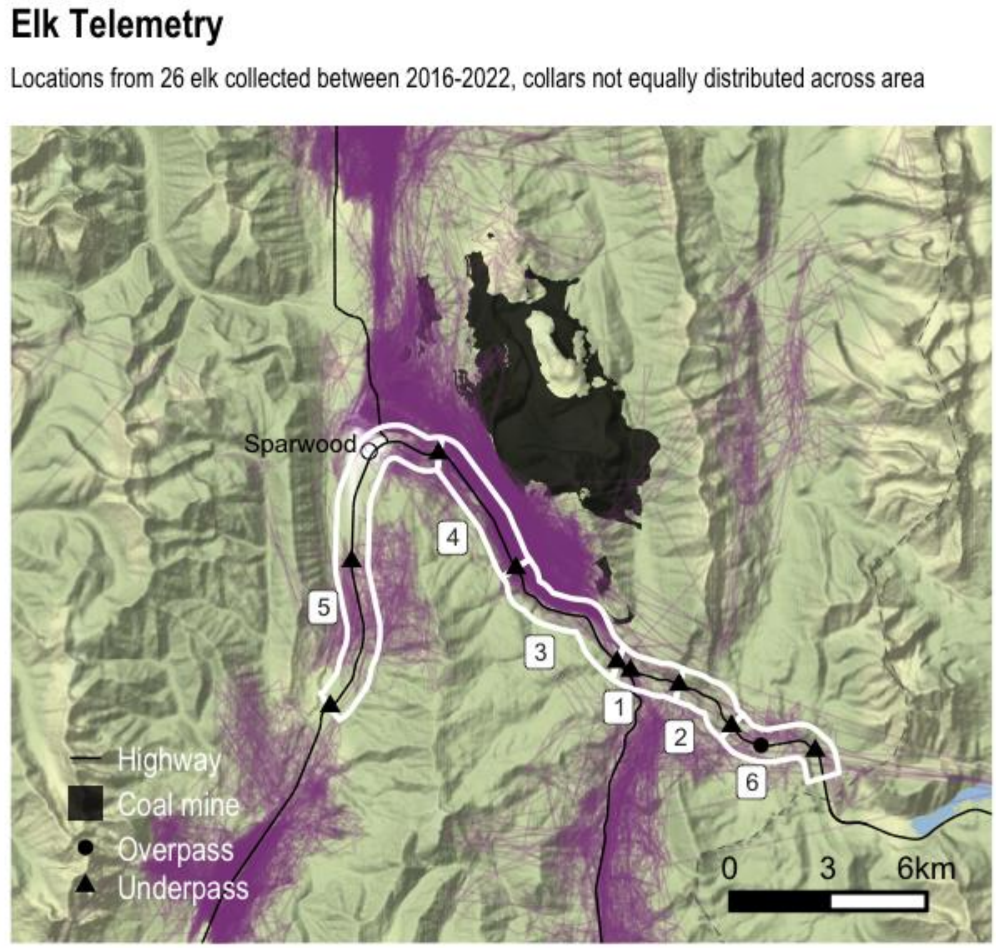

Figure 14: Elk telemetry data collected between 2016-2022 in the Elk Valley. These data have been used to inform placement of crossing structures. There are few collared elk in the valley at the moment. As the fencing progresses, we suggest collaring elk so their movements and migrations can be compared to those that occurred before fencing. Note that the map does not accurately display the intensity of elk use/crossings because collars are not randomly distributed in relation to animal density. Poole and Lamb (2022) has more details on this collaring project.

Elk Migration Routes

Routes from 11 migratory elk collected between 2016-2022, collars not equally distributed across area

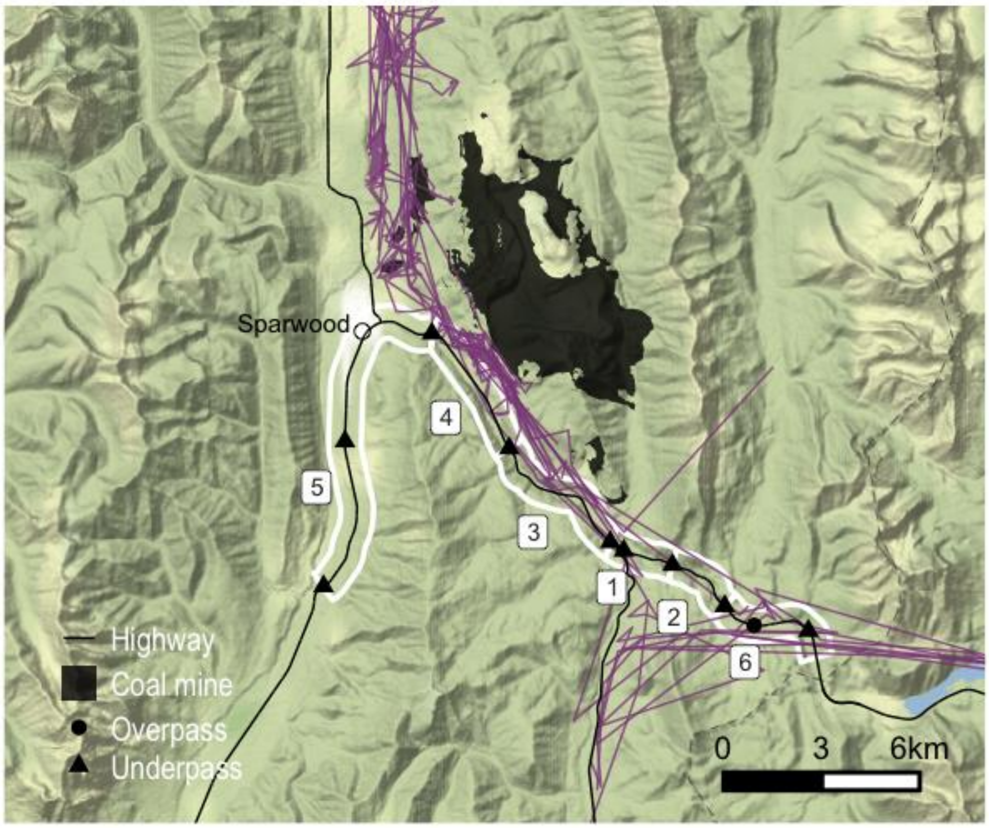

Figure 15: Elk migration routes from Poole and Lamb (2022). Most of these elk winter on the Big Ranch north of Sparwood, or to the east in Alberta. The RTR:BC project area covers a key migration route for Elk Valley elk.

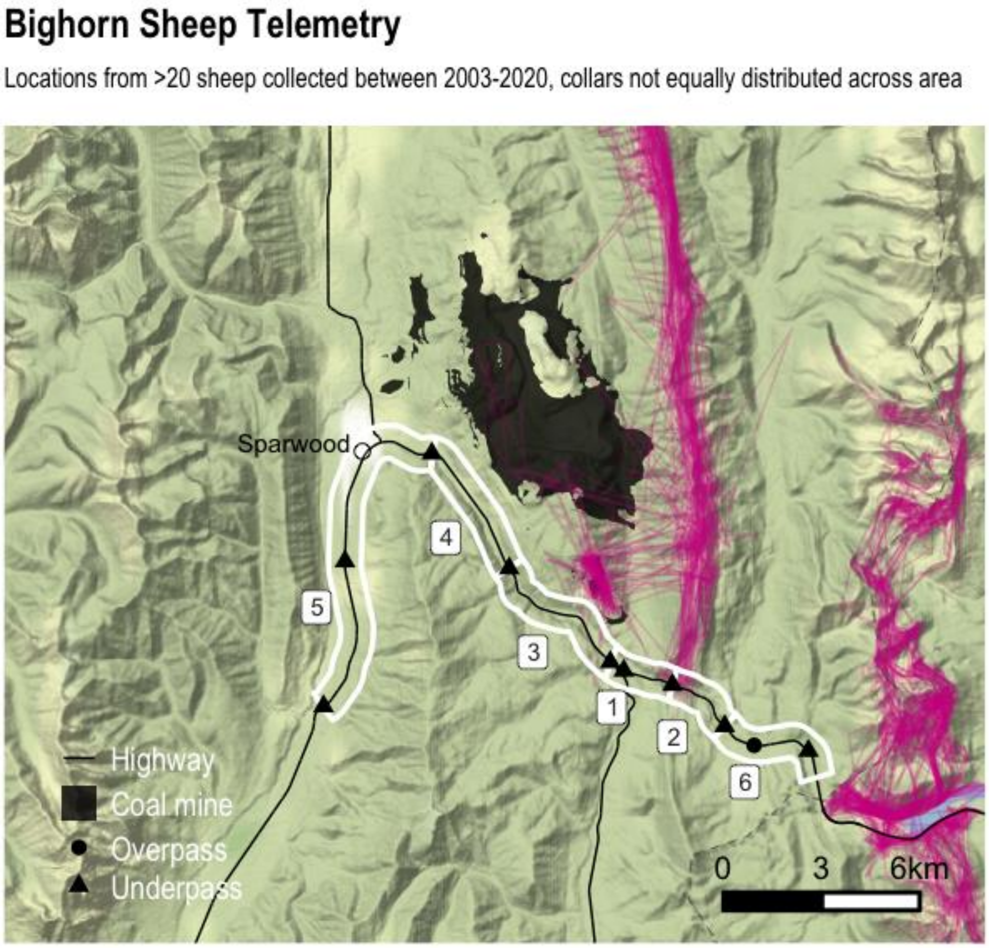

Figure 16: Sheep telemetry data collected between 2003-2020 in the Elk Valley and Continental Divide. These data have been used to inform placement of crossing structures and assess sheep crossings in the past. Note that the map does not accurately display the intensity of sheep use/crossings because collars are not randomly distributed in relation to animal density. Poole et al. (2016) has more details on this collaring project.

We assessed the number of roadkill annually detected along the project length, which we used these to estimate the cost (Table 1) of wildlife-vehicle collisions to society (Figure 17). On average, 41 roadkill are reported each year, and this may be as high as 124 after accounting for roadkill not detected.

Wildlife-vehicle collisions in our study area are estimated to cost society at least an estimated 1.6 million, but the cost could be as high as 4.8 million after accounted for undetected roadkill. We confirmed that the RTR:BC focal area is a hotspot for wildlife-vehicle collisions (Figure 18). The RTR:BC project area has the highest rate of wildlife-vehicle collisions for a highway traversing the Rocky Mountains in Southeast BC (including Highways 43 and 93). We note that areas of high wildlife-vehicle collision intensity do occur outside the mountains in the Rocky Mountain Trench near Jaffray and could be the focus of future work.

Table 1. Cost of animal-vehicle collisions to society estimated by Huijser et al. (2022) (in 2020 CDN$). Direct costs are borne by individuals, governments, or insurance companies. The cost of each direct impact is scaled by its' probability of occurrence. Passive use values included values individual people place on the existence of a given animal species or population as well as the bequest value of knowing that future generations will also benefit from preserving the species. We display the passive use values here and the grand total including passive use values. However, we use the more conservative direct cost subtotal for our calculations of cost in our RTR:BC analyses.

	Deer	**Elk**	**Moose**	**Gray wolf**	**Grizzly bear**	**Cattle**	**Horse**	**Burro**
Direct								
Vehicle repair	$6,053	$10,502	$12,926	$6,053	$6,053	$12,926	$12,926	$10,502
Human injuries	$8,379	$19,973	$36,731	$8,379	$8,379	$36,731	$36,731	$19,973
Human fatalities	$4,768	$31,784	$63,568	$4,768	$4,768	$63,568	$63,568	$31,784
Direct subtotal	$19,199	$62,260	$113,225	$19,199	$19,199	$113,225	$113,225	$62,260
Passive								
Passive use value	$6,953	$38,019	$38,019	$55,269	$5,803,005	---	---	---
Passive subtotal	$6,953	$38,019	$38,019	$55,269	$5,803,005	—	—	—
Grand total	$26,152	$100,279	$151,244	$74,468	$5,822,204	$113,225	$113,225	$62,260

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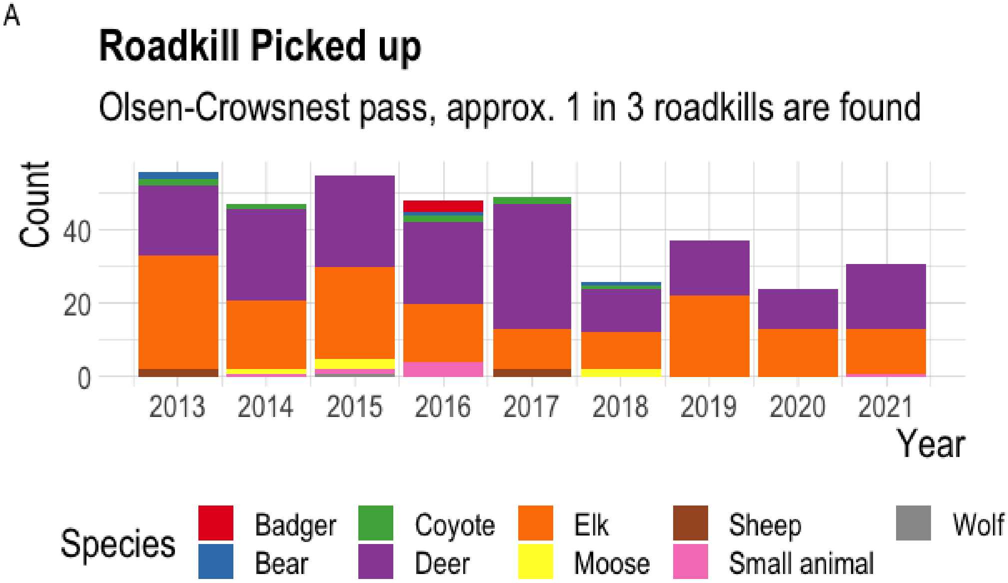

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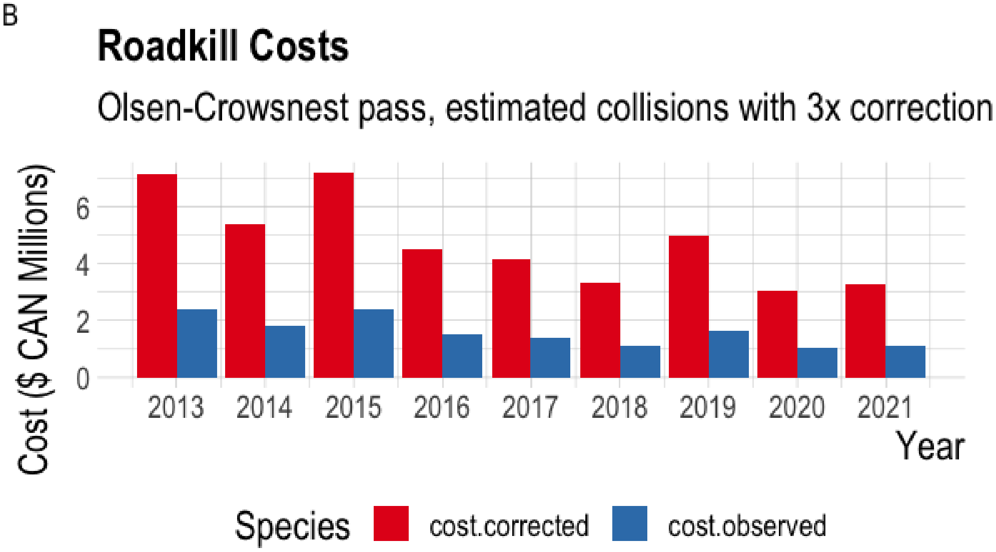

Figure 17: A) Number of roadkill detected along the project length per year and B) estimated cost of these collisions to society. Corrected costs account for unreported roadkill. Studies on collared elk, grizzly bear, and roadside surveys have indicated that only ~1 in 3 roadkill are reported.

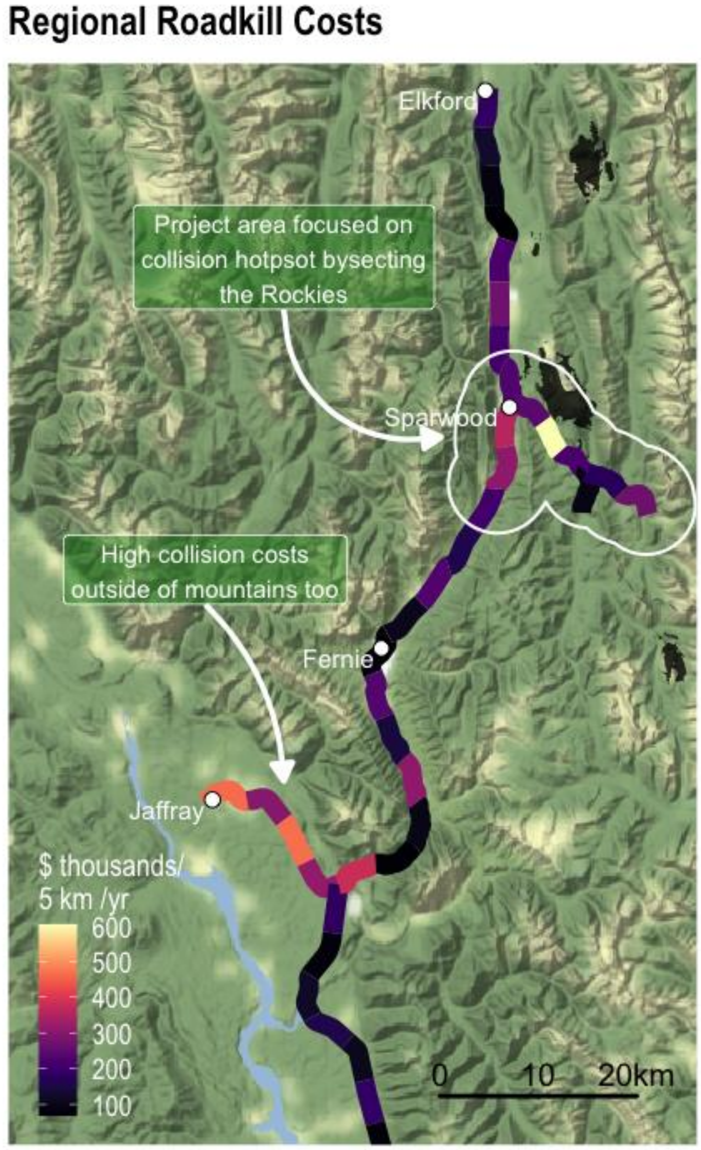

Figure 18: Estimated wildlife-vehicle collision costs along southeast BC Highway 3, 93, and 43. We estimate the annual wildlife-vehicle collision cost for each 5 km segment and note this is a minimum cost as it doesn't account for the many undetected roadkill that aren't found but likely still damaged a vehicle. The true cost could be ~3x higher per segment.

Collaboration and Engagement

Throughout this project, First Nations, stakeholder, and public engagement has been at the forefront. We continue to write articles and press releases through our partner's websites and social media updating on project plans and progress. We expect to reach a broad audience given the scope of the project and profile of our partner organizations and will look for opportunities to engage at a higher level to gain support and funding for these next phases of the project and for the future overpass.

We have been working with Ktunaxa Nation Council, Aknusti Guardians, and Yaqʔit ʔa·knuqʔi 'it to ensure the project is effective for wildlife, consistent with Ktunaxa values, and provides economic opportunities where appropriate. Each year since 2020 we have conducted annual or twice-annual field trips with Ktunaxa members to tour the RTR:BC project and seek input on future, current, and past work. We have made several project changes following these field trips and based on input from Ktunaxa. For example, we included a human gate in the Phase one fencing to allow unimpeded access to a culturally important site and will be installing signs to reduce human impact under structures in 2023. Additional comments have included a need for us to continue monitoring crossing structures to ensure an adequate number of animals cross after fencing, that predators do not hunt in the structures, and for us to incorporate what we learn from past phases into future phases. Beyond the RTR:BC footprint we also work with Ktunaxa to improve the effectiveness of existing collision reduction systems (Jaffray underpass fencing and gate) and future systems (Radium).

Some highlights include:

- Sept 16, 2022 - Walk through phase two with MOTI, MOF, and Dr. Clayton Lamb

- Nov 1, 2022 - Field trip with Ktunaxa Nation to explore and visit new fencing
- Dec 19-20, 2022 - Meeting with Ktunaxa Nation, MOTI, MOF, Dr. Clayton Lamb, Wildsight, and Y2Y to review project progress to date and check-in on next steps for the project
- Mar 21, 2023 - Field trip with Ktunaxa Nation Council, MOTI, and Wildsight to check cameras, assess fence mid-winter and tour the project area

Image 7. A field trip held on Nov 1, 2022 to explore the new fencing with Ktunaxa First Nation. Representatives from Ktunaxa Nation Council and Yaq?it ?a·knuq?i ʼit were present. We shared ideas on future plans with participants and heard suggestions for the future from participants. A key message we heard was that folks were happy to see work being done to help wildlife, and that the effectiveness monitoring was important to detect if any issues arose so we would adapt and learn as we go.

Image 8. A field trip held on March 21, 2023 to assess fence mid winter, check cameras, and tour the project with representatives from Ktunaxa Nation Council, BC Ministry of Transportation, and Wildsight. Pictured here is the group at the recently retrofitted Alexander Creek Bridge.

Discussion

The Reconnecting the Rockies: BC project area is focused on a wildlife-vehicle collision hotspot along Highway 3 bisecting the Rocky Mountains. Highway 3 transports thousands of motorists each day through wildlife corridors, winter range, and common feeding areas. This overlap between motorists and wildlife creates a dangerous situation for both parties. At least 41 medium to large mammals are found dead along the stretch of highway between the Alberta border and Hosmer, BC each year. The actual number of animals that die may be as high as 124. Wildlife-vehicle collisions within the RTR:BC project area are estimated to cost society at least an estimated 1.6 million annually, but the cost could be as high as 4.8 million. Fencing and wildlife crossing structures have been successfully used in neighbouring jurisdictions to dramatically reduce wildlife-vehicle collisions (>80%). The RTR:BC project aims fence and build crossing structures along the projects 27 km length to keep people and wildlife safer by reducing reduce collisions and allowing safer passages for both.

We have successfully constructed 4 km of fencing (2 highway km's) in 2020-2022 and retrofitted 4 underpasses. The underpasses are all being used by wildlife, and we have observed increased wildlife use of Loop Bridge underpass following the completion of the first section of fence.

We expect limited collision reductions for 2022-2023 given that phase one fencing only protects 2 km of highway, but we expect to see more collision reduction as the fence is extended in future phases. Indeed, Huijser et al. (2016) provide evidence that fences <5 km typically reduce collisions by only ~50% (0-94%), while fences >5 km typically reduced collisions by >80%. The increased effectiveness primarily stems from longer fences exposing less of the highway to the fence ends where animals can breach the highway exclusion. The RTR:BC project aims to eventually fence 27 highway kms, which will far surpass the 5 km threshold (Huijser et al. 2016).

The RTR:BC project has prioritized continued enjoyment of the landscape by people in its designs by installing gates through the fence to allow fishers to access the river, and ungulate guards across prominent side roads such as Alexander Creek to allow unimpeded access for hunters, shooters, and recreational users. While ensuring users continue to access preferred areas we also need to balance the needs of wildlife, especially at the crossing structures. In 2022, Ministry of Forests implemented a 400 meter no shooting area around phase one to allow animals safe passage near the crossing structures, and this no shooting area will be extended along the highway as future phases are completed. Based on the camera data collected to date, people are a prominent visitor at many of the crossing structures. Most use relates to fishing under the structures but there is occasional swimming or picnicking. Other jurisdictions have seen evidence that human use can inhibit wildlife use of crossing structures, but the effects vary by species (Barrueto, Ford, and Clevenger 2014). We will want to reduce the impacts of human use under the structures once the fences are erected and these structures become the primary conduits for animal movement. In 2023 we will install signage around the crossing structures to inform users that these are sensitive areas.

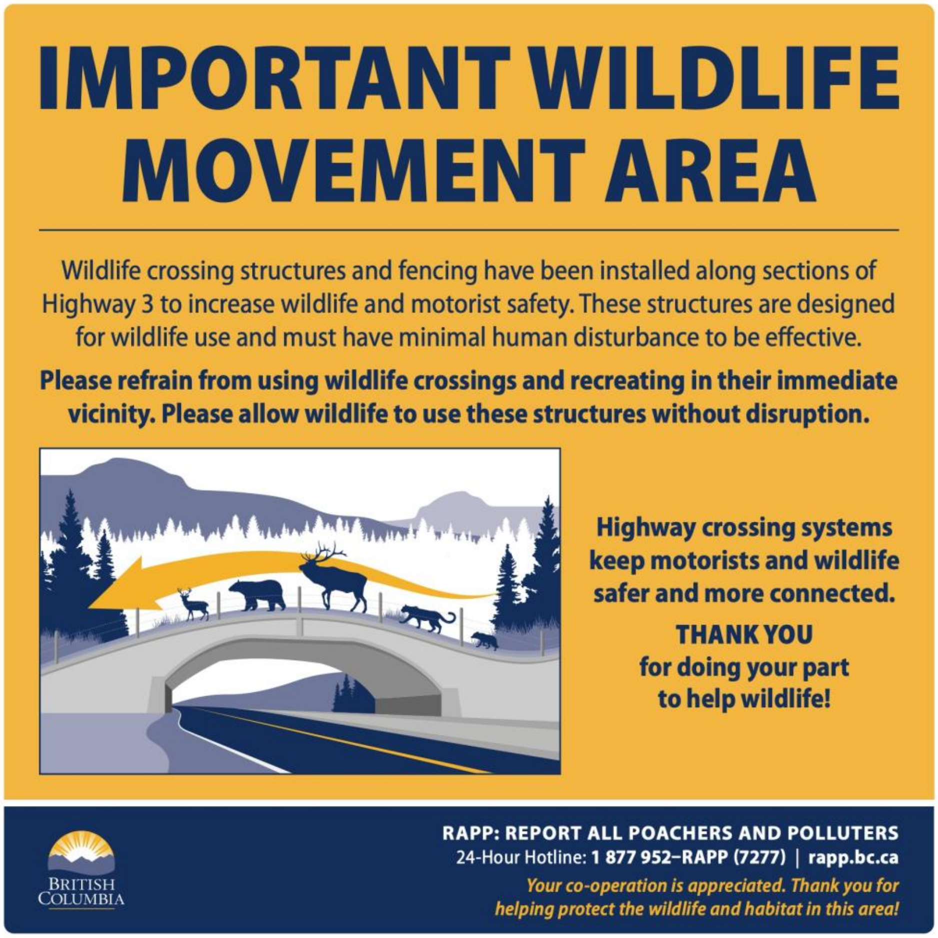

Image 9. Signage that will be installed around crossing structures to educate users on the importance of minimizing disturbance.

Recommendations

For this project

The project is progressing well and it was encouraging to see the fence installed in 2022. The retrofitting of underpasses appears to be successful (wildlife were detected using all retrofitted structures) and the changes will encourage increased wildlife use. Reductions in wildlife-vehicle collisions have not yet been assessed due to the recent fence construction (November 2022), and it's limited length (2 km of highway). We will begin assessing reductions in wildlife-vehicle collisions as the fence is extended in future years. Future considerations to increase wildlife safety and connectivity include additional work at the Carbon Bridge southwest entrance, and ensuring wildlife do not breach the fence.

Compared to the typical bridges on the project where there is a good height clearance for wildlife movement under the structure, Carbon Bridge is a small structure with low clearance nestled in a canyon. The constrained dimensions of the Carbon Bridge structure are fixed, mitigative improves are therefore restricted to improving the line of site and ability of wildlife to get to the entrance. Work to date has improved the southwest entrance, but it is our recommendation that more fill is removed to reduce the slope required to enter the structure and increase the opening of the entrance overall. In addition, the phase one fencing has further constrained this southwest entrance and we recommend ~50 meters of fencing be realigned closer to the highway to increase the area animals have to access this structure.

Exclusion fencing is the heart of a wildlife collision reduction system. Excluding wildlife from the highway is the key to reducing collisions and ensuring effective delivery of the project. Weak points in the fence include the open ends, areas where animals can dig under the fence, ungulate guards, and jump outs. Fence ends will become increasingly less of a problem as the fence gets longer. We support MOTI's approach to whenever possible tie the fence ends into a bridge or similar structure, which will reduce wildlife breaching the exclusion area. All fencing needs to have protection from wildlife that may dig under the fence. Undulating terrain is typical along the project length and small gaps will emerge in the fence that animals can slip under or dig out. Canids (coyotes, foxes, and wolves) and Ursids (grizzly and black bears) are particularly adept at digging under. Ideally additional fencing is buried in the ground, as was done in Banff National Park as a strategy to reduces breaches onto the Highway. In many cases this may be cost prohibitive, or logistically challenging due to rocky ground etc.

If additional fencing cannot be buried, we recommend attaching 6 ft chain link to the bottom of the wildlife fence and draping it along the ground. This will create at least a 5 ft barrier along the ground that will reduce risk of most animals from digging under. This draped chain link should be secured to the ground possibly with rip rap or rebar stakes.

There are many land owners and multiple-use objectives along the project length. As a result, a number of ungulate guards will be installed to allow access off the highway. Ungulate guards can successfully exclude wildlife but care is needed to ensure these structures are not breached. Fences need to be tied into ungulate guards in such a way that animals are not able to sneak between the guard and the fence end. Winter is a challenging time because snow builds up between the gaps in the guard, or linearly across the guard where the plow pushes snow to the side. We recommend maintenance contractor could help ensure ungulate guards remain effective by removing snow between the bars and from the edges.

We recommend the addition of monitoring cameras atat jump outs to monitor use of the structures and assess if animals are accessing the highway through these structures or if they are effective height for animals to be able to get off the right of way .

For future projects

One of the strengths of this project is the multidisciplinary group invovled. Having the biologists work alongside the engineers and planners ensures the project is feasible and long-lasting from an engineering perspective, but is also informed by the best available science and local knowledge to make the project as effective as it can be for wildlife. We are also learning that implementing the fencing on a working landscape is going to be a continuous challenge. There are many different landowners, major roads, powerlines, general topography and other complications to fencing that we are learning to adapt and plan ahead for.

For future highway mitigation projects, we recommend planning and executing effectiveness monitoring early. There is a lot of literature available to support highway mitigation projects including specs on crossing structures, fencing, and jump outs. There is no need to reinvent the wheel, and the latest science should guide mitigation efforts. Since our effectiveness monitoring was based on a before-after-control-impact design, we needed to start as early as possible to collect as much pre-mitigation information as possible. Another recommendation moving forward will be to look for opportunities for ecosystem restoration or additional protection in areas adjacent to the crossing structures. It will be important to look for these opportunities where needed to ensure animals continue to use these structures effectively.

Acknowledgements

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