BRITISH COLUMBIA

Ministry of Transportation

WARS 1983-2002

Wildlife Accident Reporting and Mitigation in British Columbia

Special Annual Report

Ministry of Transportation
Engineering Branch
Environmental Management Section

940 Blanshard Street
PO BOX 9850 STN PROV GOVT
Victoria, British Columbia
Canada V8W 9T5

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WARS 1983–2002
Wildlife Accident Reporting and Mitigation in British Columbia
Special Annual Report

Author: Leonard E. Sielecki, M.Sc., MCIP, R.P.Bio

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Prepared for: Environmental Management Section
Engineering Branch
British Columbia Ministry of Transportation
Victoria, B.C. Canada

Contact Person: WARS Manager
Environmental Management Section
Engineering Branch
B.C. Ministry of Transportation
4B – 940 Blanshard Street
PO Box 9850 STN PROV GOVT
Victoria, B.C. Canada V8W 9T5

Phone: (250) 387-6931

Abstract: The Wildlife Accident Reporting System (WARS) is designed to collect and store information on wildlife killed on highways in British Columbia. The WARS database contains over 78,000 records collected since 1978. Wildlife accident information is used by the Ministry to:

1) Identify accident-prone locations and accident trends;
2) direct cost-effective mitigation efforts;
3) evaluate the effectiveness of mitigation techniques;
4) provide data for highway planning purposes;
5) model and forecast accidents;
6) analyze traffic and climatic relationships for species-specific accident trends;
7) develop species-specific accident risk profiles for highway corridors; and
8) establish policies and strategies for accident issues and mitigation initiatives.

The success of the WARS system in British Columbia has made it a model for other agencies seeking to monitor wildlife-related motor vehicle accidents.

Comments: In 2002, Ministry Maintenance Contractors reported finding 5,032 dead wild animals on British Columbia highways. Approximately 80% of the animals reported killed were deer. The number of wildlife accidents reported to the Ministry decreased by 2.7% from 2001.

Keywords: WARS, wildlife, accident, reporting, system, road, kills, statistics, exclusion, fencing, British Columbia, risk, cost, deer, moose, elk, bear, sheep, mitigation, overpass, underpass, road ecology.

EXECUTIVE SUMMARY

The British Columbia Ministry of Transportation (BCMoT) administers the Wildlife Accident Reporting System (WARS). The WARS system is designed to analyze wildlife accident data collected by BCMoT Maintenance Contractors on numbered highways in British Columbia.

Since 1978, over 78,000 wildlife accidents have been reported on provincial highways. More than 90% of the accidents involved deer, moose and elk. Between 1995 and 2000, 13 people were reported killed in wildlife-related motor vehicle accidents in British Columbia. After weather, the Insurance Corporation of British Columbia (ICBC) rates wildlife as the next highest environmental contributing factor for police-attended accidents. Between 1997 and 2002, ICBC spent over $118 million on wildlife-related motor vehicle accident claims.

In 2002, over 5,000 wildlife-related accidents were reported in British Columbia (table below). Between 2001 and 2002, the number of wildlife-related accidents reported decreased by 2.7%.

Wildlife Accidents by BCMoT Region (Year 2002)

	Region 1	Region 2	Region 3	Total
Wildlife Accidents	1,221	2,871	939	5,031

In 2002, it is estimated wildlife accidents cost the Province over $20 million in motor vehicle accident claims; $580,000 in highway accident clean-up costs; $320,000 in lost provincial hunting license revenues; and $30 million in lost value to residents and non-residents who view or hunt wildlife.

BCMoT is committed to protect the safety of the motoring public; stem the rising societal cost of human fatalities and injuries, motor vehicle damage, and highway maintenance; and reduce the loss of wildlife on provincial highways. Consequently, BCMoT uses the WARS system to:

1) identify accident-prone locations and accident trends;
2) direct cost-effective mitigation efforts;
3) evaluate the effectiveness of mitigation techniques;
4) provide data for highway planning purposes;
5) model and forecast accidents;
6) analyze traffic and climatic relationships for species-specific accident trends;
7) develop species-specific accident risk profiles for highway corridors; and
8) establish policies and strategies for accident issues and mitigation initiatives.

The WARS system is becoming an increasingly valuable information resource for BCMoT, and other government agencies, consultants, researchers, wildlife associations, special interest groups and members of the general public. The Ministry of Water, Land and Air Protection uses WARS data to assess provincial wildlife population trends. ICBC uses WARS data for identifying highway locations where joint BCMoT/ICBC initiatives, such as exclusion fencing, warning reflectors, and infrared camera detection systems, can be targeted to reduce wildlife-related motor vehicle collisions. The success of the WARS system in British Columbia has made it a model for other agencies seeking to monitor wildlife-related motor vehicle accidents.

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In the year 2002, the consistent daily collection of wildlife accident information and submission of the monthly reports, critical for the operation of the WARS system and production of this report, was done by the staff of the following British Columbia Ministry of Transportation Private Maintenance Contractors:

Argo Road Maintenance (South Okanagan) Inc.
Argo Road Maintenance (Thompson) Inc.
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Caribou Road Services Ltd.
Emcon Services Inc.
Emil Anderson Maintenance Co. Ltd
HMC Services Inc.
Interior Roads Ltd.
JJM Maintenance Ltd.
Lakes District Maintenance Ltd.
Mainroad Contracting Ltd.
Mainroad East Kootenay Contracting Ltd.
Mainroad Mid-Island Contracting Ltd.
Mainroad North Island Contracting Ltd.
Nechako Northcoast Construction (Burns Lake) of 995 Ventures Ltd.
Nechako Northcoast Construction (Terrace) of 141187 Ventures Ltd.
Nechako Northcoast Construction Ltd.
O'Brien Road and Bridge Maintenance Ltd.
Peace Country Maintenance Ltd.
VSA Highway Maintenance Ltd.
Yellowhead Road & Bridge (Fort George) Ltd.
Yellowhead Road & Bridge (North Peace) Ltd.
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The timely assembly and proofing of the WARS monthly reports, vital for keeping the WARS system current and complete, was done by Ministry's District Staff:

Paul Bebington, District Operations Assistant, Lower Mainland District
Sharon Beck, District Clerk, Cariboo District
Cecil Bianco, District Operations Assistant, Okanagan Shuswap District
Hugh Eberle, District Operations Technician, West Kootenay District
Larry Griffith, Operations Technician, Vancouver Island District
Bob Hickman, Operations Technician, Vancouver Island District
Karen Jeff, District Clerk, Cariboo District
Martin Madelung, Operations Technician, Vancouver Island District
Percy Parent, Area Manager Assistant, Thompson Nicola District
Sue Pauwels, A/Operations Technician, Vancouver Island District
Deveta Roberts, Assistant Area Manager, Selkirk Area – Revelstoke, Rocky Mountain District
Grant Watson, District Operations Technician, Skeena District

Supervision and Direction for the report was provided by:

Mike Kent, Chief Environmental Officer, Environmental Management Section, Engineering Branch, British Columbia Ministry of Transportation.

Al Planiden, Manager, Roadside Development, Environmental Management Section, Engineering Branch, British Columbia Ministry of Transportation.

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British Columbia Ministry of Transportation.

Kim Brunt, Wildlife Biologist, Environmental Stewardship Division, Ministry of Water,
Land and Air Protection

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Ministry of Water, Land and Air Protection.

Lucille Green, RIMS Administrator, Construction Maintenance Branch,
British Columbia Ministry of Transportation.

Ian Hatter, Species Specialist – Ungulates, Biodiversity Branch,
Ministry of Water, Land and Air Protection.

Sharlie Huffman, Bridge Seismic Rehabilitation Standards Engineer
British Columbia Ministry of Transportation

Tammy Liddicoat, Park Information Officer, Planning and Community Relations,
Ministry of Water, Land & Air Protection.

Corrine Merx, Consultant, Environmental Management Section, Engineering Branch,
British Columbia Ministry of Transportation

Daryl Nolan, Manager, Environmental Services, Region 3,
British Columbia Ministry of Transportation

Ray Pengelly, Administrative Assistant, Engineering Branch,
British Columbia Ministry of Transportation

Brent Persello, Manager, Environmental Services, Region 2,
British Columbia Ministry of Transportation

Bev Propp, RISP Administrator, Finance and Administration Section, Engineering Branch,
British Columbia Ministry of Transportation.

Jonathan Robinson, Consultant, Information Systems Branch,
British Columbia Ministry of Transportation

Ed Sabadash, Consultant, Geometric Standards and Design Section, Engineering Branch,
British Columbia Ministry of Transportation.

Gord Smith, Graphics Technician, Engineering Branch,
British Columbia Ministry of Transportation.

Andrew Thornton, GIS Analyst, Business and Information Services Division,
British Columbia Ministry of Sustainable Resource Management.

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British Columbia Ministry of Transportation.

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4.0 WILDLIFE-VEHICLE ACCIDENT MITIGATION METHODS

4.1 Overview

Since the mid-1980s, the Ministry has been one of the pioneers and leaders in the field of wildlife–vehicle accident mitigation. The Ministry Methods utilized by the Ministry of Transportation to reduce wildlife vehicle accidents are pursued with multi–faceted objectives. The Ministry strives to reduce, and ultimately eliminate human and wildlife deaths and injuries, and motor vehicle and property damage; as well as increase public awareness and ensure mitigation techniques are cost effective. The mitigation methods employed by the Ministry include:

1. Habitat and Right–of–Way Modification
2. Wildlife Warning Signs
3. Reflectors
4. Wildlife Passage Structures
5. Wildlife Exclusion Fencing
6. Integrated Wildlife Management
7. Transfers and Relocation

4.2 Habitat and Right-of-way Modification

The habitat of rural and semi-rural highways and rights-of-way is intrinsically attractive to wildlife. Given the topography in British Columbia, highways are often located in areas where wildlife naturally congregate, especially during winter, such as valley bottoms and near lakes and rivers. Also many ungulates, in particular deer, prefer to travel along open areas close to cover, which represents the typical highway rights-of-way in British Columbia. Moose are often found feeding along highways adjacent to bogs and marshes.

Stone Sheep feeding at shoulder (Photo: Tourism BC)

Traditionally, the Ministry used a variety of agricultural type seed blends to reseed right-of-way areas, after road construction, to prevent soil erosion. Although effective for their intended purpose, some seed blends, particularly those containing legumes such as clovers and alfalfa, appear to attract animals to the roadside.

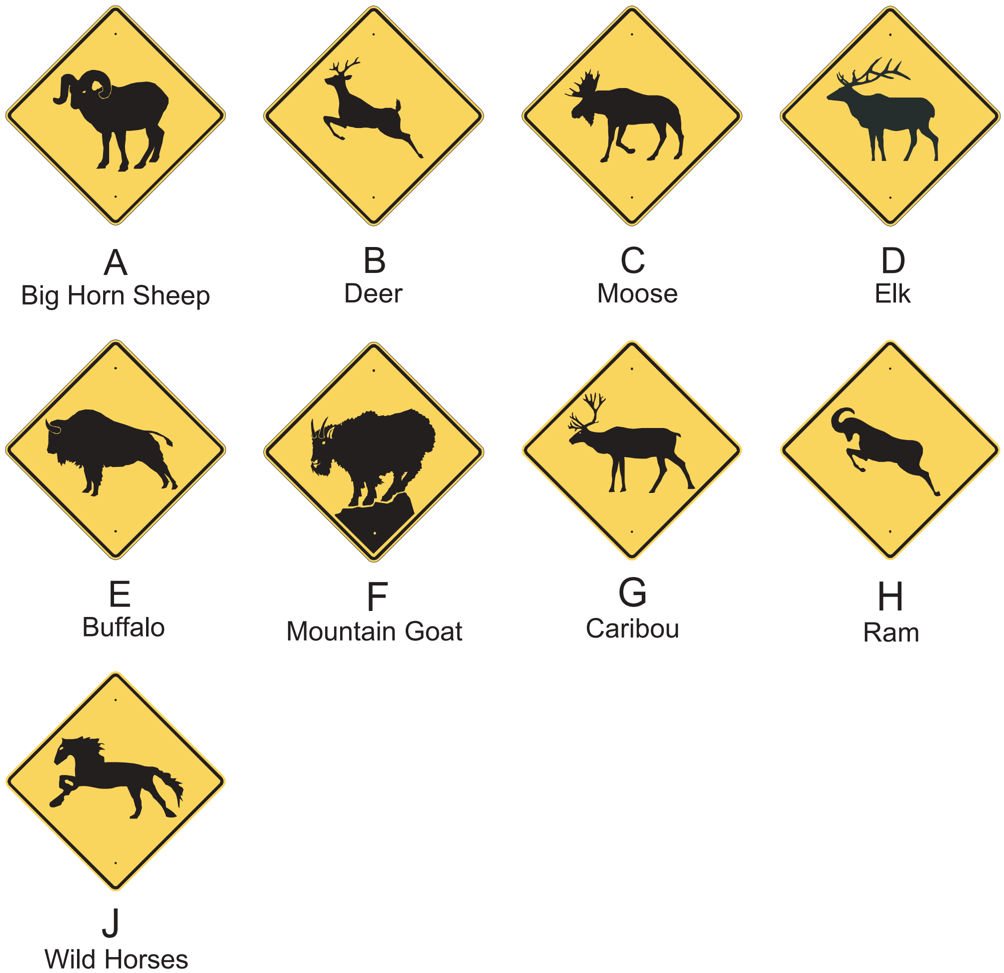
In order to deter this, the Ministry has been adjusting its seed mixes in problem areas to remove the plant types which are known to attract animals. The Ministry is also examining the potential of non-toxic, biodegradable systemic fertilizers and repellents which make roadside plants taste and smell less desirable to ungulates.

Currently, BCMoT is working closely with ICBC and the University of Northern British Columbia on a vegetation-related moose accident reduction project near Prince George. The Ministry is reviewing the potential of timed brushing and mowing in an effort to reduce the attractiveness of roadside vegetation for moose foraging.

4.3 Wildlife Warning Signs

As a consequence of addressing the potential motoring hazard created by the large number of difference species that inhabit British Columbia, the Ministry has developed one of the most comprehensive species-specific wildlife warning sign inventories in the world. (Figure 4.1)

Figure 4.1 – Examples of BC MoT Wildlife Warning Signs



New signs are developed by the Ministry as it becomes aware of the need for such signs as part of its ongoing efforts to keep the motoring public aware of potential wildlife hazards as they are identified. In 2003, the Ministry developed signs for ducks and badgers in response to requests by wildlife preservation groups (Figure 4.2). The signs were immediately put into use.

Figure 4.2 – New BC Wildlife Warning Signs

Wildlife warning signs are the Ministry's most commonly used wildlife-vehicle accident mitigation measure because they are the least expensive and easiest to install and maintain. Standard sized signs (75 cm x 75 cm) cost approximately $150 while oversized signs (244 cm x 122 cm) cost approximately $550 (Figure 4.3).

Figure 4.3 – Standard and oversized signs

75cm x 75 cm

244 cm x 122 cm

The Ministry understands wildlife warning signs have the potential to lose their effectiveness over time if motorists do not perceive a hazard. To ensure its signage is as effective as possible, the Ministry's Traffic Engineering Section continually evaluates warning sign designs developed by transportation agencies in other jurisdictions.

Badger Crossing sign
(Photo: Richard Klafki)

Elk warning signs (Photo: Leonard Sielecki)

Overhead digital sign (Photo: Mike Kent)

To increase the long-term effectiveness of its wildlife warning signs and motorist awareness of wildlife hazards, the Ministry recently developed a high level warning sign to indicate when a wildlife hazard is imminent or when the historic wildlife collision rate is extreme. These signs are particularly useful for addressing short-term and seasonal use for migration events, and other unique wildlife activities, such as salt licking on roads by mountain sheep.

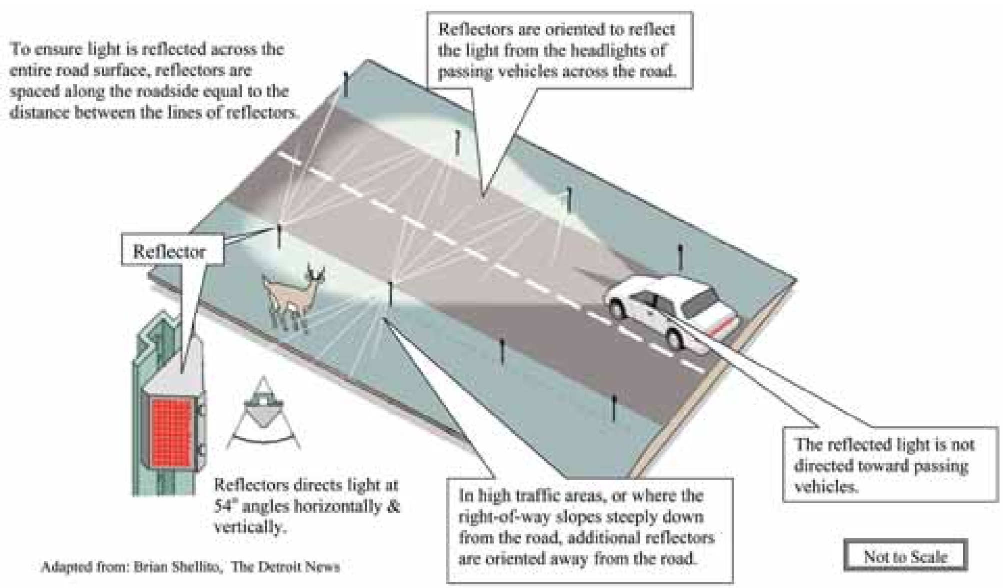
Bighorn Sheep licking salt (Photo: Leonard Sielecki)

The Ministry is currently examining the potential use of WARS data for establishing seasonal, species-specific warning messages on its changeable message signs located throughout the Province.

4.4 Reflectors

The Ministry has been installing and evaluating wildlife warning reflectors since the 1980's as part of its continued effort to reduce wildlife-related accidents. The Ministry has one of the most extensive reflector installations in North America. BCMoT installs the same types of Swarflex and Strieter-Lite reflectors used by transportation agencies in North America and Europe. The reflectors are prisms mounted on posts and installed along the sides of the highway as a means of deterring animals from entering the highway when vehicles are present. At night, as the headlights of an approaching vehicle strike the reflectors they reflect beams of light at ninety-degree angles to the roadway. (Figure 4.4) The concept behind reflectors is that reflected light apparently catches the attention of animals and distracts them long enough to delay their movement onto the road until the vehicle has passed.

Figure 4.4



Reflectors cost approximately $10,000/km to install along both sides of a highway. Maintenance costs range in the order of $500 to $1,000 annually. Reflectors require regular cleaning and alignment. Reflectors have been the targets of theft and vandalism. Locating reflectors in suitable locations along highways is essential to avoid creating new problems for regular highway maintenance.

Reflectors during winter conditions (Photo: Daryl Nolan)

To date, reflectors have been installed at over 95 locations throughout the Province. (Table 4.1) The reflectors have been installed on either one side or both sides on over 160 km of highway. Reflectors have been extensively used in the Interior of British Columbia along highways prone to high numbers of deer-related accidents. The general locations of the reflector installations are shown on the Maintenance Contract Area maps. Reflectors have been extensively used in Region 2 along highways prone to high numbers of deer-related accidents.

Table 4.1 – Wildlife Warning Reflector Locations (April 2004)

Region	District	Highway	LKI Segment	Start km	End km	Length (km)	Side of Highway	Installation Date
1	1	3	1305	64.2	66	1.8	Both	1999
1	1	3	1305	88.9	90.3	1.4	Both	1999
Region	**District**	**Highway**	**LKI Segment**	**Start km**	**End km**	**Length (km)**	**Side of Highway**	**Installation Date**
1	2	19	2313	8.367	10.555	2.188	Right	1997
1	2	19	2314	5.237	7.443	2.206	Right	1997
1	2	19	2314	8.128	10.283	2.155	Right	1997
1	2	19	2314	11.234	13.419	2.185	Right	1997
1	2	19	2347	2.03	7.17	5.14	Right	9/24/99
1	2	19	2348	9.48	14.729	5.249	Right	9/24/99
1	2	19N	2365	0	6.6	6.6	Right	1998
1	2	19S	2366	2.4	8.9	6.5	Right	1998
1	2	19N	2373	15.59	24.02	8.43	Right	1998
1	2	19S	2374	19.52	27.86	8.34	Right	1998
Region	**District**	**Highway**	**LKI Segment**	**Start km**	**End km**	**Length (km)**	**Side of Highway**	**Installation Date**
2	3	3	1380	7.24	7.94	0.7	Both	1993
2	3	3	1380	7.95	9.03	1.08	Northbound	1993
2	3	3	1380	23.54	24.73	1.19	Both	1993
2	3	3	1380	38.32	42.62	4.3	Both	1995
2	3	3	1380	58.74	62.25	3.51	Both	1993
2	3	3	1385	2.78	6.41	3.63	Northbound	1989
2	3	3	1385	18.75	21.41	2.66	Northbound	1989
2	3	3	1385	49.73	52.73	3	Both	1993/95
2	3	3	1395	1.47	2.24	0.77	Both	1993
2	3	3	1395	2.54	3.21	0.67	Both	1993
2	3	3	1395	2.98	4.11	1.13	Both	1993
2	3	3	1395	57.26	58.34	1.08	Both	1987
2	3	3	1395	65.03	66.04	1.01	Both	1994
2	3	93	2110	2.17	2.83	0.66	Both	3/31/95
2	3	93	2110	5.02	6.16	1.14	Both	3/31/95
2	3	93	2110	17.14	17.64	0.5	Both	3/31/95
2	3	93/95	2135	26.56	29.55	2.99	Both	1993
2	3	93/95	2140	0.21	0.87	0.66	Both	1983
2	3	93/95	2140	6.27	7.44	1.17	Both	1994
2	3	93/95	2140	51.02	52.28	1.26	Both	1992

Table 4.1 – Wildlife Warning Reflector Locations (April 2004) continued

Region	District	Highway	LKI Segment	Start km	End km	Length (km)	Side of Highway	Installation Date
2	3	93/95	2140	52.3	53.01	0.71	Both	1992
2	3	93/95	2140	57.74	58.31	0.57	Both	1993
2	3	93/95	2140	63.01	63.82	0.81	Westbound	1994
2	3	93/95	2140	95.41	97.05	1.64	Westbound	1994
2	3	93/95	2140	97.07	97.39	0.32	Both	1994
2	3	93/95	2140	99.15	99.7	0.55	Both	1994

Region	District	Highway	LKI Segment	Start km	End km	Length (km)	Side of Highway	Installation Date
2	4	3	1325	70.5	72.5	2	Both	9/1/95
2	4	3	1325	121.16	123.15	1.99	Both	3/31/95
2	4	3	1325	134.59	143.96	9.37	Both	3/31/95
2	4	3A	1373	59.74	60.13	0.39	Southbound	3/31/95
2	4	3	1375	14.32	14.92	0.6	Southbound	3/31/95
2	4	3	1375	24.26	31.71	7.45	Southbound	3/31/95
2	4	6	1950	9.98	10.35	0.37	Southbound	3/31/95
2	4	22	1340	10.35	11.76	1.41	Both	3/31/95
2	4	33	1327	5	9	4	Both	9/1/95

Region	District	Highway	LKI Segment	Start km	End km	Length (km)	Side of Highway	Installation Date*
2	6	5	1760	50.9	52.3	1.4	Both	1995/96
*reinstalled to new specs Sep-99								
2	6	5	1760	52.3	54.8	2.5	Both	Sep-99
2	6	5	2000	81.55	82.15	0.6	Northbound	1986/88
2	6	5	2000	85	85.2	0.2	Northbound	1986/88
2	6	5	2000	85.4	90.13	4.73	Northbound	1986/88
2	6	5	2000	90.26	91.85	1.59	Northbound	1986/88
2	6	5	2000	91.97	92.05	0.08	Northbound	1986/88
2	6	5	2000	92.43	93.11	0.68	Northbound	1986/88
2	6	5	2000	103.08	103.1	0.02	Northbound	1986/88
2	6	5	2000	104.3	104.42	0.12	Northbound	1986/88
2	6	5	2005	4.74	6.51	1.77	Southbound	1986/88
2	6	5	2005	16.81	19.44	2.63	Southbound	1986/88
2	6	5	2005	19.62	24.49	4.87	Southbound	1986/88
2	6	5	2005	27.38	27.68	0.3	Southbound	1986/88

Region	District	Highway	LKI Segment	Start km	End km	Length (km)	Side of Highway	Installation Date
2	7	97	1145	28.3	30.3	2	Both	2004
2	7	97	1145	32	35.3	3.3	Both	2003
2	7	97	1145	50.27	54.32	4.15	Both	2004
2	7	97	1145	54.3	62.4	8.1	Both	2003
2	7	97	1145	79.1	84.1	5	Both	2004
2	7	97	1150	18.8	21.6	2.8	Both	11/29/99

Table 4.1 – Wildlife Warning Reflector Locations (April 2004) continued

Region	District	Highway	LKI Segment	Start km	End km	Length (km)	Side of Highway	Installation Date
3	8	49	1197	3.22	4.12	0.9	Both	9/1/96
3	8	97	1160	128.32	128.75	0.43	Both	8/30/99
3	8	97	1170	32.39	33.6	1.21	Both	9/1/96

Region	District	Highway	LKI Segment	Start km	End km	Length (km)	Side of Highway	Installation Date
3	10	16	1520	59.34	62.81	3.47	Both	8/1/98
3	10	16	1520	74.5	76.655	2.155	Both	8/1/95
3	10	16	1520	77.41	77.845	0.435	Both	8/1/94
3	10	16	1520	78.52	79.565	1.045	Right	8/1/95
3	10	16	1520	78.535	78.695	0.16	Left	8/1/95
3	10	16	1520	80.018	81.029	1.011	Both	8/1/95
3	10	16	1520	84.225	85.253	1.028	Both	8/1/95
3	10	16	1520	87.584	92.392	4.808	Left	8/1/95
3	10	16	1520	88.507	92.404	3.897	Right	10/1/96
3	10	16	1520	93.277	94.02	0.743	Both	10/1/96
3	10	16	1520	97.36	97.928	0.568	Both	8/1/95
3	10	16	1520	98.01	98.165	0.155	Right	9/1/96
3	10	16	1520	99.218	100.095	0.877	Both	9/1/96
3	10	16	1520	103.8	104.8	1	Both	12/20/95
3	10	16	1520	108.18	110.5	2.32	Both	11/29/92
3	10	16	1580	103.8	104.8	1	Both	10/1/94
3	10	16	1590	28.39	28.99	1.6	Both	12/1/96
3	10	16	1590	29.49	31.43	1.94	Both	12/1/96
3	10	16	1590	65.28	65.98	0.7	Both	7/16/99
3	10	16	1590	66.12	66.98	0.86	Both	7/16/99
3	10	37	1514	44.9	47.1	2.2	Both	1997
3	10	383	N/A	0.16	1.66	1.5	Both	1995

Region	District	Highway	LKI Segment	Start km	End km	Length (km)	Side of Highway	Installation Date
3	11	95A	2115	12.42	12.83	0.41	Both	1983/95
3	11	95A	2115	13.17	19.79	6.62	Both	1994
3	11	95A	2115	15.72	19.24	3.52	Eastbound	1993
3	11	95A	2115	21.9	24.19	2.29	Both	1992
3	11	95A	2115	24.21	24.35	0.14	Eastbound	1992
3	11	95	2160	2.95	3.32	0.37	Westbound	1992
3	11	95	2160	12.16	13.62	1.46	Both	1993
3	11	95	2160	13.65	14.1	0.45	Both	1993
3	11	95	2160	14.19	14.82	0.63	Westbound	1994

The success of wildlife warning reflectors for reducing wildlife accidents continues to be the object of discussion and speculation. Research by BCMoT and other transportation agencies continues to provide inconsistent evaluations of the devices.

Based upon the WARS data collected, it is apparent not all wildlife reflector installations have been successful. Most installations are less than 2 kilometres long, with 17% being

0.5 kilometres or less in length. Short installations make evaluation difficult because it is easier for animals to travel to the ends of the reflector installations and cross the highway. Given the relatively short distances of the majority of the reflector installations, the relatively low number of wildlife accidents recorded before and after the reflectors were installed, and the lack of measurable controls, determining if the reflectors produce statistically significant reductions in the numbers of deer-related motor vehicle accidents is very difficult.

The “before and after” method typically used to evaluate reflectors does not give a true picture of effectiveness because there is no control of those factors which can change during the course of the evaluation period, such as weather, traffic flow, and deer population densities (Damas and Smith, 1983). However, even if accidents are reduced following the implementation of a safety project, it does not necessarily follow that the decrease was caused by the project (Griffin, 1997).

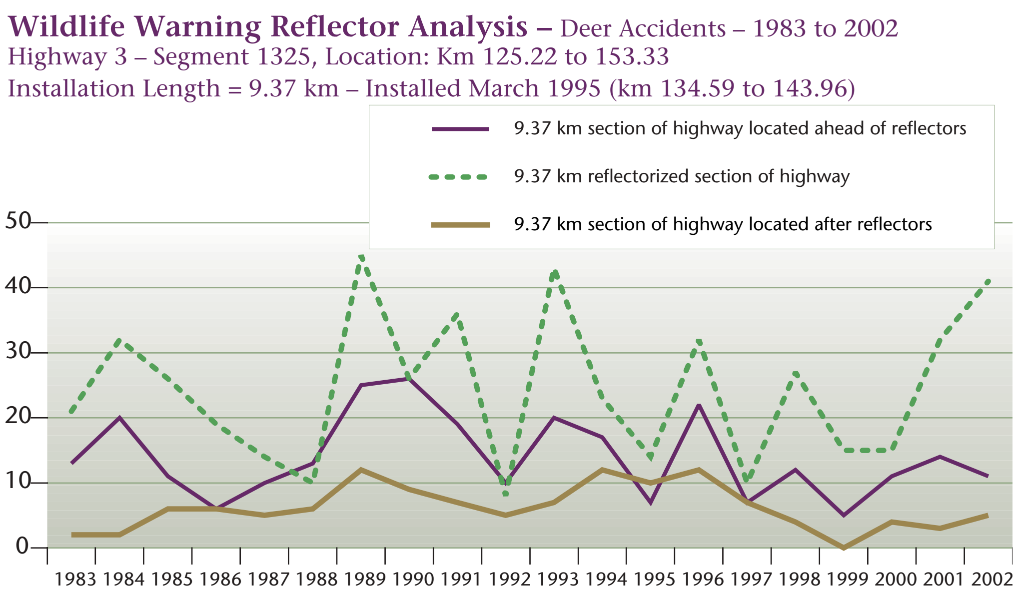
Wildlife Warning Reflector Installation Case Studies

Highway 3, located near the Canada/US border in British Columbia, north of the U.S. states of Washington, Idaho, and Montana, has one of the worst records for ungulate related motor vehicle accidents in British Columbia. In an attempt to reduce the number of deer related motor vehicle accidents, BCMoT installed wildlife warning reflectors on a 9.37 km section of Highway 3 (LKI Segment 1325), east of Grand Forks, and on a 7.45 km section of Highway 3 (LKI Segment 1375), east of Creston. The installations were completed in March 1995. These are the longest continuous reflector installations in British Columbia.

a) Highway 3 (Segment 1325)

When comparing the deer accident rates before and after the reflector installation, it appears the number of deer accidents recorded increased after the installation (Figure 4.4). When comparing the deer accident rate for the 9.37 km reflectorized section of the highway with the deer accident rate for an immediately adjacent 9.37 km non-reflectorized section of the highway, it appears the installation of reflectors did not alter the overall local accident trends.

Figure 4.4 Wildlife Warning Reflector Installation Analysis (Hwy 3, Segment 1325)

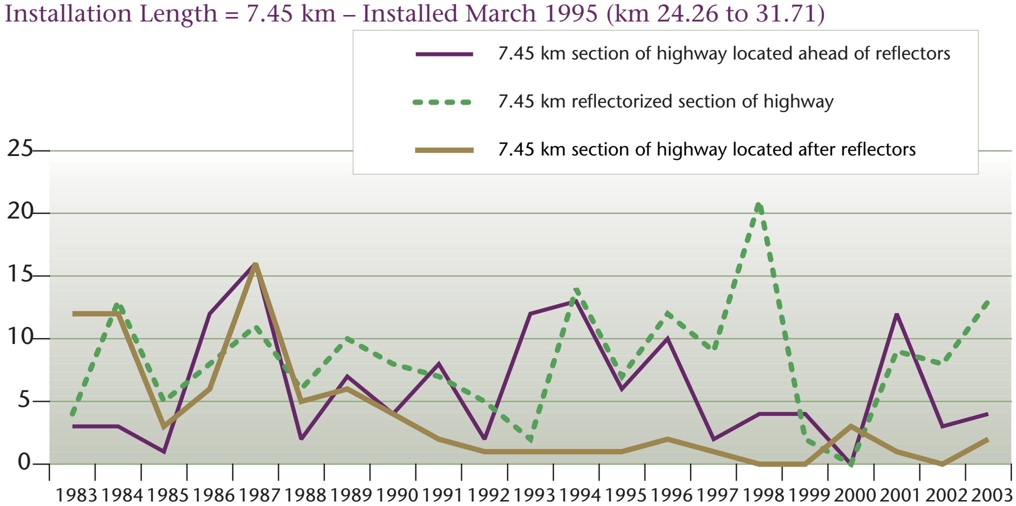


b) Highway 3 (Segment 1375)

When comparing the deer accident rates before and after the reflector installation, it appears the number of deer accidents recorded increased after the installation (Figure 4.5). When comparing the deer accident rate for the 7.45 km reflectorized section of the highway with the deer accident rate for immediately adjacent 7.45 km non-reflectorized sections of the highway, it appears the installation of reflectors did not alter the overall local accident trends.

Figure 4.5 Wildlife Warning Reflector Installation Analysis (Hwy 3, Segment 1375)

Wildlife Warning Reflector Analysis – Deer Accidents – 1983 to 2002
Highway 3 – Segment 1375, Location: Km 16.81 to 39.16
Installation Length = 7.45 km – Installed March 1995 (km 24.26 to 31.71)



Further Study

Although these trends were not observed as part of a controlled scientific experiment, they raise questions about the effectiveness of wildlife warning reflectors. When comparing the deer accident rates before and after a reflector installation, there appears, at least in these two cases, to be no consistent accident rate drop after the reflector installation that can be specifically attributed to the reflectors.

A more thorough analysis of WARS data is required to determine the long-term effectiveness of wildlife warning reflectors on provincial highways. There may be many reasons why dramatic fluctuations in the number of accidents occur, including climate, traffic speed and volume, time of day, and wildlife movement.

In 1999, ICBC provided BCMoT with $19,000 to initiate a controlled study to determine the effectiveness of wildlife warning reflectors on a 3.4 km stretch of Highway 5 between Clearwater and Vavenby, in central British Columbia. It is anticipated data will be collected for at least 4 to 5 years before any conclusive results can be expected.

Spectrometric Evaluation of Wildlife Warning Reflectors

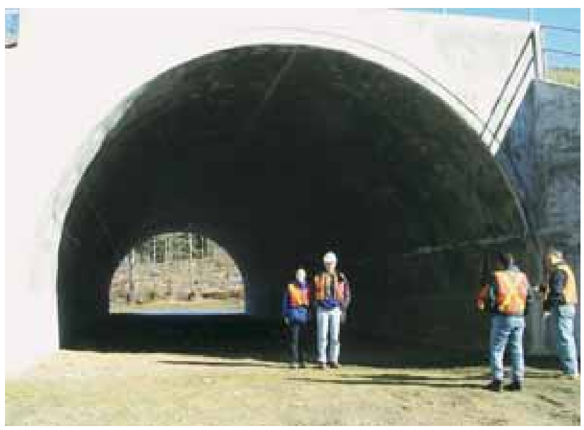
In addition to field tests, BCMoT began examining how wildlife warning reflectors may influence the roadside behavior of deer. As a first step toward understanding how wildlife warning reflectors operate, BCMoT conducted tests on different coloured

Reflectors (Photo: Leonard Sielecki)

Swarflex and Strieter-Lite reflectors to determine their fundamental spectrometric and photometric properties (Sivic and Sielecki, 2001). The tests were designed to measure the reflected light spectrum, luminous intensity and light distribution in a horizontal and vertical plane. BCMoT has traditionally used red coloured Swarflex and Strieter-Lite reflectors. Questions have been raised regarding the effectiveness of red coloured reflectors for deer (Zacks, 1986). In light of deer vision research (Jacob et al., 1994), BCMoT is investigating if other colours (green, amber and white) of reflectors may be more effective than red ones. Installation of white reflectors has begun on selected sections of Highway 19 as part of the Vancouver Island Highway Project.

Trepanier Overpass, 1987 (Photo: Bill Harper)

Wildlife Underpass, 1987 (Photo: Bill Harper)



Wildlife Underpass, 1999 (Photo: Leonard Sielecki)

VIHP Underpass, 1999 (Photo: Leonard Sielecki)

4.5 Wildlife Passage Structures

Grade-separated wildlife passage structures have special importance with regards to the Ministry's efforts to minimize habitat fragmentation. Whether they are used independently, or incorporated with wildlife exclusion fencing and wildlife exclusion systems, they represent the safest method of allowing wildlife to traverse a highway corridor.

In 1987, BCMoT constructed the first wildlife overpass in Canada and the second in North America. The Trepanier Overpass on the Okanagan Connector built upon the concept of the first overpass built in Utah. At a cost of approximately $1 million, the Trepanier Overpass was developed from the design of a pedestrian highway overpass. Structural advancements were required to accommodate the weight of soil and vegetation necessary to create a "natural" environment to encourage wildlife use. Detailed wildlife studies

conducted for the Okanagan Connector supported the decision to construct the overpass. The overpass provided an essential passage for critical summer and winter deer habitat.

There are over 30 crossing structures located in British Columbia used for wildlife passage. All, but one, are underpasses. They were installed on the Coquihalla Highway (Highway 5), the Okanagan Connector, Highway 97 and the Vancouver Island Highway. The Ministry has found that wildlife overpasses can be difficult to locate given terrain and geologic constraints. If designed properly, underpasses can be multi-purpose, suiting both wildlife and highway infrastructure needs. The size and design of the structures has been evolving as the understanding of how wildlife interact at the highway/wildlife habitat interface grows. Underpasses are now larger and more species-friendly, with carefully selected flooring materials to suit the target species.

In a continued effort to maximize the use of environmental enhancement funds and improve the effectiveness of passage structures, the Ministry is focusing its attention to underpasses for multi-species use. Large multi-plate culverts can cost upwards of $500,000 while concrete bridges and box culverts can cost several million dollars. Stream crossing structures can also function as wildlife underpasses, if consideration is given to ensuring that the design criteria includes provision for wildlife movement. This can be accomplished through the incorporation adequately sized passage envelopes and suitable trail surfacing over riprapped areas.

4.6 Wildlife Exclusion Fences

Since the mid 1980s, the Ministry has been proactively locating wildlife exclusion fencing on high speed, high volume highways transecting identified wildlife habitat. (Table 4.2)

The greatest investment in wildlife accident mitigation by BCMoT has been its wildlife exclusion systems, incorporating specialized fencing designs and crossing structures. Since the mid 1980s the Ministry has been one of the leaders in designing and developing wildlife exclusion systems. MoT's wildlife exclusion systems on the Coquihalla and the Okanagan Connector were pioneering efforts for their time.

The recently completed Vancouver Island Highway wildlife exclusion installations are state of the art initiatives. With each successive project, the Ministry has refined its designs and standards, to improve the efficiency and effectiveness of its wildlife exclusion systems. Both fence and crossing structure designs have evolved over time.

One-way gate approach (Photo: Mike Kent)

One-way gate (Photo: Mike Kent)

Gate tynes (Photo: Leonard Sielecki)

Table 4.2 Locations of Wildlife Exclusion Fencing

Total Fencing Length on British Columbia Highways = 467.44 km

(This figure includes fencing located on both sides of highways)

Location: Coquihalla Highway (No. 5)	Distance (km)	Completion Date
Dry Gulch – Henning Bridge	5.99	July 1994
Henning Bridge – Juliet Creek	9.23	May 1993
Juliet Creek Bridge – Brodie Bridge	9.35	Oct 1993
Brodie Bridge – Kingsvale Bridge	8.72	March 1997
Upper Clapperton Creek – Desmond Lake	8.3	April 1990
Desmond Lake – Meadow Creek Road	8.6	July 1988
Meadow Creek Road – Chuwhels Mountain Road	8.2	Sept 1987
Chuwhels Mountain Overpass – Connolly Lake Overpass	5.2	June 1993
Connolly Lake Overpass – Inks Lake Interchange	7.6	May 1994
Total Fencing (includes both sides of highway)	**140.44 km**	

Location: Okanagan Connector Freeway (No. 97C)	Distance (km)	Completion Date
Aspen Grove to Drought Hill Interchange	82	Fall 1990
Total Fencing (includes both sides of highway)	**164 km**	

Location: Highway 97*	Distance (km)	Completion Date
Bentley Road to Deep Creek	15	March 1999
Total Fencing (one side of highway)	**15 km**	

Location: Inland Island Highway (No. 19)	Distance (km)	Completion Date
Mud Bay to Trent River (one side of highway)	20	March 1999
Millar Creek to Oyster River (both sides of highway)	23	April 2001
Maple Lake Pit to Headquarters Creek (both sides of highway)	26	August 2001
Oyster River to Willow Creek (both sides of highway)	15	May 2001
Total Fencing (includes both sides of highway)	**148 km**	

** Fencing materials provided by BCMoT; ICBC contributed $128,000, construction labour and on-going maintenance provided by members of the Summerland Sportsmens' Association and the Peachland Sportmens' Association, affiliated associations of the British Columbia Wildlife Federation.*

The Ministry has the most extensive network of wildlife exclusion fencing in North America. To date approximately 470 km of fencing has been installed on the Coquihalla Highway (Highway 5), the Okanagan Connector Freeway, Highway 97 and the Vancouver Island Highway Project.

Wildlife fence on Highway 97 (Photo: Leonard Sielecki)

In most cases, fencing is installed as a part of new highway construction or on existing highways where problematic wildlife accident locations have been identified.

Fencing can be installed as a primary deterrent or integrated with crossing structures such as overpasses, underpasses and one way gates. This type of mitigation is expensive. It can cost between $40,000 to $80,000 per km to fence both sides of a highway. Construction costs vary greatly due to differences in terrain and locations.

Exclusion fencing is the most effective means of keeping wildlife off highway right-of-ways. The Ministry's experience with 2.4 m high fencing on both sides of right-of-ways show it is 97–99% effective in preventing wildlife-vehicle accidents.

Wildlife exclusion fencing has proven very effective in reducing wildlife accidents on the Coquihalla Freeway (Highway 5) located between Hope and Merritt. On the 35 km portion of the Coquihalla Freeway, between Dry Gulch Bridge and Kingsvale Bridge, wildlife exclusion fencing eliminated wildlife accidents (from 74, in the 1989 to 1993 period, to 0, in the 1994 to 1998 period).

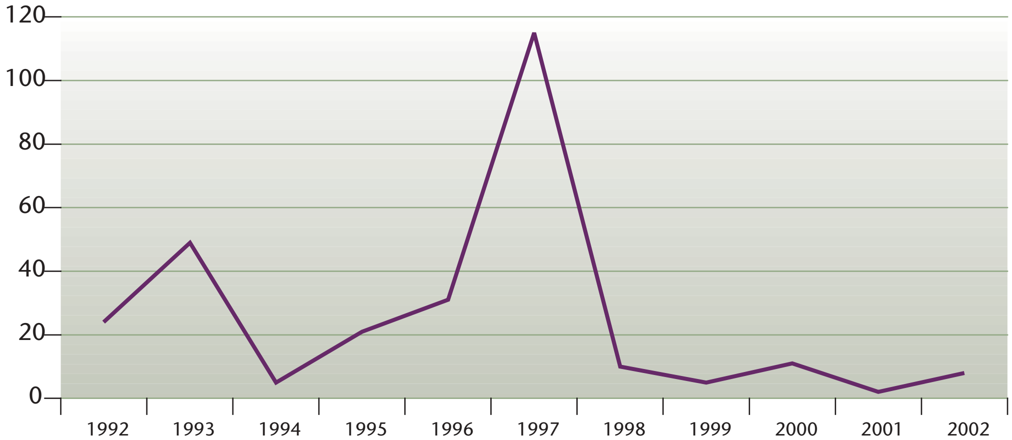
Since the wildlife exclusion fencing was installed on the Coquihalla Connector Freeway (Highway 97C) in 1990 to 1998, no wildlife accidents have been recorded in either the westbound or eastbound lanes of the highway where the fence is located.

Slumping ground (Photo: Leonard Sielecki)

On Highway 97, between Peachland and Summerland, after a 21 kilometre wildlife exclusion fence was constructed on the west side of the highway, the rate of wild animal accidents/km/year dropped by over 93%. From 1979 to 1998 the annual accident rate was 1.93 accidents/km/year. In 1999, after the fence was completed, the accident rate dropped to 0.13 accidents/km/year. (Figure 4.6)

Fallen tree (Photo: Leonard Sielecki)

Figure 4.6 – Recorded Deer Accidents (1992 to 2002)
Effectiveness of Wildlife Fence (Highway 97 Peachland to Summerland)



The Mud Bay to Trent River section of wildlife exclusion fencing on the Inland Island Highway was constructed on the west side of the highway alignment. The single-sided fencing configuration was in accordance with the Vancouver Island Highway Project's wildlife consultants recommendation for dealing with Roosevelt Elk resident in the area.

Wildlife exclusion fencing has just been constructed between Oyster River and Willow Creek and between Millar Creek and Oyster River on both sides of the Inland Island Highway. Additional fencing is currently under construction on both sides of the Inland Island Highway between Maple Lake Pit and Headquarters Creek.

Exclusion fencing has been found to be the most effective means of keeping wildlife off highway rights-of-way when installed in conjunction with wildlife crossing structures. Underpasses increase the success of exclusion fencing by increasing the permeability and habitat connectivity across highways (Clevenger and Waltho, 2000). The Ministry's experience with 2.4 m high fencing on both sides of rights-of-way shows it is 97-99% effective in preventing wildlife-vehicle accidents. These results are appear higher than the 80% reductions in wildlife accidents experienced when wildlife exclusion fencing was installed along the Trans-Canada Highway in Banff National Park (Clevenger, Chruszez and Gunson, 2001).

BCMoT has also found wildlife exclusion fencing appears to be effective when installed on only one

Amphibian fencing (Photos: Leonard Sielecki)

Amphibian fencing connecting to underpass (Photos: Leonard Sielecki) side of a highway, if the unfenced side of the highway has pre-existing barriers to animal movement, such as a cliff face. On Highway 97, between Bentley Road and Deep Creek Bridge, fencing was installed on the west side of the highway right-of-way. On the east side of the highway right-of-way there is a steep cliff dropping down to Okanagan Lake. It is anticipated that the wildlife exclusion fence on the west side of the highway right-of-way will prevent a repeat of earlier recorded accident peaks (see Figure 4.3).

Vancouver Island Highway Project wildlife fencing (Photo: Leonard Sielecki)

As part of its growing commitment to increase protection for other species of wildlife, BCMoT is currently installing amphibian exclusion fencing being attached to the wildlife exclusion fencing located adjacent to Millar Creek on the Inland Island Highway. The fence extends for 1.8 km on both sides of the highway from the north side of Millar Creek to Keddy Swamp tributary No. 3 for a combined length of 3.6 km.

It should be noted, regular maintenance and monitoring are key factors to ensuring wildlife exclusion fencing remain effective. During fence audits, BCMoT has found that the integrity of fencing can be compromised by poor fence designs, faulty construction and materials, extreme snow accumulation and tree falls, as well as poachers and ATV riders seeking passage through the fence

4.7 Integrated Wildlife Management

It is becoming evident that approaching the issue of wild accident mitigation from a single species perspective does not provide the maximum benefit for motorists or wildlife. In British Columbia, integrated wildlife accident management is becoming a greater component of new construction and rehabilitation projects. While, for over 20 years, BCMoT projects have focused on the accident issues associated with larger ungulates, primarily deer, elk and moose, new projects are increasingly becoming more responsive to the needs of smaller mammals and amphibians.

Wildlife exclusion systems are being designed and integrated with larger scale structures and alignment drainage schemes to provide protect an increasing number of animal species. The construction of larger underpasses, such as bridges and culverts, and the retention of natural watercourses, vegetation and landforms under these structures, increases their effectiveness for wildlife and fish passage. High quality wildlife habitat ponds are developed along highway alignments to lessen the impact of highways on wildlife habitat.

Vancouver Island Highway Project Habitat Pond (Photo: Sean Wong)

Most recently, on the Vancouver Island Highway Project, wildlife crossing structures and wildlife habitat ponds were carefully integrated with natural topography and drainage systems, to reduce the potential for wildlife-related motor vehicle accidents and limit the wildlife habitat fragmenting effects of highways.

4.8 Transfers and Relocations

While the Ministry strives to minimize and mitigate the impact of highway development on wildlife, it is not always possible to do so. At times, unforeseen situations develop. As a consequence, in order to ensure a species is protected, the Ministry has conducted a number of limited transfers and relocations. These were done, either to deal with a temporary situation due to construction, or for permanent species protection.

The Ministry's more current and successful transfers and relocations were associated with the Vancouver Island Highway Project. Although extensive wildlife studies were conducted before and during the construction phase of the highway and wildlife habitat protection and accident mitigation infrastructure was established as an integral part of the project for predicted numbers and species of wildlife, unexpected situations developed. Shortly before the highway was scheduled to open, the Ministry environmental staff identified large numbers of previously undiscovered salamanders becoming active after long-term hibernation in right-of way mud, and Roosevelt elk migrating into the area after highway construction activities ended.

Newt Salvage (Photo: Sean Wong)

While passage structures were designed and constructed for the salamanders, the Ministry had these amphibians transferred in buckets by hand across the highway. The transfers continued until amphibian fencing was in place and the salamanders were safely guided to strategically placed underpasses.

Repellent Boxes (Photo: Leonard Sielecki)

While the Ministry strives to minimize the impact of highway development on wildlife, unforeseen factors can make it impossible to do so in all cases. Although extensive pre-development wildlife studies were conducted and wildlife vehicle accident mitigation was established as integral part of the Vancouver Island Highway Project for predicted numbers and species of wildlife, unexpected numbers of Roosevelt elk began appearing after the highway opened in September, 1999.

Initially, the Ministry kept the elk off the highway with repellents and scare tactics. However, after a unexpected number elk were killed in motor vehicle accidents within the first year of the highway operating, the Ministry focused its efforts on more direct methods of mitigation. In order to reduce potential hazards, the Ministry, in consultation with the B.C. Ministry of Water, Land and Air Protection (MWLAP), decided to relocate as many of the animals from problematic locations along the highway as possible. Relocation of wildlife is not a common approach for the Ministry to deal with potential wildlife hazards. However, this approach was taken because of the size of the animals involved and the posted speed limit of the highway. The relocation was organized and conducted by MWLAP biologists for the Ministry. In November and December, 2000, a total of nine elk from the estimated herd of 50 animals were captured. These animals were then relocated to the west coast of Vancouver Island, approximately 100 km away. (Map 4.1)

Elk Relocation

Corral (Photo: Kim Brunt)

Capture (Photo: Kim Brunt)

Transport (Photo: Kim Brunt)

Release (Photo: Kim Brunt)

Map 4.1 Elk Relocation – Waterloo Creek to Klanawa River