TAC 2017 Environmental Achievement Award Submission

Wildlife Detection Systems, Highway 3, British Columbia
Real-time warning systems for protecting wildlife and drivers

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Outline

Highway 3 is the most southern trans-provincial highway in British Columbia. It is a key national transportation link for trade, industry and tourism between the Pacific Ocean and the rest of Canada. Along the western slopes of the Rocky Mountains, Highway 3 transects critical wildlife habitat corridors that run between Canada and the United States (Figure 1). Many iconic North American ungulates and carnivores use these corridors to survive. Traffic on Highway 3 represents a serious impediment to the safe movement across the highway for many species of wildlife. Concurrently, the larger wildlife represent a significant potential hazard for drivers (Figure 2).

As part of the 2015 Rural Highway Safety and Speed Review conducted by the British Columbia Ministry of Transportation and Infrastructure (BCMoTI), the Highway 3 corridor, between Cranbrook and the Alberta border, was identified as having one of the highest densities of wildlife-vehicle collisions in the province. Presently, the mountainous terrain and extensively fragmented land tenure preclude the construction of wildlife exclusion systems along this corridor. To test alternative technological solutions, to protect both wildlife and drivers, BCMoTI developed specifications for a wildlife detection system (WDS) (Figures 3 and 4) and installed two systems on Highway 3, one near Elko and the other near Sparwood (Figure 5). Despite numerous technological, environmental and operational challenges, the project was delivered on budget and on time. Since going live in 2016, the systems have proven to reduce wildlife-vehicle collisions while maintaining critical wildlife habitat connectivity.

Degree of Innovation

The WDS is the first successful implementation of combined radar and thermal camera technology for wildlife detection on highways in Canada. In the past, other jurisdiction have tried various technologies with limited or no success. To accomplish this success, BCMoTI assembled a unique multi-disciplinary team of traffic safety engineers, wildlife specialists, and industry software and hardware experts to develop and implement the wildlife detection system (WDS). In addition to staff from BCMoTI's Headquarters Engineering and Environmental Management Branches, its Kootenay District Office, and its Regional Traffic Management Centre, the team included staff from PBX Engineering, FLIR 360 Surveillance, and WestCana Electric. The team's wide-ranging combination of skills, knowledge and experience proved invaluable for the success of the project.

State-of-the-art radar and infrared technology camera developed for airport and facility security was integrated with advanced image detection software and messaging systems to provide drivers with real-time warnings of wildlife near and on roadways (Figures 6, 7 and 8). The system alerts approaching drivers by activating warning signs that stay on for the duration that the wildlife is within defined detection zones.

The development team overcame the challenges of remote wildlife-vehicle collision-prone locations where power and communications infrastructure was severely limited. Through a cell modem and wireless local area network (LAN), the systems are remotely monitored and managed by BCMoTI's staff.

The WDS was required to deal effectively with a wide range of conditions, including;

- Wildlife ranging in size from wolves to moose
- Movements by individual and groups of animals
- Animals that remain stationary while grazing or sleeping on rights-of-way
- Cars, trucks, motorcycles, cyclists, horseback riders and pedestrians
- Extreme and inclement weather and environmental conditions ranging from snowfall and rain, to fog and smoke, and temperatures ranging from -30C to +40C.

During system development, testing was required to quantify the accuracy of the WDS, including:

- False Positives: invalid events that trigger system operation
- False Negatives: events that should have triggered system operation
- False Alarm Rate: the total rate of invalid (false positive) events relative to the total quantity of events
- Detection Rate: the total quantity of detection events relative to the total quantity of false negative events
- Downtime: the amount of time where the system is unavailable for normal operation

To date the WDS has been found to be approximately 97% accurate.

Contribution Made to the Protection and Enhancement of the Environment

The wildlife detection systems (WDS) were installed on two wildlife-vehicle collision prone corridors on Highway 3:

1. Elko, east of the Highway No. 3 and Highway No. 93 junction, and
2. Michel, east of the Town of Sparwood.

The Elko installation covers 2.6 km of highway in an area frequented by large numbers of deer and Big Horn Sheep. Each day, approximately 3300 vehicles pass through the Elko corridor. The Michel installation covers 5.5 km of highway in an area frequented by large numbers of deer and elk. Approximately 2800 vehicles pass through the Michel corridor daily. According the BCMoTI Wildlife Accident Reporting System (WARS), both corridors collectively experience the highest rates of motor vehicle-related large ungulate mortality on British Columbia highways.

The wildlife detection systems have increased safety for both wildlife and drivers in the Elko and Michel corridors on Highway 3. The systems enable BCMoTI to monitor wildlife activity near and on highways in order to provide drivers with real-time warnings of potential wildlife hazards to reduce vehicle-related wildlife mortality. The systems' dynamic messaging increases driver awareness of wildlife and fosters more environmentally responsible driving behaviour that reduces the potential for wildlife-vehicle collisions and/or their severity (Figure 9). The 24/7 real-time infrared video footage collected by the systems provides traffic safety engineers and wildlife researchers a unique opportunity to view the wildlife-highway interface and obtain better understanding into how different species of wildlife interact with highways. Increased knowledge of the wildlife-highway interface fosters BCMoTI's ongoing efforts to develop more effective wildlife mitigation.

Unlike wildlife exclusion systems which focus wildlife movements to engineered structures constructed at specific locations along highway corridors, the WDS allows wildlife to move unimpeded along traditional migration routes between critical habitats. This eliminates disruptions to normal wildlife activity. The wildlife detection systems represent a viable and more environmentally dynamic alternative to wildlife exclusion systems that funnel wildlife to underpasses and overpasses. The systems can also provide safer wildlife passage across highways where topography and geology preclude the construction of wildlife exclusion systems. The system offers transportation departments the ability to provide safe crossings for species of wildlife, such as Grizzly Bears, which do not adapt well to wildlife overpasses and underpasses.

Since installation, the WDS system has detected, tracked and recorded hundreds of animals near to or crossing Highway 3, including:

- Herds of elk in the Michel area
- Residents sheep herds in the Elko area
- Numerous deer
- Cougar, bear, wolverine, coyote and other small animals

The number and species of wildlife detected along the Elko and Michel corridors at the WDS locations is far greater than originally anticipated by BCMoTI.

In 2015, the WDS systems were installed at the Elko and Michel sites and subjected to extensive software and hardware testing prior to going live. The WDS has proven effective in modifying driver behaviour so that potential wildlife-vehicle collisions and their severity can be reduced. When the wildlife warning signs are flashing, vehicle speeds in the Elko and Michel corridors are lower (Table 1). The average vehicle speed reductions range from 4.0 km/h to 8.3 km/h. Typically, lower vehicle speeds are associated with shorter stopping distances and reduced vehicle collision severity. The greater vehicle speed reduction on the Elko corridor may be responsible for the significantly greater success of the WDS system in reducing wildlife-vehicle collisions at this location

Table 1. Vehicle speed reductions due to WDS

Average Vehicle Speed (km/h) (24 Hour Period)	Elko WDS	Michel WDS
When wildlife warning signs are not flashing	89.9	86.4
When wildlife warning signs are flashing	81.6	82.4
Reduction due to WDS	8.3	4.0

Given the high levels of wildlife activity along the Elko and Michel corridors, the WDS flashing wildlife warning signs are activated for approximately 7.5 hours a day at each location. The number of deer, Big Horn sheep, elk and bear-vehicle collisions at the Elko site dropped from an annual average of 15.1, for the period 2004 to 2013, to 4 in 2016, after the WDS was operating for a full year. The number of deer and elk-vehicle collisions at the Michel site dropped from an annual average of 19, for the period 2004 to 2013, to 15 in 2016. These early results are promising. Longer term studies are needed on how the influence of the WDS systems on driver behaviour and vehicle speeds can be increased.

Financial Implications

In British Columbia, wildlife-vehicle collision clean-up and mitigation, vehicle damage, and human fatalities and injuries cost the provincial government, the motoring public and automobile insurance providers over $35 million annually. When factoring the cost of wildlife overpasses, which can be upwards of $12 million each, conventional wildlife exclusion systems can cost in the order of $500,000 to $800,000 per kilometre to construct.

The two WDS systems cost a total of $2.5 million to develop and install. It is estimated constructing two equivalent conventional wildlife exclusion systems with wildlife overpasses would have cost upwards of $3.4 million in materials and labour alone. The land tenure along the Elko and Michel corridors is complex due to industrial operations and railways. Consequently, the cost of purchasing private lands and securing easements necessary for the construction of conventional wildlife exclusion, would have been prohibitive for BCMoTI. Even without the additional cost of the land and easements necessary for the conventional wildlife exclusion systems, the WDS systems represent a cost savings of 26.7%.

The human cost of wildlife-vehicle collisions can be considerable. Each wildlife-vehicle collision-related human fatality the WDS systems prevent represents a significant savings to society. Collisions with large species of wildlife frequently occur in remote locations where medical and ambulance services are severely limited or non-existent. The potential for drivers and/or passengers to sustain permanent crippling injuries or die as a result of serious wildlife-vehicle collision-related injuries increases the longer critical medical treatment is delayed. Consequently, provincial governments bear significant health care costs arising from wildlife-vehicle collisions. Reducing the potential for wildlife-vehicle

collisions reduces the potential for human deaths and injuries, and provincial health care costs.

In Canada, wildlife represent a significant source of traditional food for many First Nations peoples. Concurrently, large numbers of people in rural areas also depend on hunting as a source of food. By serving foreign and other non-local hunters, guide outfitters create employment and generate income in rural areas. By reducing the potential for wildlife mortality due to wildlife-vehicle collisions, the WDS can help those who rely on wildlife for food and employment. From a greater national and global ecological perspective, where the extinction of endangered or threatened species (i.e. Wood Bison, Peary Caribou, and Woodland Caribou), can be prevented, the value of the WDS to both society and the global ecosystem is immeasurable.

Overall Applicability to Transportation

The WDS is the first successful implementation of radar and thermal camera technology for wildlife detection on highways by a Canadian department of transportation. The WDS developed by BCMoTI provides a proven, cost-effective approach for reducing wildlife-vehicle collisions. The WDS uses ground surveillance radar, thermal (infrared) cameras and video analytic technologies to consistently and accurately detect wildlife near or on highways. The detection system is integrated with digital message signs (DMS) to provide real time advanced warning to drivers. The technology and expertise for implementing the WDS is available to any department of transportation. The WDS developed by BCMoTI can easily be integrated into the traffic safety infrastructure of other provinces and territories to reduce vehicle-related wildlife mortality on roads and highways while protecting drivers. The WDS offers Canadian departments of transportation a cost-effective option to wildlife exclusion systems for protecting wildlife while providing unhindered access across roads and highways to critical habitats.

By providing real-time information about potential wildlife hazards, the WDS helps drivers make informed decisions about their driving behaviour. This is especially important for vulnerable non-local drivers who may be unaware of the potential for encountering wildlife when driving in an unfamiliar area. Drivers who heed the WDS messages and reduce their vehicle speeds help reduce their potential for wildlife-vehicle collisions and the potential severity of collisions if they occur.

Conclusion

The WDS has proven to be an effective application of radar and infrared technologies for reducing wildlife collisions on Highway 3 in southeastern British Columbia. The technical and operational challenges commonly faced by departments of transportation in Canada were overcome to produce a system that is extremely effective in detecting wildlife and warning drivers in real-time. The WDS offers departments of transportation a potential alternative to wildlife exclusion systems in locations where, topography, geology, land tenure and land uses preclude the cost-effective use of wildlife exclusion systems.

APPENDIX

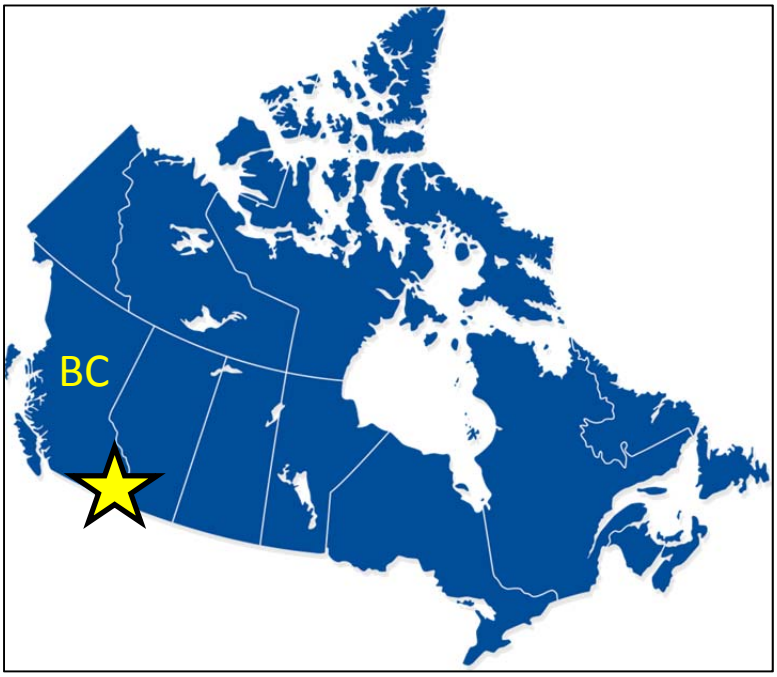

Figure 1. Location of project in British Columbia

Figure 2. Wildlife hazard for drivers on Highway 3 in eastern British Columbia

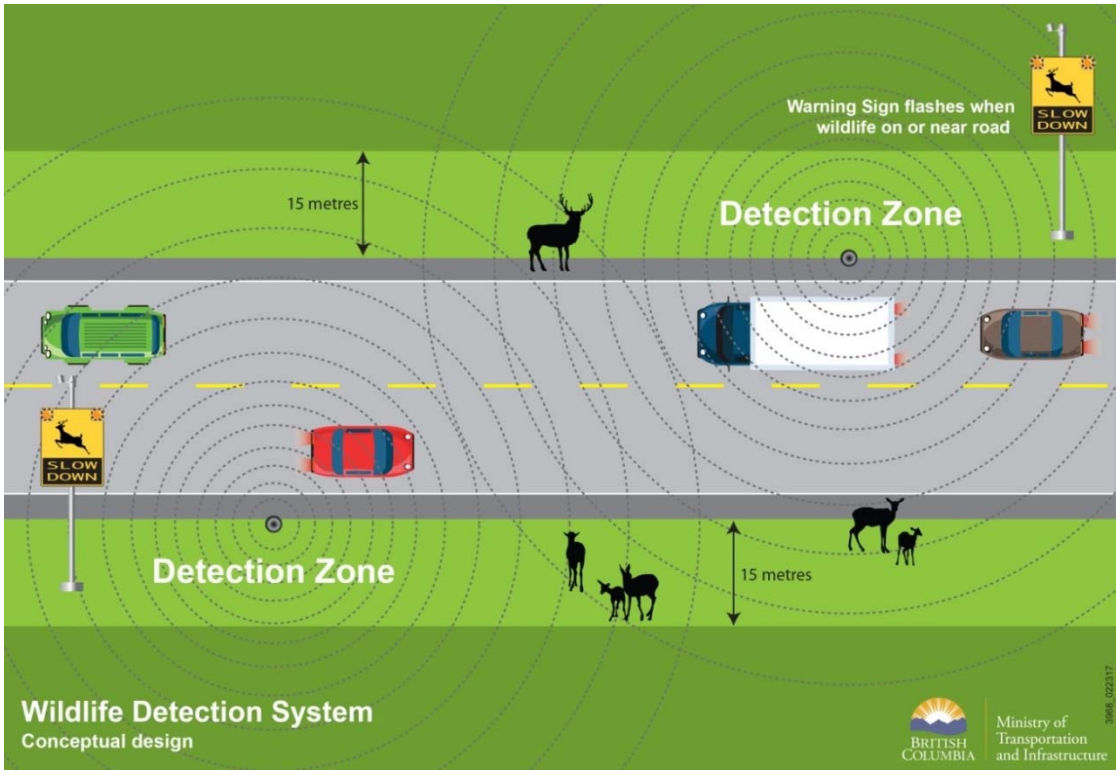

Figure 3. Wildlife detection system concept

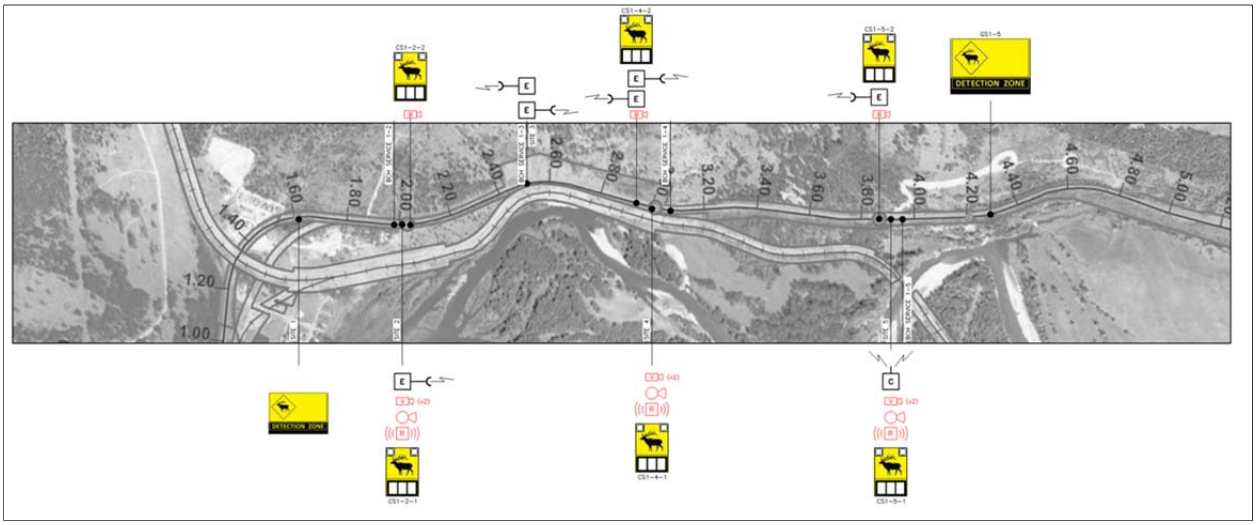

Figure 4. Wildlife detection system and warning sign specifications

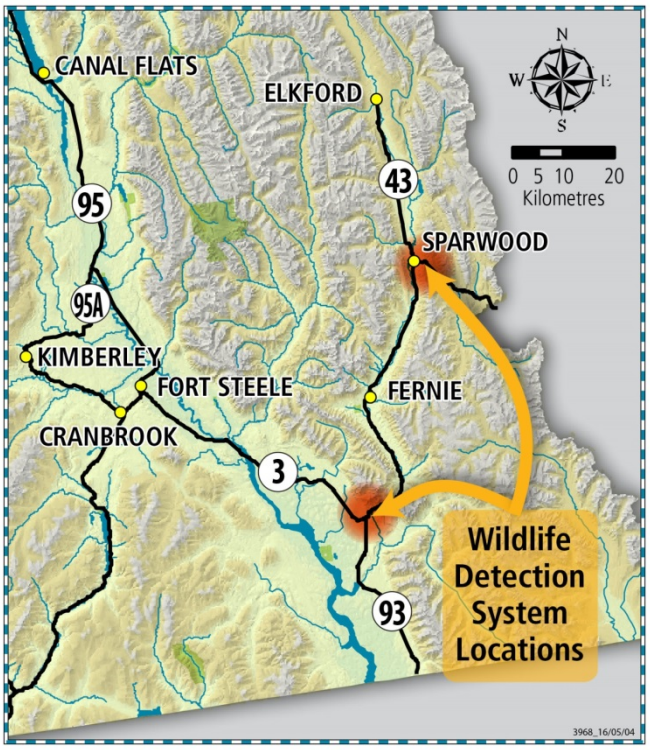

Figure 5. Locations of wildlife detection systems on Highway 3 in British Columbia

Figure 6. Installing wildlife detection system and warning signs at Michel site

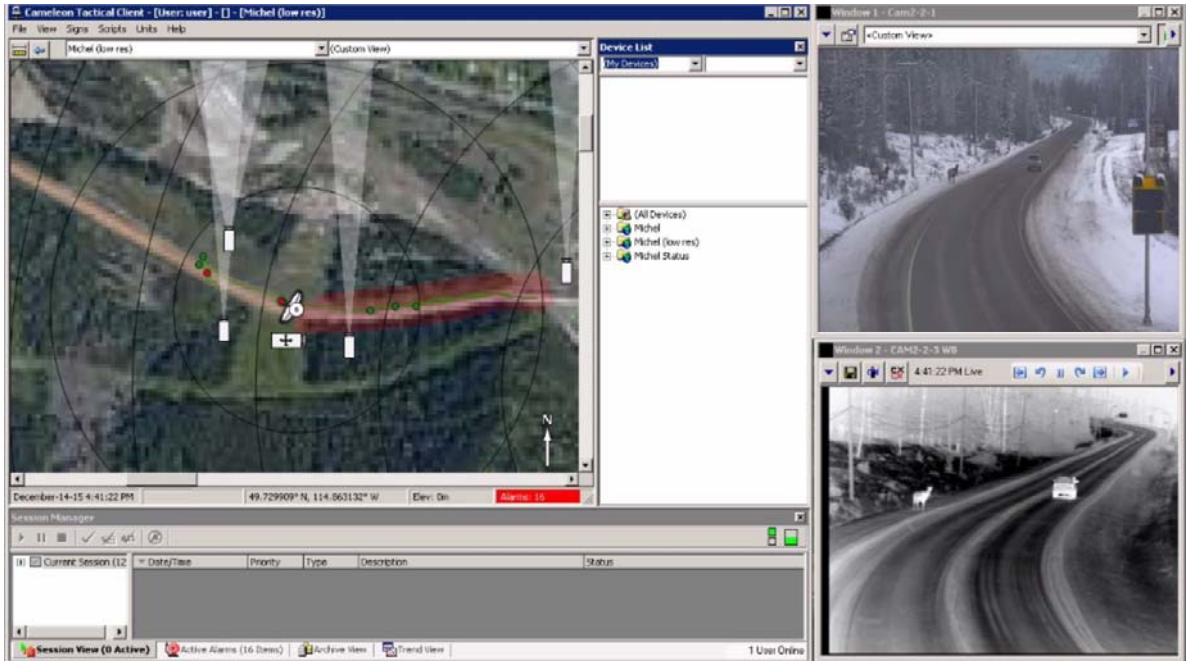

Figure 7. Wildlife detection system software interface

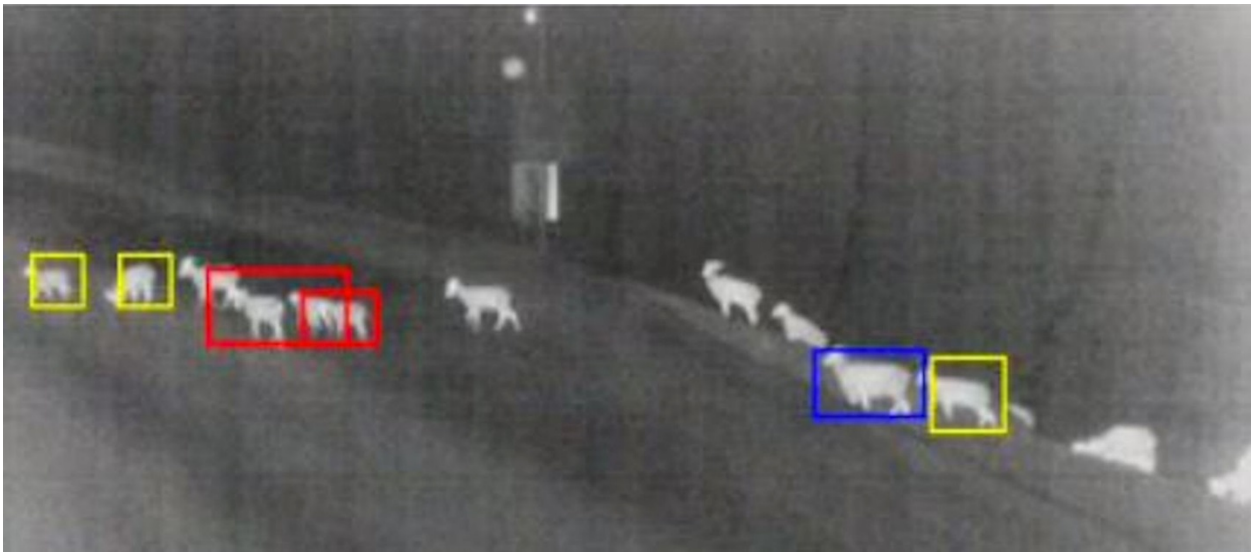

Figure 8. Tracking Big Horn sheep by wildlife detection system software

Figure 9. Successful detection of deer and driver notification by wildlife detection system