Mitigation efforts to reduce mammal mortality on roadways in Kootenay National Park, British Columbia

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Introduction

Of the more than 500 regularly occurring birds, mammals, reptiles, and amphibians in British Columbia, it is with little doubt that a large number of those species have been hit and killed by vehicles. But not surprisingly, only about 11 species cause significant property damage or human injury as a result of collision. These 11 species are all mammals, and include Cougar (*Puma concolor*), Black Bear (*Ursus americanus*), Grizzly Bear (*Ursus arctos*), Mountain Goat (*Oreamnos americanus*), Bighorn Sheep (*Ovis canadensis*), Thinhorn Sheep (*Ovis dalli*), Moose (*Alces alces*), Mule Deer (*Odocoileus hemionus*), White-tailed Deer (*Odocoileus virginianus*), Caribou (*Rangifer tarandus*), and Elk (*Cervus canadensis*). Of these, Moose and deer are the most commonly reported, owing in large part to their abundance and preference for foraging along roadways.

Vehicle collisions with deer and other large mammals have well-known social, economic, and ecological impacts. In the United States over 4,000 collisions with deer occur every day, and in 1993 there was over 1.5 million deer crashes resulting in nearly 14,000 human injuries and US $1.1 billion of vehicle damage (Durbin 2004). In British Columbia, Hesse (this issue, pgs. 3-7) summarizes the social, economic, and ecological costs related to vehicle collisions with large mammals.

In this paper we summarize species and numbers of large mammals killed by vehicles on Highway 93 in Kootenay National Park (KNP) from 1951 to 2005, and numbers of Bighorn Sheep killed by vehicles on Mile Hill adjacent to KNP from 1997 to 2005. We also summarize a variety of preventative measures that have been used to mitigate for wildlife collisions and discuss the pros and cons of each type.

Study Area and Methods

Kootenay National Park occupies an area of the Rocky Mountains in southeastern British Columbia (Figure 1). It is bound by the British Columbia-Alberta border on the east, and reaches its southern limit just south of Radium Hot Springs on the east side of Highway 95. Within KNP, the area of interest in this paper includes only Highway 93, which measures approximately 92 km and runs roughly through the middle of the park. Mortality records of Bighorn Sheep on Mile Hill (the hill leading south out of Radium Hot Springs and adjacent to KNP) are tabulated from data provided by Parks Canada wildlife biologist Alan Dibb.

To summarize the numbers of mammals hit by vehicles, we reviewed all mortality records that were stored in a Parks Canada wildlife database. We assumed that from 1979 onwards, reporting of large mammals was fairly reliable from year to year, but we have made no attempt to relate the number of vehicle-induced wildlife collisions to any specific factors. Such analyses are ongoing.

A number of mitigation measures are available

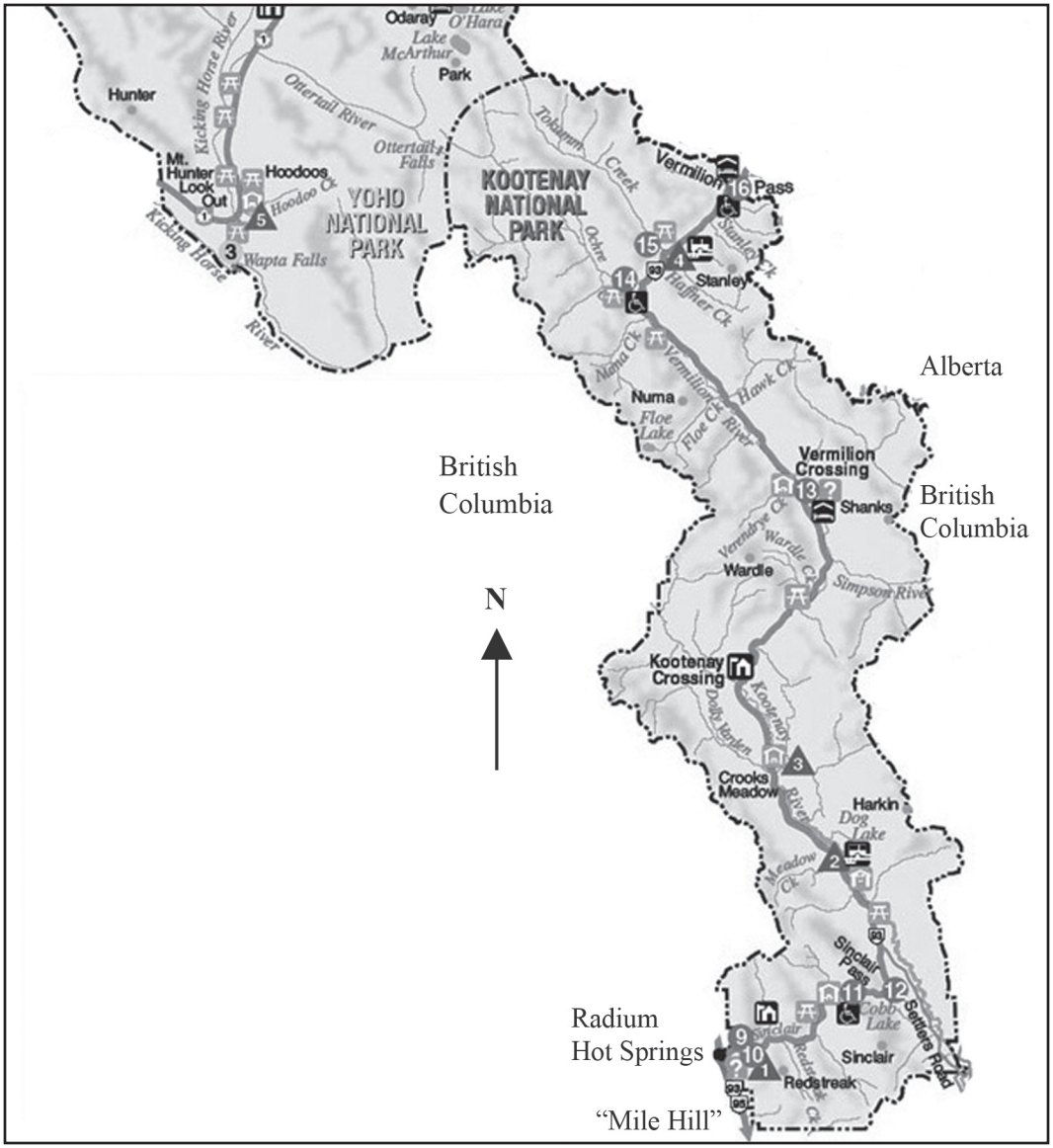

Figure 1. Map of Kootenay National Park showing major locations discussed in this paper, including "Mile Hill" located on Highway 93/95 heading south out of Radium Hot Springs. Map provided by Parks Canada.

to help reduce animal mortality on roads. Here, we provide an overview of four types, some of which have been used in KNP, and others which have been used in adjacent Banff National Park (BNP), Alberta. We attempt to provide an assessment of effectiveness for each mitigation type based on tested applications, as well as on perceived outcomes from other mitigative efforts (as determined by numbers of mortalities, animal behaviour, and human behaviour).

Results and Discussion

Summary of Mammal Mortality

A total of 1,337 mammals representing 17 species were reported dead as a result of vehicle collisions between 1951 and 2005. Between 1951 and 1973, vehicle collisions with Elk, Mule Deer, and White-tailed Deer were either sporadic, or poorly documented, compared to post-1973 when each of these species was reported in every year (except Mule Deer which was not reported in 2001 and 2004). Between 1970 and 2005, in decreasing order of abundance, there were 480 White-tailed Deer, 322 Elk (Figure 2), 146 Mule Deer, 93 Moose, 78 Bighorn Sheep, and 2 Mountain Goats killed by vehicles in KNP. As shown in Figure 3, numbers fluctuated substantially among years for these mammals.

Figure 2. A bull Elk foraging along the roadside in Kootenay National Park, BC. 10 August 2006 (R. Wayne Campbell).

From 1951 to 2005 there were 49 vehicle collisions

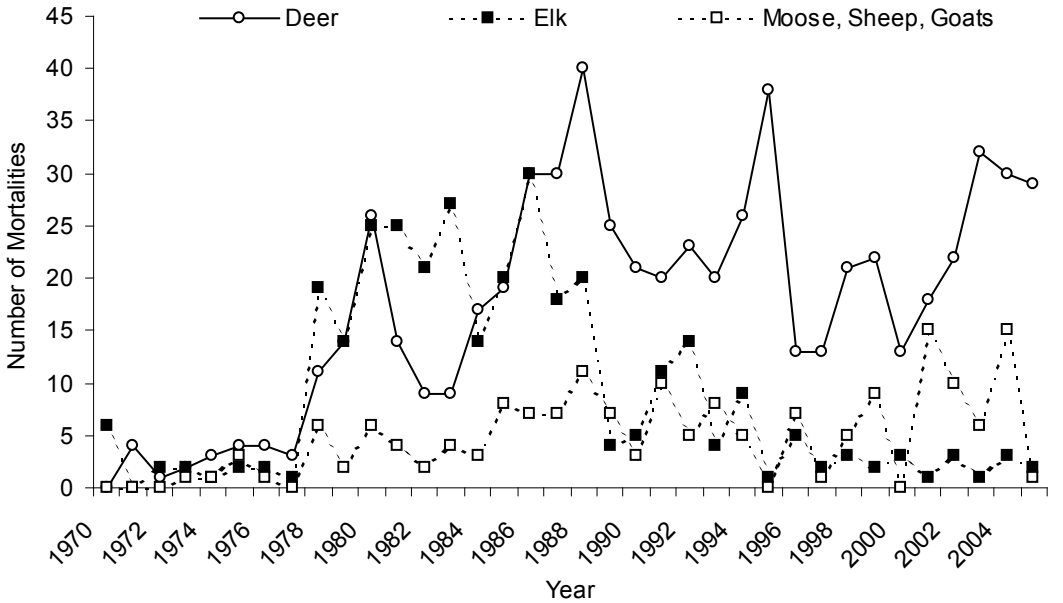

Figure 3. Summary of annual mortality rates for Mule Deer, White-tailed Deer, Elk, Moose, Bighorn Sheep, and Mountain Goat in Kootenay National Park from 1970 to 2005. Data provided by Parks Canada.

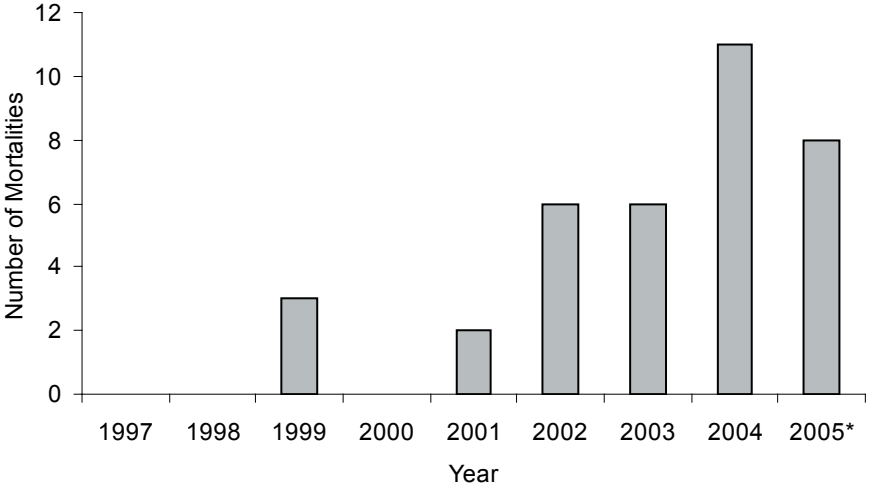

Figure 4. Numbers of Bighorn Sheep killed on Mile Hill adjacent to Kootenay National Park. Data provided by Alan Dibb, Parks Canada. *Data for 2005 is current only to July.

with Black Bear and one collision with Grizzly Bear in 1999. In the cat family, there were three collisions involving Canada Lynx (*Lynx canadensis*), one involving Bobcat (*Lynx rufus*), and three involving Cougar. In the canid family, there were 73 collisions with Coyote (*Canis latrans*) and 13 collisions with Gray Wolf (*Canus lupus*). Of 32 North American Porcupines (*Erethizon dorsatum*) killed in KNP, 27 were killed between 1980 and 1990, compared with three between 1991 and 2005. Among the mustelids, the American Marten (*Martes americana*) was the most frequently reported species with 18 records of vehicle-induced mortality, while the largest species in this family, the Wolverine (*Gulo gulo*), was reported only once in 1990. It is believed that for the smaller mammals, including the North American Porcupine and mustelids, infrequent reporting is responsible for inaccurate counts of these species (Shelagh Wrazej pers. comm.).

Printed Matter and Public Awareness

Efforts to reduce mortality using printed matter (*e.g.,* brochures, decals, newspaper advertisements) and public awareness (*e.g.,* television, radio, information kiosks) have had varying degrees of effectiveness. In response to the high incidence of Bighorn Sheep killed on Mile Hill from 1997 to

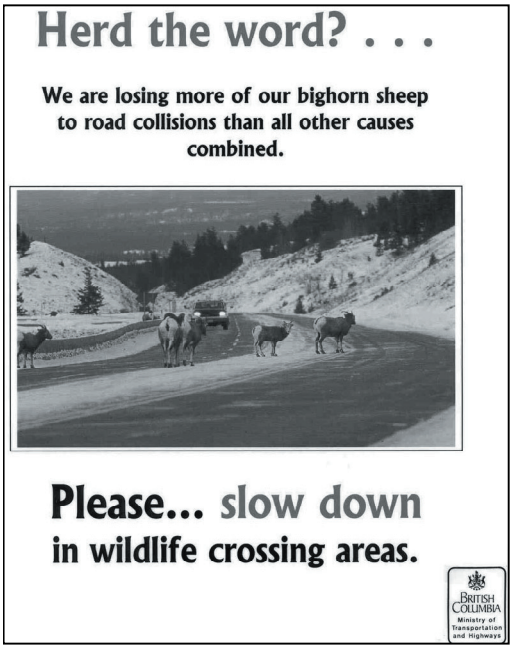

Figure 5. One of the posters used during a *Highway Wildlife Mortality Awareness* event on Mile Hill in an effort to reduce collisions with Bighorn Sheep.

2005 (Figure 4), the BC Ministry of Water, Land, and Air Protection commissioned a study to determine what could be done to lessen collisions. As part of that study, a *Highway Wildlife Mortality Awareness* event was held in April 2005 (Figure 5). It included a census of 235 drivers and passengers that were asked whether they would support a reduction in the posted speed limit along the Mile Hill "kill zone". Only 44 (18.8%) supported the idea. The event also incorporated a highway mortality flagging display, which included hundreds of flags each placed at the location of a mortality incident (one flag = one dead animal). Organizers agreed that the flagging exercise did cause drivers on average to reduce their speed, but only to the posted limit of 90 km/h limit (apparently most drivers exceed the speed limit traveling down the hill).

In 1989, KNP established the Wildlife Memorial Week and used notices in local newspapers (*e.g.,* Valley Echo, 9 August 1989) to raise awareness. In 1990, KNP published an awareness notice in *PICA*, the journal of the Calgary Field Naturalists Society, to raise awareness among visitors and commuters. Another newspaper article, appearing in the Valley Echo on 29 June 1992, corresponded to the public that KNP and local trucking company representatives are working together to help reduce wildlife vehicle collisions. The group, known as the Kootenay Parkway Standing Committee, has worked to increase communication among truckers as to the whereabouts of wildlife, reduced road use during peak activity times for wildlife, raise awareness via Parks Canada training for truckers at safety meetings.

Road Signs and Reflectors

Throughout North America, numerous types of road signs have been developed over the years by various transportation departments, conservation groups, insurance companies, and park managers in an effort to reduce vehicle collisions with wildlife. While there are too many to describe here in detail, we summarize some local designs and assess their general effectiveness.

On Mile Hill, with the support of the Ministry of Environment, the Wildlife Collision Protection Program erected a large 10 x 20 ft black and yellow billboard to notify drivers that Bighorn Sheep are on the road, and that they occur very near the smaller, diamond-shaped sheep signs that are inset on the billboard (Figure 6). Within KNP, similar diamond-shaped yellow signs with black images of "deer jumping from roadsides", and the near life-size cutouts of Elk with attached eye reflectors and an "*attention*" warning message (Figure 7), are used at key areas for these species along Highway 93. Occasionally, some of the smaller signs are decorated with high-visibility orange reflectors or flags. The long-term use of these signs can result in driver complacency, but changing the size, color, or decoration (*e.g.,* adding flags or reflectors) can aid in reducing this problem. The use of temporary signs also appears effective at reducing collisions, when animals such as sheep and wolves are only in an area for a short time.

Figure 6. Bighorn Sheep billboard on the east side of Highway 93/95 above Mile Hill on the Shuswap Reserve near Invermere, BC. Autumn 2005 (Bill Swan, Osprey Communications).

In 2003, KNP was involved in a *Drive for Wildlife* program that included all of the mountain national parks in southern British Columbia and Alberta. Various roadside signs, gas station posters, and vehicle bumper stickers were used to spearhead the program. The signage most visible to drivers was the 70 km/h speed caution signs surrounded by vivid black and orange flares and topped with a photograph

Figure 7. Cutout Elk signs with reflective eyes and an "attention" warning were erected in 1986 at Settlers Road and Wardle Flats to warn drivers of key crossing areas. Kootenay National Park, BC. 10 August 2006 (Larry Halverson).

of the species most at risk of collision with vehicles (Figure 8). The intended purpose of the photo was to communicate why the speed is being reduced, and also to give drivers a connection with the species.

In addition to reflectors being used on animal signs as a warning mechanism, Swareflex Wildlife Reflectors (SWR) are specifically designed for the purpose of creating "optical fences". The idea is that if the SWRs are placed along the edge of a roadway at consistent heights and at regular intervals, then vehicle headlights will reflect a beam of light that will deter deer from crossing. Hence, the SWRs are only effective at night. Poll (1989) suggested that a three to five year "presence-absence" technique using SWRs should be implemented in KNP, but cautioned that results may be inconclusive due to small sample size. Sheehan (1995) followed through with the recommendation in two key mortality areas (Crook's Meadow to Dolly Varden, and McLeod Meadows) from 1989 to 1993 and confirmed that although there was a reduction in the number of road mortalities, the results could not be statistically atributed to the SWRs alone. Such factors as time of collision (*i.e.,*

Figure 8. As part of the *Drive for Wildlife* program, these wildlife speed limit signs were used to increase driver awareness and identify species of concern.

day, night, dawn/dusk), which are at times difficult to obtain, and collisions that result in unreported mortalities (*e.g.,* a large truck hits an animal, receives no damage, and the animal wanders away to die elsewhere), greatly hindered the evaluation of SWR effectiveness (Sheehan 1995). Beaubier (1999) expanded the analysis in KNP to include data from a longer period (1989 to 1995), but also concluded that there was no significant reduction in Elk, deer and Moose road mortality as a result of SWRs.

In various locations throughout North America where SWRs have been extensively tested on reducing deer mortalities, there is a growing consensus that they do not work effectively. By in large, this appears to be a function of deer not being able to see light in the wavelengths produced by the reflectors, or of deer becoming habituated to the light (see Danielson and Hubbard 1998 and Curtis and Hedlund 2005 for a more complete review). Sheehan (1995) also notes that Elk and deer may cross roads in the presence of reflectors for more pressing reasons (*e.g.,* predation threat, sexual attraction of males to females during mating season, extreme weather, historical migration routes).

Underpasses, Overpasses, and Fences

The use of underpasses and overpasses to mitigate wildlife mortality was first introduced in the early 1970s, and has since become increasingly widespread throughout the world (Reed et al. 1975, Forman et al. 2003). In adjacent Banff National Park (BNP), wildlife underpasses are relatively common and widespread along Highway 1, occurring mostly at river and creek crossings. In that park in 1997, as part of a highway twinning project from the junction of Highway 1 and 1A to the junction of Highway 1 and 93 (~20 km), wildlife overpasses (see Preston this issue, pg. 12, Figure 7) were constructed both as a measure to further reduce wildlife vehicle collisions, but also to facilitate greater numbers of animal movements at key crossing locations.

Wildlife overpasses in BNP are used primarily by large mammals, although differences in crossing rate differ between carnivores and herbivores (Clevenger and Waltho 2000, Forman et al. 2003). Elk and deer appear to use underpasses and overpasses at much the same frequency, while Moose prefer overpasses and sheep prefer underpasses (Forman et al. 2003). Species such as Cougar and Gray Wolf appear to prefer underpasses, although overpasses are also used regularly by all large carnivores (Forman et al. 2003). Much of the effectiveness of the underpass/overpass system is in no doubt related to the animal-exclusion fence (2.4 m high) that parallels much of the highway, thus forcing animals that are inclined to cross, to use the structures. However, if animals become entrapped along the highway because of fences, the chances of escape are greatly diminished (Figure 9). Other factors such as the width and height of underpasses, line of vision for animals during crossing, and distance to human activity are other important factors (see Clevenger and Waltho 1999 and Forman et al. 2003 for further discussion).

Figure 9. Fences generally exclude animals from entering the roadway, but occasionally they become trapped in the narrow corridor and cannot escape because of fences. One-way gates are possible options to allow passage of animals from the roadside to the safe side. Highway 93/95 near Skookumchuk Prairie, Wasa, BC. 8 March 2003 (Larry Halverson).

There are presently no wildlife underpasses or overpasses in KNP. However, should the need for such structures arise, it is strongly recommended that prior assessments of key crossing areas be identified (Forman et al. 2003). Historical road mortality data can provide an important part of this assessment, as it will quickly identify those locations where animals

are regularly feeding or crossing, provided the data are collected systematically and reliably. Incidental observations of mammals foraging along roads, and of animals successfully crossing, are currently being recorded in KNPs wildlife databases. Such observations from other regions throughout British Columbia should also be recorded and stored in a permanent repository such as that housed by the Wildlife Data Centre of the Biodiversity Centre for Wildlife Studies. Ultimately, determining the functional success of passages for wildlife movement will be largely dependent on where the structures are located (Foster and Humphrey 1995, Clevenger and Waltho 1999).

Fences are used extensively along Highway 1 in BNP, but in KNP there are none. The primary purpose of fences is to exclude animals from roadways, although snowfences clearly have other intended functions. The positive effect of fences, especially for large mammals, is that they greatly reduce vehicle-collisions. However, the biggest negative effect appears to be the disruption of animal movement (see Preston this issue, pgs 8 - 15) patterns on a day-to-day, seasonal, or annual basis. In some instances, predators such as wolves have learned to trap sheep, deer, and Elk against fences as a more efficient method of hunting. Additional negative impacts occur when animals wander into fenced areas from non-fenced areas. In such cases, the incidence of vehicle collision greatly increases as an animal with no direct escape route often panics from entrapment and frantically darts across the road in search of cover. Fencing need not be on both sides of the road to cause problems either. Roads with fences on only one side allow animals to cross, but upon reaching the other side, they must either walk along the verge without protective cover, or turn back to re-cross the road, thus increasing the chances of vehicle collision (Figure 9).

Infrared Cameras

In 2003 a new technology, the Wildlife Protection System (WPS), was tested in Kootenay National Park through a cooperative venture of partners including the Insurance Corporation of BC, Parks Canada and InTransTech Corp. The system uses infrared cameras to detect the presence of wildlife on or near the highway. When wildlife is detected, flashing lights are triggered, warning drivers to reduce their speed and to anticipate wildlife on the roadway (Figure 10).

Advantages to the system include:

- Wildlife do not become habituated to it as they may to scents, reflectors, and other deterrents because the system focuses on modifying the behavior of the motorists, rather than of animals;

- Drivers are less likely to become complacent about the signs because warning messages are only displayed when wildlife is present;

- It does not interfere with the natural movement of wildlife, unlike fencing, and it does not require construction of overpasses or underpasses;
- It does not need to be fixed in a single geographic location, but can be transported to seasonally high risk areas; and

- It has the potential to operate 24 h/day, in contrast to some mitigation warning tools that operate only at night.

The primary challenges with this system was related to maintenance issues with power supply and computer malfunctions. Most of these problems would likely be reduced or eliminated in locations where power could be accessed from power lines, rather than being generated on-site (Kinley et al. 2003b). The tracking software also required some upgrades. Even at top performance, a clear line of sight is required so that the camera can "see" the roadside. Although relatively expensive, this system holds promise in the future if costs can be reduced, reliability enhanced, and possible vandalism issues addressed. The system may be particularly effective as a moveable unit to areas where there are seasonally high roadkills, or to provide large "crosswalks" between fenced areas.

The WPS is capable of collecting video footage, thereby providing a unique opportunity to investigate wildlife locations, numbers and behaviour on and near road systems (Kinley et al. 2003a). Further study using this tool should help in testing and modifying other wildlife accident mitigation methods.

Figure 10. The Wildlife Protection System uses an infrared camera to detect animal presence along roadways, which subsequently triggers flashing lights warning approaching motorists. Highway 93 near Dolly Varden Creek, Kootenay National Park, BC. (Alan Dibb).

Conclusion

There are over 90,000 incidental wildlife observations, and over 11,000 mortality records (including those from highways, railways, and predator captures) recorded in Banff, Yoho, and Kootenay National Parks' databases, and many of these are useful for identifying key wildlife corridors. For example, on two independent occasions large concentrations of White-tailed Deer (Figure 11) were observed along a short stretch of Highway 93. On 25 April 2004, 142 deer were observed along a 32-km stretch of highway feeding on early spring vegetation. Most of these deer were between Kootenay Crossing and the McLeod Meadows Campground. On 7 May 2006, the entire length of the highway was driven 1.25 h prior to sunset. A total of 94 White-tailed deer were observed, although 92 of them occurred on only

Figure 11. White-tailed Deer are the most frequently killed large mammal in Kootenay National Park, and are often concentrated along Highway 93 between Kootenay Crossing and McLeod Meadows. Dickaebusch Creek, BC. 19 June 2003 (R. Wayne Campbell).

a 23.5-km stretch between Kootenay Crossing and Settlers Road (see Figure 1). That same drive also yielded three Black Bears (one near Serac Creek, one near Kootenay Crossing, and one near Olive Lake), five Elk (near Kootenay Crossing), and 16 Bighorn Sheep (near the park's west gate). The Wardle Flats area, Crook's Meadow to Dolly Varden, and the area near McLeod Meadows, have been previously identified as important areas for Elk and deer (Poll et al. 1984, Poll 1989, Sheehan 1995).

Although not previously discussed, there have been other efforts in KNP to help reduce vehicle-induced wildlife mortality. For example, in earlier years carcasses of killed animals were often dragged into nearby adjacent forest, which often attracted predators and scavengers, and subsequently led to their own vehicle collision. Efforts to reduce these residual mortalities have included relocating carcasses to remote areas where encounters with vehicles are greatly minimized. However, habituation by predators and scavengers became a recognized problem, so the park experimented with burning the carcasses at the local lumber mill. Carcasses are now hauled well off the highway edge and are only relocated to a remote area if they are found within 500 m of a park facility or trailhead.

Vehicle collisions with wildlife are major social, economic, and ecological concerns, especially when large mammals are involved. Efforts to reduce collisions in KNP have been largely preliminary, and the success of each mitigative action appears dependent on consistent application (*i.e.,* signage, public information kiosks) and location (*i.e.,* targeting mortality hotspots). New techniques to reduce vehicle collisions with wildlife are currently being developed and tested (see Figure 12, and also Rea et al. pages 39-42 in this issue), and it will be exciting to learn of their effectiveness. In the meantime, it seems most beneficial to implement a combination of mitigation actions that incorporate both animal and human behaviours (Forman et al. 2003).

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Figure 12. Parks Canada wildlife biologist Alan Dibb is using radio collars on Bighorn Sheep to assess movement patterns and winter range in response to habitat restoration in an effort to shift animals away from Mile Hill at Radium Hot Springs, BC. 29 October 2005 (Michael I. Preston).

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About the Author

Larry (Figure 12) has always liked the outdoors and is often found bent over, observing some little critter, or with his binoculars pointed skyward in search of birds. He lives in the Columbia Valley and has worked as a naturalist in Kootenay National Park since 1972. Larry is the co-founder of Wings Over the Rockies Bird Festival and is currently on the board of directors for the Canadian Intermountain Joint Venture, one of the newest North American Bird Conservation Initiatives. He is also a regional co-ordinator for the Biodiversity Centre for Wildlife Studies in Radium Hot Springs.

Figure 12. Larry Halverson birdwatching near Radium, BC. 9 May 1997 (R. Wayne Campbell).