Mitigating Wildlife Migration Barriers in the Peace Basin

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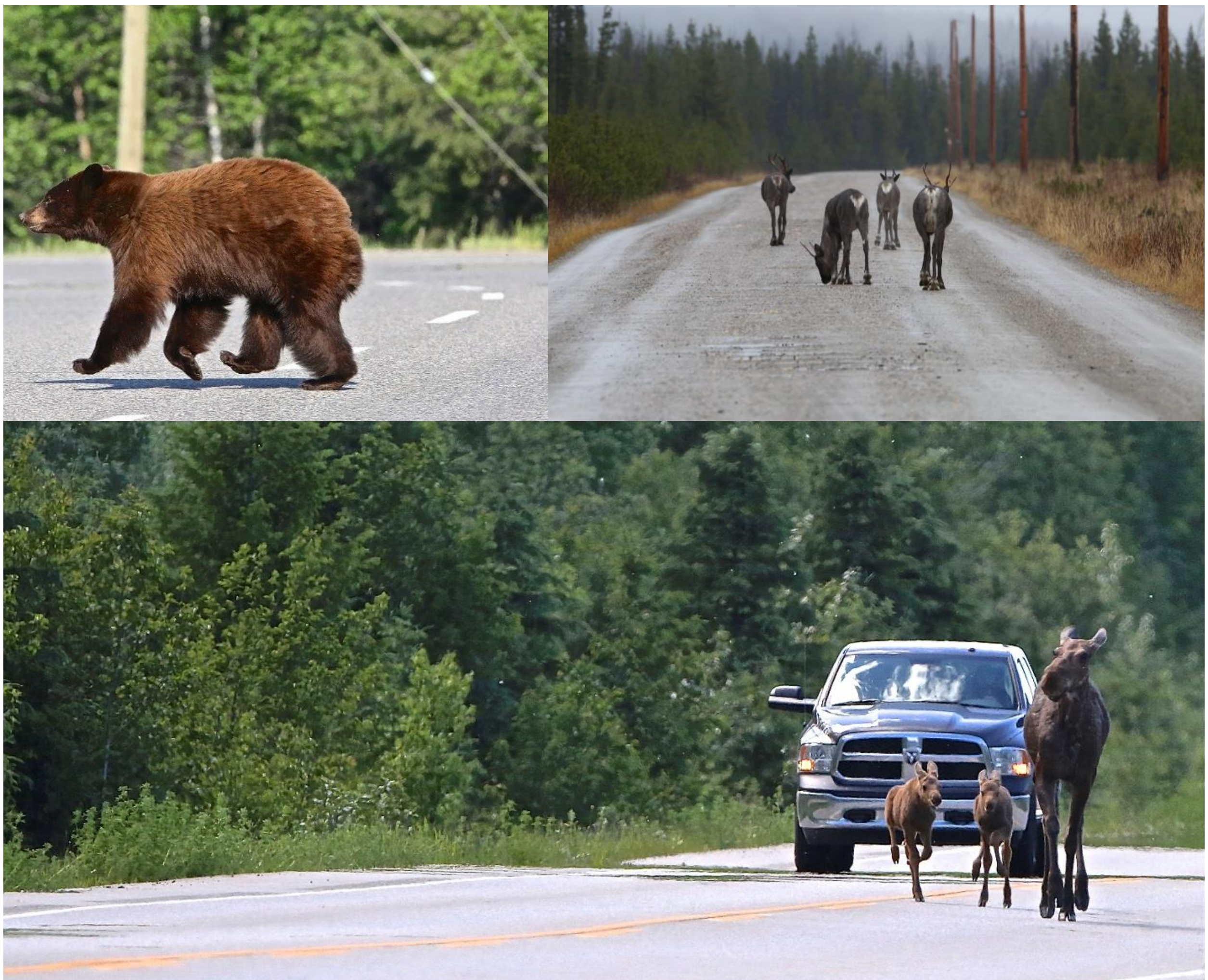

Photos by Roy V. Rea

Prepared for: Fish and Wildlife Compensation Program

Prepared by: Yellowstone to Yukon Conservation Initiative (Y2Y)

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Executive Summary

Maintaining connectivity for the many native wildlife species that rely on the Peace region to travel along the Rocky Mountain corridor, which connects the Rocky Mountain Park system with the Muskwa-Kechika Management Area to the north, is crucial for their preservation and well-being and aligns with the FWCP Species of Interest Action Plan. Specific actions are to restore function of ungulate range by enhancing connectivity, identify limiting factors (collisions) affecting moose populations/other important ungulate populations and make recommendations to conduct habitat enhancement to benefit moose, elk, and deer populations through the mitigation of roadside attractants that result in collisions, and highway design/management that can result in fewer collisions. If wildlife cannot connect to other populations it limits their genetic diversity, which will lead to long-term population decline.

Highways and resource roads in the Peace River Valley run through important ungulate and carnivore habitat that has been curtailed by hydroelectric dam construction and impoundments. Species displaced by the reservoirs have had to move to other habitats, many of which are transected by roads or highways, further disrupting connectivity and habitat linkages.

Two areas identified as particular challenges to maintaining wildlife connectivity within the basin affected by dam construction and impoundments, are the Highway 29 and Highway 97 transportation corridors. Along these highways, woodland caribou, elk, moose, white-tailed deer, mule deer, grizzly and black bear, and fisher suffer mortality due to wildlife-vehicle collisions (WVCs) and/or they avoid the roads altogether, creating physical and genetic discontinuities between populations.

Yet data about collisions – data that would help to design modifications to reduce mortality for vulnerable species, increase the availability of habitat for use and travel, and improve safety for motorists – is widely dispersed and has not been rigorously analyzed to identify spatial and temporal collision trends.

Our project – a collaboration among the Yellowstone to Yukon Conservation Initiative, the University of Northern BC (UNBC), BC Conservation Foundation (BCCF) and including First Nations field monitors and data-sharing – assesses the impacts of major transportation corridors on wildlife mortality and connectivity in the Peace region, within the area affected by hydroelectric dam construction and related infrastructure.

The analysis of WARS and Otto wildlife vehicle collision data suggests that WVCs in the Peace have generally increased from 1978 to 2014 for moose, deer, elk and bear. Our analyses have also delineated 17 hotspots (6 moose, 5 deer, 3 elk, 1 bear, and 2 multi-species) in the study area, only one of which was signed with a wildlife warning sign.

This report and the Operational Plan attached in Appendix 1 will make clear recommendations for cost-effective mitigation at those hotspots, to reduce mortality, improve wildlife movement

ability between the Williston Reservoir and Peace River, and restore population-level interactions, but some options are outlined in the Recommendations section provided below. We will use newly acquired knowledge to identify / address risks, limiting factors, opportunities for protecting wildlife species as they cross highways. We are grateful to the Fish and Wildlife Compensation Program and partners for the opportunity to complete this initial study and to start the important long-term journey towards improving wildlife connectivity.

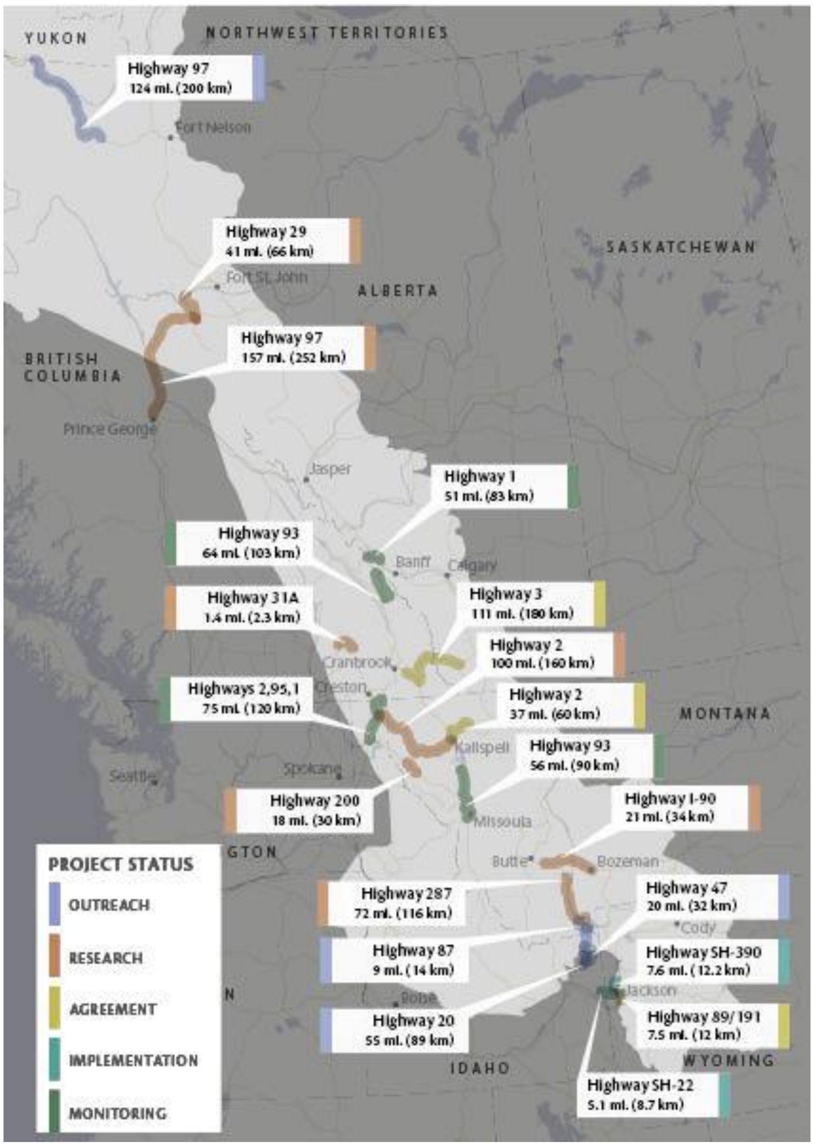
Table of Contents

List of Figures

List of Tables

1. Introduction

Highways are one of the greatest obstacles to the Y2Y vision of an interconnected system of wild lands and waters stretching from Yellowstone to Yukon (one of the most intact remaining mountain ecosystems in the world) harmonizing the needs of people with those of nature. Scientific assessment shows that where highways fragment wildlife habitat and populations, they present major threats to migratory routes and disrupt wildlife connectivity. They have the potential to affect not just individual animals, but whole species.



Mitigating the impact of highways on wildlife is a key focus for Y2Y across the region.

Whether wildlife are killed or seriously injured trying to cross, or deterred from crossing altogether, highways impact their ability to seek food, reproduce and adapt to seasonal and climatic changes - and, ultimately, can impede the gene flow needed for species to survive ("Population Fragmentation and Inter-Ecosystem Movements of Grizzly Bears", Michael Proctor et al, 2012).

To make the major roads in the Y2Y region safer for wildlife and people, Y2Y has worked on research, outreach, monitoring and the implementation of proactive solutions such as crossing structures, fencing, and dynamic signage, on over 1,600 km of highways across BC, Alberta, Idaho, Montana and Wyoming. But there remains much more to be done to reduce the barriers to safety and connectivity.

Northern BC has some of the highest-risk highways for WVCs in BC, which endangers both wildlife and humans, and experts have identified the urgent need to reduce the impacts here before many more are killed and some wildlife species face extirpation. The Peace River Break here represents a ‘pinch-point’ in the broader Y2Y region: situated at the narrowest point in the 2,000 mile-long ecosystem, it is critical for wildlife needing to move between large islands of protected habitat, and connects Canada’s Rocky Mountain Park system with the Muskwa-Kechika Management Area to the north. But population connectivity for several wide-ranging species, including grizzly bear and caribou, is already constrained and vulnerable to fracture. And hydroelectric dam construction, related infrastructure and the resulting increase in construction traffic, have an additional impact, displacing ungulates and carnivores from their habitat to areas transected by busy roads.

The BC Ministry of Transportation and Infrastructure (MoTI’)s Wildlife Accident Reporting System (WARS; a carcass collection system) Report, showed that along Highway 97 in 2012 alone, 256 larger mammals were killed in WVCs, though MoTI estimate the true figure could be ~1000. Local knowledge suggests that highway 29 also has significant casualties and was added to the study based on feedback from community members and First Nations.

Existing WVC data for major highways has not been analyzed at fine scale, and there are no formal roadkill reporting processes for adjoining resource roads. This project will increase our understanding of wildlife movements and mortality across key Highways 97, 29 and well-travelled adjoining roads, and build the case for urgent mitigations.

Project Outline

Y2Y, in partnership with First Nations and the University of Northern BC (UNBC), developed a system to account for wildlife mortality, including site-specific, cost-effective recommendations for reducing WVCs. This involved assembling and analyzing WVC data from a range of sources (see Methods); and engaging with First Nations communities to obtain local knowledge; and supplement existing information.

Project expertise was provided through collaboration with UNBC Senior Laboratory Instructor Roy Rea, who has significant experience in WVC analysis in northern BC; and the West Moberly First Nations and Saulteau First Nations, through which we hired Field Monitor/Technicians, to provide crucial first-hand local and traditional knowledge of wildlife movement and the broader landscape, and recommendations for locally known ‘hot-spots’. Additional project support and expertise has been provided by Gayle Hesse, Provincial Coordinator of the Wildlife Collision Prevention Program for the BCCF.

The following activities have been undertaken in support of this project:

- A wildlife collision analysis on sections of Highway 97 and Highway 29 in the Peace region. This included assembling and analyzing dispersed data, engaging with First Nations communities to provide local knowledge. The resulting collision analysis provides a detailed inventory of wildlife mortality, which includes all species for which data is collected, and has focused on wide-ranging species such as moose, elk and deer, and at-risk species such grizzly bear.

- Field work to assess the conditions and wildlife habitat in the vicinity of recurring collision sites, and assessing and ranking priority sites using established criteria, including thorough mapping.
- Wildlife Collision Working Group meetings with Northern Region MoTI staff to introduce the project and provide interim project updates to MoTI and ICBC. Liaison with highways maintenance contractors regarding WARS data and various complications associated with WVC location information, using MoTI's LKI and RFI locational systems. Liaison with various MoTI staff regarding technical challenges in translating WARS data into GIS-compatible format.
- Putting together recommendations for mitigation measures for priority sites into a final Operational Plan (Appendix 1). The impact of collisions on, and cost to, motorists, insurance companies and the provincial government is significant. Cost-effective mitigation measures for collision hotspots in the Peace may include practical solutions that have proven very successful elsewhere in B.C. and in Alberta, such as signage, roadside attractant removal, wildlife fencing, jump-outs and wildlife over-and-underpasses. These mitigation measures will improve safety for both motorists and wildlife, helping to protect the many native wildlife species that rely on the habitat and resources found in Peace Basin.

2. Goals and Objectives

Goals

Our **long-term goal** is to reduce mortality of and movement barriers for species of concern within the Peace, and restore habitat functionality and connectivity, and ecosystem integrity. This project aligns with the FWCP Species of Interest Action Plan.
This project cuts across actions including:

- Restore function of ungulate winter range for woodland caribou herds
- Use newly acquired knowledge to identify / address risks, limiting factors, opportunities for protecting…furbearer populations
- Identify limiting factors affecting moose populations/other important ungulate populations
- Conduct habitat enhancement to benefit moose, elk and deer populations

Our more immediate **project goals** are:

- To improve our understanding of the impact of key highways and adjoining resource roads in the Peace Region, as a limiting factor on, and barrier to, migration and movement ability of key species; and
- To provide a robust, scientific basis for our road ecologist to make site-specific recommendations to support future habitat management and transportation planning decisions and initiatives.

Project Objectives (as per proposal)

- Assess approximately 250 kilometers of key transportation routes in the Peace Basin (Highway 97 and adjoining resource roads) for wildlife impact over a 12-month period, using collision and carcass data and remote camera footage (types/numbers of animals, times of day and year that they are being killed, and precise location).
- Identify and document key WVC sites in the Peace Valley, especially those with high volume collisions and mortality, in a coherent fashion based on sound science.
- Engage local communities in local road ecology issues and solutions to improve safe passage of wildlife, through community meetings in McLeod Lake and Moberly Lake and through the roll-out of the Roadwatch BC mapping tool and smartphone app.
- Share information with relevant agencies and First Nations to inform carnivore species management by identifying areas where carnivores are viewed adjacent, crossing or dead along the highways, with specific recommendations made to mitigate impact and reduce wildlife mortality.
- Identify specific habitat and wildlife features near to Highway 97 such as mineral licks.
- Build wildlife ecology capacity in the region through training of a UNBC student who will work on the project. (Building student resumes through field experience brings students closer to the job market and working as biologists in BC.)
- Heighten public awareness about increased possibilities for humans and wildlife to co-exist peacefully and sustainably, and how to reduce WVCs that have an impact on animals and humans, and wider communities.
- Establish a model for future research and mitigation approaches.

3. Study Area

Approximately 55.6972° N, 121.6333° W

Our study area was located along numbered highway corridors in the Peace basin near the Williston Reservoir, in the traditional territories of the Mcleod Lake Indian Band and the Saulteau and West Moberly First Nations. This included Highway 97 through the Pine Pass from Summit Lake to Chetwynd, and Highway 29 from Chetwynd to Hudson's Hope.

Additional surveys were completed east of Chetwynd on Highway 97 and south on Highway 29 at the recommendation of First Nations Field Monitor/Technicians, who suggested areas they understood to be wildlife corridors and that were of interest to them.

Many animals (such as moose and deer) moving through their territories and around the reservoir were believed to be coming into conflict with vehicles throughout the Peace River Break, so we thought it important to include some of these areas of concern (such as collision hotspots near Moberly Lake) into our study design (Figure 1).

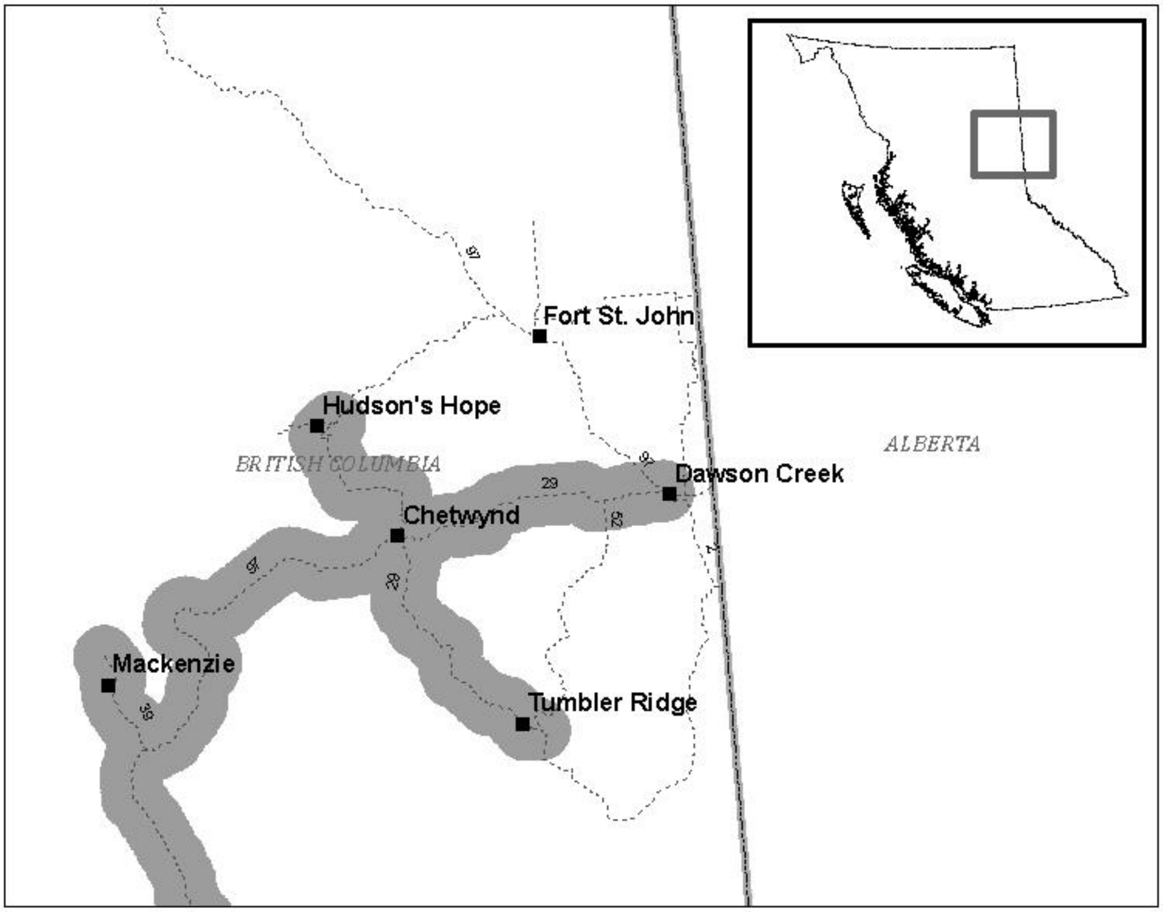


Figure 1. Study area for the Peace Basin Wildlife Vehicle Collision Hotspot ID and Countermeasure Development project. Located to the east and west of the Rocky Mountains, from Summit Lake near Prince George to Hudson's Hope, Tumbler Ridge and Dawson Creek. The grey buffer around the numbered highways indicates the 5km radius around our study sites that were characterized using a GIS.

4. Methods

Data Collection and Analysis

Wildlife vehicle collision data used for this study were collected between 2010 and 2014 and were acquired through two means: 1) from MoTI, using their WARS data use license agreement; and 2) from Otto GPS devices that were installed in the Northern Health Connections Bus fleet, and operated jointly by UNBC and Diversified Transport as part of a moose and deer vehicle collision study in northern BC, (a record of dead moose and deer recorded by bus drivers when passing by carcasses). WARS data from 1978 to 2014 were also used to determine long-term wildlife vehicle collision trends in the study area.

For our project, we analyzed 44,222 vetted WARS records that were recorded from 1978-2014. Of these data, we sorted records by day, month, year and species and by highway segment and landmark kilometer. We specifically sorted by moose, elk, deer, bear and caribou and pinned each carcass to where it was collected on the highway. There were too few caribou records to be of use however, and for that reason we dropped caribou from the study.

To delineate collision hotspots, WARS and Otto data from 2010-2014 were uploaded into ArcMap. Kernel Density Estimation was used for each species layer for use in recognizing areas where the frequency of collisions with a species met the number of collisions over the 5-year period within 1km that we determined to be significant. For the purpose of our study, we determined that any segment of highway that had more than 2 bear, 10 deer, 2 elk, 3 moose or a mix of species with less than the number of bear, deer, elk or moose for a hotspot designation, but also contained collisions with animals such as beaver, coyote, fox, porcupine and bobcat that totaled more than 15 individuals per kilometer, would be deemed as a hotspot.

This determination could be considered somewhat arbitrary, but was a balance between having the numbers so low that too many sections of highway would need to be considered as hotspots (that we would be unable to assess and desensitizes motorists) or having the numbers so high that no highway segments would qualify as a hotspot (see Rea et al. 2014). Using these criteria, we identified 16 hotspots (6 moose, 5 deer, 3 elk, 1 bear, and 2 multi-species) and 11 coldspots (5 moose, 3 deer, 4 elk, 1 bear, and 1 multispecies; and were defined as a highway segment close to and of similar length to the hotspot), three of which were used as coldspots for 2 different species.

We conducted site assessments at each hotspot and coldspot, which included the collection of data describing habitat and road infrastructure at fine and coarse spatial scales. Our choice of individual factors for measurement was premised on the wildlife-vehicle collision literature, expert opinion, previous experience, and First Nations Ecological Knowledge. We worked with First Nations monitoring staff on each site assessment (Figure 2). Monitors helped specifically in elucidating the importance of recording various travel corridors used by wildlife and mineral lick features and in pointing out food resources.

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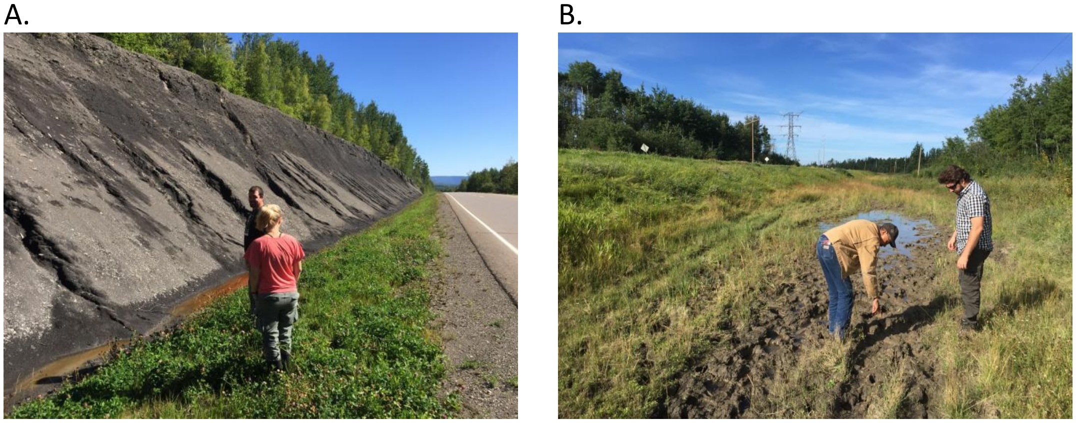

Figure 2. A. Researcher Camille Martens and First Nations Monitor Clayton Garbitt examine an elk trail ascending a step bank in an elk collision hotspot (Hwy 29) near Moberly Lake, BC. B. Tim Burkhart (Y2Y) and Bud Napolean inspect a roadside (Hwy 97) mineral lick in a moose collision hotspot near Arras, BC. August 2016.

Field Data

Fine-scale habitat variables

Fine-scale habitat variables were measured within the highway right-of-way in July and August of 2016, and included vegetation type and height, forest edge composition, the presence of mineral licks, wildlife trails, fields and meadows, and bogs. These were variables likely to influence moose movements and habitat use patterns (Seiler 2005; Dussault et al. 2006; Mountrakis and Gunson 2009; Danks and Porter 2010).

We estimated the mean percentage of browse species cover and non-browse vegetation cover (grasses/forbs/aquatic plants) within the verge at each site. Estimates were made from the roadbed throughout the length of the site and averaged for both sides of the road. The mean height of verge vegetation was estimated to the nearest meter and averaged over the site length for each side, and then for each site. Mature forest type along the edge of the road corridor was estimated from the roadbed, and categorized as predominantly conifer, deciduous or mixed, mature and immature every 100 m or when a forest type change occurred (Table 1).

Road Infrastructure variables

Fine-scale road infrastructure variables were measured within the highway right-of-way in August of 2016, and included variables that could influence the probably of encounters between motorists and wildlife such as the width of the corridor, speed limits, and wildlife warning signs (Table 1).

Table 1 Independent variables used for models describing attributes found in wildlife vehicle collision hotspot and coldspot (control) highway sites in the Peace region of British Columbia. Coarse-scale habitat data were examined within a 500 m and 5 km radius of each site.

Variable Name	Description
FINE-SCALE HABITAT	**MEASURED IN THE FIELD**
Presence of licks	Presence of licks within each site
Roadside vegetation	The percentage of each browse and non-browse species within the verge of each site
Verge vegetation height	Mean (to the nearest half meter) height of vegetation growing in the verge (along the roadside)
Bog[a]	Percentage of land adjacent to highway sites that was bog
Coniferous/deciduous/ mixed forest	Percentage of stand types adjacent to road characterized as coniferous, deciduous, mixed, immature, mature
Fields/meadows	Percentage of land next to road comprised of meadow/fields
Trails	The number of obvious wildlife trails bisecting the road
ROAD INFRASTRUCTURE	**MEASURED IN THE FIELD**
R-O-W Width	Width of right-of-way measured with a range finder
Lanes	The number of lanes of highway in the site
Cross roads	Total number of cross roads bisecting highway site

Highway center lines	The percentage of solid and dashed center lines
Curves and crests	The percentage of the site with curves and crests that obscure the motorists sight lines
Rumble stripping and rails	The percentage of the site with rumble stripping and that has K-Rail concrete barriers
Signage	The presence of wildlife warning signs and speed limits
Highway lighting	Percentage of the site with Highway lighting
Fencing	The percentage of the site with roadside fencing
Infrastructure crossing	The presence of transmission line or railway crossing bisecting the highway site
Ditch depth	Average depth of ditch in meters
Traffic Volume	Annual average daily traffic volumes for each site based on data from the nearest traffic station
Distance to nearest town	The highway distance to the nearest town in combination with the population density of each town
COARSE-SCALE HABITAT	**MEASURED USING REMOTELY SENSED DATA**
Elevation	Mean elevation above sea level (m) within each buffer
Aspect	Mean aspect (in degrees) of land within each buffer zone
Lakes	Total area (m^2) of lakes within each buffer
Wetland	Total area (m^2) of wetlands within each buffer
Burns and cutblocks	Total area (m^2) of burns and clearcuts and length of fire and clearcut edge within each buffer
Tree species[a]	Predominant forest tree species within each buffer
River	Total area (m^2) of rivers within each buffer
Linear	Total linear forest edge (m) within each buffer

[a] Indicates variable is a categorical variable

Coarse-scale habitat variables

We used a GIS to quantify the habitat attributes within a 500m and 5km radius around each site (Table 1). Aspect, slope, and elevation were identified using a digital elevation model for the study area. First order tree species and the area of lakes and swamps were calculated from the BC Vegetation Resource Inventory (BC Ministry of Forests and Range). We used satellite/aerial photograph imagery to quantify the distance from the hot- or coldspot to the nearest town (then determined the population of that town), the location of traffic count stations (and traffic volumes for each) as well as the length of linear edge (Figure 3).

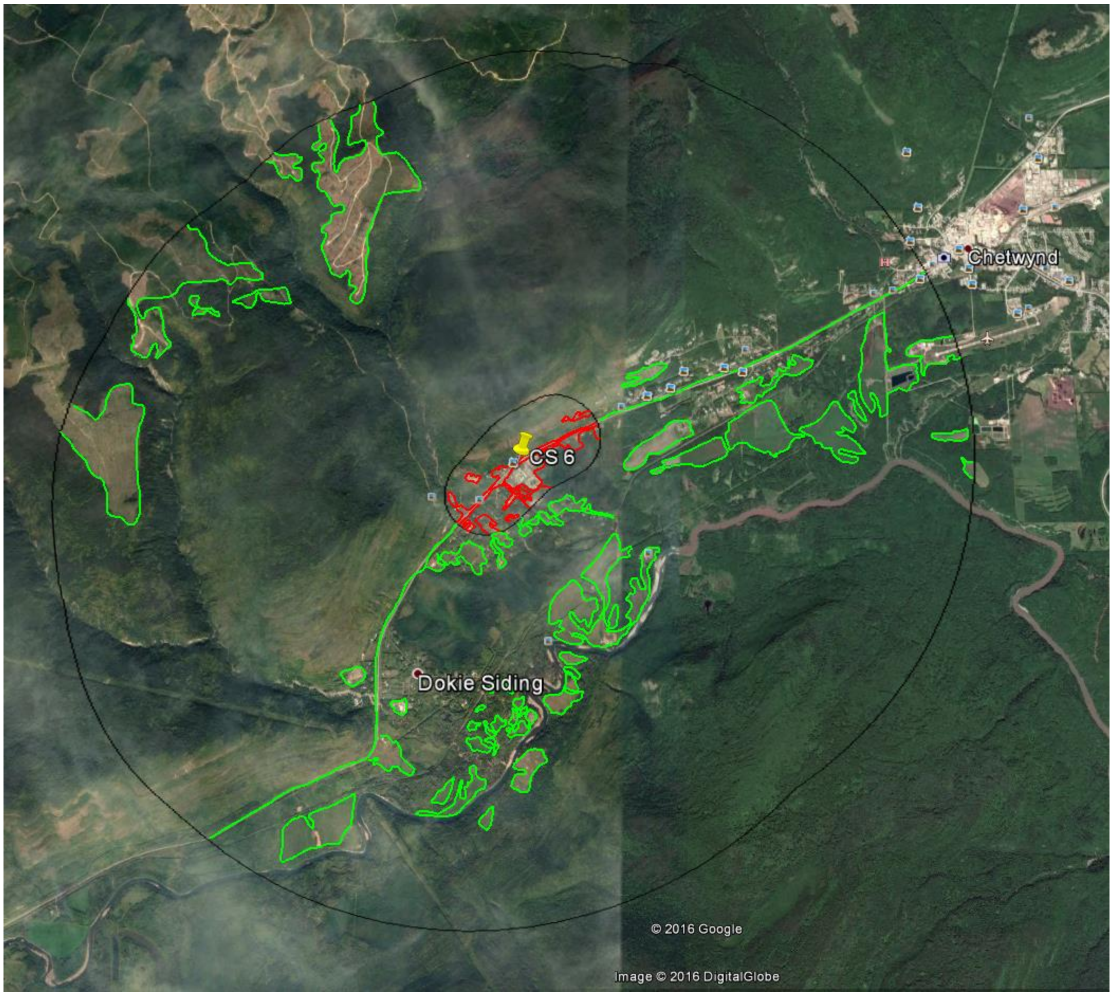

Figure 3. A screen capture of one of the hotspots to the west of Chetwynd, BC showing the 500m and 5km buffer around the site along with the trace tool used to calculate edge (red in the 500m and green in the 5km buffer).

We used Kernel Density Estimation for each species layer in the GIS, to delineate areas where the frequency of collisions met the number of collisions over a 5-year period within 1km, which we set to qualify as a hotspot. We then produced heat maps for each species to show where all collisions had taken place between 2010 and 2014, both inside and outside of the hotspots (e.g., deer Figure 4).

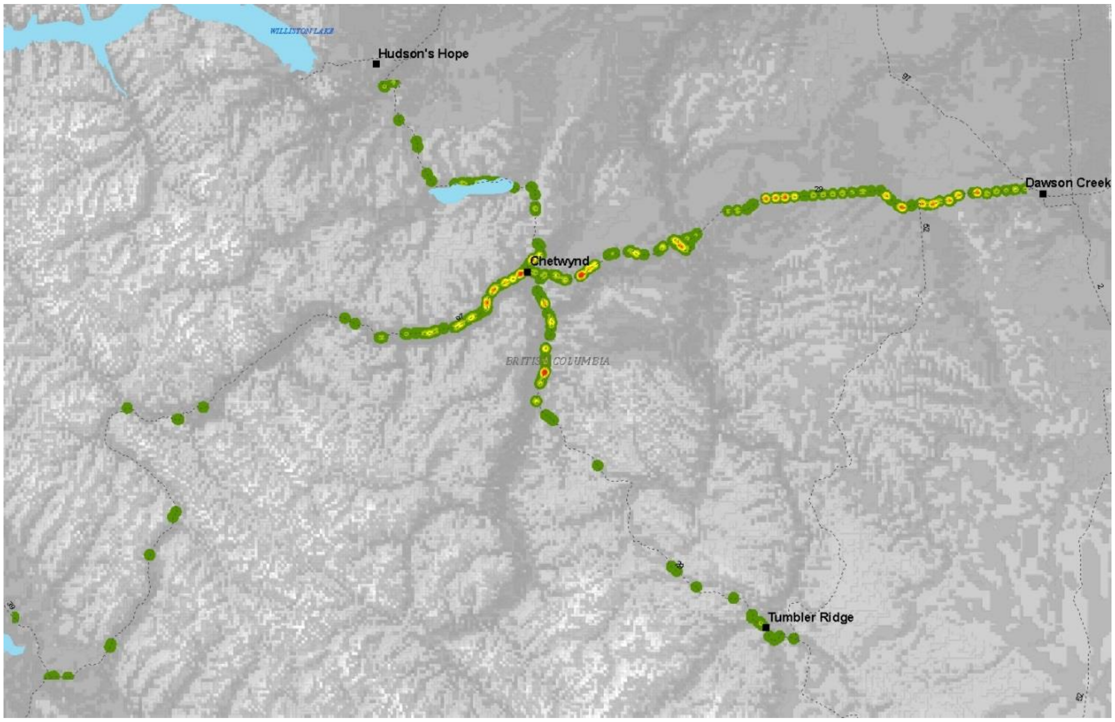

Figure 4. A heat map showing the locations of all deer collisions in the Peace between January 2010 and December 2014. Green indicated 1-4 deer collisions per km from 2010 to 2014 while yellow signifies 4-6, orange signifies 6-10 and red is 10 and above.

5. Results and Outcomes

This project is part of a larger goal of examining wildlife mortality on linear disturbances throughout the region, including roads, railways and resource roads, and work will continue. However, we present preliminary study results and report back against our objectives and outcomes below.

Overview of Study Results

According to the Ministry of Transportation and Infrastructure WARS database, collisions in the Peace with moose and deer have generally increased from 1978 to the mid 2000's, after which there has been a slight decline (especially for moose), whereas collision trends with elk and bears have generally increased over the last 40 years with some inter-annual variation (Figure 5).

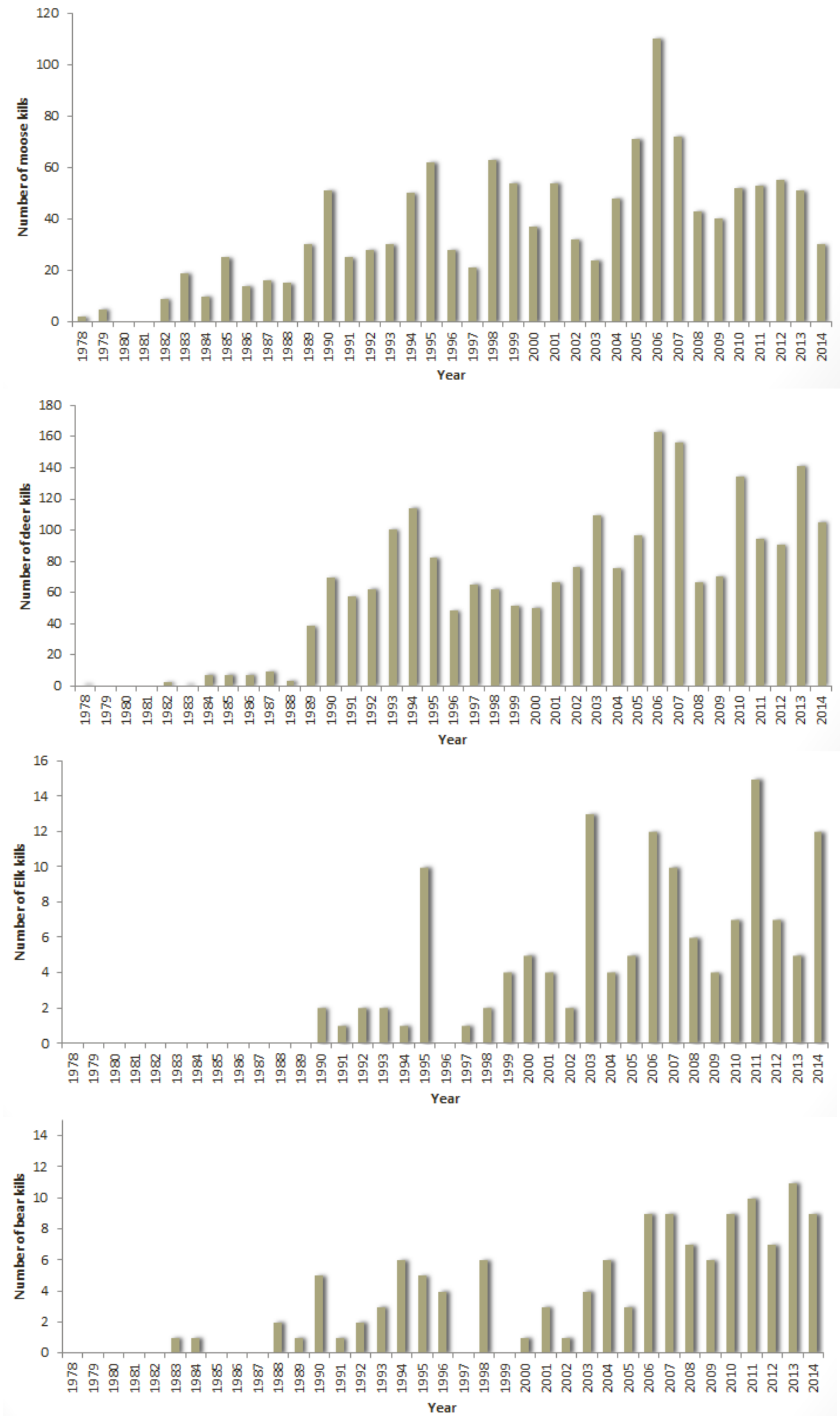

Figure 5. Trends in moose-, deer-, elk-, and bear- vehicle collisions as reported in WARS between 1978 and 2014 for the Peace.

According to our WARS and Otto data, our analysis suggested that between 2010 and 2014 moose-vehicle collisions in our study area were concentrated in 6 hotspots (Figure 6), while deer-vehicle collisions were concentrated in 5 hotspots (Figure 7). WARS data also indicated that elk-vehicle collisions were concentrated in 3 hotspots (Figure 8), bear-vehicle collisions in 1 hotspot (Figure 9) and multispecies-vehicle collisions in 2 hotspots (Figure 10). Only one hotspot had a wildlife warning sign posted within it.

Species specific fine- and coarse-scale data for logistic regression have been analyzed and formatted as part of the Operational Plan (Appendix 1). We found that the average speed limit in hotspots (90 km/hr) is higher than that in coldspots (76.6 km/hr), that there is less solid center line (60% of site length; easier to pass and speed) in hotspots than coldspots (81.5%), that coldspots have on average a higher proportion of roadside fencing (50.5% of the site) than coldspots (24.3% of the site). This course and final scale habitat and road feature data have informed proposed mitigation measures in the Operational Plan circulated to MoTI partners and available in Appendix 1.

Additionally, on average, there is a higher proportion of farmer's fields (38.8% of the site) and less forest associated with control sites/cold spots than hotspots (11.4%). On average, bigger burns characterize hotspots (20 ha within the 5km buffer around the site) than coldspots (10 ha within the 5km buffer around the site). Hotspots are located closer (6.8km on average) to villages than coldspots (11.8km on average) and hotspots are located closer to cities (20.7km on average) than coldspots (29.2km) and the population centers are more densely populated near hotspots (5,403 people on average) than coldspots (3,722 people on average). Finally, hotspots have higher annualized average daily traffic 2,908 cars per day) than coldspots (1,885 cars per day).

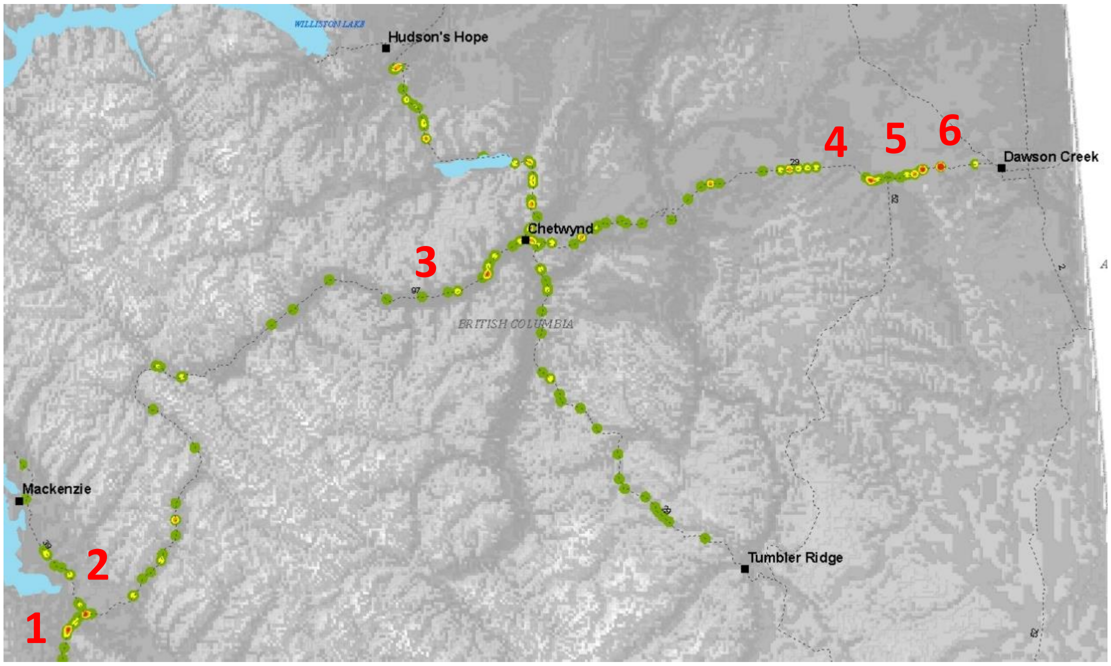

Figure 6. Hotspots in the study area where moose vehicle collisions were ≥ 3 moose collisions/km/5 year period (2010-2014).

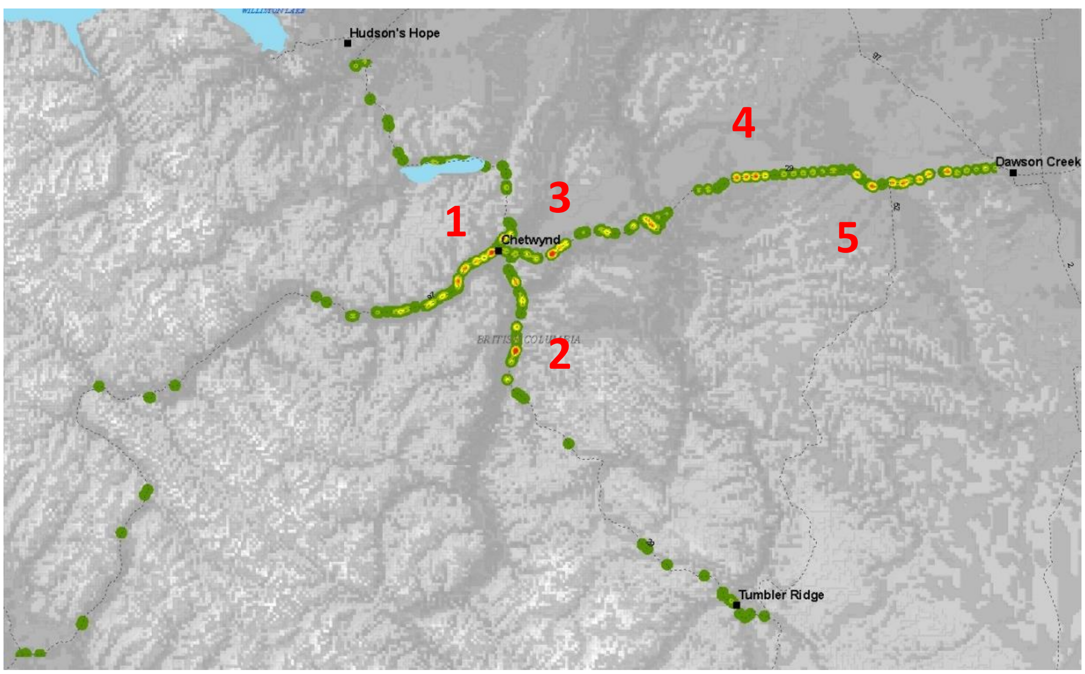

Figure 7. Hotspots in the study area where deer vehicle collisions were ≥ 10 deer collisions/km/5 year period (2010-2014).

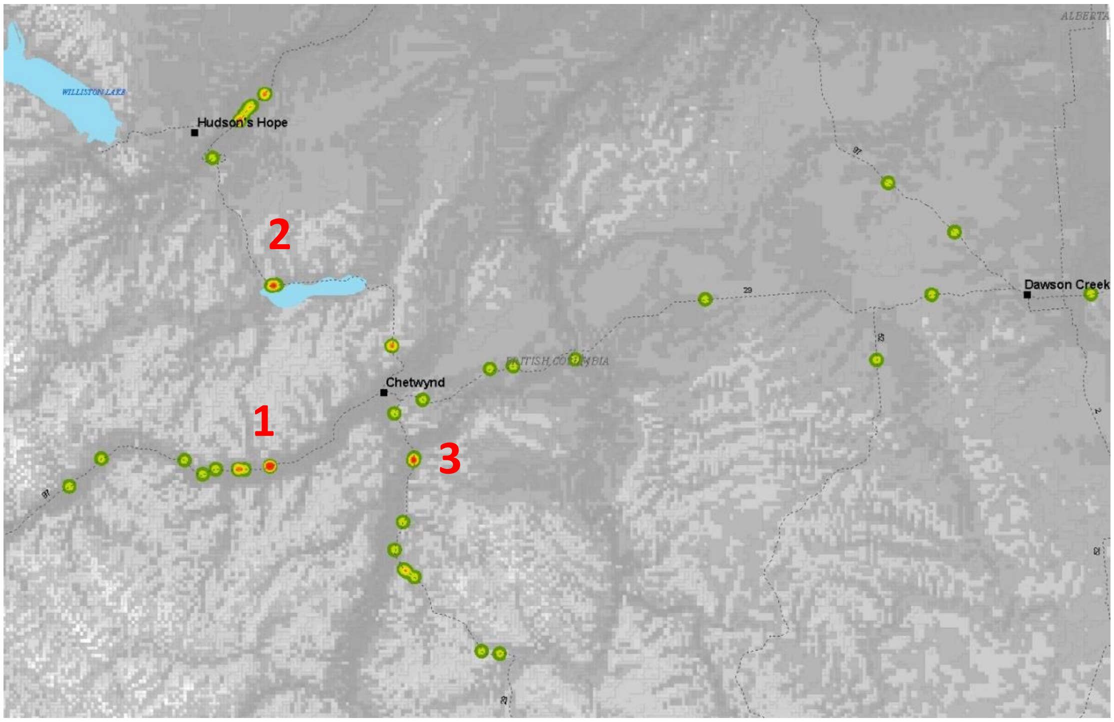

Figure 8. Hotspots in the study area where elk vehicle collisions were ≥ 2 elk collisions/km/5 year period (2010-2014).

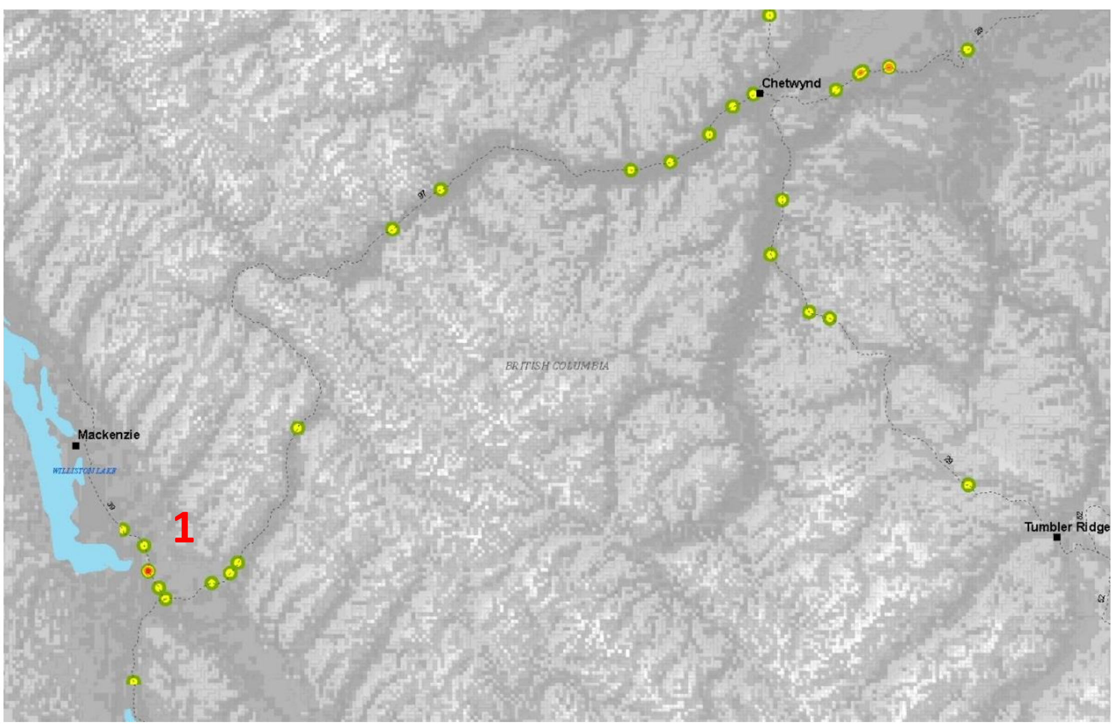

Figure 9. Hotspots in the study area where bear vehicle collisions were ≥ 2 bear collisions/km/5 year period (2010-2014).

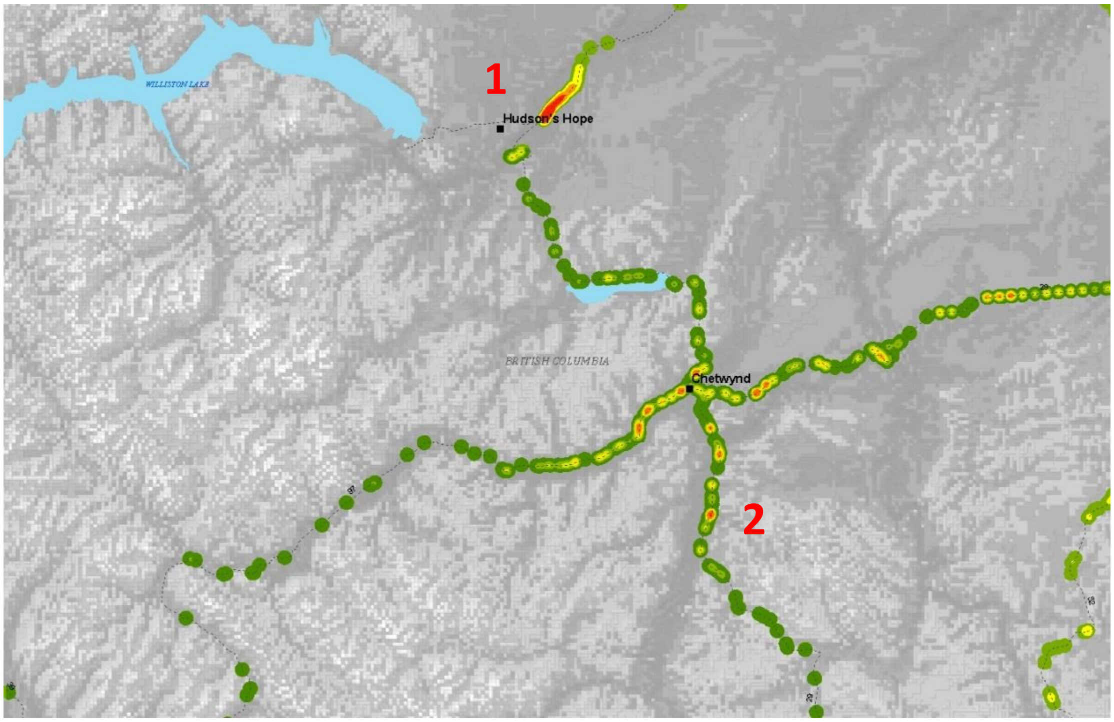

Figure 10. Hotspots in the study area where multi-species vehicle collisions were ≥ 15 individual animal collisions/km/5 year period (2010-2014).

Update on Project Objectives/Deliverables

- ~315 kilometers of key transportation routes in the Peace Basin were assessed for wildlife impact over a 12-month period, with specific site (including physical site characteristics, local and traditional knowledge) and collision information recorded in a bank of organized data, with maps and summaries of when and where various wildlife species are being killed on Highways 29 and 97.
- 17 WVC 'hotspot' sites were scientifically identified and documented.
- Local communities were informed on local road ecology issues through community outreach at West Moberly with Saulteau First Nations (moose management meeting).
- Information has been shared with the Prince George Wildlife Collision Working Group, MoTI (including Minister Trevena), MFLNRO and ICBC as well as Saulteau First Nations and West Moberly First Nations lands departments to inform road safety and wildlife management in region.
- Specific habitat and landscape features on and adjacent to Highway 97 and Highway 29 have been identified, helping to increase understanding of wildlife use/attraction (e.g. mineral licks adjacent to roadsides, high-quality roadside browse).
- Wildlife ecology capacity in the region has been built through training of a UNBC student (Camille Martens) who worked on the project as part of her undergraduate thesis.
- Y2Y's broader public-awareness work on co-existence and wildlife connectivity was informed by the study, which was referenced in our 2016 *Connections* newsletter, in

multiple presentations by Y2Y staff in B.C. communities and universities, and in an article in *British Columbia* magazine (Appendix 2). This work will also inform the next phase of connectivity research and outreach in northeast BC.

- This project has established a strong foundation for WVC reductions, identifying gaps in the research and next steps for future research and mitigation approaches. Background research provided literature reviews and summaries of similar, current projects and research initiatives to provide hot spot identification methodologies, mitigation efficacy assessments, use of citizen science in roadkill monitoring, use of camera traps in assessment of mitigation, prioritization of mitigation treatments, cost effectiveness of mitigation, species-specific mitigation information, WVC data accuracy concerns, and other pertinent topics.

Outcomes

- Increased science-based understanding of wildlife habitat, behaviour and crossing challenges, and potential causes of increased WVCs along Highway 97 and Highway 29. This includes increased understanding of the role that variables, including highway speeds, passing lanes, distance to population centres, and habitat condition, play in making roads more dangerous for wildlife and motorists.
- Increased knowledge of priority sites for mitigation and most appropriate mitigation methods, through analysis of fine and coarse-scale habitat and road infrastructure features in each species-specific site.
- Recommendations to develop site and species-specific countermeasures for each site and prioritize locations along roads for effective mitigation solutions, such as crossing signs, wildlife crossing structures and mineral-lick removal, among others.
- Improved public awareness of the WVC issue, through communications and media including *British Columbia Magazine,* which published an article on this project in their Winter 2017 issue (see Appendix 2).

Next Steps

With the completion of an Operational Report with site-specific mitigation proposals (see Appendix 1), we will be developing a project to address collision causes and roadside attractants in 2018. We have already met several times with operational staff at MoTI, the Northern BC Wildlife Collision Working Group, as well as briefing the Minister in person.

Improving public education and awareness about WVCs is an important part of any mitigation scheme (Clevenger et al., 2001). As well as working directly with relevant authorities, Y2Y has worked with partners on this project (UNBC and BCCF) to disseminate information through social media (Facebook, Twitter), websites, e-newsletters and communications, and earned media. We will continue to raise the issue of WVCs in our communications and media, including this project's outcomes and next steps. Target audiences will be motorists, Peace Region communities (from Prince George to Fort St. John), First Nations communities, and the general public, who will be encouraged to "help wildlife cross the road."

6. Discussion

Our analysis of WARS and Otto wildlife vehicle collision data suggests that WVCs in the Peace have generally increased from 1978 to 2014 for moose, deer, elk and bear. These collisions lead to loss of hundreds of animals each year and presumably injuries and occasional loss of life for motorists. Our analyses delineated 17 hotspots (6 moose, 5 deer, 3 elk, 1 bear, and 2 multi-species) between Summit Lake, Tumbler Ridge, Dawson Creek and Hudson's Hope (see Table 2), only one of which was signed with a wildlife warning sign.

Table 2. List of wildlife-vehicle collision hotspots in our study area identified by species, highway segment number and the kilometer markers on each end of the hotspot.

HOTSPOT ID	Species	Highway Segment	Km start	Km end
HS-1	Moose	1157	151.5	152.27
HS-2	Moose	1157/1161	156.19	0.5
HS-2.8	Multi	1181	0.0	4.5
HS-3	Bear	1163	4	5
HS-4	Elk	1161	123.87	124.5
HS-6	Moose	1161	137.5	138
HS-7	Deer	1161	146.4	147
HS-8	Elk	1169	33	33.7
HS-9	Multi	1185	8.75	9.5
HS-10	Deer	1185	17	18
HS-11	Deer	1172	10	11
HS-12	Deer	1172	56	56.3
HS-13	Moose	1172	76.5	77.5
HS-14	Deer	1172	76.75	77
HS-15	Moose	1172	86.5	87.5
HS-16	Moose	1172	90	91.2

Fine and coarse scale habitat and road infrastructure features have been analyzed with collision data to understand how they may be linked to collision occurrence in species-specific hotspots. Our analyses suggested that faster highway speeds, more passing lanes (indicated by broken center lines), less distance to larger population centers and more traffic are road infrastructure variables that appear to be linked to increased collision occurrence. Habitat variables such as larger burns and more forested habitat (less farmer's fields) also better characterize hotspots than coldspot controls.

7. Recommendations

Management Implications

By identifying 17 WVC hotspots in our study area, we can now make recommendations to authorities about where collision countermeasures should be considered for installation. We will work with the MoTI and road maintenance contractors to ensure that countermeasures are considered for each of our identified sites. The Operational Plan (Appendix 1) has a comprehensive list of findings and recommendations for site-specific collision mitigation, including signage, brush cutting, mineral lick deactivation and night time driving speeds.

At a minimum, signage can be installed at each site currently without signage to mitigate the present risk of collision between motorists and wildlife. During our field work, we discovered that only one of the hotspots (moose HS-13) had appropriate WVC warning signage. Therefore, we have recommended the installation of species-specific warning signs at each hotspot and wildlife corridor signage for the stretches of road on which hotspots exist. Additionally, we recommend the removal of signage in areas where WARS data no longer supports evidence of frequent WVCs and therefore associated sign retention.

Due to landscape-level changes caused by increasing agricultural and industrial development in the Peace Break (particularly development associated with the construction of the Site C Dam site), a review of WARS data and wildlife warning signage placement should be undertaken on a regular basis (Rea 2008).

We have recommended brush cutting in sites identified as having roadside forage species which provide attractive browse for ungulates and where such vegetation may impact driver sight lines. We also recommended mineral lick decommissioning in one site containing a roadside mineral lick.

Solutions may include the installation of warning signs with reduced speed limits, but also include the replacement of broken center lines with solid center lines to reduce passing and speeding through hotspots. Although, habitat features such as forested area burned and converted into farmer's fields appears to be linked to collision occurrence, further analyses into the importance of these variables at species-specific sites will help elucidate their overall importance. Possible adjustments to habitat characters related to collision occurrence can be discussed with the appropriate authorities and may help inform future land management and road placement decisions.

Suggested further Actions: Research and Outreach

Ensuring that signage and other forms of collision countermeasures remain current requires that new data be incorporated into road safety planning. Although there are no data to suggest how often reassessments should be done and the need to reassess will depend on several factors (e.g., changes in traffic volumes, access, animal population densities and the type and extent of habitat conversion), identifying hotspot locations every 5 years may prove to be a useful exercise. This will allow road safety personnel to identify the most relevant places for mitigation and will keep motorists sensitized to such changes.

Long-term monitoring of WVC's and wildlife movement along Peace highways and other transportation routes will enable researchers to highlight the benefits of mitigation strategies to local and regional wildlife populations as well as cost savings to society. Accounting for more animals killed by cars will help us better determine the impact that traffic has on wild populations and the importance of determining ways to mitigate these impacts.

A new and growing RoadWatch program utilizing smart-phone technology (Miistakis Institute, Mount Royal University, Calgary, AB) would allow citizens to report wildlife sightings (dead or alive) that they encounter while driving, and enable motorists and researchers to work together to provide to the Ministry georeferenced data along number highways *and* resource roads, where many wildlife species killed by vehicles go unreported. It may also prove to be another way to engage motorists to pay closer attention to the wildlife with which they share the roads. (The adaptation and roll-out of the RoadWatch BC was mentioned in our original proposal, but it was not practical to undertake that in the initial phase of the project).

Passengers can record information in real time (provided that there is cell phone coverage) or store the information until cell coverage can be obtained (Note: this means the app works without cell coverage, in areas such as the Pine Pass). Drivers will have to remember where, when, and what they saw and then record their observation using an on-line mapping tool. Participants in a Road Watch BC program for resource roads could come from both industrial and commercial road users and recreational road users (hunters, fishers, boaters, campers). Y2Y and the BCCF are currently designing a pilot trial of the RoadWatch tool with support from the Insurance Corporation of British Columbia.

Ultimately we hope to widen the area of analysis through a further project that entails WVC assessments and proposed mitigations across the Peace Basin. In that, we would focus on resource roads identified during the first year as problematic for wildlife-vehicle collisions, as well as Highway 29 through the Peace-Moberly tract area up to the Dinosaur Reservoir, and on highways in the Tumbler Ridge area that are within the tributary watershed of the Peace River.

In Conclusion

Land development, increased access and increased traffic flow in the Peace continue to put wildlife into conflict with motorists. Such patterns are only likely to be exacerbated as highways are twinned and more vehicles occupy road surfaces in an area that continues to be developed with oil and gas and hydroelectric projects. Collision with some species of animals such as moose are on the decline, but this is likely to reflect declining numbers of animals, rather than efficacious mitigation planning. Where declining moose populations are concerned, every collision death should be avoided (Gorley 2016); the same could be said for every wild animal population in the Peace.

Further work to increase data, and to prioritize and advance mitigation of collision hotspots so that motorists' safety and animal welfare can be enhanced is essential, and we hope to continue our work in this important arena and help drive forward the above recommendations.

8. Acknowledgements

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9. References

Apps, Clayton. December 2013. Assessing Cumulative Impacts to Wide-ranging Species Across the Peace Break Region of Northeastern British Columbia. Yellowstone to Yukon Conservation Initiative. http://y2y.net/publications/technical-reports/AppsY2YPeaceBreakCarnivoreCEAReportFINAL.pdf

Clevenger, Anthony et al. May 2010. Highway 3: Transportation Mitigation for Wildlife and Connectivity in the Crown of the Continent Ecosystem. Montana State University, University of Calgary and the Yellowstone to Yukon Conservation Initiative. http://www.rockies.ca/crossroads/files/H3%20Final%20Report%2007_01_10_FINAL.pdf

Clevenger, Anthony et al. Summer 2010. Highway mitigation fencing reduces wildlife-vehicle collisions. Wildlife Society Bulletin, 29(2): 646-653.

Danks ZD, Porter WF. 2010. Temporal, spatial and landscape habitat characteristics of moose-vehicle collisions in western Maine. Journal of Wildlife Management 74:1229-1241.

Dussault C, Poulin M, Courtois R, Ouellet J-P. 2006. Temporal and spatial distribution of moose-vehicle accidents in the Laurentides Wildlife Reserve, Quebec, Canada. Wildlife Biology 12:415-425.

Gorley, R.A. 2016. A strategy to help restore moose populations in British Columbia. 36p.

Hesse, S. Gayle. 2006. Collisions with Wildlife: An Overview of Major Wildlife Vehicle Collision Data Collection Systems in British Columbia and Recommendations for the Future. Wildlife Collision Prevention Program.

Hesse, G., et al. June 2010. Evaluating the Potential of the Otto Wildlife GPS Device to Record Roadside Moose and Deer Locations for Use in Wildlife Vehicle Collision Mitigation Planning. Wildl. Biol. Pract.:1-13.

Insurance Corporation of British Columbia. 2015. Quick Statistics 2015.

Lee, T., M. S. Quinn, and D. Duke. 2006. Citizen, science, highways, and wildlife: using a web-based GIS to engage citizens in collecting wildlife information. Ecology and Society 11(1): 11: http://www.ecologyandsociety.org/vol11/iss1/art11/.

Mountrakis G, Gunson K. 2009. Multi-scale spatiotemporal analyses of moose–vehicle collisions: a case study in northern Vermont. International Journal of Geographical Information Science 23:1389-1412.

Parks Canada, http://y2y.net/files/366-10-facts-about-wildlife-crossings.pdf.

Rea, Roy V., Chris J. Johnson, Scott Emmons. 2014. Characterizing Moose–Vehicle Collision Hotspots in Northern British Columbia. Journal of Fish and Wildlife Management. Vol. 5, Iss. 1, p.46.

http://fwspubs.org/doi/pdf/10.3996/062013-JFWM-042.

Seiler A. 2005. Predicting locations of moose–vehicle collisions in Sweden. Journal of Applied Ecology 42:371–382.

Sielecki, L.E. 2010. WARS 1988-2007: Wildlife Accident Reporting and Mitigation in British Columbia, Special Annual Report. British Columbia Ministry of Transportation and Infrastructure.

Yellowstone to Yukon Conservation Initiative. Jan 28-29, 2008. At the Crossroads: Transportation and Wildlife: Highway 3 Transportation Corridor Workshop Summary. http://www.rockies.ca/crossroads/files/Final_Highway3_WorkshopSummary_Web.pdf

Yellowstone to Yukon Conservation Initiative. 2013. Protected or in Peril? Conservation in the Peace River Break and Muskwa-Kechika Regions: Workshop Notes, March 15-16 2013, University of Northern British Columbia, Prince George, BC.

Appendix 1

A Site-Specific Operational Plan for Reducing the Risk of Vehicle Collisions with Wildlife in the Peace Break

by

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Specific recommendations from this study and in this report are provided by the authors for sponsoring agencies and highway safety planners to consider. These recommendations do not represent the findings, opinions or policies of sponsoring agencies or of UNBC.

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Executive Summary

Seventeen wildlife-vehicle collision (WVC) “hotspots” were identified in 2016 in the Peace Break Region of northern British Columbia. None of the hotspots contained appropriately placed and delineated (with distance tab) wildlife warning signage at the time of assessment. We identify by highway segment number and landmark kilometre each of the 17 hotspots and identified by wildlife species the types of animals being recurrently killed at each site. We make site- and species-specific recommendations for countermeasure installations at each site to mitigate WVCs.

Cover photograph: A cow moose with twins running down the highway in front of a vehicle in northern BC. June 2015. Roy V. Rea

Background

Wildlife vehicle collisions have been documented by MOTI and independent researchers as a significant road safety concern both generally in northern BC and specifically in the Peace region, in northeastern BC, since 2001 (Sielecki 2010, Rea 2006, O'Keefe and Rea 2012, BC MOTI 2014a). The Peace region is also an area of concern for the Yellowstone to Yukon Conservation Initiative (Y2Y). The Peace River watershed provides a natural east-west break in the Rocky Mountain ranges, known as the Peace Break. The Peace Break is the narrowest point in the Y2Y corridor, and is bisected by major highway systems as well as the Peace Reach of the Williston Reservoir. These linear east-west alterations to the landscape have interrupted ecologically-intact habitat continuity for wide-ranging terrestrial species (Apps 2014). The identification and mitigation of highway locations where wildlife mortality is recurrent provides an opportunity to lessen the cumulative effects of human development in this ecologically diverse area.

WVC Hotspot Identification

Following 18 months of WVC data vetting and analysis in 2016 and 2017, we determined that 17 highway sites (hereafter referred to as hotspots) in the Peace Break Region of northern British Columbia were associated with recurring WVCs between 2010 and 2014. Carcass data used to delineate these hotspots were recorded by highway maintenance contractors using the Wildlife Accident Reporting System (WARS) and obtained from the Ministry of Transportation and Infrastructure.

Hotspots were divided into five species categories: deer, moose, bear, elk, and a multi-species category. Species hotspots were defined as ≥ 15 deer, ≥ 4 moose, ≥ 2 bear, ≥ 2 elk, and ≥ 20 individuals of mixed species per kilometre per five-year period (between January 2010 and December 2014).

Using the British Columbia Landmark Kilometre Inventory (July 2015 Version; BC MOTI 2015) and WARS data, we imported and georeferenced all carcass locations using a geographic information system (GIS) and ArcMap 10.2 (ESRI 2011. ArcGIS Desktop: Release 10.2. Redlands, CA: Environmental Systems Research Institute). We used the Route Event Layer tool to attach the collision records from WARS to numbered highways and used Kernel Density Estimation to delineate hotspots in the GIS.

Concurrently, and for the purpose of establishing site differences between highway stretches with recurrent WVCs and segments without WVCs, we also established 11 sites (hereafter referred to as coldspots) where no WVCs had occurred between 2010 and 2014 (Figure 1). Site characteristics such as layers of forest cover, elevation, area of wetlands, area of burns, etc., were imported into the GIS and compared between hotspots and coldspots. We also used data on traffic volumes and distance to nearest population centres, as well as data we collected in the field at each site (e.g., roadside browse availability, ditch depth, and adjacent habitat type), to compare hotspots to coldspots (see Martens 2017).

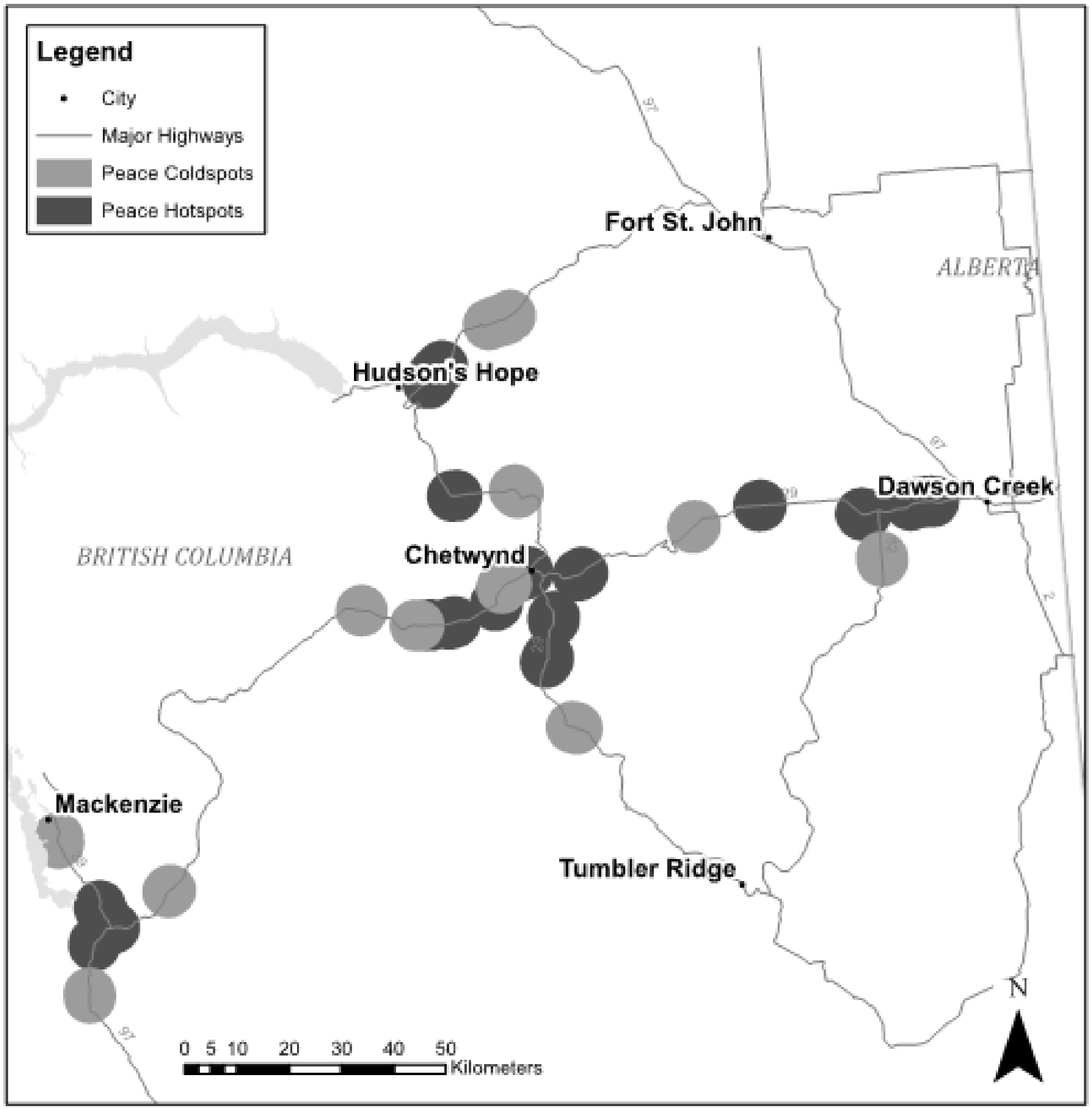

Figure 1. Map of the Peace Break Region showing WVC hotspots (dark grey) and coldspots (lighter grey) delineated using WARS data collected between 2010 and 2014.

Project constraints

There were constraints on understanding the complexities of wildlife movement and making subsequent region-wide recommendations because of the differences in boundaries between the Peace Region (as denoted by FWCP, the funding partner) and the

Peace Break (as denoted by Y2Y, the project proponent). Highway 29 Segment 1102 (Hudson's Hope to Highway 97) and Highway 97 Segment 1202 (Dawson Creek to Fort St John), both of which incur significant numbers of WVCs, were not included in the project because they were outside the FWCP Peace Region.

We acknowledge that WARS data is subject to underreporting. BC MOTI estimates "the number of wild animals recorded by the WARS system represents only about 25% to 30% of the actual number of wild animals killed" (Sielecki 2010). This is supported by Hesse and Rea (2016) who reported WVC underreporting as high as 65% on some northern BC highways. Regardless, analysis of the effects of underreporting on hotspot identification and subsequent WVC management strategies (Snow et al. 2015) concludes that even if underreporting is very high (≥ 75%) WVC data derived from well-planned carcass collection protocols (such as WARS) can be used to identification of high risk stretches of highway, prioritize these areas for mitigation treatment, develop appropriate mitigation strategies, and monitor the results of mitigation.

Identified Hotspots

As part of this project, all WVC hotspots in the Peace Break were given a hotspot ID, and identified by species of wildlife involved in recurrent collisions, the number of carcasses recorded in each site between 2010 and 2014, highway number, highway segment, highway description, kilometre marker and nearest recognizable LKI feature (Table 1). Field site assessments during the summer of 2016 revealed that only one site HS-2 (Moose) had appropriate species-specific signage with the correct distance board associated with it. Therefore, we have recommended warning signs be established at each site and in some cases, brush-cutting and mineral lick decommissioning (Table 1).

Table 1. Peace Break WVC hotspot table showing species-specific hotspots (2010-2014 WARS data) and their locations as well as recommended mitigation measures, by highway number. Note: * Year of LKI revision in brackets; ** When warning signage is the recommended countermeasure, signage should be placed with distance boards at both ends of the hotspot; *** The direction was reversed on this segment as part of the 2016 LKI revision. It is now numbered beginning from Tumbler Ridge;

Hotspot ID	Species	No. Carcasses sp. (other)	Hwy	Current LKI Segment Number	Previous LKI Segment Number*	Highway Description	Km Start	Km End	Nearest Recognizable LKI Reference	Site-Specific Mitigation Measures**
HS-8	Elk	2(2)	**29**	1101	1169 (2016)	Chetwynd to Hudson's Hope	33	33.7	33.55: Sign HHope 31km Bennett Dam 55 Ft St John 155	Elk Signage; Brush Control
HS-28	Deer / Moose / Multi-Species	134/7(14)	**29**	1102	1181 (2016)	Hudson's Hope to Hwy 97	0	4.5	4.29: Longstreet Road	Warning Signage
HS-9	Deer / Multi-Species	20(2)	**29**	1100***	1185 (2016)	Tumbler Ridge to Chetwynd	84.14	84.89	84.73: Tidwell Bend Bridge 2268 N End (Pine River)	Warning Signage; Brush Control
HS-10	Deer	11(2)	**29**	1100***	1185 (2016)	Tumbler Ridge to Chetwynd	75.64	76.64	76.16: Dickebusch Cr Bridge 2675 S End	Deer Signage
HS-3	Bear	4(1)	**39**	1163	1163	Mackenzie	4	5	5.48: BCR Crossing	Bear Signage; Brush Control
HS-1	Moose	5(0)	**97**	1157	1155 (2014)	Prince George to Hwy 39 Jnct	151.5	152.27	153.35: Finlay FSR	Moose Signage
HS-2	Moose	9(3)	**97**	1157/1161	1155/1160 (2014)	Highway 97 -- 0.19 south of Hwy 39/97 junction to 0.5 north of Hwy 39/97 junction	156.19	0.5	156.26: Gas Station to 0.54: BCR crossing	Moose Signage

Table 1 Continued. Peace Break WVC hotspot table showing species-specific hotspots (2010-2014 WARS data) and their locations as well as recommended mitigation measures, by highway number. Note: * Year of LKI revision in brackets; ** When warning signage is the recommended countermeasure, signage should be placed with distance boards at both ends of the hotspot; *** The direction was reversed on this segment as part of the 2016 LKI revision. It is now numbered beginning from Tumbler Ridge; **** MVC hotspot identified in Rea 2008 – 1170_76 to 77km; ***** WVC hotspot identified previously by C. Newby, G. Hesse, R.V. Rea, and N. Long; (unpublished data).

Hotspot ID	Species	No. Carcasses sp. (other)	Hwy	Current LKI Segment Number	Previous LKI Segment Number*	Highway Description	Km Start	Km End	Nearest Recognizable LKI Reference	Site-Specific Mitigation Measures**
HS-4	Elk	2(3)	**97**	1161	1160 (2014)	Hwy 39 Jnct to Chetwynd	123.87		123.29: Hasler Rd	Elk Signage
HS-5	Elk/Deer	5/10(1)	**97**	1161	1160 (2014)	Hwy 39 Jnct to Chetwynd	127.8	128.8	127.17: Ganson Rd	Warning Signage
HS-6	Moose	4(8)	**97**	1161	1160 (2014)	Hwy 39 Jnct to Chetwynd	137.5	138	138.51: Bissette Creek Bridge	Moose Signage
HS-7	Deer	24(3)	**97**	1161	1160 (2014)	Hwy 39 Jnct to Chetwynd	146.4	147	146.46: Tuscoola Mt Cemetery Access	Deer Signage
HS-11	Deer	26(4)	**97**	1172	1170 (2014)	Chetwynd to Dawson Creek	10	11	10.32: Ranson Rd	Deer Signage
HS-12	Deer	20(3)	**97**	1172	1170 (2014)	Chetwynd to Dawson Creek	56	56.3	56.02: 271 Road	Deer Signage; Brush Control
HS-14	Deer / Moose	16/6	**97**	1172	1170 (2014)	Chetwynd to Dawson Creek	76.75	77	76.71: 247 Road	Warning Signage; Brush Control
HS-13****	Moose	4(11)	**97**	1172	1170 (2014)	Chetwynd to Dawson Creek	76.5	77.5	77.09: 208 Road	Moose Signage
HS-15*****	Moose	7(12)	**97**	1172	1170 (2014)	Chetwynd to Dawson Creek	86.5	87.5	86.82: 235 Road	Moose Signage; Brush & Lick Control
HS-16	Moose/Deer	8/10(3)	**97**	1172	1170 (2014)	Chetwynd to Dawson Creek	90	91.2	90.19: 231 Road	Warning Signage; Brush Control

Recommendations

Signage

In 2014, MOTI introduced the use of wildlife corridor warning signs (BCMOTI 2014b). MOTI does not provide a specific definition for a wildlife corridor, but it appears to refer to stretches of highway greater than 10 kilometres in length where WARS data has indicated high numbers of WVCs and where drivers might reasonably expect to encounter wildlife over extended distances. There are various configurations of the corridor signs, depending upon the length of the wildlife corridor and the species most often involved in WVCs.

MOTI has already begun the installation of corridor and gateway signage at the beginning and end of highway segments within the Peace Break area (e.g. Segment 1163).

Figure 2. W-066-1 Gateway Sign. Highway 97, north of Prince George (Gayle Hesse).

In addition to corridor signage, we recommend wildlife warning signage installation at each identified hotspot. Signs should be species-specific for each location with signs appearing in both traffic directions at the beginning of the hotspot indicating to motorists the length of the hotspot. For example, the first site listed in Table 1 (HS-8) indicates that the hotspot is 33-33.7 (0.7) kilometres long. Here, both southeast-bound and northwest-bound signs located at the start and stop points of the hotspots (delineated in Table 1) should indicate that motorists need to watch for elk for 0.7 kilometres.

Due to industrial and agricultural development, landscapes in northern BC are quickly changing, as are the ways that animals manoeuvre through them. Changes in wildlife populations (particularly the recent significant declines in moose populations in northern BC) will also impact animal movement and habitat use, and subsequently WVC trends. Therefore, it is important that the signage reflect the findings of the analysis and motorists are provided with the warnings reflecting the most current data analysis.

Signs should not be generic either in their distance indications or in their overall appearance. Such signs lead to drivers becoming accustomed to and desensitized to warning signage (Preston et al. 2006). Multi-species hotspots such as HS-9 and HS-28 will require innovative multi-species signage.

Sielecki (2017) developed and proposed the use of a Wildlife Hazard Rating System® (WildHAZ®) which combines a colour-coded and hazard-severity rating system that can be retrofitted to existing traditional wildlife warning signs (Figure 3). WildHAZ® can also incorporate changeable speed advisory or speed regulatory speed tabs providing additional information for motorists (Figure 4). Although this system shows promise in its flexibility, it is not currently recognized in the Manual on Uniform Traffic Control Devices and therefore its use is unlikely to be approved by MOTI.

Figure 3. Wildlife Hazard Rating System, using colours to denote hazard (Sielecki 2017).

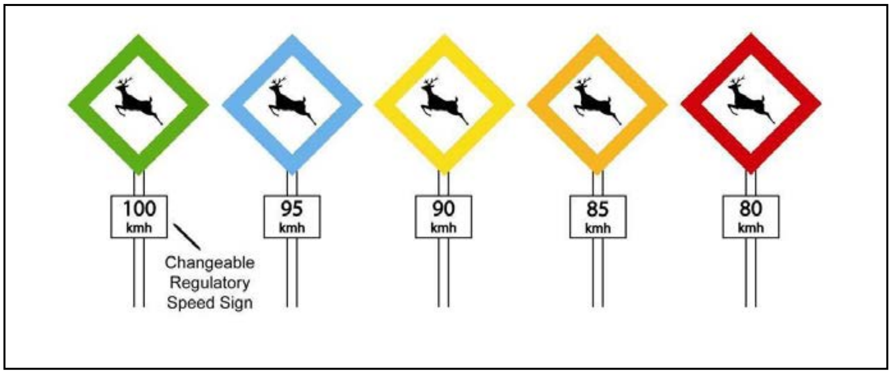

Figure 4. WildHAZ® system with changeable regulatory speed signs (Sielcki 2017).

Sign innovations incorporating new and more realistic animal silhouettes (Figure 5), cow-calf moose sign symbols (Figure 6), updated colours (fluorescent orange or chartreuse), and increased reflectivity into the existing wildlife warning sign designs in the MOTI Catalogue of Standard Traffic Signs may be more likely to meet MOTI approval. Other non-traditional signage such as wildlife-silhouette shaped signs (Figure 7: Highway 16) or LED-enhanced wildlife warning signage (Figure 8; Highway 16 and Figure 9; Highway) may be suitable for use in these sites.

Figure 5. Example of a more realistic moose silhouette that could be used to update traditional moose wildlife warning signs (Depositphoto.com).

Figure 6. Example of a sign showing a cow/calf pair image that could be added to the existing MOTI Catalogue of Standard Traffic Signs (M. Sullivan).

Figure 7. Moose silhouette sign located near Wansa Creek, Highway 16 east of Prince George (RV Rea).

Figure 8. LED-enhanced moose collision warning sign, located near Tabor Mountain, Highway 16 east of Prince George (RV Rea).

Figure 9. LED-enhanced deer collision warning sign, located on Highway 97 north of 100 Mile House (G. Hesse).

Night-time driving speeds

Because research clearly shows that slower speeds (i.e., less than 70km/hr), especially at night reduce the likelihood of WVC (Rodgers and Robbins 2006), we recommended including night-time driving speed tabs of 70km per hour on signs posted in hotspots.

Brush cutting

Our field analysis of the roadside vegetation complexes at the identified hotspots, including species (e.g., willow, dogwood, birch, etc.) important as forage for browsers, indicate that the vegetation growing in some hotspots (HSs-8, 9, 3, 12, 14, 15, 16) may be attractive to browsers and may also create sightline impairments. Because the numbers of ungulate WVCS have their highest peaks in fall and winter (Sielecki 2010), we recommend regular brush cutting in those sites, specifically in mid-summer months, when cutting can result in browse species producing less attractive/palatable fall and winter foliage and shoots (Rea et al. 2007).

Mineral lick deactivation

One site (HS-15) contains a roadside mineral lick, which was previously identified by Rea (2008) and confirmed by site visits from Newby, Hesse, Rea, and Long (2015 unpublished data). Roadside mineral licks result in increased numbers of visits to the roadside by ungulates, particularly moose, thus increasing the risk of WVCs. Deactivating roadside mineral licks can reduce the number of roadside visits by moose (Rea and Rea 2005, LeBlond et al. 2007). The mineral lick located within HS-15 sits in a flat and grassy right-of-way, making it easily accessible for decommissioning. Based on the results of previous lick deactivation treatments in MOTI's Fort George District, the application of reject rock over the lick site, paying particular attention to achieving no perimeter mineral soil disturbance, is recommended.

Summary/Conclusions

Using WARS data from between 2010 and 2014, we found 17 WVC collision hotspots (six moose, five deer, three elk, one bear, and two multi-species hotspots) in the Peace Break Region. We identified each hotspot by highway number, segment number and nearest landmark (using MOTI's LKI system), and assessed various field characteristics at each site.

During our field work, we discovered that only one of the hotspots (moose HS-13) had appropriate WVC warning signage. Therefore, we have recommended the installation of species-specific warning signs at each hotspot and wildlife corridor signage for the stretches of road on which hotspots exist. Additionally, we recommend the removal of signage in areas where WARS data no longer supports evidence of frequent WVCs and therefore associated sign retention.

Importantly, our results suggest that signs installed in the late 2000s, in response to the recommendations of Rea (2008), no longer appear to be associated with hotspots identified with 2010-2014 WARS data (with the exception of moose HS-13). This may be a result of signage effectiveness (i.e., drivers are paying attention to signs) or of a change in conditions leading to WVCs (e.g. declines in moose population or increasing human development). Therefore, due to landscape-level changes caused by increasing agricultural and industrial development in the Peace Break (particularly development associated with the construction of the Site C Dam site), a review of WARS data and wildlife warning signage placement should be undertaken on a regular basis (Rea 2008), perhaps every five years.

We have recommended brush cutting in sites identified as having roadside forage species which provide attractive browse for ungulates and where such vegetation may impact driver sight lines. We also recommended mineral lick decommissioning in one site containing a roadside mineral lick.

Mitigation methods such as wildlife fencing and associated grade separations (underpasses and overpasses) have been shown to reduce the numbers of WVCs by >80% (Clevenger and Huijser 2011). These measures are extremely costly and typically only applied in very specific situations after extensive site and landscape-level research, traffic pattern and cost analyses which wereoutside the scope of this project. Therefore, we did not make any recommendations that included fencing or grade separation.

The recommendations we provide will help motorists identify highway locations where the likelihood of WVCs is increased above background levels in the Peace Break. Signage can influence driver behaviour and recommended brush cutting and mineral lick decommissioning may alter animal behaviours in a way that reduces their use of roadside habitats. Together, implementation of these mitigation measures may help reduce WVCs and the subsequent wildlife mortality.

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References

Apps, C. 2014. Assessing Cumulative Impacts to Wide-Ranging Species Across the Peace Break Region of Northeastern British Columbia Summary Report. Prepared for Yellowstone to Yukon Conservation Initiative, Canmore, Alberta. 20 pp.

BC Ministry of Transportation and Infrastructure. 2014a. Rural highway safety and speed review. BC Ministry of Transportation and Infrastructure. Victoria, BC, Canada. 58 pp.

BC Ministry of Transportation and Infrastructure. 2014b. Installation guidelines for wildlife warning signs. Technical Circular T-07/04. BC MOTI, Victoria, BC. 3 pp.

British Columbia Ministry of Transportation and Infrastructure. 2015. Landmark Kilometre Inventory. July 2015 Version (201507). 595p.

Clevenger, A.P., and M.P. Huijser. 2011. Wildlife Crossing Structure Handbook Design and Evaluation in North America. Publication No. FHWA-CFL/TD-11-03. US Department of Transportation Federal Highway Administration. Lakewood, Colorado, USA.

ESRI 2011. ArcGIS Desktop: Release 10. Redlands, CA: Environmental Systems Research Institute.

Hesse, G. and R. V. Rea. 2016. Quantifying wildlife vehicle collision underreporting on northern British Columbia highways (2004 to 2013). Unpublished report prepared for the Ministry of Transportation and Infrastructure. Prince George BC. 60 pp.

Leblond, M., C. Dussault, J.P. Ouellet, M. Poulin, R. Courtois, J. Fortin. 2007. Management of roadside salt pools to reduce moose-vehicle collisions. Journal of Wildlife Management. 71:2304-2310.

Martens, C. 2017. Identification of Wildlife-Vehicle Collision Hotspots in Northern BC. Undergraduate thesis, University of Northern BC. 59p.

O'Keefe, S., and R.V. Rea. 2012. Evaluating ICBC animal-vehicle crash statistics (2006-2010) for purposes of collision mitigation in northern British Columbia. Unpublished report prepared for the Insurance Corporation of British Columbia. 94 pp.

Preston, M.I., Halverson, L., and Hesse, G. 2006. Mitigation efforts to reduce mammal mortality on roadways in Kootenay National Park, British Columbia. Wildlife Afield 3(1):28-38.

Rea, R.V. 2006. Elucidating temporal and species-specific distinctions in patterns of animal-vehicular collisions in various communities and regions of northern British Columbia. In: Road Health-University Wildlife Collision Working Group Team: using collision data, GPS technology and expert opinion to develop strategic countermeasure recommendations for reducing animal–vehicle collisions in northern British Columbia. A report of the Wildlife Collision Working Group. p. 5-25, 54-123.

Rea, R. V. 2008. A site-specific operational plan for reducing moose-vehicle collisions in Northern British Columbia. Unpublished report. Prince George, BC. 8p.

Rea, R.V. and R.V. Rea Sr. 2005. Of moose and mud. Public Roads 69:32-39. US Department of Transportation Federal Highway Administration, Washington DC.

Rea, R.V., K.N. Child, D.P. Spata, and D. MacDonald. 2007. Influence of cutting time on brush response: Implications for herbivory in linear (transportation) corridors. Environmental Management 40:219-230.

Rodgers, A.R. and P.J. Robins. 2006. Moose detection distances on highways at night. Alces 42:75-87.

Sielecki, L.E. 2010. WARS 1988-2007: Wildlife accident reporting and mitigation in British Columbia: Special annual report. Environmental Management Section, Engineering Branch, British Columbia Ministry of Transportation and Infrastructure. Victoria, BC, Canada.

Sielecki, L.E. 2017. The Deer-Vehicle Collision Phenomena in the United States. PhD Dissertation, University of Victoria, 374 pp.

Snow, N.P., Porter, W.F., and Williams, D.M. 2015. Underreporting of wildlife-vehicle collision does not hinder predictive models for large ungulates. Biological Conservation 181:44-53.

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NATURE

PREVENTING WILDLIFE VEHICLE COLLISIONS

A research partnership in northern B.C. is studying collision hotspots and looking for ways to make our highways safer for both drivers and wildlife

BY TIM BURKHART

AROUND THE WORLD people are expanding efforts to help wildlife cross the road, making highways safer for motorists and animals alike. In northern B.C., a working landscape with vast tracts of wild habitat, highways cut through important wildlife corridors, with sometimes-fatal results. B.C. sees an average of three human fatalities from wildlife collisions per year, with two of those deaths—and 160 injuries—on northern roads. Road-kills of wildlife, including large predators and ungulates, can be highly significant ecologically, especially for threatened species like caribou. Costs to society associated with collisions, from injury and vehicle damage to lost hunting revenues, average $6,617 per deer, up to $30,760 for moose.

The reality is that most of these costs can be prevented. A research partnership in northern B.C., comprising researchers from University of Northern B.C., Yellowstone to Yukon, and the B.C. Conservation Foundation, with support from the Fish and Wildlife Compensation Program (FWCP), is studying collision hotspots—stretches of road with a high occurrence of collisions over a recent five-year period with bear, moose, deer and elk—on northern highways, with the goal of prevention. Attractants for wildlife, such as road-side mineral licks, clover and other browse, or corridors linking important habitat on either side of a highway can be identified and mitigated with help from the Ministry of Transportation and Infrastructure and highway contractors. Fencing and crossing structures ranging from small culverts beneath a highway to major overpasses can work to significantly reduce collisions; in Banff, mitigation measures including the iconic forested overpasses have resulted in more than an 80 percent reduction in all wildlife being struck on the highway.

Warning and educating drivers is another important part of reducing collisions. The FWCP study made clear that all but one of the hotspots identified on Highways 97 and 29 in the Peace Region are without any appropriate wildlife warning signage. "Right now motorists enter these sites without any warning that it's a hotspot," says Dr. Roy Rea of UNBC. "Sign placement should reflect current data trends."

The winter months are highest risk for collisions with wildlife; November and December for deer and November, December and January for moose. At any time of the year, motorists should remember to Drive Wildlife Aware. Gayle Hesse, provincial coordinator for the Wildlife Collision Prevention Program with the B.C. Conservation Foundation, advises travellers to "Slow down; drive expecting to see wildlife on the roads; and remember that if one animal is seen there are likely others following along behind, so look out for them all!"