Reconnecting the Rockies:BC

2020-2023 Progress Report

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1 Executive Summary

Highway 3 in southeast British Columbia (BC) is a hotspot for wildlife-vehicle collisions and presents an obstacle for wildlife connectivity. 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 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 of these issues and which has informed 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 the safe movement of wildlife across the highway through exclusion fencing and wildlife crossing structures. The Reconnecting the Rockies: BC (RTR:BC) project proposes to fence 27 km of Highway 3 from Olsen Crossing east of Hosmer to the BC-Alberta border. On average, 39 roadkill are reported in this stretch each year, but this number may be as high as 116 after accounting for unreported roadkill. These collisions cost society at least $1.5 million per year, but the cost could be as high as $4.4 million. Similar mitigation projects in neighboring jurisdictions (AB, MT, WA, CO, etc.) have successfully reduced collisions with wildlife by >80%, suggesting the RTR:BC could recover $1.2-3.5 million in savings annually for taxpayers while improving human and wildlife safety.

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 2020-2023 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 treatment and control cameras deployed at each site, over a million photos classified, and ongoing grizzly bear collaring. Early results show wildlife are readily using the underpasses within the fenced sections. Wildlife detection rates increased by 2-3 fold at Loop Bridge and the Loop CP overhead following fencing. Due to data access and quality limitations of collision data, we were not able to assess the fence effectiveness at reducing collisions at this time, but resolving these issues 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.

2 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; M. K. Poole et al. 2016; McLellan 2015; Benz et al. 2016; Mowat et al. 2020; Lamb et al. 2023). 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 the expanding footprints of 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; Lamb et al. 2023). 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 wildlife-vehicle 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). Research in the Elk Valley highlights the area as a hotspot of grizzly bear collisions, with one-third (33%) of all grizzly bear collisions reported within the province found here, despite the valley making up less than 1% of the provincial grizzly bear range (Lamb et al. 2023). Collisions with vehicles is a leading cause of grizzly bear mortality in the Elk Valley, contributing to the bear population not being able to sustain itself *in situ* (Lamb et al. 2023).

It is well established that the true number of animals killed by vehicle strikes is likely much greater than is reported in government databases (T. S. Lee et al. 2021). 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 (Lamb et al. 2023). Similarly, neither of the two collared elk killed by vehicles on numbered highways in the Elk Valley were recorded in government databases (K. Poole and Lamb 2022). Most vehicle strikes are likely unreported, due to the nature of these collisions.

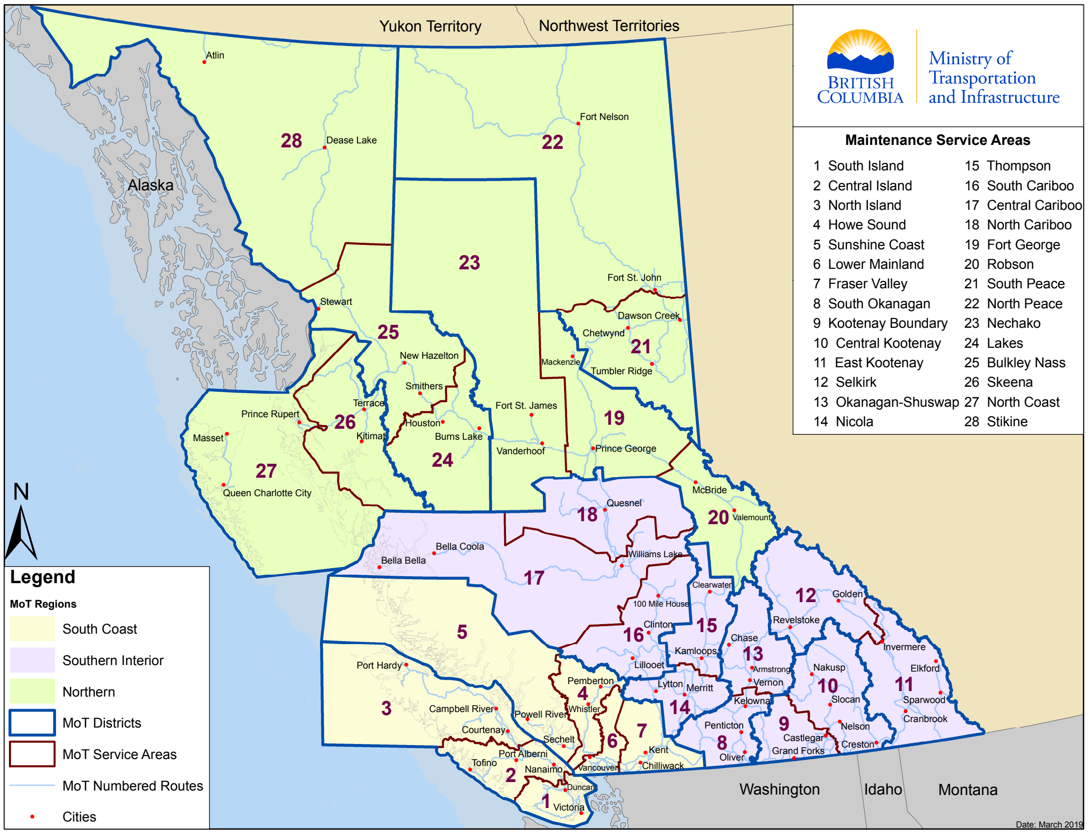

Image 1. Ministry of Transportation and Infrastructure Regions and Service Areas. The Reconnecting the Rockies: BC project is found within East Kootenay Service Area #11.

There has been over two decades of research contributing to the proposed solutions to increase human and wildlife safety along Highway 3. 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 habitat 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 (T. Lee, Clevenger, and Lamb 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 Western Transportation Institute. The government ministries decided to pilot the work by focusing on a 27 km stretch of Highway 3, that extended 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 the Alexander-Michel valley which is though to be an internationally significant wildlife movement corridor (Banks 2021; Proctor et al. 2015).

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, a wildlife crossing system in Banff National Park, Alberta has 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 these 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), is exceptional as it's led 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 Nations, industry (Teck), elected officials, the highway contractor, conservation organizations, scientists, 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.

3 The Reconnecting the Rockies:BC project area

3.1 Continental scale and significance in the Crown of the Continent

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 in North American (Pither et al. 2023). 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 (Laliberte and Ripple 2004; Dirzo et al. 2014; Wolf and Ripple 2017).

Much of the Crown is situated between two core protected area complexes. The southern complex is composed of Waterton Lakes, Akamina-Kishinena, Glacier [USA], and Castle protected areas, while the northern complex is made up of Glacier [Canada] 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, off-highway vehicle and motorcycle riding, 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 wildlife corridors located within the RTR:BC project in southeast BC provide important transboundary connections (Palm et al., n.d.). Losing these connections 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 maintains population connectivity with these larger areas of secure habitat. Dozens of large mammals are killed each year in these wildlife corridors and beyond as they attempt to cross Highway 3. The RTR:BC project aims to substantially reduce the mortality from wildlife-vehivle collisions and improve connectivity wildlife corridors and adjacent habitats in southeast British Columbia.

3.2 Local scale

The RTR:BC project area is located along Highway 3 in British Columbia, 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. The intent is to complete one phase per year between 2022-2027, but progress may be expedited or delayed depending on available funding.

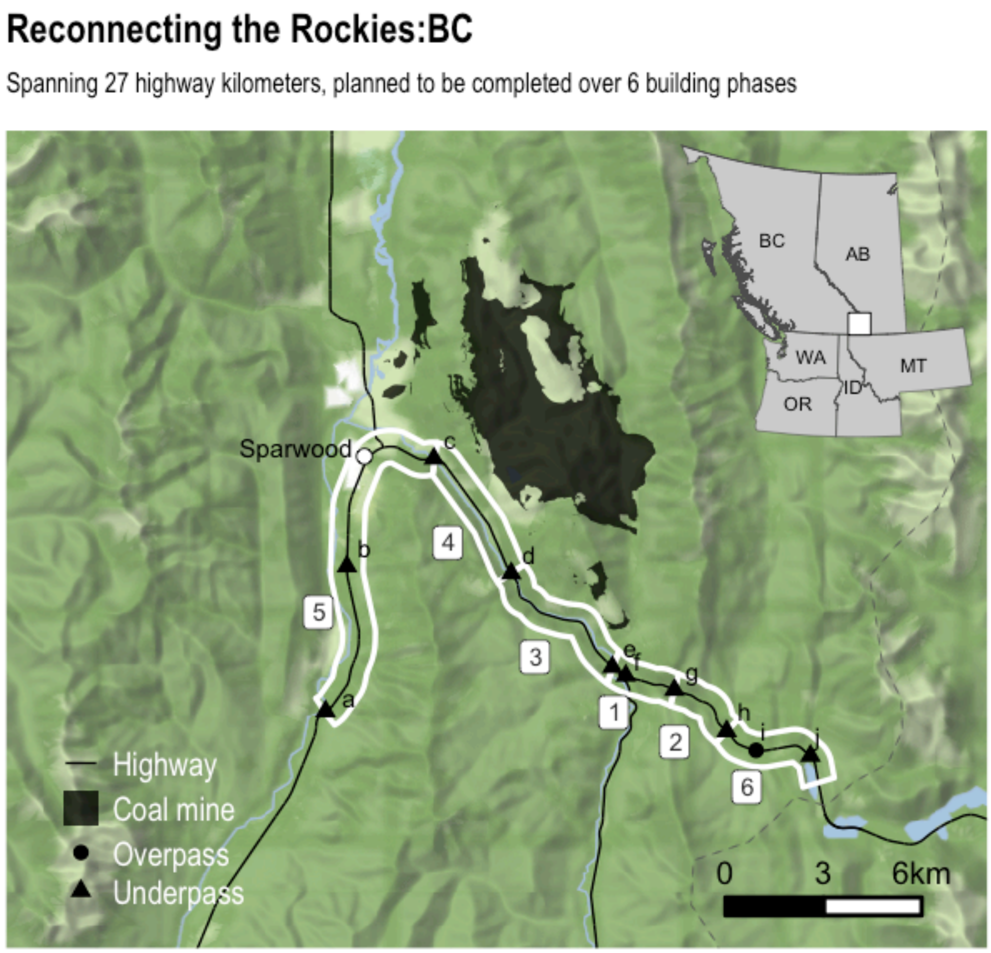

Figure 1: Project location along Highway 3 in southeast British Columbia, Canada. The project is proceeding in 6 phases (depicted as number in white squares), which correspond to the following years: 1=2022 (complete), 2=2024, 3-6=2024-2027. Crossing structures are as follows: a) Olsen Overhead, b) Sparwood West, c) Michel, d) Old Town, e) Loop, f) Loop Overhead, g) Carbon, h) Alexander, i) Alexander-Michel, and j) Crowsnest.

4 Project Progress

To date we have completed Phase 1, and are on track to complete Phase 2, and potentially Phase 4, for 2024. We have constructed 4 km of fencing (2 highway km's) in 2020-2023 and retrofitted 4 underpasses.

In 2021, we retrofitted Loop Bridge and Carbon Creek Bridge. These sites were selected as they offered an opportunity to improve wildlife movement at minimal cost. We also completed geotechnical surveys at the proposed overpass site. In 2022, we retrofitted Alexander Creek Bridge. At each structure, retrofitting often meant manually creating trails 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 retrofitted in 2021. Work on Alexander Bridge completed in 2022 prepared for the next phase of fencing between Carbon and Alexander – which will connect three complete structures in 2024.

The original plan was to complete Phase 2 in 2023 but progress was delayed. The bids for the work ended up coming in higher than available budget, partly due to a delayed posting of the work. MOTI and the RTR:BC team decided to pause the work and attempt to fence Phase 2 and 4 in 2024 to get the project back on schedule. Plans are currently underway to get Phase 2 out to bid in early 2024, but progress on Phase 2 and 4 will depend on available budgets.

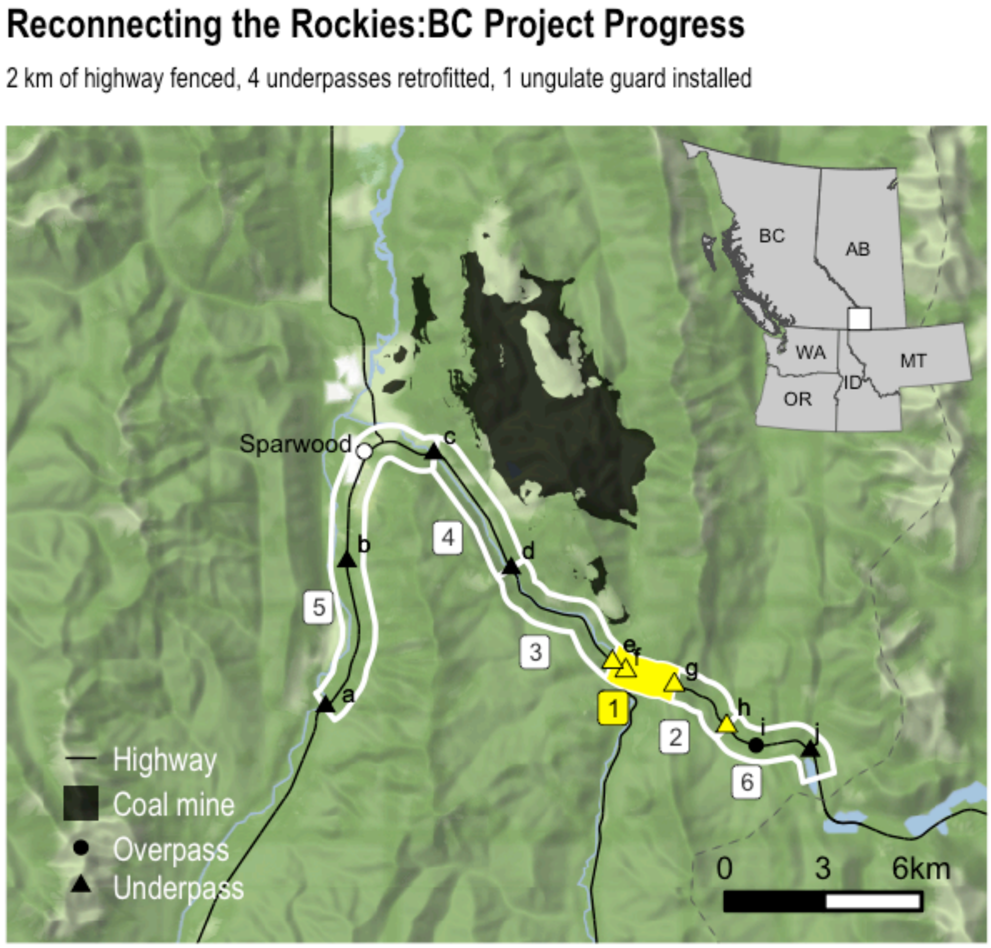

Figure 2: Progress on fencing and crossing structures to date. Completed structures and sections of fence highlighted in yellow. Phase 1 structures are Loop Bridge, Loop CP overhead, and Carbon Bridge, from left to right. Alexander bridge was retrofitted in 2022 to prepare for Phase 2 fencing.

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 1 wildlife exclusion fencing between Loop Bridge and Carbon Bridge.

Image 5. A jumpout along the Phase 1 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. The horizontal bar at 45 cm above the exit ramp reduces animals jumping back into the right of way.

Image 6. An collage of wildlife using the retrofitted Loop Bridge underpass following fence construction.

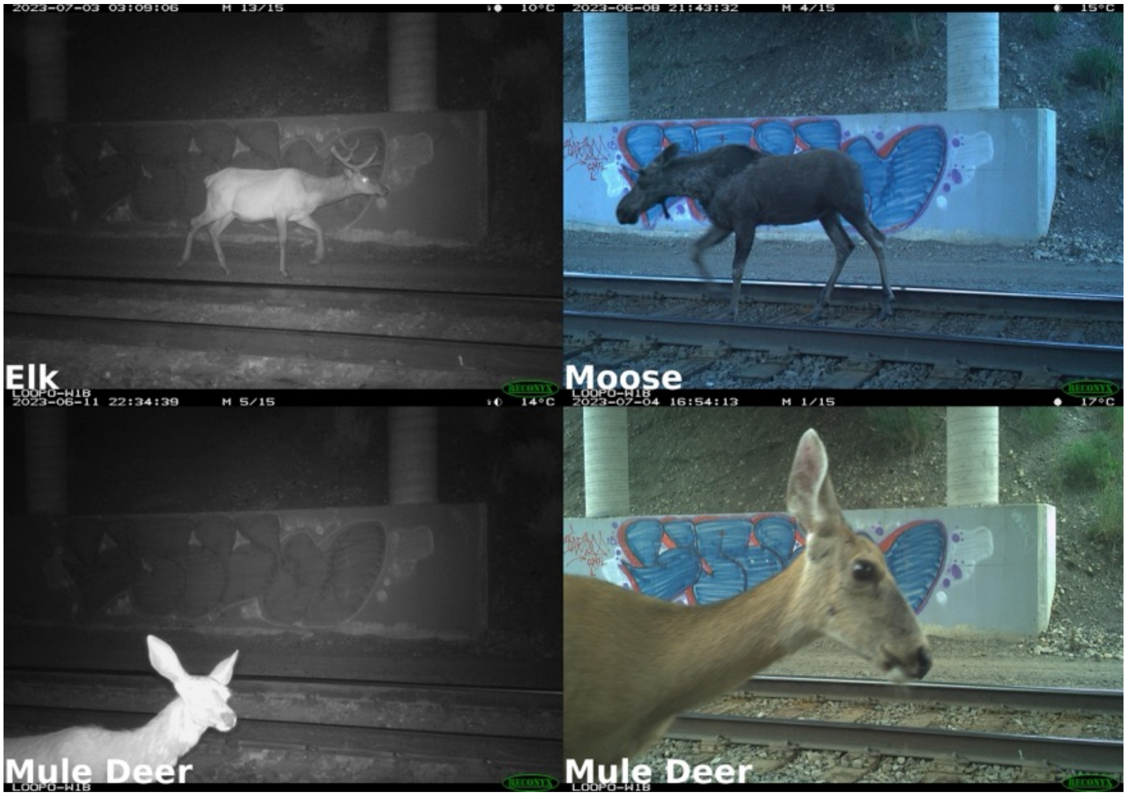

Image 7. An collage of wildlife using the retrofitted Loop CP underpass following fence construction.

5 Effectiveness Monitoring

5.1 Design and 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 Hwy 3, and determine if mitigation results in a collision reduction that improves motorist and animal safety. Ensuring mitigation positively influences wildlife crossing and safety is important because we want the fencing to reduce collisions, while still ensuring animals are able to 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 which 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 100 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, bighorn sheep, 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 and sheep telemetry data (2003-2022) and ongoing grizzly bear telemetry monitoring (2016-current) for this work. We are using all three datasets to assess animal use of the area before the project and ensure crossing locations are in ideal locations. We also monitoring grizzly bear responses during and after the project.

In addition to the remote camera monitoring and telemetry data, MOTI has committed to 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 due to lags in updating datbases and data accurracy issues, but we expect more WARS data to become available for our next report. Once data are available and accuracy is confirmed we will begin analyzing these reductions. Assessment of roadkill reductions will be done by comparing 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.

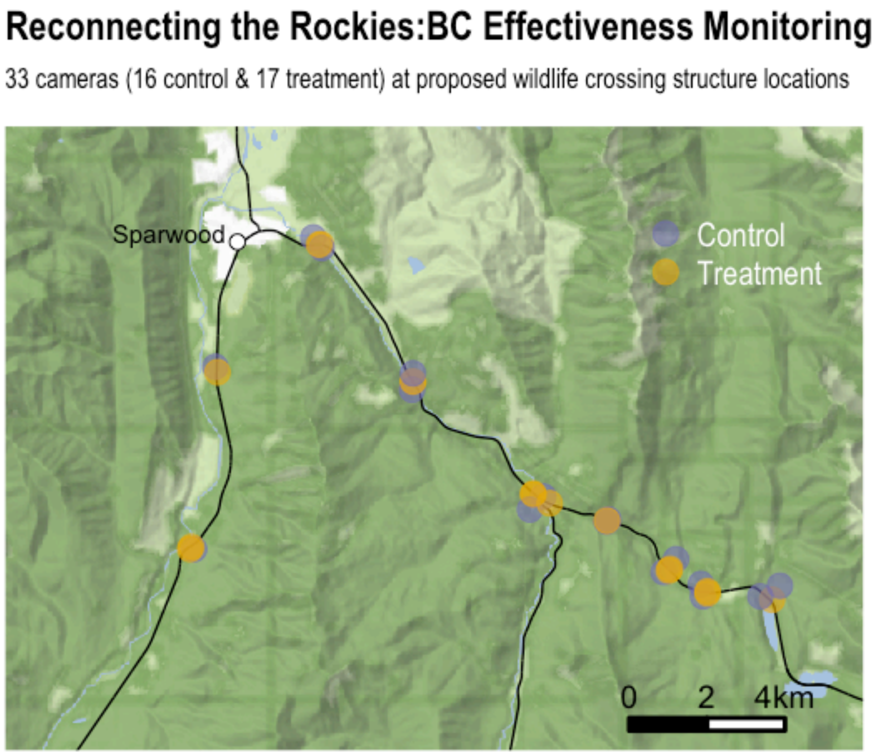

Figure 3: Cameras monitoring crossing structures (Treatment) and adjacent wildlife trails within 500 m of highway (Control).

5.2 Results

Between 2020-2023 we collected a total of 1,100,069 photos from the pre-treatment and control cameras in the RTR:BC project. After removing false triggers from wind, 897,797 photos have been captured of wildlife, people, and vehicles (Figure 4). The total number of photos increased since 2020, mostly due to an increase in the number of cameras deployed and the addition of monitoring sites at railway underpasses (Figure 5). In 2023 we fine tuned the programming of cameras to capture fewer images of trains, which reduced the total # of train images. Average monthly detection rates for wildlife varied by structure (Figure 6) and by location type (pre-treatment vs control, Figure 9. Notable mitigation emphasis sites with abundant wildlife using the structure or nearby controls were

Alexander-Michel Overpass, Crowsnest Underpass, Loop Bridge, and Sparwood West (Figure 6 & Figure 9). Human use of the structures varied and needs to be monitored closely, and perhaps reduced, once fencing is in place 7).

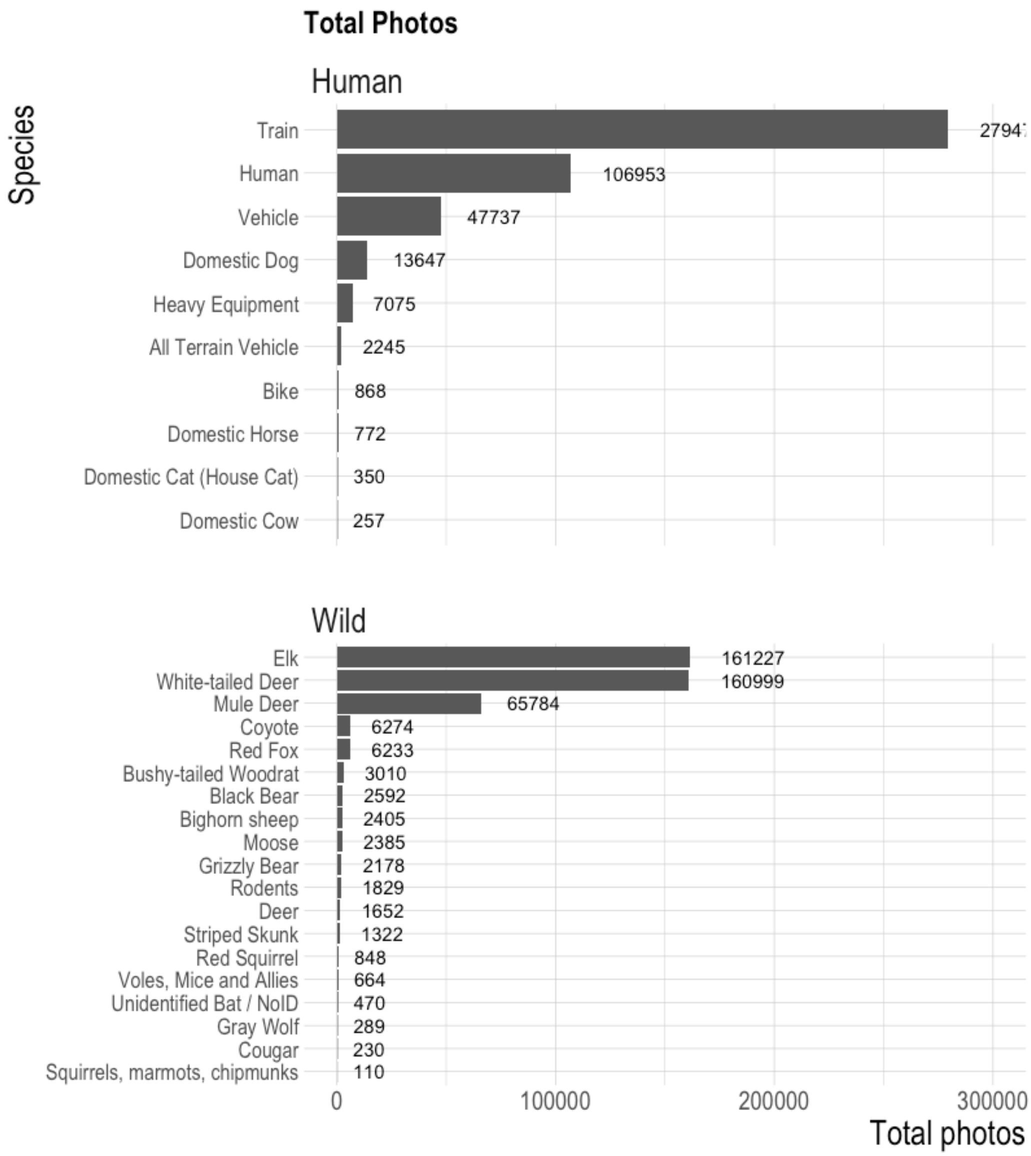

Figure 4: Total photo count across cameras by species and type.

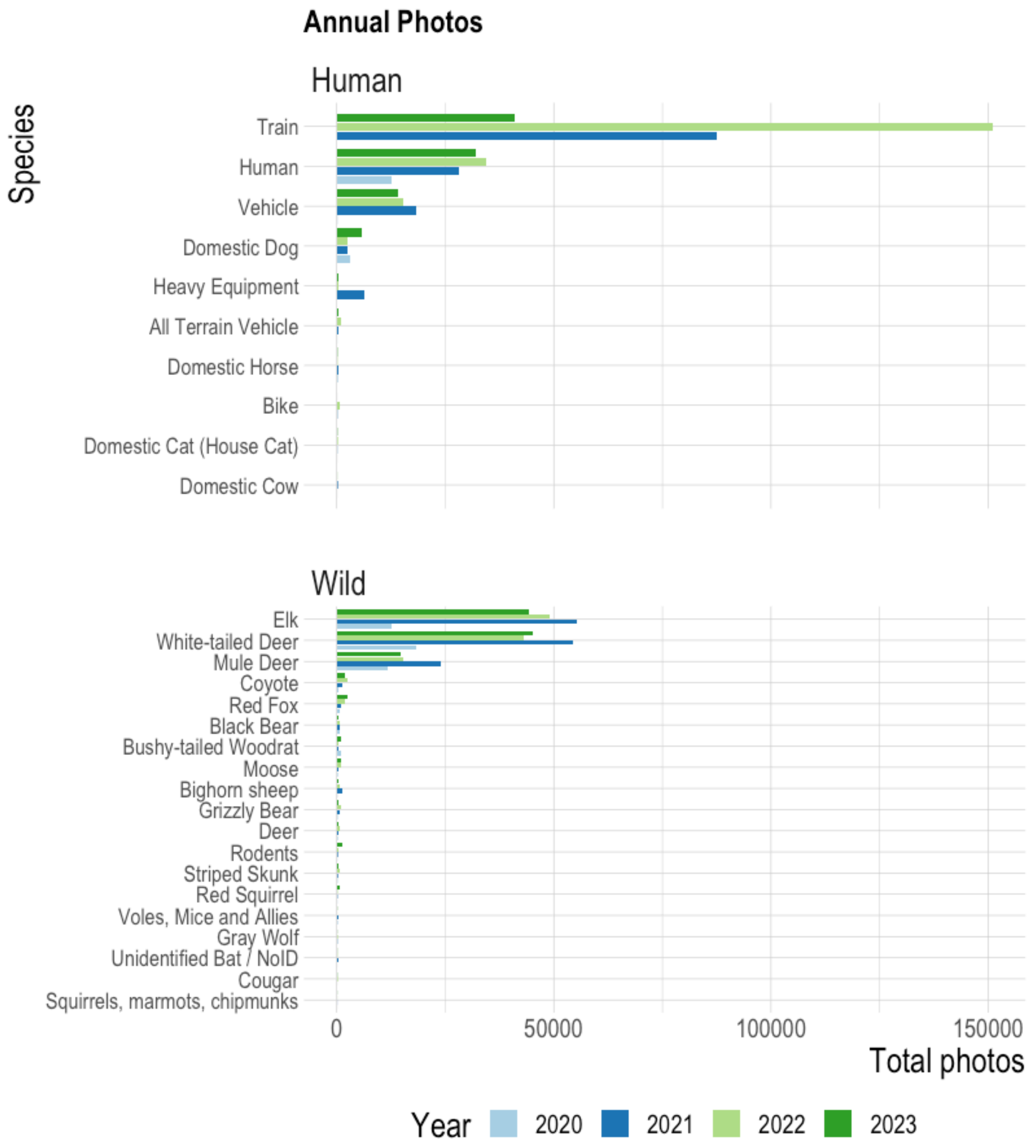

Figure 5: Annual photo count across cameras by species and type.

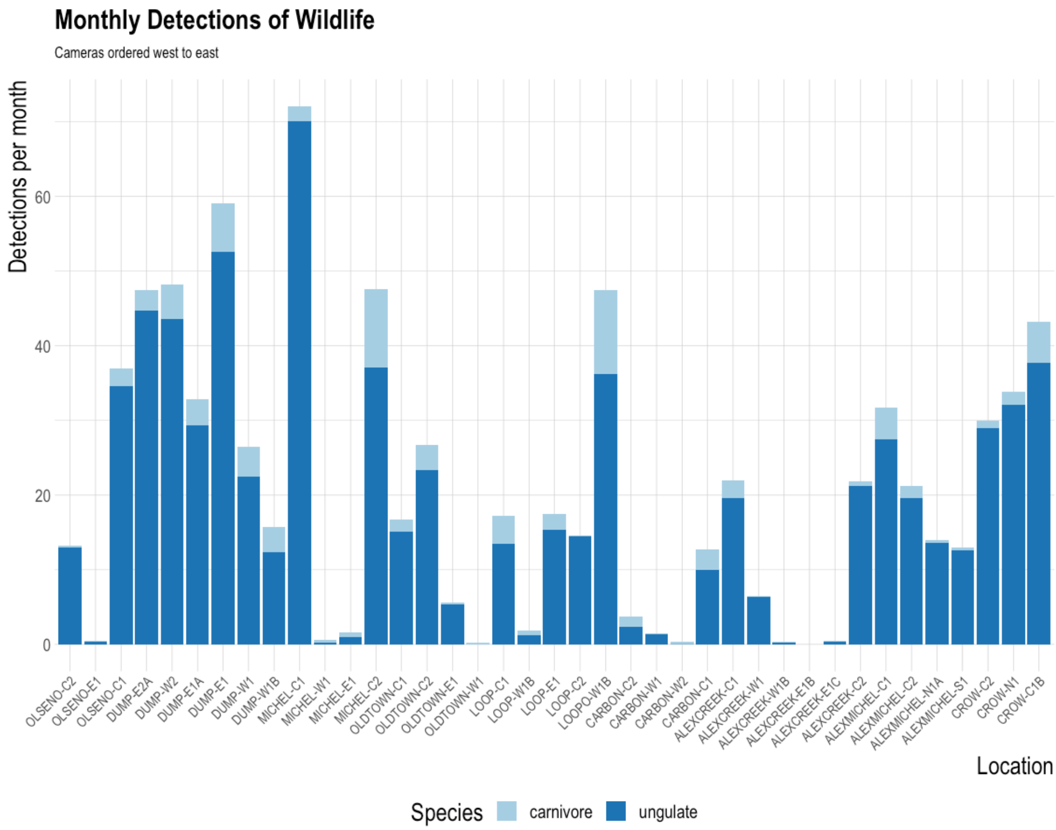

Figure 6: Average monthly detection rate for each camera.

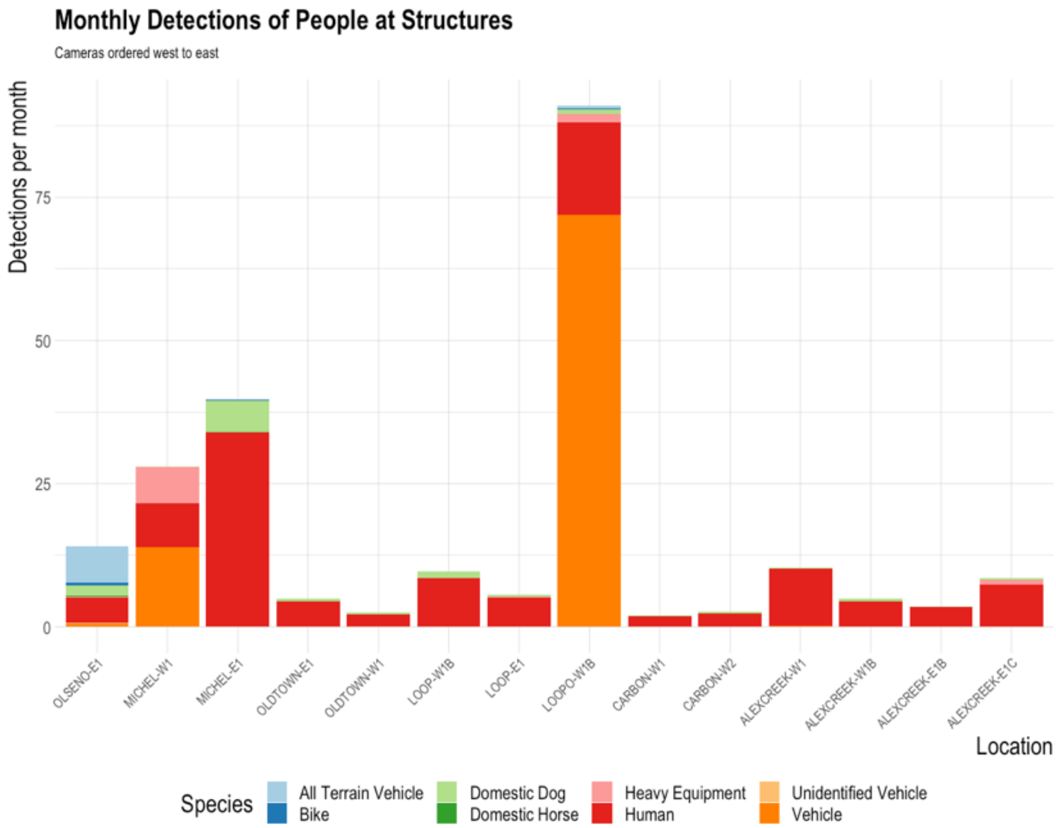

Figure 7: Average monthly detection rate for people at each camera. Trains removed to increase comparison between structures. Loop overhead and Olsen overhead each see 20-200 trains per month

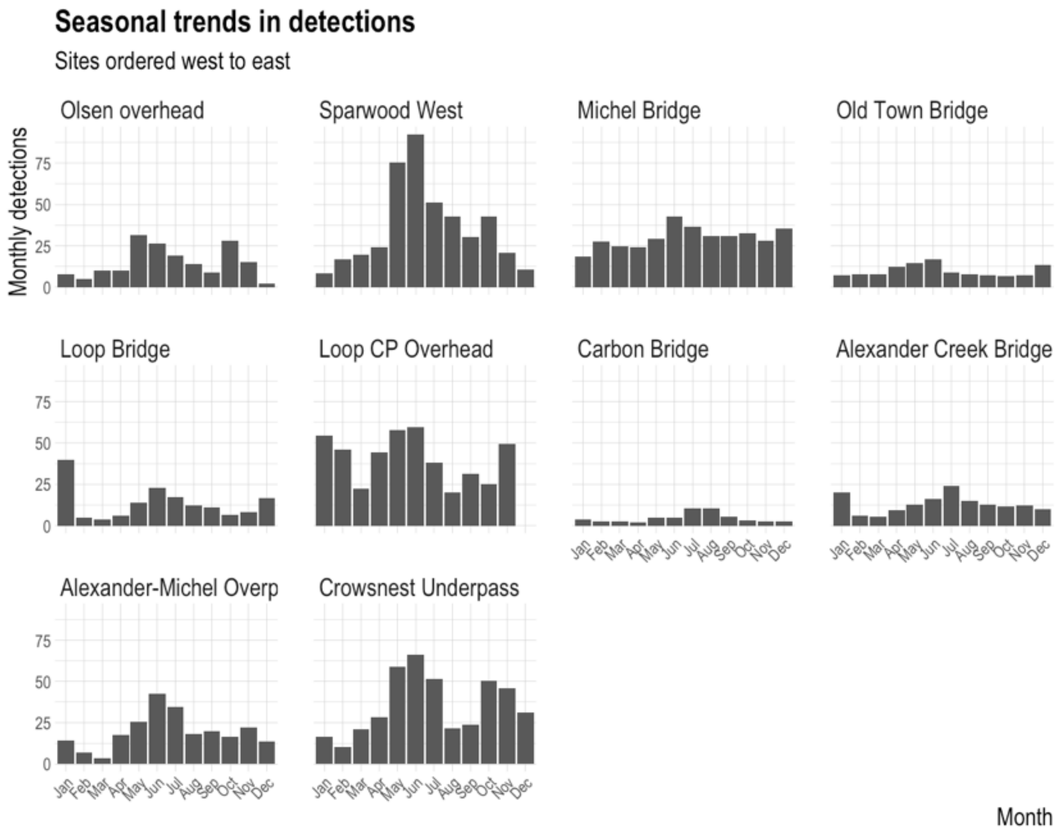

Figure 8: Seasonal trends in monthly detections for each site.

Wildlife were observed crossing under all existing bridges even before fencing guided them towards it. Excluding the Alexander-Michel Overpass, Crowsnest Underpass, and Sparwood West mitigation emphasis sites, which didn't have infrastructure in place yet, the average monthly wildlife detection rate for control cameras was 23.7 and 8.1 for pre-treatment cameras (Figure 9). 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 was serving as an effective structure pre-fencing.

We monitored crossing success as the proportion of wildlife that entered each structure and crossed through to the other side (Figure 10). 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.

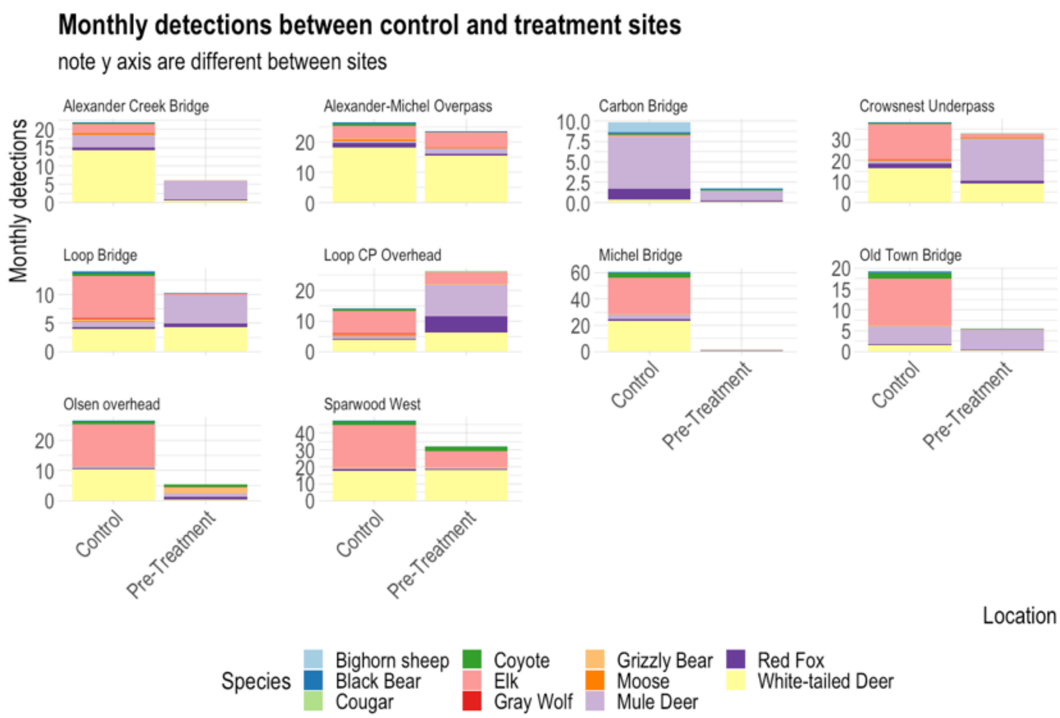

Figure 9: Detection rate comparison between treatment and control cameras.

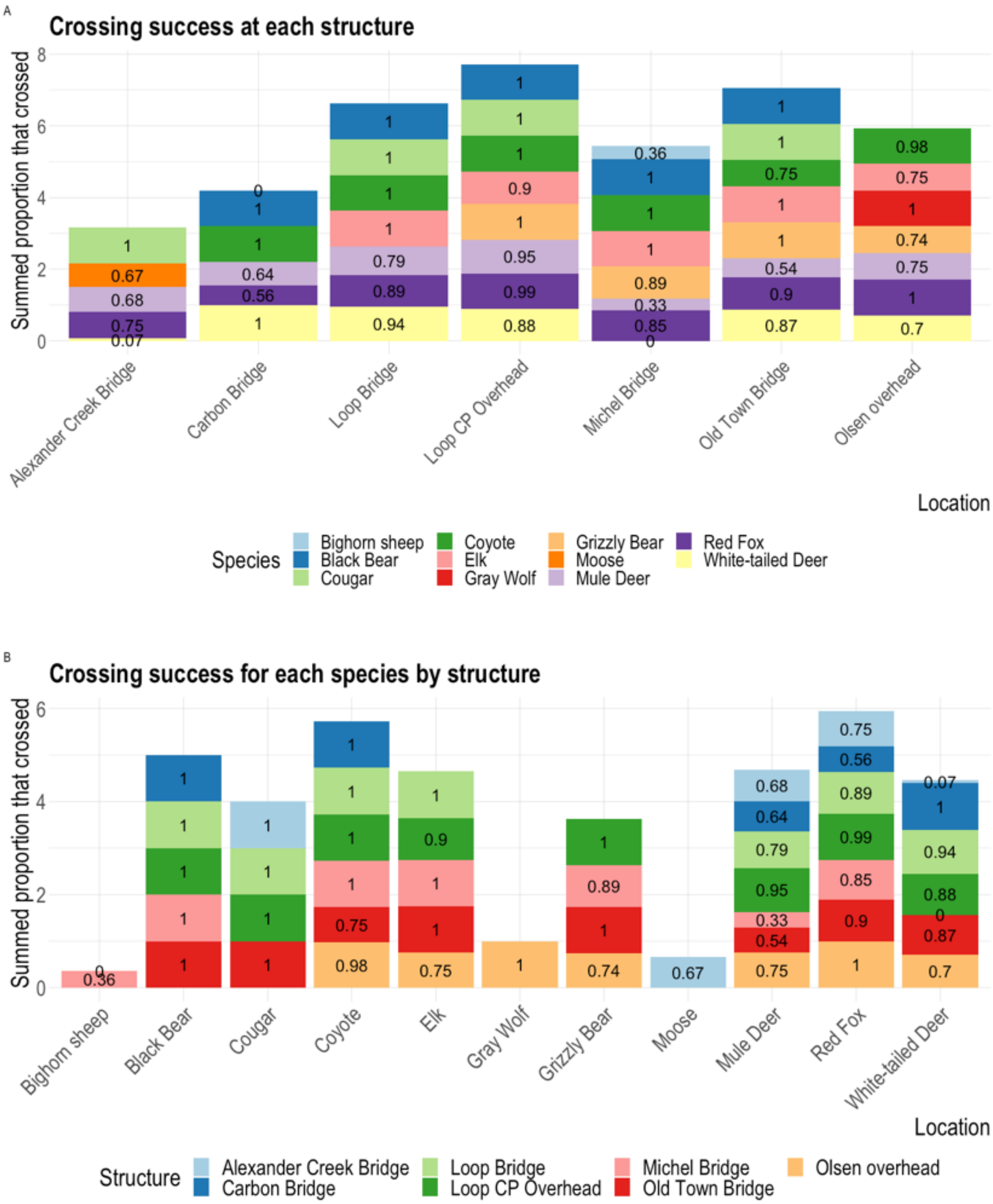

Figure 10: Proportion of successful crossings observed (crossing success) at each site (A) and by species (B). A value of 1 means all individuals of that species who entered the structure were observed crossing through the camera field of view. A value of 0.5 would mean that only half the animals successfully crossed, while the other half turned back the way they came and did not cross.

We assessed monthly detection rates for structures within the Phase 1 fencing completed fall 2022. The before-after-control-impact design provided strong evidence that animals were dramatically increasing their use of the Loop and Loop CP overhead structures following fencing (Figure 11). Carbon bridge, which is small structure with limited potential as a crossing site due to low overhead dimensions, generally saw little use before fencing and we continued to detect minimal use following fencing. Compared to pre-fencing levels, wildlife detection rates increased post-fencing at the Loop and Loop CP overhead structures by 260% and 140%, respectively.

Generally, common species such as deer and elk consistently increases their use of the structures following fencing, often exceeding detection rates found at control cameras (Figure 12). However, with only a year of data post fencing and some animals having low detection rates (0-3 detections per month) we are just starting to get a sense of how fencing is changing the use of these structures. Future years of monitoring on these sites and assessment of future phases will provide more robust insights.

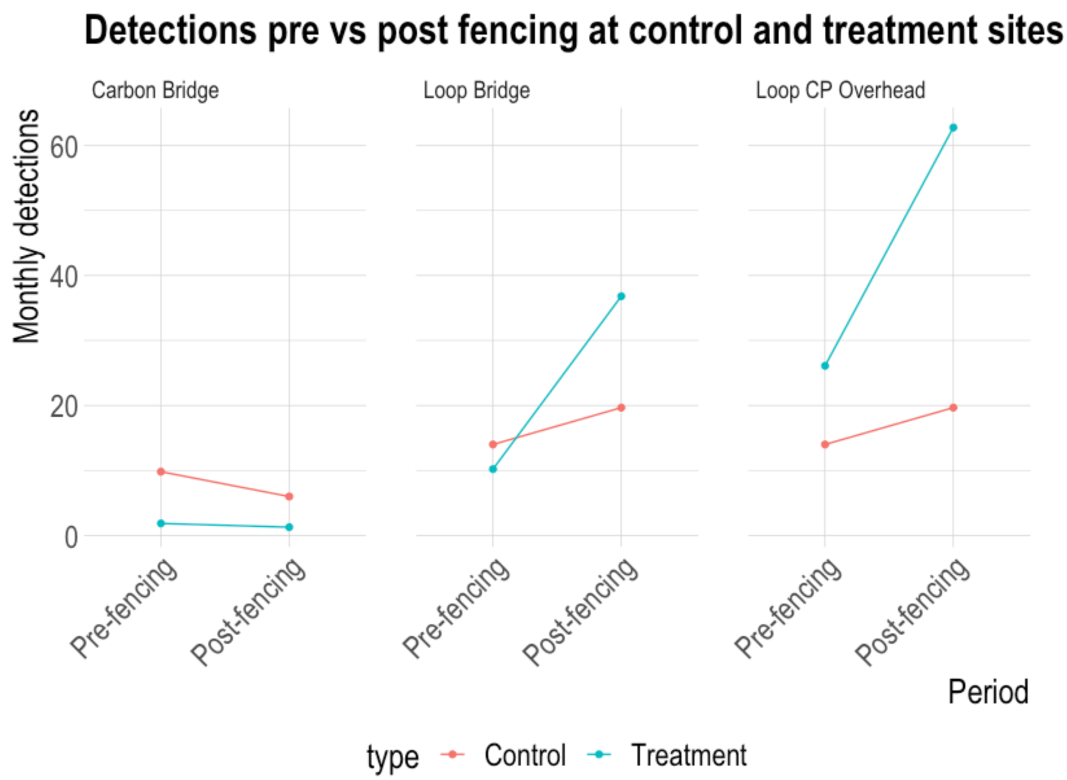

Figure 11: Before-after-control-impact assessment of detection rate before and after fencing at treatment cameras under structures and control cameras adjacent to structure in forest.

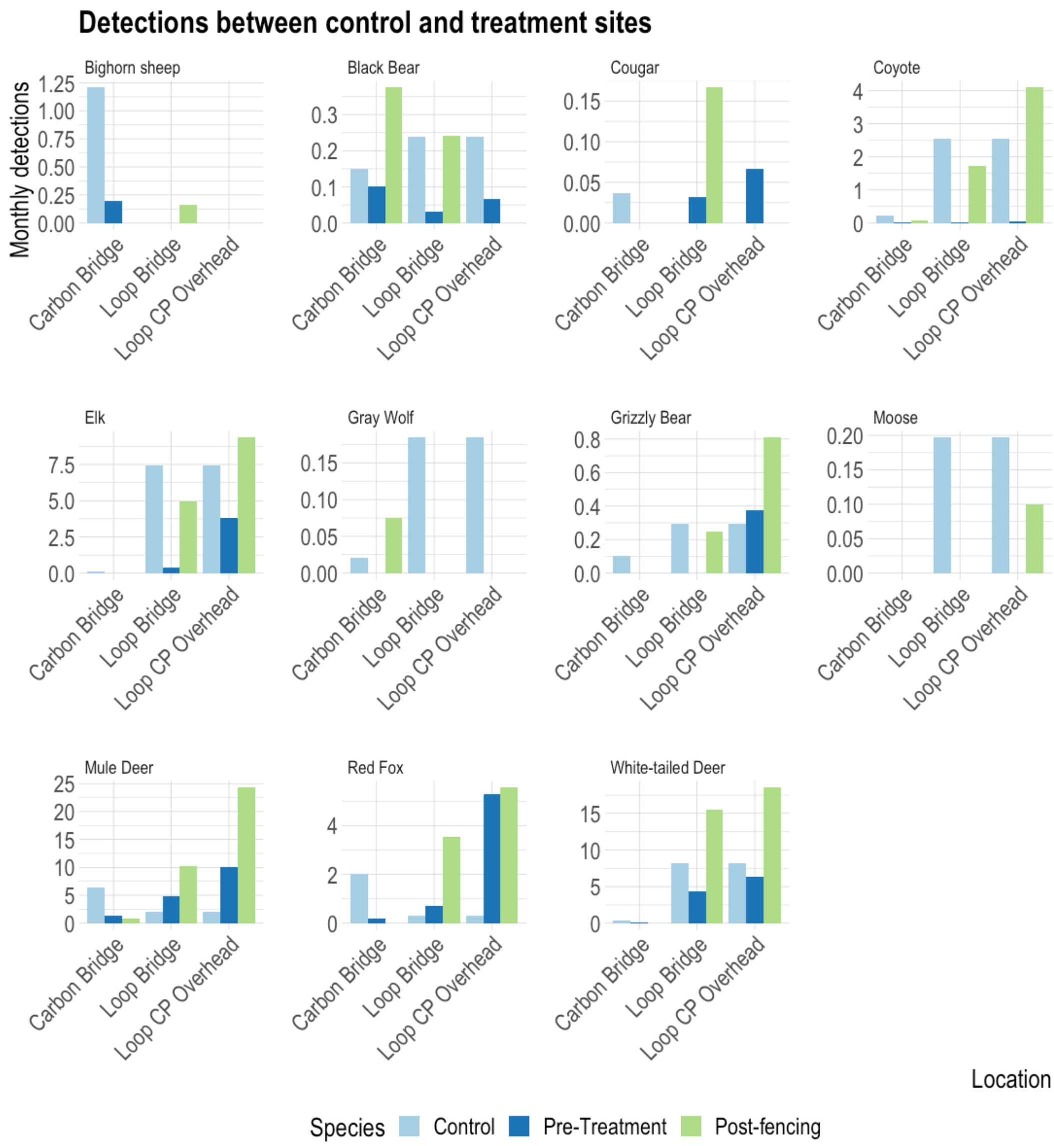

Figure 12: Comparison between control cameras and pre vs post fencing detection rates for common species at fenced sites.

We assessed monthly detection rates spatially by species and for control and treatment cameras (Figure 13 & Figure 14). 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.

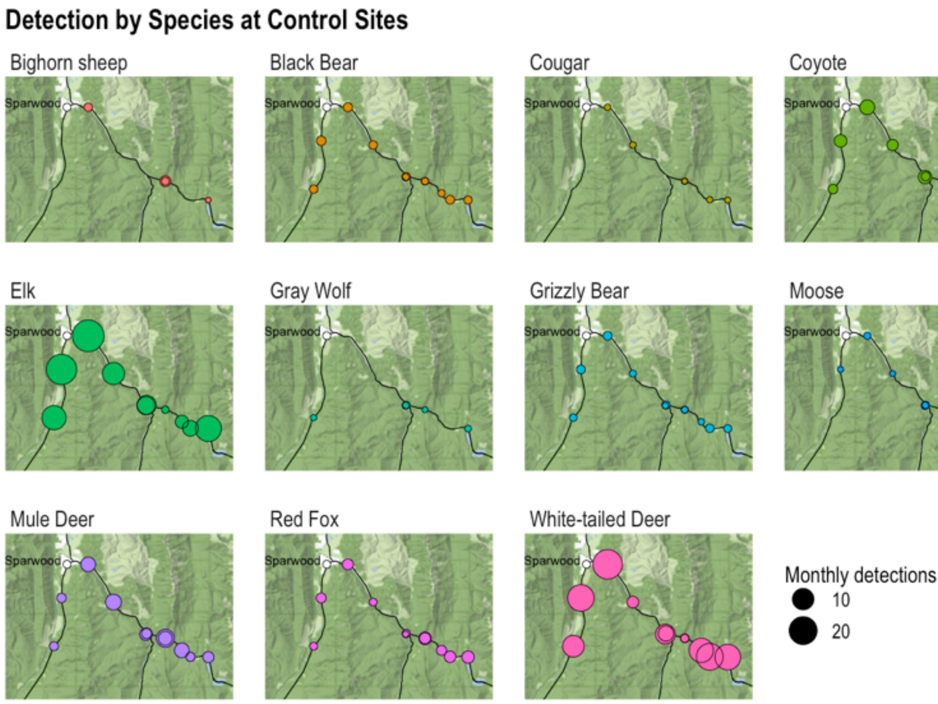

Figure 13: Detections by species across control cameras only.

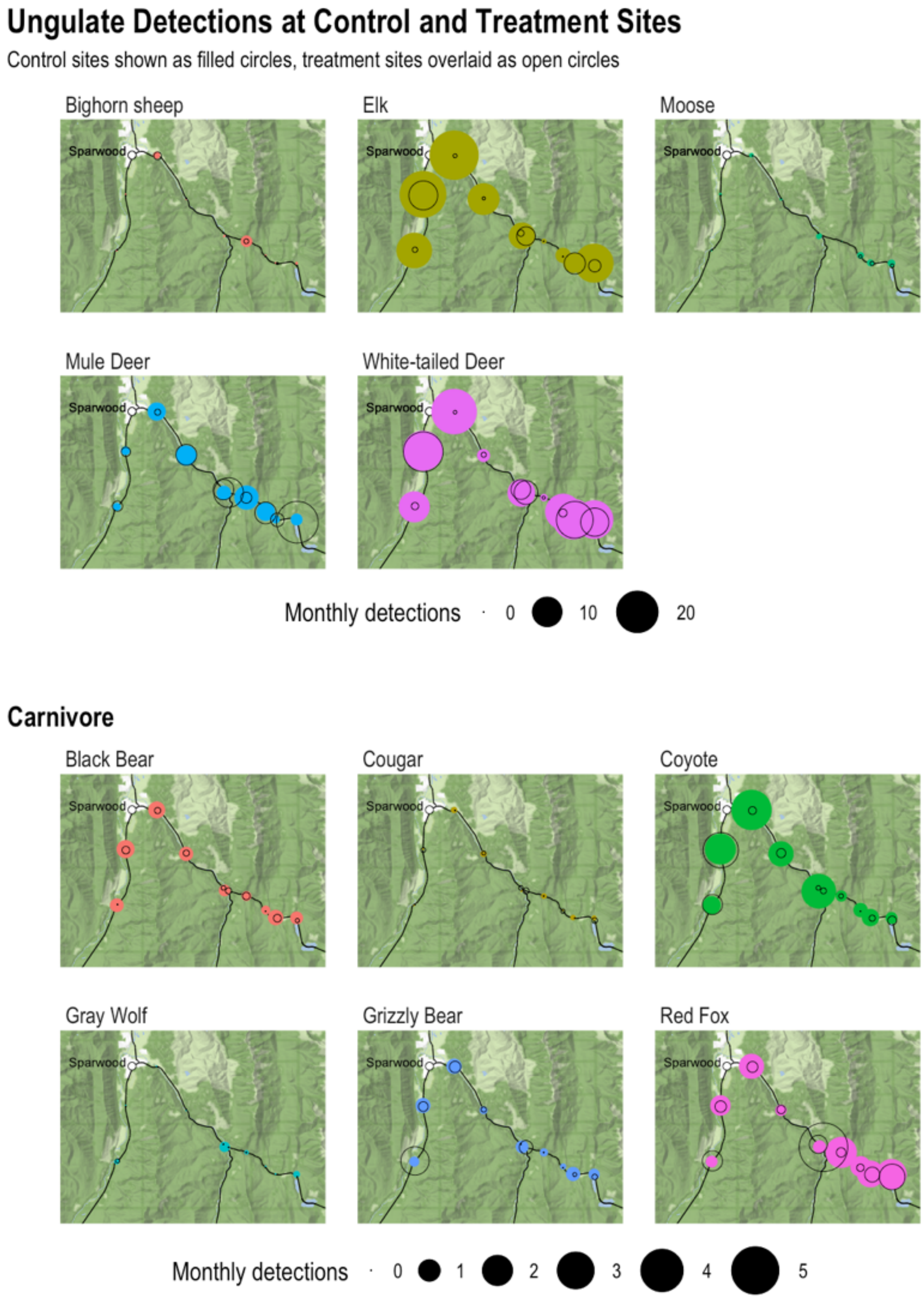

Figure 14: Detections by species across cameras for ungulates (top) and carnivores (bottom). Colored circles are control cameras, black outline are treatment cameras. Circle size indicates average monthly detection rate.

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 15). 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.

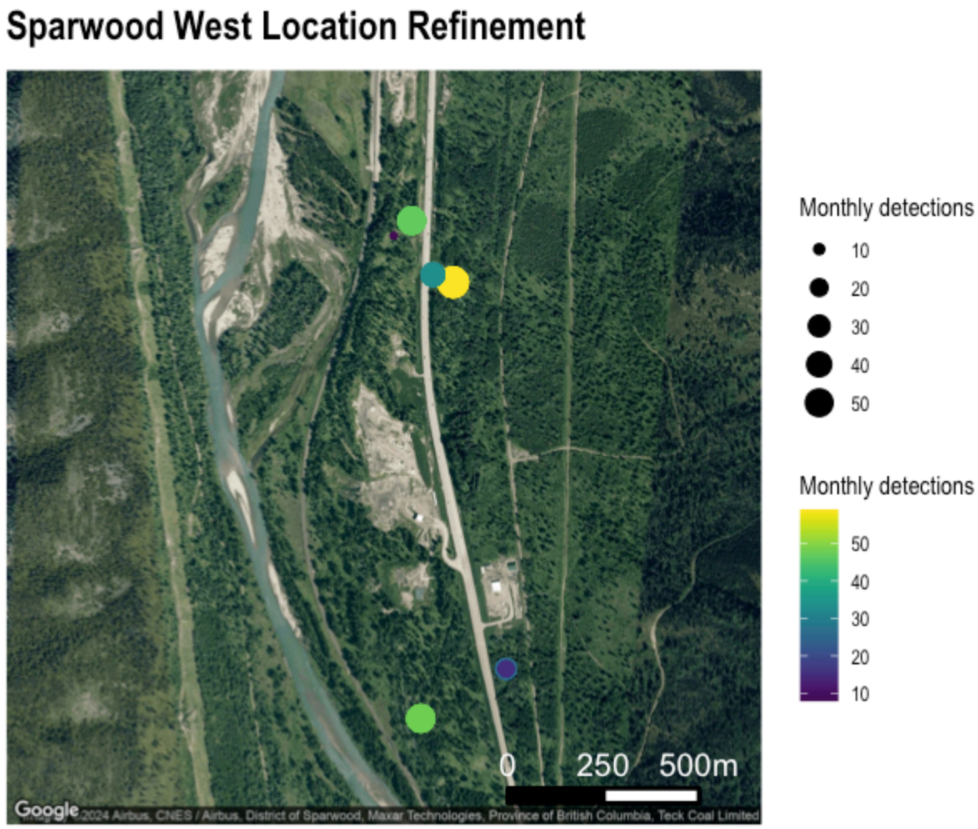

Figure 15: Average monthly detection rates for proposed north and south Sparwood West underpass sites. The north site is preferred from an engineering perspective, and appears to have higher wildlife detection too. Future land use on the east side of the highway needs to be considered.

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 (T. 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 16), and key crossing areas for grizzly bear and elk throughout the 27 km including west of

Sparwood, near Elkview mine, and Corbin area (Figure 17). The project will also safeguard an elk migration route between reclaimed portions of Elkview mine, Corbin, and Alberta (Figure 18). 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.

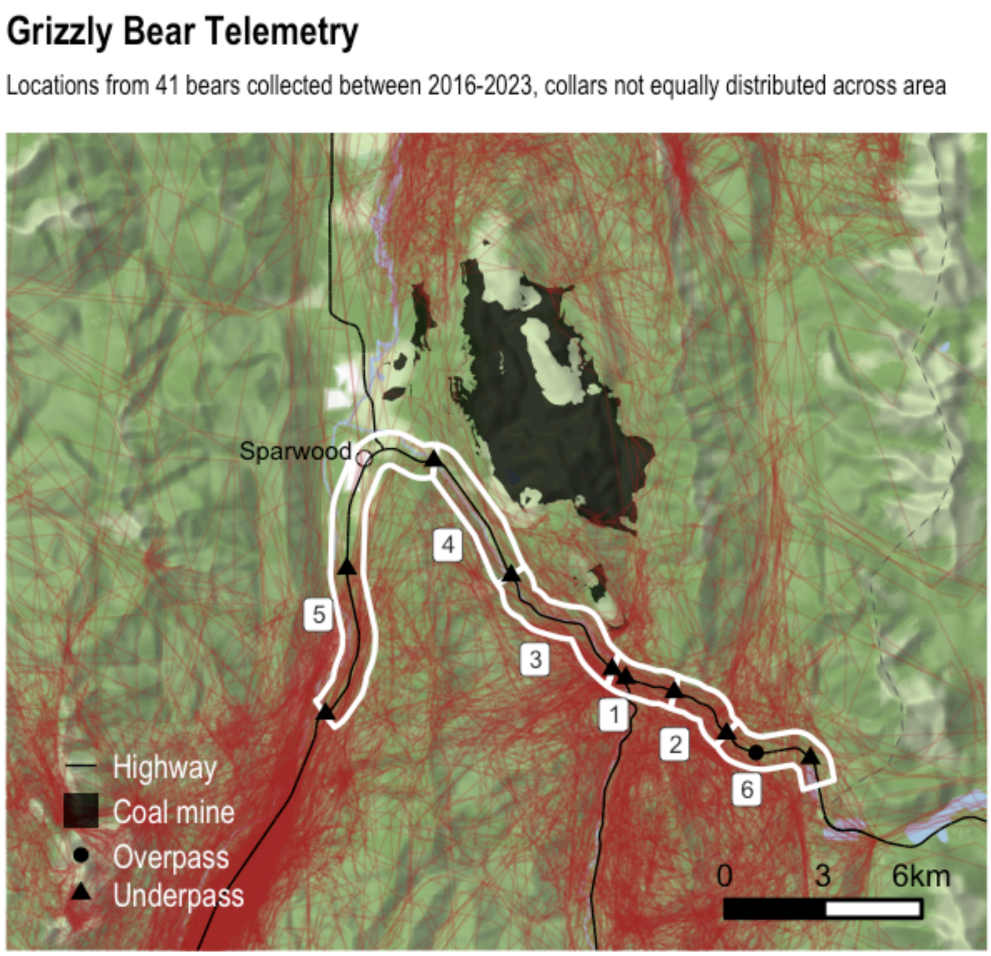

Figure 16: Grizzly bear telemetry data collected between 2016-2023 in the Elk Valley. These data have been used to inform placement of crossing structures. As the fencing continues,

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.

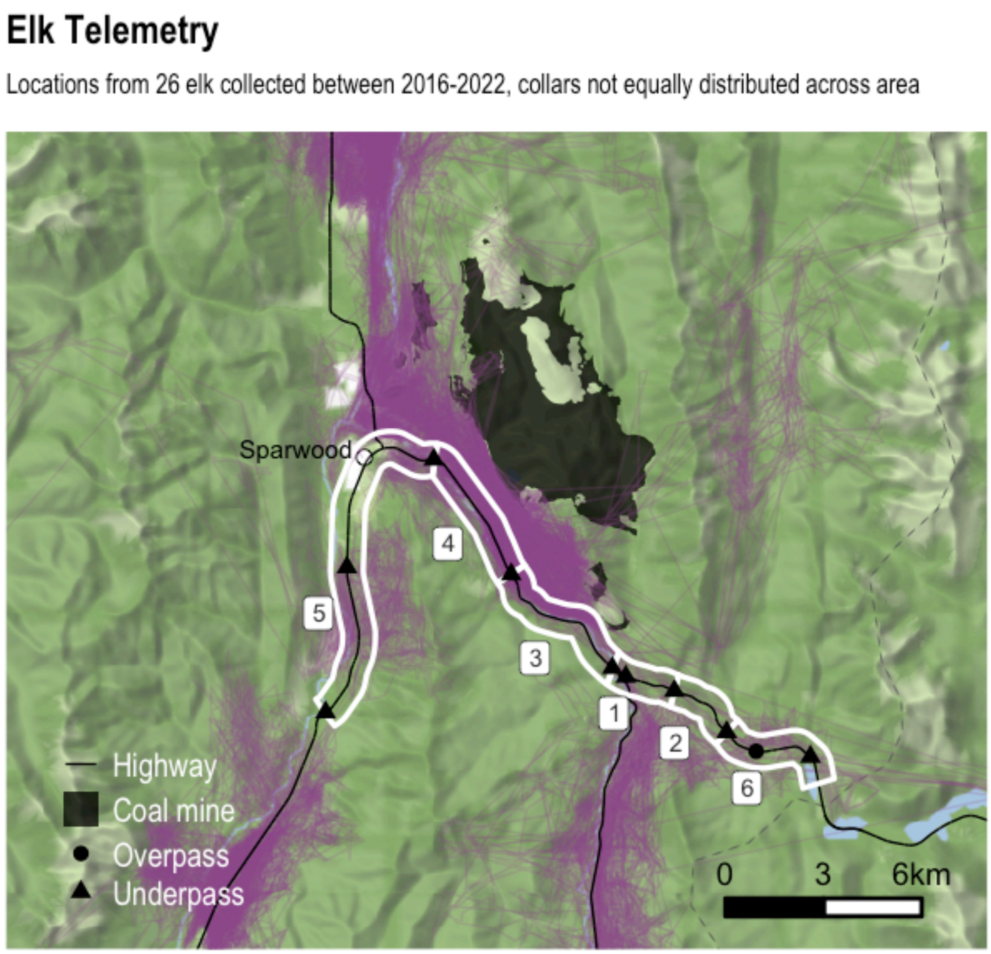

Figure 17: Elk telemetry data collected between 2016-2022 in the Elk Valley. These data have been used to inform placement of crossing structures. There are few collared elk in the valley at the moment. As the fencing progresses, we suggest collaring elk so their movements and migrations can be compared 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.

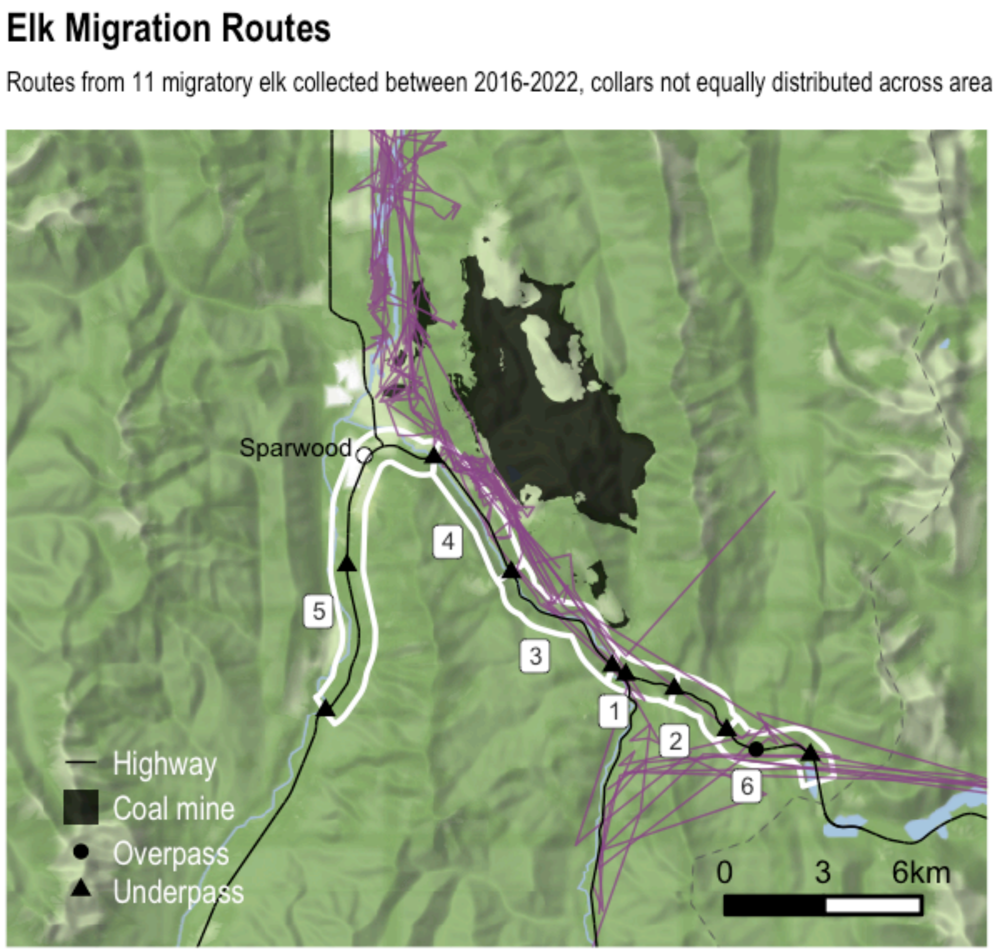

Figure 18: Elk migration routes from Poole and Lamb (2022). Most of these elk winter on the Big Ranch north of Sparwood, or to the east in Alberta. The RTR:BC project area covers a key migration route for Elk Valley elk.

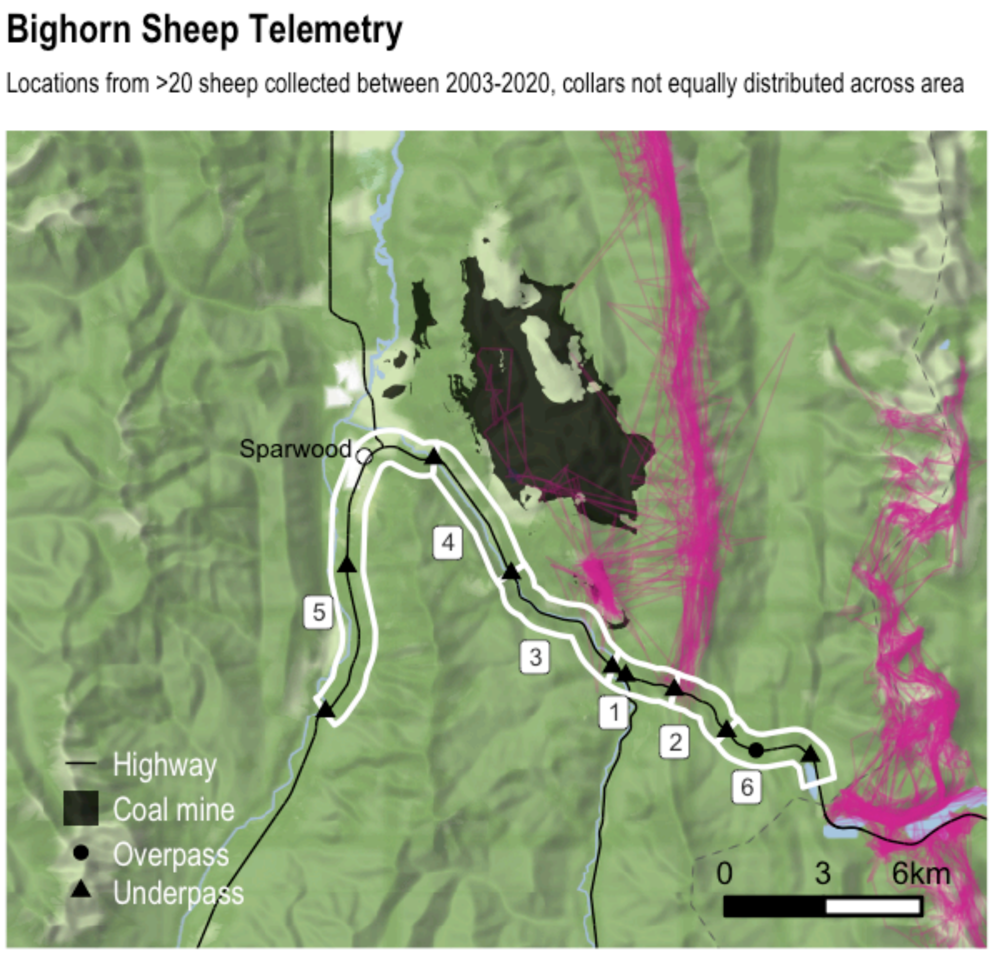

Figure 19: Sheep telemetry data collected between 2003-2020 in the Elk Valley and Continental Divide. These data have been used to inform placement of crossing structures and assess sheep crossings in the past. Note that the map does not accurately display the intensity of sheep use/crossings because 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 then used in conjunction with Table 1 to estimate the cost of wildlife-vehicle collisions to society (Figure 20). On average, 39 roadkill are reported each year, and this may be as high as 116 after accounting for roadkill not detected. Wildlife-vehicle collisions in our study area are estimated to cost society at least an estimated $1.5 million, but the cost could be as high as $4.4 million after accounted for undetected roadkill. We confirmed that the RTR:BC focal area is a hotspot for wildlife-vehicle collisions (Figure 21). 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	$5,964	$10,349	$12,737	$5,964	$5,964	$12,737	$12,737	$10,349
Human injuries	$8,257	$19,682	$36,195	$8,257	$8,257	$36,195	$36,195	$19,682
Human fatalities	$4,698	$31,320	$62,640	$4,698	$4,698	$62,640	$62,640	$31,320
Direct subtotal	$18,919	$61,351	$111,572	$18,919	$18,919	$111,572	$111,572	$61,351
Passive								
Passive use value	$6,851	$37,464	$37,464	$54,462	$5,718,290	---	---	---
Passive subtotal	$6,851	$37,464	$37,464	$54,462	$5,718,290	—	—	—
Grand total	$25,770	$98,815	$149,036	$73,381	$5,737,208	$111,572	$111,572	$61,351

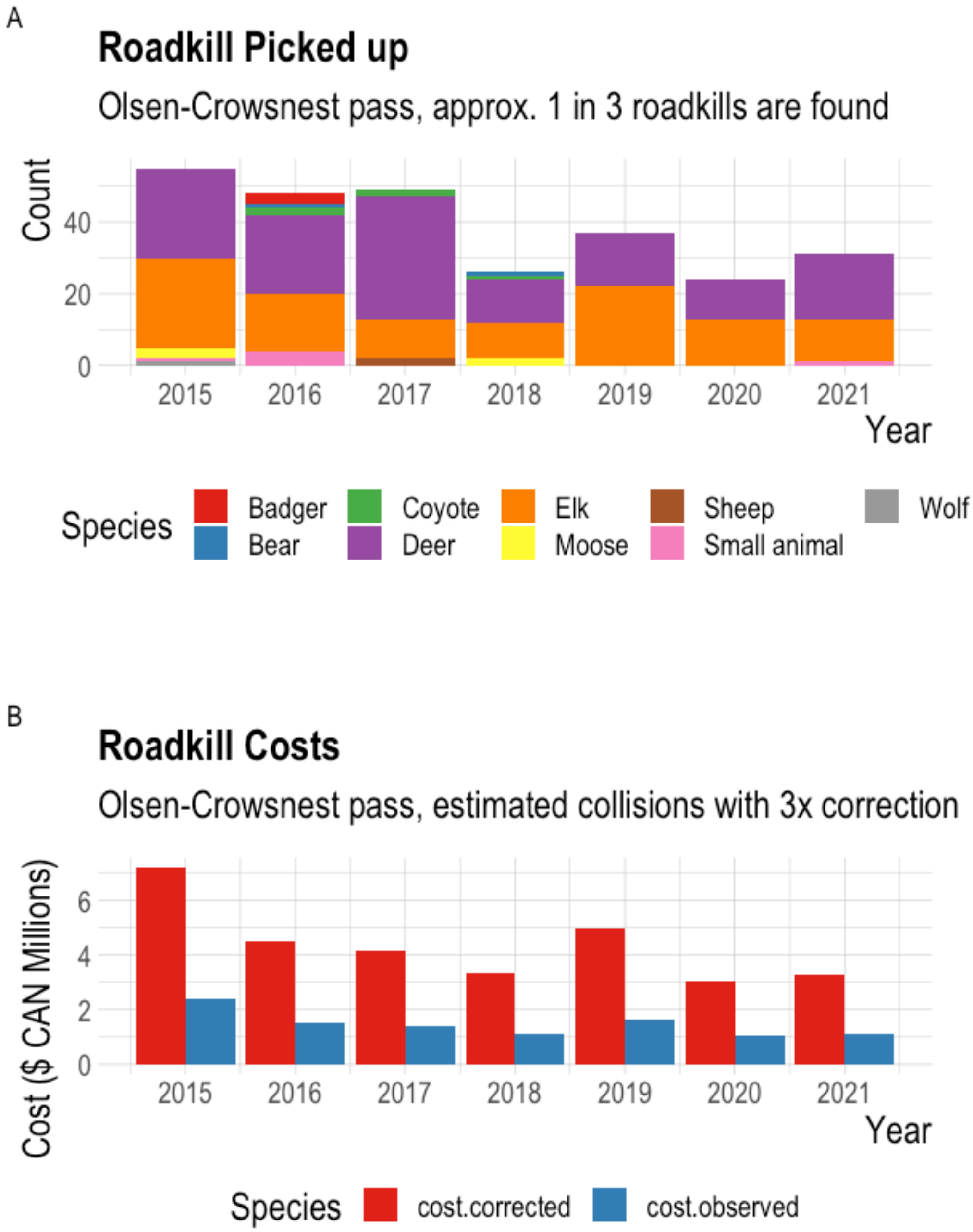

Figure 20: A) Number of roadkill detected along the project length per year and B) estimated cost of these collisions to society. Corrected costs account for unreported roadkill. Studies on collared elk, grizzly bear, and roadside surveys have indicated that only ~1 in 3 roadkill are reported.

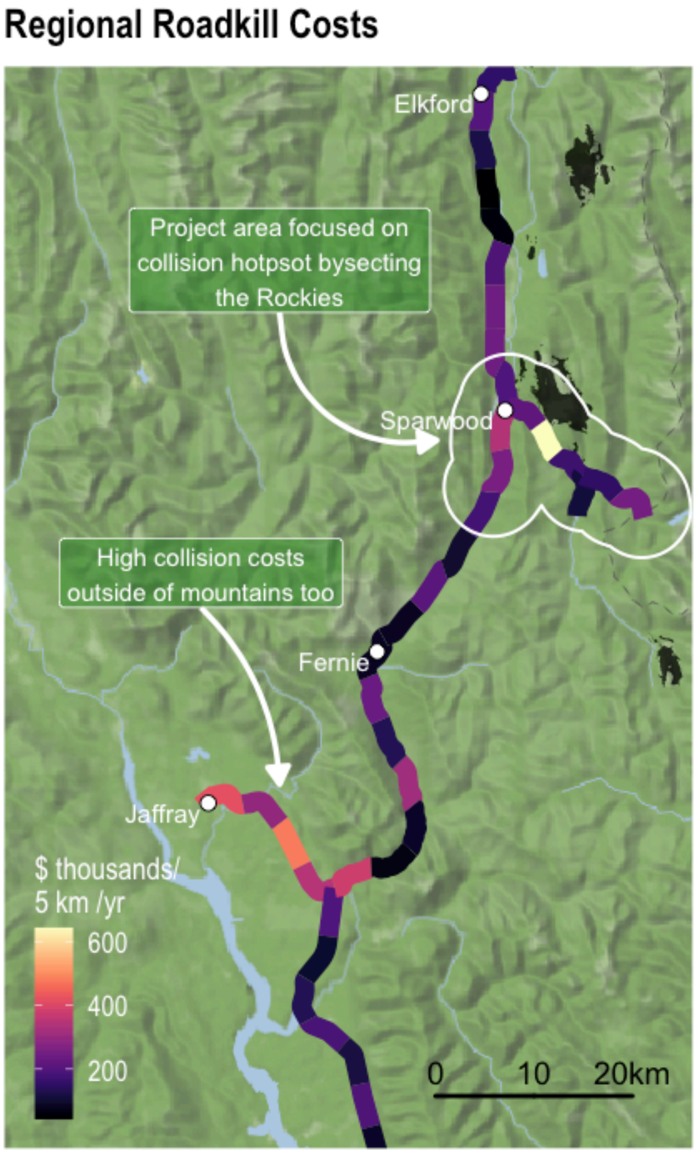

Figure 21: Estimated wildlife-vehicle collision costs along southeast BC Highway 3, 93, and 43. We estimate the annual wildlife-vehicle collision cost for each 5 km segment and note this is a minimum cost as it doesn't account for the many undetected roadkill that aren't found but likely still damaged a vehicle. The true cost could be ~3x higher per segment.

6 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. Several local news outlets have written articles about project progress as well as larger outlets such as Canadian Geographic. Project partners Y2Y and Wildsight also hosted a community event in Fernie in March 2024, to engage with the public about wildlife-vehicle collisions, the significance of the regional landscape for wildlife movement, and to share updates on current and future Reconnecting the Rockies project phases to make Highway 3 safer. 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 Yaq?it ?a·knuq?i 'it to ensure the project is effective for wildlife, consistent with Ktunaxa values, and provides economic opportunities where appropriate. Since 2020 we have conducted multiple 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 1 fencing to allow unimpeded access to a culturally important site, and installed 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 and Shuswap First Nations to improve the effectiveness of existing collision reduction systems (Jaffray underpass and Kicking Horse Canyon) and future systems (Radium).

7 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 39 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 116. Wildlife-vehicle collisions within the RTR:BC project area are estimated to cost society at least an estimated $1.5 million annually, but the cost could be as high as $4.4 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 2020-2023 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 expected limited collision reductions for 2022-2023 given that Phase 1 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 valued 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 1 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, picnicking, or water monitoring. 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 installed signage around the crossing structures to inform users that these are sensitive areas.

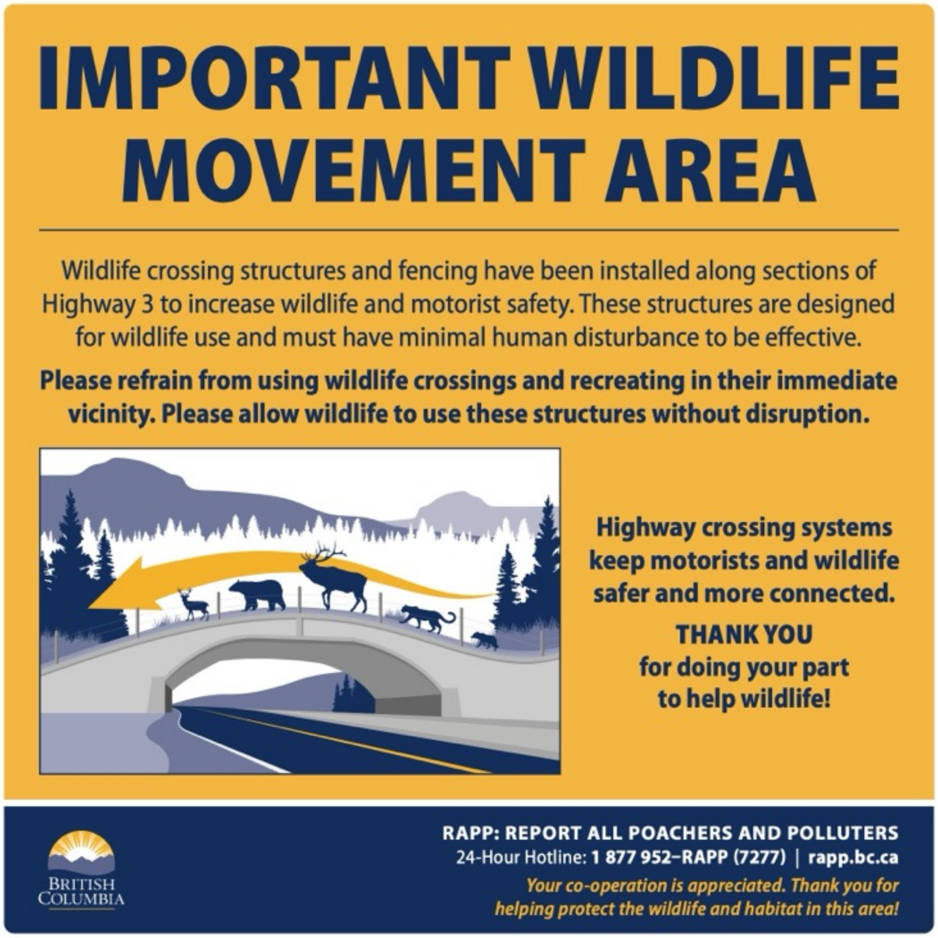

Image 8. Signage that is being installed around crossing structures to educate users on the importance of minimizing disturbance.

Image 9. Signage installed at the entrance to the Loop Bridge.

8 Recommendations

8.1 For the RTR:BC project

The project is progressing well and it was encouraging to see the first section of 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. Fencing and retrofitted underpasses at Loop Bridge and Loop CP overhead produced 2-3 fold increases in wildlife detection rates at these structures. There was not a similar increase at Carbon bridge, which was not unexpected due to the generally low visibilty under this small structure. Reductions in wildlife-vehicle collisions have not yet been assessed due to the recent fence construction (November 2022), it's limited length (2 km of highway), and roadkill data accurracy and completeness challenges. 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, therefore mitigative improvements are restricted to improving the line of site and the 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 1 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 reduce 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 ground 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 that the highway maintenance contractor could help ensure ungulate guards remain effective by removing snow between the bars and from the edges.

The RTR:BC team should also consider human use of the structures, which is known to decrease wildlife use. The monitoring data provide insights into the intensity of human use of these structures, which will be increasingly important to manage after fencing is in place and these crossings are the only places animals can use to traverse the highway.

Concerns have been raised in the past about forcing animals into underpasses that have trains going through them (railway overheads). These are legitimate concerns and we are monitoring these underpasses closely. The Loop CP overhead is one such structure that has a train track going through it that has been fenced. Early results suggest that animals were already using this underpass prior to fence construction at high rates (higher than controls) and post fencing this use increased by >2x. We are not aware of any collisions between trains and wildlife under these structures yet, but are monitoring the area closely. Notably, there is ample room for wildlife to cross through these structures without being on the tracks, which will reduce risk. For example, there is a dirt trail that goes under the structure beside the railway that provides enough room to drive a truck under. Still, some animals choose to follow the tracks, but are only constricted under the underpass for seconds as they cross, which is unlikely to result in high rates of collisions. Overall the number of trains per day is orders of magnitude fewer than the number of cars per day on the highway and we expect many fewer collisions for animals crossing under the overheads compared to crossing the highway. Regardless, attention will need to be paid to ensure collisions are minimized under the overheads. One present risk is the unmitigated spilling of grain that occurs on the tracks that attracts wildlife. Collaboration with CP to solve this issue or to do focal cleanups around crossing structures is recommended.

Funding remains a challenge on this project, especially as it pertains to the Alexander-Michel overpass, which is the cornerstone of the project but remains unfunded. The RTR:BC team has been working hard to find funding each year which has allowed for steady progress towards the project goals. The cost for fencing has been higher than expected (>$250,000 per fence km) which has strained budgets and progress. A dedicated strategy for funding will be needed to complete the project on time, especially as costs will rise substantially in the latter phases which have purpose-built underpasses and overpasses.

8.2 For future projects

One of the strengths of this project is the multidisciplinary group involved. 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 to 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 landscape 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.

9 Acknowledgements

We would like to acknowledge the huge contributions from our team members and their organizations: Duane Wells (MOTI), Matt Jones (MOTI) Candace Batycki (formerly Y2Y) and Tim Johnson (Y2Y), Tracy Lee (Miistakis Institute), and Randal Macnair (Wildsight). The Ktunaxa Nation and member communities have been integral supporters of this work, providing support in principle, advice on numerous field trips, and have helped us keep the big picture in mind: that we need to keep people and animals safe on highways and generally help them both move around the landscape in a good way. We have countless others to thank that have contributed to this work in the past year and before. This work could not have been completed without their work, advice, and guidance. To all those who have helped pave the way, thank you.

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