Title

Comprehensive Monitoring of Wildlife Mortality on British Columbia Highways Using the WARS System (1978 to 2005)

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Publication Date

2005-08-02

COMPREHENSIVE MONITORING OF WILDLIFE MORTALITY ON BRITISH COLUMBIA HIGHWAYS USING THE WARS SYSTEM (1978 - 2005)

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1. Abstract

The British Columbia Ministry of Transportation (BCMoT) has been operating its Wildlife Accident Reporting System (WARS) for almost three decades. Detailed information on motor vehicle-related wildlife mortality is systematically collected on a daily basis on major highways throughout British Columbia. Since its inception, WARS has become an increasingly valuable tool for highway planning and operational purposes. With WARS, BCMoT is able to support the British Columbia Government's commitment to environmental stewardship by:

- quantifying the magnitude of motor vehicle-related wildlife mortality;
- identifying mortality-prone locations and mortality trends;
- modeling species-specific risk profiles for highway corridors;
- developing wildlife mortality mitigation initiatives;
- focusing mitigation efforts to mortality-prone locations;
- monitoring the effectiveness of mitigation initiatives; and
- establishing corporate and operational policies and strategies for accident issues and mitigation initiatives.

BCMoT highway planners and wildlife biologists use WARS to protect wildlife, by identifying population clusters and migration routes prone to highway-related mortality, and designing exclusion fencing and crossing structures to meet the needs of the species impacted. WARS provides a rare opportunity to examine the impact of an extensive highway network transecting wildlife habitat distributed over a large geographic area with diverse climatic and physiographic characteristics. The WARS database contains information on the major ungulates and carnivores

found in British Columbia that cannot be extracted from any other data sources.

2. Background

Motor vehicle-related wildlife mortality is one of the unfortunate legacies of highway development throughout the world. It is estimated in the United States alone, over one million deer-related motor vehicle collisions occur each year (United States General Accounting Office, 2001). This wildlife mortality can be considered a long-term residual negative impact that results in significant costs to wildlife and society.

The ultimate cost to some species of wildlife may be extinction. From badgers in Holland and the UK, to penguins in New Zealand and elephants in India, the profile of motor vehicle-related wildlife mortality is becoming a more predominant public issue for road authorities worldwide. Correspondingly, society bears the significant costs of property damage to vehicles, as well as personal injuries and death to motorists and passengers.

Although growing public demands in many countries are forcing national, state, and local road authorities to address the issue of motor vehicle-related wildlife mortality, the lack of comprehensive data is a serious problem. Few road authorities have initiated the data collection systems necessary to understand the fundamentals of their respective wildlife/highway environments. Without sufficient accurate data, it is difficult for road authorities to optimize decisions and investments in wildlife accident mitigation. In British Columbia, the British Columbia Ministry of Transportation (BCMoT) has been operating its Wildlife Accident Reporting System (WARS) for almost three decades. As a consequence, both wildlife and motorists in British Columbia reap benefits from systematic wildlife mortality monitoring and the accident mitigation decision-making process the monitoring supports.

3. The wildlife/highway interface in British Columbia

The diverse climatic, geographic and physiographic characteristics of British Columbia have produced fourteen distinct biogeoclimatic or ecological zones (British Columbia Ministry of Forests, 1999). The environments of these zones vary from dense rainforests on the west coast and deserts in the southern interior valleys to broad rolling plateaus in the central interior valleys and alpine tundra in the northern mountains. As a result of the exceptional range of wildlife habitats provided by these biogeoclimatic zones, British Columbia has one of the most diverse variety of large ungulate and carnivore species in North America.

Two parallel mountain ranges transect British Columbia creating numerous valleys where many large ungulates, primarily deer, elk, moose, and mountain sheep, use winter ranges for up to six months of the year. As most of the province's major highways were built in the valley bottoms

severing the winter ranges and the migratory corridors of many wild animals, conflicts and collisions are an annual occurrence.

The highway environment in British Columbia is a very complex and varied one, ranging from multi-lane freeways located in urban centres to two-lane highways transecting the undeveloped hinterland. British Columbia has a diverse number of wild animal species, ranging from seemingly ubiquitous deer to elusive wolves, each with their own highway interaction characteristics. For muchs of British Columbia's history, the highway/wildlife habitat interface was poorly understood. Wildlife mortality was a seemingly accepted cost of constructing highways to foster resource and agricultural development in hinterland of the province. Little had been done to assess the impact of highways on wildlife, their migratory corridors and their use of critical ranges.

The implications of the fundamental lack of understanding of the highway/wildlife habitat interface in British Columbia culminated in 1978. That year, a newly constructed 6 kilometre long highway bypass on Vancouver Island experienced over 300 dead deer from motor vehicle-related collisions in its first twelve months of operation (Kent, 2004).

The unexpected and unexplained magnitude of this highway-related wildlife mortality provided the impetus for BCMoT to examine the number of wildlife-vehicle collisions occurring on highways throughout the province. In conjunction with the British Columbia Ministry of Environment, BCMoT initiated a program to record the location, number and type of wildlife collisions.

4. Initial data collection

In 1978, wildlife accident collection began when BCMoT's maintenance staff were required to record the location of each wildlife collision (Kent, 2004). The Ministry of Environment required wildlife data relating to species, sex and age. Reporting forms were developed to be completed on a monthly basis. Concurrently, in co-operation with the Royal Canadian Mounted Police, a one-year specific decal program was developed on the police accident report used in British Columbia. This program recorded species, sex and age along with the other accident information.

The initial reporting forms proved to be difficult to implement operationally. Difficulties arose, especially when road foremen were asked to perform relatively detailed forensic analysis, including determining the sex of dead porcupines, typically, a very challenging task. Consequently, it was difficult to maintain a consistent reporting regime. Only where deer collisions were the highest, and the implications of wildlife collisions were most apparent, was there a diligent effort by maintenance staff to consistently complete and accurate monthly collision reports.

Although improvements in the reporting system evolved from its inception, inconsistent data entry and sporadic reporting led to a database that could not be relied upon for predictive mitigative measures. As a consequence, BCMoT began the development of an improved, more comprehensive data collection system with a more robust database program, collectively know as the Wildlife Accident Reporting System (WARS).

5. Wildlife Accident Reporting System (WARS)

The need for consistent and reliable data in an easy to store and access format led to the evolution of the WARS system, a database system designed to be a decision-supporting tool for developing proactive and reactive wildlife accident mitigation solutions. All accident data collected since 1978 was used to populate the WARS database. The first PC-based interactive WARS system was developed using FoxPro software in 1988. In 1999, when the database outgrew this platform, the data was migrated to a Microsoft Access database. Currently, efforts are underway to migrate the database to an Oracle database platform to better accommodate the growing size of the data base and perform the complex analysis now being required for BCMoT purposes.

6. Current data collection

Originally, BCMoT's maintenance staff were responsible for collecting data for the WARS system. In 1988, the Provincial highways maintenance functions were privatized. Now, the WARS system is supported by an established network of private Highway Maintenance Contractors that collect wildlife accident information on Provincial highways throughout British Columbia. Each time the remains of a wild animal on a highway are discovered, the Maintenance Contractors complete a H0107 accident reporting form (Figure 1). Detailed geographic, temporal and species-specific information is collected for each accident. The completed H0107 forms are sent to the BCMoT District offices where the reports are assembled and verified. At BCMoT Headquarters, the reports are entered into the WARS database.

7. Assumptions and constraints

BCMoT estimates the number of wild animals recorded by the WARS system represents about 25% to 35% of the actual number killed. The low number of reports can be attributed to a number of factors, including the species involved. In high traffic areas, the remains of small animals, like rabbits and badgers, often become unrecognizable after being run over by a large number of vehicles. Other animals, primarily deer and moose, are removed from the roadside or skinned and beheaded at the roadside by passing motorists before they are identified and reported.

BRITISH COLUMBIA

Ministry of Transportation

MONTHLY WILDLIFE ACCIDENT REPORT

MONTH *(Please Circle)* Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec **YEAR** _____

REGION *(Please Circle)* 1 2 3 4 5 6 **DISTRICT** _____ **DISTRICT NO.** _____

Enter the day of the month (e.g. 1, 2, 3, ... etc.) in the "Day" column below.

Day	Time of Kill (D) 1 = Dawn, 2 = Day, 3 = Dusk, 4 = Dark	Location of Killed Animal — RFI = Road Features Inventory (optional); LKI = Landmark Kilometre Index (must be completed)					Deer Sign within 100m Y/N	Deer Rflctr Y/N	# Killed	Animal Type — Please Specify Sex (Male / Female / Unknown); Please Use "Y" to indicate if Yearling or Younger (Other: Sheep, Caribou, Coyote, Porcupine, etc)												Comments
		Hwy No.	RFI Landmark	RFI Offset	LKI Segment	LKI Km	Nearest Town			Deer M	Deer F	Deer U	Moose M	Moose F	Moose U	Elk M	Elk F	Elk U	Bear M	Bear F	Bear U	Other (please specify)	

Please provide the following information to assist in report follow-ups:

Maintenance Contractor Contact (Please Print) _____ Telephone _____

Ministry District Contact (Please Print) _____ Telephone _____

Within 30 days of completion, please send this form to:

Leonard Sielecki, WARS Manager
Wildlife Accident Reporting System (WARS)
British Columbia Ministry of Transportation
4B - 940 Blanshard Street, PO Box 9850 STN PROV GOVT
Victoria BC V8W 9T5
Phone: (250) 356-2255 / Email: leonard.sielecki@gems9.gov.bc.ca

Note: If you suspect that an animal has been the target of poachers, please contact your local Conservation Officer or call the ORR (Observe, Record, Report) Line at 1-800-663-9453.

H0107 (2001/06) Page ____ of ____

Figure 1. H0107 Monthly Wildlife Accident Reporting form

In some cases, informal arrangements exist between local detachments of the Royal Canadian Mounted Police (RCMP) and wildlife agencies so the meat of wild animals killed in traffic accidents is sent to food banks.

For the most part, data is believed to be lost due to the following factors:

1. animals die outside the highway right-of-way and are not found;
2. animal remains are removed by natural predators or scavengers;
3. animal remains are obscured by snow, ice, vegetation, or roadside debris;
4. animal species or accident locations are incorrectly identified; and
5. random and systematic errors and omissions in reporting and data processing.

8. Data quality

The quality of the data contained in the WARS system is very dependent on the reporting diligence of the Ministry's Maintenance Contractors. Since wildlife accidents tend to occur at very untimely hours, under less than ideal weather conditions, comprehensive reporting at the accident scene is difficult, if not impossible, at times.

Accurate reporting of wildlife accident locations is essential for effectively identifying and evaluating accident patterns. Given the limited amount of training provided for reporting wildlife accidents, accurate differentiation between various species of bears, deer, elk and sheep has been sporadic. Correct species identification is completely dependent on those completing the WARS H0107 accident forms. As a result, some species are misreported, based on species and normal range.

Historically, not all WARS H0107 report forms have been completed with diligence. In particular, the accuracy of accident locations has been problematic. In 2004, of the 4,768 report forms received for the year, 20% lacked valid segment numbers, and 31% lacked valid kilometre references. These reports did not contain enough information to determine the valid segment numbers and km references. This was a improvement over 1995, when 28% lacked valid segment numbers and 44% lacked valid km references.

In 1999, new WARS H0107 forms were developed, in conjunction with the Ministry's Maintenance Contractors, to address the issue of data completeness and accuracy. To date, the data provided on the new forms is increasingly more complete and accurate.

9. Wildlife accident location reporting

In British Columbia a number of different highway locating reference systems are used. Some confusion exists between the use of the Road Features Inventory (RFI) and the Landmark Kilometre Inventory (LKI) systems for identifying wildlife accident locations. Ministry Contractors largely use the RFI system for locating highway features and structures such as

bridges, signs, etc. The WARS system uses the LKI system for locating wildlife accidents. Wildlife accidents reported with RFI references are often converted to LKI references by Ministry Maintenance Contractors staff or Ministry staff. Errors can occur during data conversion. In time, it is anticipated the problems associated with wildlife accident location reporting will diminish dramatically when the Ministry implements a new referencing system, currently under development and nearing completion.

The impact of the inaccuracies in location information for accident analysis with WARS data has been compounded by earlier problematic data entry procedures at BCMoT Headquarters. Previously, if a kilometre reference was not reported for an accident, the value "0" was often entered into the WARS database for the kilometre reference. This reduced the quality of the WARS database location information by confusing accidents that occurred at the beginning of an LKI segment with those accidents with incomplete location information.

At this time, while it is very unlikely wildlife accidents occur uniformly along any segment of highway in British Columbia, the most accurate way to display accidents recorded in the WARS database provincially is by the LKI segment. Within each LKI segment, it is most probable certain locations experience higher than average wildlife-related accident rates. Such locations can only be identified when wildlife accidents are consistently reported with accurate and complete kilometre references.

From an operational perspective, the reporting of wildlife accident locations could be improved by having those who complete the WARS H0107 reporting forms provide GPS coordinates for each accident. GPS coordinates would help ensure more consistent and accurate reporting of accident locations. GPS coordinates would also make transferring the WARS data into a GIS system for mapping and analysis easier. Improving the reporting of accident locations with GPS devices would require BCMoT to provide GPS devices and training for the crews responsible for attending wildlife accidents.

10. Wildlife accident location reporting

While, the WARS system was primarily designed to provide BCMoT with general information about the types of wild animals killed on Provincial highways and the locations of the accidents, WARS is increasing becoming a valuable tool for wildlife researchers. The value of the WARS data could be significantly improved for wildlife research by increasing the detail regarding species identification. While, some of BCMoT's Maintenance Contractors who complete H0107 forms are avid hunters or are naturalists, with significant personal knowledge about the various species of wildlife, some do not.

If those who complete the WARS H0107 reporting forms could distinguish between the various species, WARS data could be used for more advanced wildlife management. In particular, if

detailed information about rare or endangered species, such as badgers or grizzly bears, could be collected and provided to wildlife researchers, it is possible the chances of survival of such wild animals could be increased.

The collection of more comprehensive specific species information would require BCMoT to provide specialized training by wildlife biologists to the Maintenance Contractors responsible for dealing with wildlife accidents.

11. Increasing information reported

While the WARS database is an invaluable resource for wildlife accident research and mitigation, the quality of the data and its usefulness for BCMoT purposes, and for wildlife researchers, could be improved. There are many related and unrelated, man-made and natural factors which may influence drivers and wildlife interactions, and affect highway conditions (Figure 2). Many of these factors are difficult to measure and evaluate. However, significantly more knowledge is required about these factors, if the highway/wildlife habitat interface is to be better understood. If additional data relating to these factors could be collected during the reporting process, the value of WARS data for analytical purposes would increase.

Although wildlife accident data collection is a requirement of BCMoT's maintenance contracts, the process is based on goodwill and trust. To date, there has not been an audit of WARS monthly reporting ever done. Initiating an audit would be an ackward exercise because for the most part, reporting is done as well as it can be, given the circumstances. Wildlife-related motor vehicle accidents typically occur early in the morning, or later in the evening. The weather conditions can be poor, with snow and freezing rains not uncommon in the northern regions of British Columbia in the late fall to early spring. This is compounded by the fact that human welfare and highway safety are the paramount priorities for BCMoT and its Maintenance Contractors. The first object of the Maintenance Contractors responding to wildlife-related motor vehicle accidents is to ensure the highway becomes fully operational as soon as possible with motorist safety being their primary objective. After removing the gruesome remains of a dead wild animal, or arranging to have a seriously injured wild animal euthanized, late at night on a cold, rainy or snowy winter evening, possibly after witnessing a human fatality or serious human injuries, completing a WARS H0107 form in a timely and diligent manner can be a much lesser priority than getting cleaned up and recovering emotionally. Attending a wildlife-related motor vehicle accident is one of the least appealing responsibitities of BCMoT's Maintenance Contractors.

Although it would be very advantageous for analysis purposes to have additional accident site information recorded, improving the accurate reporting of location and species is the most pressing objective at this time.

Category	Factors
1. Wildlife characteristics	species, age, sex, size, intelligence, vision, speed, agility, movement style, stage of reproduction, nutritional needs, movement behavior, population, population cycles
2. Wildlife activities	feeding, breeding, sleeping, migrating, evading predators, chasing prey
3. Natural water sources	Intermittent and permanent streams, rivers, slews, lakes, ponds, springs, waterfalls
4. Man-made water sources	settling ponds, surface drainage systems, wells, dugouts
5. Natural food sources	natural vegetation, salt licks, fish-bearing waters, prey
6. Man-made food sources	orchards, gardens, fields, pets, livestock, garbage
7. Wildlife shelter	caves, cliffs, forests, culverts, bridges
8. Habitat conditions	seasonal vegetation changes, snow depth, drought, flooding, fire, overgrazing
9. Traffic	volume, speed, composition, time-of-day, time-of-year
10. Vehicles	size, design, operating condition, brakes, lights, horns
11. Drivers	wildlife hazard awareness, highway familiarity, general alertness, driving skill, response time, response actions
12. Highway design	road width, number of lanes, curvilinearity of alignment, right-of-way width, shoulder width, ditch depth, pavement surface, lighting
13. Roadside maintenance	native and non-native right-of-way vegetation, weed control, mowing, brushing, ditching, snow removal, de-icing, dust control, sign and reflector repairs
14. Roadside development	urban, suburban, rural, industrial, commercial, agricultural
15. Accident mitigation devices	wildlife signs, fencing, under/overpasses, reflectors
16. Topography	elevation, cliffs, slopes, plains, undulating terrain
17. Weather	rain, snow, sleet, fog, haze, smoke, wind, cloud cover
18. Time of day	dawn, day, dusk, night, length of day/night
19. Lunar cycle	phases of the Moon, intensity of Moonlight
20. Adjacent human activities	construction, forestry, farming, mining, hunting, off-road recreation, controlled and uncontrolled forest and grass fires
21. Man-made and natural barriers	Buildings, walls, fences, hedges, cliffs, barriers, guardrails

Figure 2. Wildlife-related motor vehicle accident factors (adapted from Sielecki, 2004)

12. Provincial motor vehicle-related wildlife accident implications

Since 1978, over 90,000 wild animals have been reported killed on Provincial highways in British Columbia. Since, it is estimated that this number represents only 25% to 35% of the actual number of wildlife animals actually killed, the impact to wildlife is significant. It is estimated, each year, more wild animals are killed in motor vehicle-related accidents on Provincial highways in British Columbia than are killed by licensed hunters (Sielecki, 2004).

Large ungulates, such as moose and elk, represent a formidable potential hazard to motorists (Figure 3). However, the physical strength of motor vehicles provide motorists and their passengers with a degree of security that results in a significantly greater numbers of wild animals being killed than humans in motor vehicle-related wildlife accidents (Figure 4). In British Columbia, in 2004, the ratio of recorded human fatalities, attributable to motor vehicle accidents involving animals, to the number of recorded wildlife fatalities, found is 0.0004 or 0.04%.

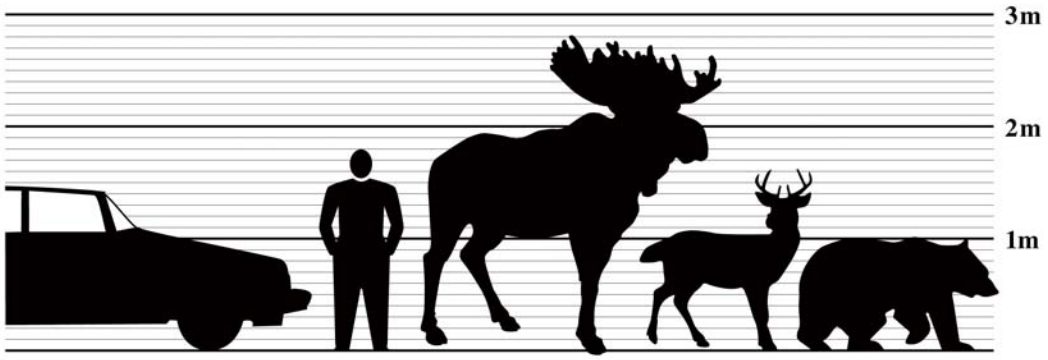

Figure 3. Relative size of moose, deer and bear compared to a 1.8 metre human and compact auto (adapted from Maine Interagency Work Group on Wildlife/Motor Vehicle Collisions, 2001)

From a wildlife management perspective, the monetary value of the motor vehicle-related wildlife mortality can be estimated based upon the following:

a) lost value of wildlife;

b) lost value of wildlife for resident hunters and non-resident hunters; and

c) lost value of wildlife for non-hunting residents.

a) Lost Value of Wildlife

The British Columbia Ministry of Water, Land and Air Protection (MWLAP) has done extensive analysis of the economic value of wildlife resources in the province (Reid, 2001). In British Columbia, participants in hunting and viewing are estimated to spend about $466 million each year directly associated with their wildlife-related recreation. The expenditures by participants in wildlife-related activities and their impacts on income and employment are spread throughout the Province thus making important contributions to rural economies.

Total Reported Human Fatalities, Human Injuries and Wildlife Fatalities (1993 to 2003)			
Year	**Human Fatalities***	**Human Injuries***	**Wildlife Fatalities****
1993	1	272	4798
1994	3	287	5339
1995	4	148	4764
1996	0	148	3902
1997	1	146	3661
1998	0	170	4611
1999	5	154	4889
2000	0	201	4785
2001	2	265	5172
2002	2	295	5031
2003	3	287	6008
Totals	21	2373	52960

Figure 4. Total Reported Human Fatalities, Human Injuries and Wildlife Fatalities
(* Source: British Columbia Ministry of Transportation Highway Accident System)
(**Source: British Columbia Ministry of Transportation Wildlife Accident Reporting System)

b) Lost Value of Wildlife for Resident Hunters and Non-resident Hunters

One measure of the value of wildlife lost due to motor vehicle-related accidents can be estimated by determining how much hunters are willing to pay to hunt. MWLAP surveyed thousands of resident hunters in 1996 to determine their "willingness to pay" in order to obtain an animal from a certain species (Figure 5). This "willingness to pay" by British Columbia hunters can be considered the equivalent of the "true net market value" of that species. For non-resident hunters, the "net return" to the Province is determined to be the value of their expenditures less the cost to the Province for supplying the services they need.

The value of non-resident hunting in British Columbia is significant. Non-resident hunters contribute to the Provincial economy by purchasing hunting licenses and supplies, and hiring hunting guides. The true market value of wildlife may be more accurately determined by public auction, but only if all hunting opportunities were auctioned.

Since 2000, the British Columbia Ministry of Water, Land and Air Protection (MWLAP) has auctioned off mountain sheep hunting licenses in Reno, Nevada (McDonnell, 2004). The auction is used as a fund raising initiative for the British Columbia Habitat Conservation Trust Fund (HCTF) to help support mountain sheep management (Figure 6).

	Net Value to British Columbia (Canadian Dollars)	
Species	**Resident Hunters ($)**	**Non-resident Hunters ($)**
bear	950	2,340
caribou	2,960	2,930
cougar	2,050	3,400
deer	1,270	7,450
elk	3,250	3,290
moose	1,250	1,680
mountain sheep	4,700	4,170

Figure 5. Resident and Non-resident Hunters Net Value to British Columbia
Source: British Columbia Ministry of Water, Land and Air Protection

Auction Item	2000	2001	2002	2003
Bighorn Sheep tag (non-resident)	$215,250	$152,626	$134,768	$154,313

Figure 6. MWLAP Bighorn Sheep Tag Auction Proceeds (Canadian Dollars)
Source: British Columbia Ministry of Water, Land and Air Protection, Wildlife Program

Although the successful bids in the auctions for British Columbia wild game animals continue to be considerably higher than the value MWLAP has generally determined for these types of animals, the auction results show certain species wildlife are considered very valuable by some hunters.

c) Lost Value of Wildlife for Non-hunting Residents

No species-specific figures are available for the value of wildlife to non-hunting residents. Regardless, the presence of wildlife generates considerable economic activity in British Columbia. The impact of motor vehicle-related accidents on wildlife species with critically low populations can have serious implications on wildlife viewing activities. Species, such as mountain goats and mountain sheep, which attract viewing attention, have low reproduction rates and limited areas of habitat. Consequently, the loss of even a few members of a small herd in motor vehicle-related accidents can threaten the survival of the herd and reduce the long-term Provincial economic benefits generated by residents viewing the herd.

13. Injured Wildlife and Orphaned Offspring

In addition to the loss of wildlife as a result of motor vehicle-related accidents, there are other issues which arise, in particular the welfare of injured animals and orphaned offspring.

a) Injured Wildlife

While the most severely injured animals are euthanized as humanely as possible by conservation officers of the British Columbia Ministry of Water, Land and Air Protection or law enforcement personnel, most often the Royal Canadian Mounted Police in rural areas, the recovery of less severely injured wildlife is a growing concern in British Columbia.

In British Columbia, wildlife rehabilitation practitioners requires a specific permit to possess, treat, release, and euthanize wildlife. In general, to obtain a permit for a designated rehabilitation facility there must be a need in the community for such services and the individuals must have approved facilities for the species to be admitted, demonstrate training or experience, an established relationship with a veterinarian, liability insurance, and submit annual records of all wildlife treated. Individuals can also apply for permits to temporarily house and transport wildlife to designated rehabilitation facilities. Annual permits for B.C. rehabilitators are administered by Federal and Provincial agencies.

The Wildlife Rehabilitators Network of British Columbia, a non-profit volunteer-run organization, was founded in 1989 to assist in the recovery of injured wild animals, including those involved in motor vehicle accidents. The Wildlife Rehabilitators Network's membership includes licensed rehabilitation facilities and individual rehabilitators, rehabilitation volunteers, wildlife researchers, government and humane association representatives, veterinarians and other animal care personnel, and interested members of the public. The Wildlife Rehabilitators Network continues to provide valuable assistance to injured wild animals.

b) Orphaned Offspring

One of the most sensitive impacts of wildlife accidents is the orphaning of young offspring when adult females are killed. Of the orphaned wildlife species, orphaned bears have received the closest attention by the BC Provincial Government. The majority of orphaned bear cub occurrences involve Black Bears as British Columbia has one of the largest populations of Black Bears in North America. Although the Province has the second largest population of Grizzly Bears in North America, orphaned Grizzly Bear cubs are encountered less often.

At present, there are no approved programs or protocols in North America to re-introduce orphaned grizzly bears cubs back into the wild. Upon the loss of their mother, most often due to human related activity, orphan grizzlies cubs are either reluctantly destroyed by conservation officers or relegated to a life in captivity (Macquisten, K, 2004). Historically, Provincial policy in British Columbia required that orphaned bears cubs be euthanized. Existing Provincial policy

states that orphaned bear cubs are not good candidates for translocation and should be killed in all situations. This policy exists for the following reasons:

- orphaned bear cubs are believed to be unlikely to survive and to be successful on their own if left in the wild;
- large predators such as bears are difficult for wildlife rehabilitators to deal with in captive environments;
- there is a public safety concern regarding the release of large and potentially dangerous predators that have been raised in a captive environment, if they rely on humans for food and lose their fear of people;
- there is a lack of agreement in the scientific community on whether bear rehabilitation is successful in returning bears to the wild; and,
- Black Bears are not a species of conservation concern and the Ministry of Environment, Lands and Parks has limited resources. These resources are more appropriately aimed at managing species that are at risk.

Despite this policy, Conservation Officers, wildlife staff or members of the public took 102 bears to rehabilitation facilities between 1990 and 2000. The majority of these bears were cubs. There are a complex set of reasons leading to Conservation Officers placing bear cubs in rehabilitation facilities. The reasons include the public interest in this procedure, a change in some regional policy direction on this issue, more wildlife rehabilitators becoming interested, and the development of bear cub rearing and rehabilitation protocols in the U.S. (Orphan Bear Cub Review Committee, 2000).

To deal with this difficult situation, and to address public concerns, the British Columbia Ministry of Water, Land and Air Protection has been reviewing its policy and procedure on the handling of orphan bear cubs.

14. WARS data analysis

WARS data is used to produce annual reports as well as a wide range of adhoc reports. Annual reports provide detailed information and analyses of wildlife-vehicle accidents for a given year. Multi-decade reports provide considerable information of wildlife-vehicle accidents and examine trends such as frequency, location and magnitude of accidents. Adhoc reports are created for highway staff and consultants in need of specific information for particular species on selected highways.

15. Accident management applications

The WARS system has enabled the Ministry to maximize the use and effectiveness of its existing warning system infrastructure in a manner supported by statistically significant data, and

not speculation or unfounded assumptions. It enables the Ministry to be proactive in its wildlife accident mitigation efforts. Monitoring accident rates and locations over time helps the Ministry identify developing problems in a timely manner.

The WARS system allows BCMoT to consider a variety of wildlife accident mitigation measures, such as wildlife warning signs, wildlife exclusion fencing, and wildlife crossing structures, in the most cost-effective manner. The WARS system can direct Ministry attention to high wildlife accident locations to reduce the operating costs for Maintenance Contractors.

The WARS system enables BCMoT to address wildlife mortality by:

a) quantifying the magnitude of motor vehicle-related wildlife mortality;
b) identifying mortality-prone locations and mortality trends;
c) modeling species-specific risk profiles for highway corridors;
d) developing wildlife mortality mitigation initiatives;
e) focusing mitigation efforts to mortality-prone locations;
f) monitoring the effectiveness of mitigation initiatives; and
g) establishing corporate and operational policies and strategies for accident issues and mitigation initiatives.

16. Supporting wildlife accident mitigation research

WARS data is used to support decisions for applying new technology or theories. On existing highways, WARS data is used extensively to identify locations for the development of conventional and specialized wildlife warning signs to alert motorists of the presence of wildlife. WARS data is currently being used to develop seasonal, species-specific warning messages for changeable message boards to maximize the timeliness and effectiveness of the messages. For highway redevelopment and new highway construction, WARS data is used to identify locations for the construction of wildlife exclusion fencing and wildlife underpasses.

BCMoT works closely with the Insurance Corporation of British Columbia (ICBC) to improve highway safety in British Columbia. BCMoT uses WARS data to evaluate cost-sharing proposals for highway safety projects and identifying highway locations where joint BCMoT/ICBC initiatives, such as exclusion fencing, can be targeted to reduce wildlife-related motor vehicle collisions. Researchers working for ICBC have been using WARS data to support the development of the infrared camera-based *Wildlife Protection System*™ designed to detect wildlife on Provincial highways and warn oncoming motorists.

17. Identifying wildlife habitat and critical wildlife populations

The information contained in the WARS database provides a rare opportunity to examine the highway/wildlife habitat interface. WARS enables highway planners to reduce the fragmenting

effect of highway corridors on wildlife habitats by ensuring wildlife migration routes that cross highway alignments are identified and protected. In addition, critical populations of endangered species can be safeguarded when wild animals are able to cross highways safely.

The WARS database also contributes to a better understanding of province-wide scale wildlife migration patterns, population dynamics, and habitat needs. The WARS system has provided various Government of British Columbia ministries, non-government organizations as well as wildlife researchers working in neighbouring Canadian provinces and American states. The decades of records contained in the WARS database provide a rare and invaluable collection of wildlife-related motor vehicle accident information on a large number of different species of both large and small wild animals that cannot be assembled from any other information sources.

The WARS system has provided unexpected insights into the evolution of the Province's road ecology. WARS data has been used to identify the introduction of alien species in the natural habitat. Possums were found to have been inadvertently released on Hornby Island. Bison were found to have escaped from a paddock in the Peace River area. The colonization or recolonization of an area can be confirmed by the discovery of the remains of species of wild animals that have never been reported in an area, or have been extirpated in an area for many years. Coyotes have been found in the Lower Mainland and wolves in the East Kootenays. After years of hunting and extermination, especially in and near urban area centres and livestock grazing lands, both animal populations have recovered to levels where they are becoming increasingly involved in motor vehicle accidents. The impact of new highway development on wildlife can also be identified with WARS data. Some higher carnivores which are relatively rare, may not successfully survive when their territories are disturbed by a major highway or expressway. In particular, cougar mortality is a relatively rare occurrence on highways in British Columbia. In an average year, less that one cougar is reported for the entire 41,000 kilometre Province road network. In 1999, two cougars were killed on a new 20 kilometre section of the Vancouver Island Highway in the first two months that section of highway was operational.

18. Applicability of the WARS System for other Transportation Agencies

Given its simplicity, ease of implementation and low cost, the WARS model is applicable to any transportation agency with the need to document wildlife mortality on roads and highways. The WARS model can be used by most transportation agencies within their existing organizational maintenance reporting structures.

19. Summary

The ongoing systematic daily collection of multi-species wildlife accident data by the BCMoT's Maintenance Contractors continues to provide BCMoT with information critical for

understanding the highway/wildlife habitat interface. In addition to helping identify motor vehicle-related accident trends among larger ungulates, such as deer, moose and elk, and carnivores, such as bears and cougars, the WARS system has provided unexpected insights into the evolution of the Province's road ecology.

The ability to continuously monitor motor vehicle-related wildlife accidents has become a vital component in understanding many of the spatial and temporal aspects of wildlife mortality on British Columbia highways. As the WARS database grows each year, it becomes an increasingly valuable decision-supporting tool for directing the BCMoT's wildlife accident mitigation efforts. As improvements in the WARS system occur over time, BCMoT's ability to proactively address the issues of wildlife-related motor vehicle accidents will increase. The success of BCMoT's WARS system has made it a model for other agencies seeking to monitor wildlife-related motor vehicle accidents (Staines, 2001; Ramp and Croft, 2002, L-P Tardiff and Associates, 2003.)

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