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 and Infrastructure and Infrastructure 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.

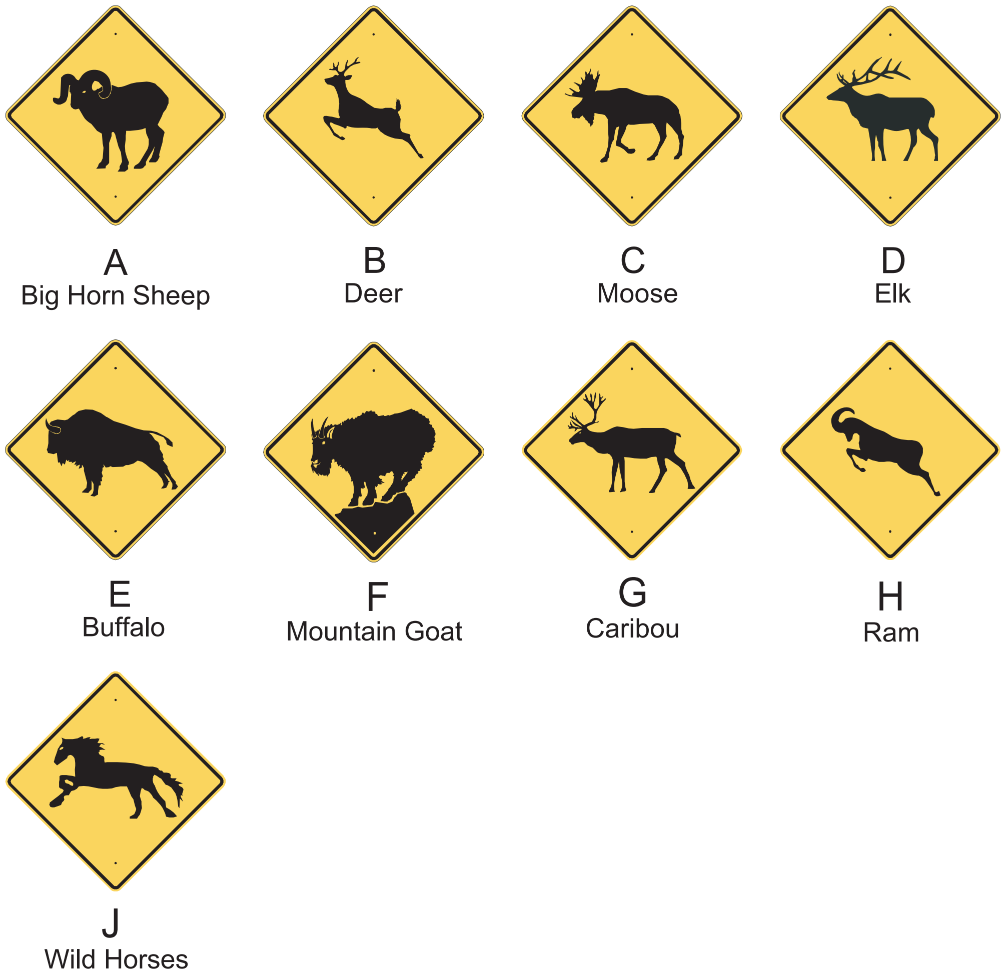
In order to deter this, the Ministry has been adjusting its seed mixes in problem areas to remove the plant types which are known to attract animals. The Ministry is also examining the potential of non-toxic, biodegradable systemic fertilizers and repellents which make roadside plants taste and smell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

Badger Crossing sign
(Photo: Richard Klafki)

Elk warning signs (Photo: Leonard Sielecki)

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.

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

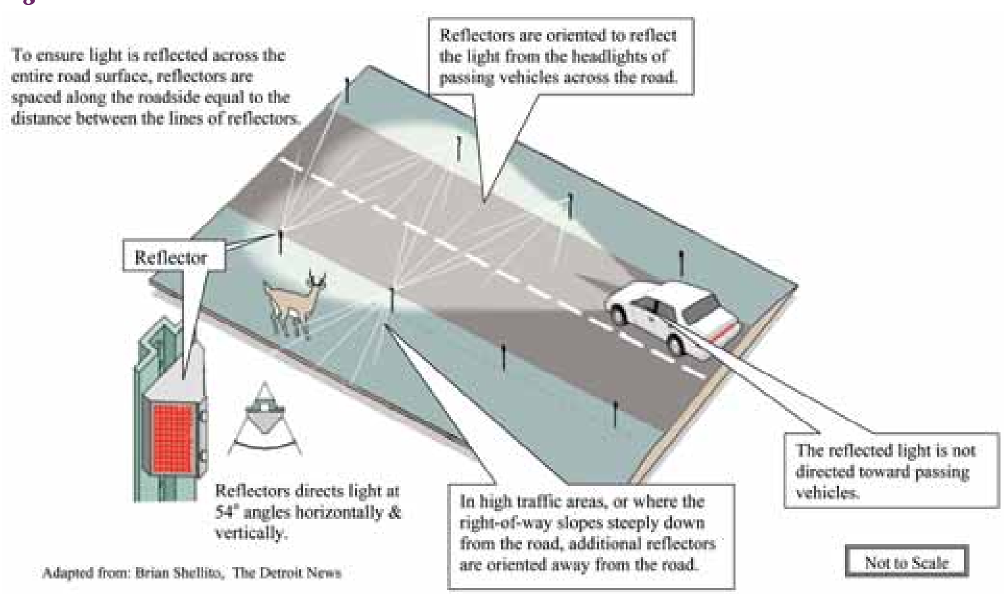
Bighorn Sheep licking salt (Photo: Leonard Sielecki) use for migration events, and other unique wildlife activities, such as salt licking on roads by mountain sheep.

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 1980s 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).

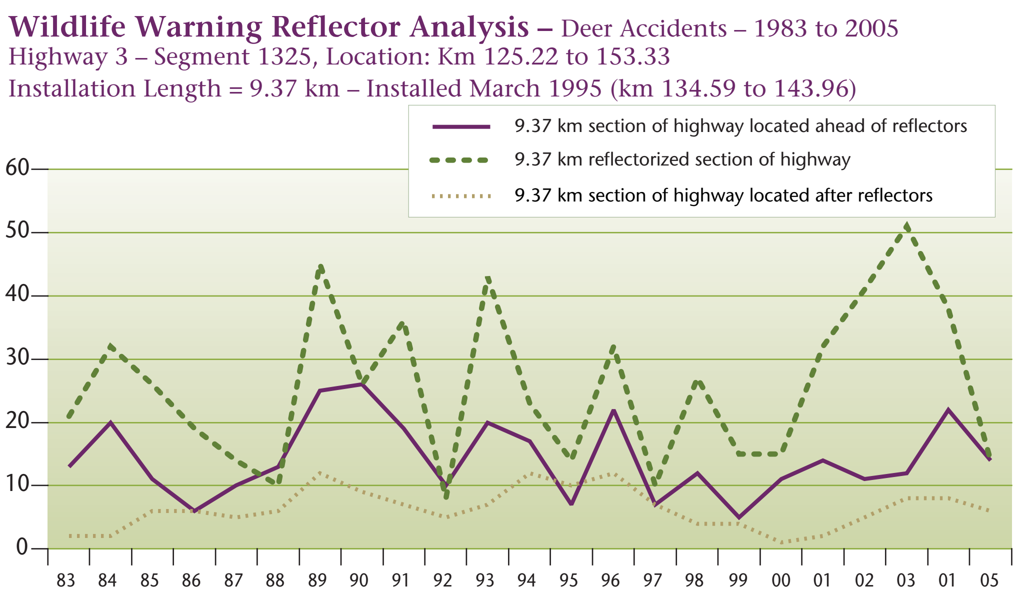
Wildlife Warning Reflector Installation Case Studies

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.

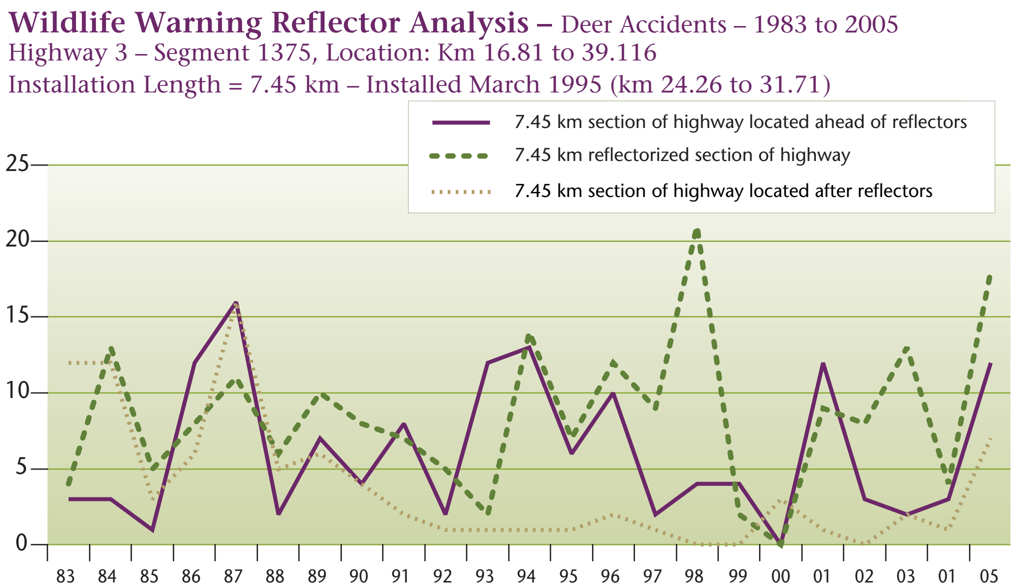
Figure 4.5 Wildlife Warning Reflector Installation Analysis (Hwy 3, Segment 1325)



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



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. (Sielecki, 2001b)

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)

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.

Wildlife Underpass, 1999 (Photo: Leonard Sielecki)

VIHP Underpass, 1999 (Photo: Leonard Sielecki)

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)

One-way gate approach (Photo: Mike Kent)

One-way gate (Photo: Mike Kent)

Gate tynes (Photo: Leonard Sielecki)

The greatest investment in wildlife accident mitigation by BC MoT 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.

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**	

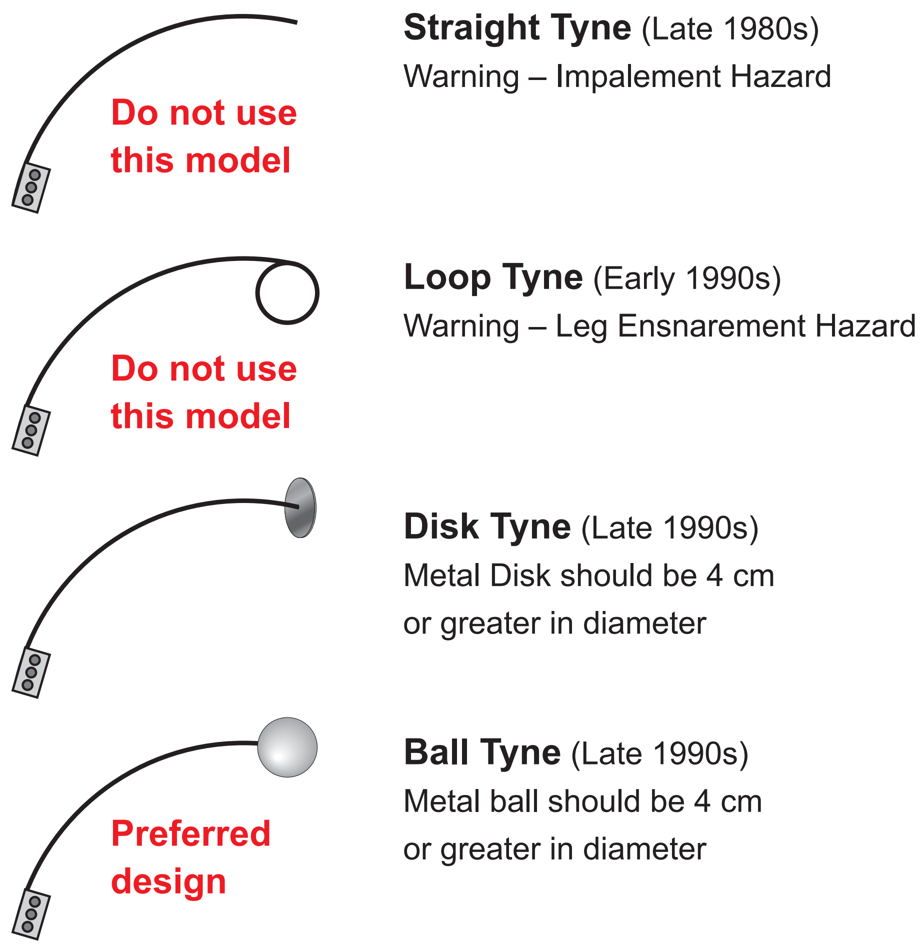
Location: Okanagan Connector Freeway (No. 97C)	Distance (km)	Completion Date
Aspen Grove to Drought Hill Interchange	82	Fall 1990
Total Fencing (includes both sides of highway)	**164 km**	

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.*

Figure 4.7 – One-way Gate Metal Tyne Design Evolution



Source: Leonard Sielecki, 2005 British Columbia Ministry of Transportation and Infrastructure

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).

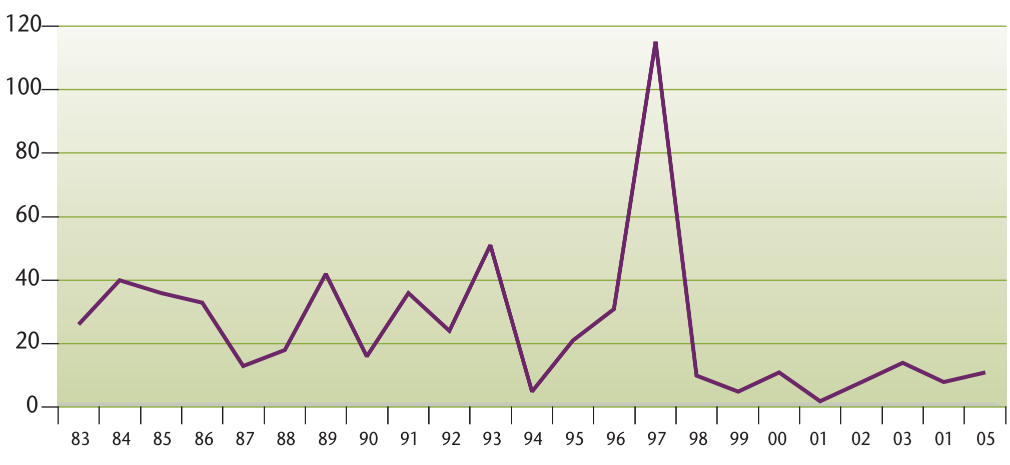
Since the wildlife exclusion fencing was installed on the Coquihalla Connector Freeway (Highway 97C) in 1990 to 1998, no wildlife accidents have been recorded in either the westbound or eastbound lanes of the highway where the fence is located.

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)

Slumping ground (Photo: Leonard Sielecki)

Fallen tree (Photo: Leonard Sielecki)

Figure 4.8 - Recorded Deer Accidents (1983 to 2005)
Effectiveness of Wildlife Fence (Highway 97 Bentley Road to Deep Creek)



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).

Amphibian fencing (Photos: Leonard Sielecki)

Amphibian fencing connecting to underpass (Photos: Leonard Sielecki)

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

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.

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

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.

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.

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

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 most current and successful transfers and relocations are associated with the Vancouver Island Highway Project (VIHP). 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. The relocations of newts and Roosevelt Elk are described below.

Newt Salvage (Photo: Sean Wong))

4.8.1 Temporary Amphibian Relocations on the VIHP

Shortly before the highway was scheduled to open, the Ministry environmental staff identified large numbers of previously undiscovered newts becoming active following long-term hibernation in right-of way mud, after highway construction activities ended.

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

Repellent Boxes (Photo: Leonard Sielecki)

4.8.2 Roosevelt Elk Relocation on the VIHP

Although the VIHP's wildlife consultants conducted extensive pre-development wildlife studies and wildlife vehicle accident mitigation was established as an integral part of the VIHP 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 an unpredicted 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.

Relocation of large ungulates has not been a common for the protecting motorist and wildlife in British Columbia, the Ministry, in consultation with the B.C. Ministry of Environment (MoE), decided to relocate as many of the Roosevelt elk from problematic locations along the VIHP as possible. However, this approach was taken because of the size of the animals involved and the posted 110 km/hr speed limit of the highway. The relocation was organized and conducted by MoE 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, to a location where suitable habitat had been identified.

Elk Relocation

Corral (Photo: Kim Brunt)

Capture (Photo: Kim Brunt)

Transport (Photo: Kim Brunt)

Release (Photo: Kim Brunt)

4.8.3 British Columbia Habitat Conservation Trust Fund (HCTF) Roosevelt Elk Relocation Projects in British Columbia[1]

The Roosevelt elk are a majestic ungulate species found in North America. In Canada, their distribution has been limited to Vancouver Island and parts of the Lower Mainland in British Columbia. Since the colonization of the western coast of North America by Europeans, hunting and development pressures have threatened Roosevelt elk. By 1900, Roosevelt elk, with the exception of small herd on Vancouver Island and a small isolated population near Phillips Arm, had been extirpated from British Columbia. Due to their limited numbers, Roosevelt elk are a “Blue-listed” species in British Columbia.

1 Adapted from Reynolds, D., Lower Mainland Roosevelt Elk Recovery Project, HCTF Project File #: 2-127, 3. Annual/Progress Report (April 29, 2006.)

Map 4.1 Elk Relocation – Waterloo Creek to Klanawa River

As part of its commitment to support the British Columbia Government's mandate of environmental stewardship, the Ministry uses its Environmental Enhancement Fund to support the efforts of the British Columbia Habitat Conservation Trust Fund (HCTF) with its Vancouver Island Roosevelt Elk Relocation and Lower Mainland Roosevelt Elk Recovery Projects. These HCTF projects help the Ministry increase motorist safety by reducing the potential for elk-related motor vehicle collisions while protecting a relatively rare and valuable wildlife resource.

4.8.3.1 Elk Relocation and Recovery

Efforts of the HCTF have led to the establishment of new populations of Roosevelt elk on Vancouver Island and the restoration of Roosevelt elk populations in Lower Mainland forests. Initially, elk from Vancouver Island were released on the Sunshine Coast on the Sechelt Peninsula in 1987 and near Powell River in 1993. These populations have grown quickly and soon provided animals for release elsewhere on the coast.

The main goal of the project is to establish viable populations of elk in priority wilderness areas of the Sunshine Coast and the Lower Mainland. Elk are trapped and relocated to wilderness areas where there is little risk of the animals becoming problematic. Efforts are made to release elk only onto Provincial Crown lands that are of superior habitat quality and geographically isolated to prevent the animals returning to trap sites or urban habitats. Groups of 20 to 25 elk are targeted for release at selected locations in each area. Groups targeted for release are composed mostly of cows and calves and a few young adult bulls.

By capturing nuisance elk for habitat stocking purposes, elk-related conflicts involving motorists, landowners, forest companies and the general public are reduced at the source location, enabling the MoE to meet its elk management objectives. The establishment of viable elk populations in unoccupied habitats is a primary management objective of the MoE in the south-eastern British Columbia. The project also supports the objectives of the Provincial Biodiversity and Environmental Stewardship Branch for Roosevelt elk management and recovery.

The Vancouver Island Roosevelt Elk Relocation Project was established to address elk-related agricultural conflicts and human safety issues. Roosevelt elk on Vancouver Island are captured and relocated to areas identified as high quality elk habitat to enhance elk distribution and abundance on the island.

In 2000, the HCTF established the Lower Mainland Roosevelt Elk Recovery Project to continue the re-establishment of elk in historically occupied watersheds. The project involves the capture and relocation of elk endangered by highway development on Vancouver Island, nuisance animals from the urban fringe along the Sunshine Coast, and animals in conflict with forest licensees. Roosevelt elk are captured and relocated from urban conflict areas to remote wilderness areas.

4.8.3.2 Project Partners and Stakeholders

The HCTF has established partnerships to support the Roosevelt elk relocation and recovery projects. In addition to the British Columbia Ministry of Transportation and Infrastructure, its partners include: the British Columbia Conservation Corps, the British Columbia Conservation Foundation, the British Columbia Ministry of Environment, Coastal Inlet Adventures, Regional Power, the Sunshine Coast Rod and Gun Club and First Nations on the Sunshine Coast and the Lower Mainland.

Extensive stakeholder consultation has been conducted throughout the life of the projects. Project activities and achievements have been publicized through press releases, videos, posters, local meetings, consultations and presentations.

4.8.3.3 Approach

Once suitable trapping sites near problematic Roosevelt elk locations are identified, bait is used to attract the animals to the sites. Once the elk became habituated to the bait, portable traps are erected and baited until elk became reasonably comfortable with the traps. When weather conditions are appropriate and transportation is possible, the elk are trapped and relocated. Elk are loaded into stock trucks and transported, sometimes by barge, to release sites. Before release, at least one cow in each group, preferably a lead cow, is radio-collared for monitoring purposes.

As MoE budgets permit, helicopter aerial surveys are conducted annually or bi-annually at each of the release sites and recovery areas. Most released elk are observed during the initial and subsequent aerial surveys due to the ease of locating the lead cows wearing radio-collars. Mature bulls are more difficult to locate because their preferred habitats are less predictable. In addition, very few mature bulls retain radio-collars more than 2 years. Information collected during the surveys provides vital data on the health of recovering populations by providing information on productivity and recruitment. Population estimations are obtained through the use of a sightability model derived by Kim Brunt, Wildlife Biologist, MoE, in Nanaimo, and a population growth model developed by Darryl Reynolds, Senior Wildlife Biologist, MoE, in Sechelt.

4.8.3.4 Relocations

Since the Lower Mainland Elk Relocation Program was established in 2000, 211 Roosevelt elk have been relocated. The proportion of habitat occupied by Roosevelt elk in the Lower Mainland has increased approximately 550%, from 1200 km in 2000 to approximately 6800 km in 2006. Over the same time period, the Roosevelt elk population has increased more than 250%, from approximately 315 individuals in 2000 to 839 individuals in 2006.

In 2005/2006, a total of 69 elk were relocated to various priority areas in the Lower Mainland. Groups of 20 elk were released at both the Brittain and Indian Rivers, 21 elk were released at the Vancouver River, and the remaining 8 elk were released near Gray Creek.

4.8.3.5 Benefits

While relocating Roosevelt elk from highway locations where conflicts with motor vehicles exist protects both the elk and the motoring public, the additional benefits are significant.

Roosevelt elk in British Columbia are the only genetically pure Roosevelt elk known to exist in North America. From a natural genetic perspective, it is critical to protect and conserve the limited gene pool by avoiding interactions between the Roosevelt and Rocky Mountain subspecies.

Roosevelt Elk Relocation

Photo Credits: Darryl Reynolds and Kim Brunt, MoE

Consequently, relocated Roosevelt elk are only released into locations where there is there is no possibility of range overlap with either Rocky Mountain elk or genetically contaminated Roosevelt elk (i.e., Roosevelt x Rocky Mountain hybrids). The establishment of geographically separated, genetically pure, populations provides an effective safeguard against natural catastrophic events. This approach helps ensure the preservation of species stock.

In addition to reducing the potential for elk-related motor vehicle accidents and protecting a valuable gene pool, the relocation projects also provide the following benefits:

- restoration of natural biodiversity and ecosystem function to coastal forests,
- re-establishment and recovery of a locally extirpated subspecies,
- range expansion of a relatively rare and geographically isolated subspecies
- reduced elk/forest industry and elk/human conflict,
- restoration of First Nations cultural, sustenance and ceremonial practices, and
- increased future sustainable harvest opportunities for resident and non-resident hunters.

Wildlife Exclusion Systems Case Studies

(Reprinted from Sielecki 2005b, 2007; used with permission)

BCMoT has constructed wildlife exclusion systems on both existing and new highways. From the mid-1980s until the mid-1990s, BCMoT designed and built two new, major, high speed, limited access sections of highway transecting large tracts of wildlife habitat in the southern interior of British Columbia. The highways connected the Lower Mainland with Kamloops and Kelowna. Construction occurred in three phases: Coquihalla Highway (Highway 5) Phases I and II, Okanagan Connector (Highway 97C) Phase III. The wildlife exclusion systems developed on these highways were the first projects of their kind in British Columbia. The installation on the Coquihalla Highway is an example of a retro-fit on an existing highway, while the Okanagan Connector is an example of integrating a wildlife exclusion system as a component of a new highway. The Coquihalla Highway and Okanagan Connector projects were followed by projects on Highway 97 and the Vancouver Island Highway. In 1999, a collective effort involving the Ministry, the Insurance Corporation of British Columbia and the Summerland Sportsmens' Association and the Peachland Sportsmen's Association, affiliated associations of the British Columbia Wildlife Federation, resulted in the construction of a wildlife exclusion system on Highway 97 near Okanagan Lake. This project was a retrofit on a long-established highway. Between 1999 and 2001, the Ministry constructed four wildlife exclusion systems as integral components of two phases of new highway construction on the Vancouver Island Highway (Highway 19). With each successive project, the Ministry has refined its designs and standards, to improve the efficiency and effectiveness of its wildlife exclusion systems. The Vancouver Island Highway installations are state-of-the art initiatives in British Columbia.

Coquihalla Highway (Highway 5)

The Coquihalla Valley has long served as the major transportation route in British Columbia linking the Lower Mainland with the Interior. The origins of the highway network in the valley originate with the Hope-Nicola Trail in 1876. The development of road access culminated with the construction of the Coquihalla Highway (Highway 5).

The Coquihalla Highway crossing Dry Gulch.

The Coquihalla Highway is a high speed (110 km/hr (68.4 mi/hr)) toll road which extends 195 km (121.2 mi) north from Hope to Kamloops, via Merritt. It is the only toll road in British Columbia. Construction on the Coquihalla Highway between Hope and Merritt started in 1979 and was completed in 1986. Despite the challenges of severe mountainous terrain and winter conditions, the highway became operational in May, 1986, to coincide with provincial and national traffic destined for Expo 86 in Vancouver. Starting north of Hope, at an elevation of approximately 50 m (164 ft), the Coquihalla Highway climbs steadily up the western slopes of the Cascade Mountains. For the first 42 km (26.1 mi), through the Coquihalla Pass, the highway ascends to the Coquihalla Summit at an elevation of 1244 m (4081 ft). Once past the summit, the highway continues another 78 km (48.5 mi) northeast, traversing the top of the Thompson Plateau, then descending to Merritt, which has an elevation of 595 m (1592 ft).

Over its length, the Coquihalla Highway passes through a number of climatic regimes. Near Hope, the highway environment is subject to temperate climate due to warm, moist Pacific Ocean airflows (Pojar and Meidinger, 1991). Here, summers are typically dry and summer temperatures average 25°C (77°F). Winters are typically wet and mild. Snowfalls are infrequent in low-lying areas, with accumulations melting within a few days. Further north, the Coastal Range acts as a barrier separating the moist Pacific air from the interior of the Province. As the moist ocean air is forced to rise over these mountains, heavy precipitation occurs on the western slopes, with rain at lower elevations and snow at higher ones. Rainfall in Hope can exceed 2 m (6.6 ft) each year. About 80 km (50 mi) east of Hope the interior valleys between the mountain ranges receive considerably less precipitation and experience hot summers. Further north, near Merritt, summer temperatures often exceed 30°C (86°F).

The steep terrain at the southern portion of the highway combined with heavy snowfalls has created a challenging environment for highway construction. The Coquihalla Highway can experience severe winter conditions. Snow accumulations of over 12 m (39.4 ft) are not uncommon, and in years of heavy snowfall, snow depths have reached 15 m (Shewchuk, 1998). In January, 2006, almost 50 cm (1.6 ft) snow fell during a 15 hour period stopping traffic (Public Safety and Emergency Preparedness Canada, 2006). A number of avalanche tracks have been identified along this portion of the highway. On average, about 100 avalanches occur per year along the Coquihalla Highway southwest of the summit. Most avalanches are small and pose no threat to motorists as they usually do not reach the highway.

At lower elevations, the Coquihalla Highway passes through large stands of Douglas fir and ponderosa pine. As the highway climbs to higher elevations, it passes through large stands of Engelmann spruce, lodgepole pine, and subalpine fir. Once past the Coquihalla Summit, the highway traverses the top of the Thompson Plateau and then descends through expansive rolling countryside with many small lakes. Extensive grasslands are found closer to Merritt.

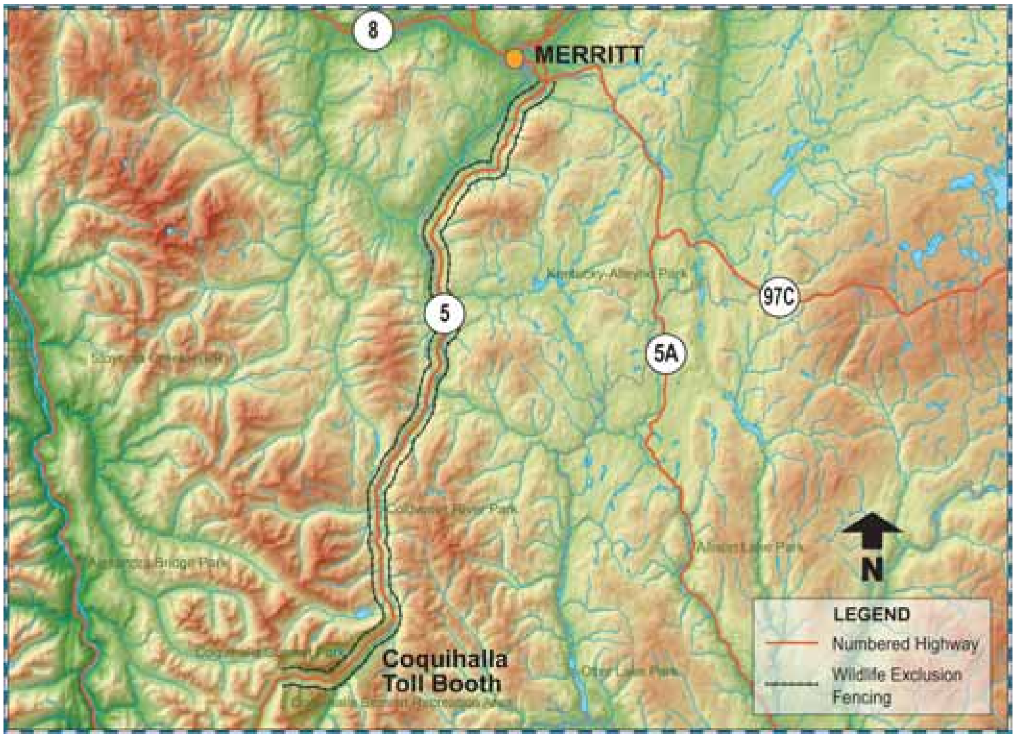
Despite challenging terrain and seasonal climatic conditions, the Coquihalla Valley contains prime wildlife habitat. The primary large ungulate species found throughout the area are mule deer and smaller numbers of moose. Small concentrations of elk are found in the southern reaches of the valley. Mountain goats are widespread but restricted to rugged areas in the Coast Mountains Black bears occur throughout this area. Fewer numbers of wolves, cougars and grizzly bears are also found here. Between 1979 and 1981, prior to the construction of the Coquihalla Highway, winter wildlife studies were conducted (Kent, 2005). The studies indicated few resident deer and moose resided in the area. Limiting the studies to the winter periods resulted in a serious shortfall in information regarding migratory animals. The winter tracking studies were unable to identify the annual Spring/Summer and Fall movements of large herds of deer from the Tulamene Valley to the Coldwater Valley and down to Boston Bar across the proposed highway alignment. The lack of information became apparent just after the highway opened. In 1986, when between May and July and between October and November, unexpectedly large numbers of deer were killed during their seasonal migrations. The combination of large ungulates and high speed vehicle traffic prompted BCMoT to construct its first wildlife exclusion system to protect wildlife and motorists.

BCMoT initially installed wildlife reflectors in response to these deer-related accidents. When it became apparent the reflectors alone would not be able to reduce the high numbers of accidents on the highway, BCMoT began the design and construction of wildlife exclusion fencing on Phase I of the highway (Figure 4.9).

Wildlife exclusion fencing on the Coquihalla Highway.

By improving on the designs originally developed by Public Works Canada for Banff National Park, BCMoT was able to develop effective fencing and one-way gates (Kent, 2005). Wildlife exclusion fencing was constructed for a distance of approximately 70 km (43.5 mi) on both sides of the highway, between the toll booth and Merritt (Figure 4.10).

Map 4.2 – Location of the wildlife exclusion fencing on the Coquihalla Highway.



Fencing on the Coquihalla Highway was constructed to control deer primarily because of their numbers in the area, but was designed to handle moose because of their more significant potential accident severity risk. Wildlife exclusion fencing has proven very effective in reducing wildlife accidents on the Coquihalla Highway (Highway 5) located between Hope and Merritt. On the 35 km (21.7 mi) portion of the Coquihalla Highway, between Dry Gulch Bridge and Kingsvale Bridge, wildlife exclusion fencing reduced wildlife accidents by 100%. Data from the WARS database indicates the number of wildlife accidents declined from 74, in the 1989 to 1993 period, to 0, in the 1994 to 1998 period.

Okanagan Connector (Highway 97C)

The Coquihalla Connector (Highway 97C) is a high speed freeway (110 km/hr (68.4 mi/hr) posted speed limit) that links the Coquihalla Highway (Highway 5) at Merritt to Highway 97 and the Okanagan communities of Kelowna and Peachland (Figure 4.11). The highway is approximately 108 km (67.1 mi) long and provides a vital link in the Province's highway network, connecting Vancouver and the Fraser Valley to the Okanagan Valley via the Coquihalla Highway. This highway is one of the highest elevation highways in Canada. At Pennask Summit, the Okanagan Connector reaches an elevation of 1,740 m (5708.6 ft).

The Okanagan Connector lies east of the crest of the Coast and Cascade mountain ranges and west of the Columbia Mountains (Ministry of Sustainable Resource Management, 2006). This area is located in the Southern Interior Ecoprovince of British Columbia, which includes the Thompson Plateau, the Pavilion Ranges, the eastern portion of the Cascade Ranges, and the western margin of the Shuswap and Okanagan Highlands.

The leeward portion of the Coast and Cascade ranges and the drier portion of the highlands share much the same climate as the Thompson Plateau (Pojar and Meidinger, 1991). Lying in the rain shadow of the coastal mountains, this area has some of the warmest and driest areas

Okanagan Connector

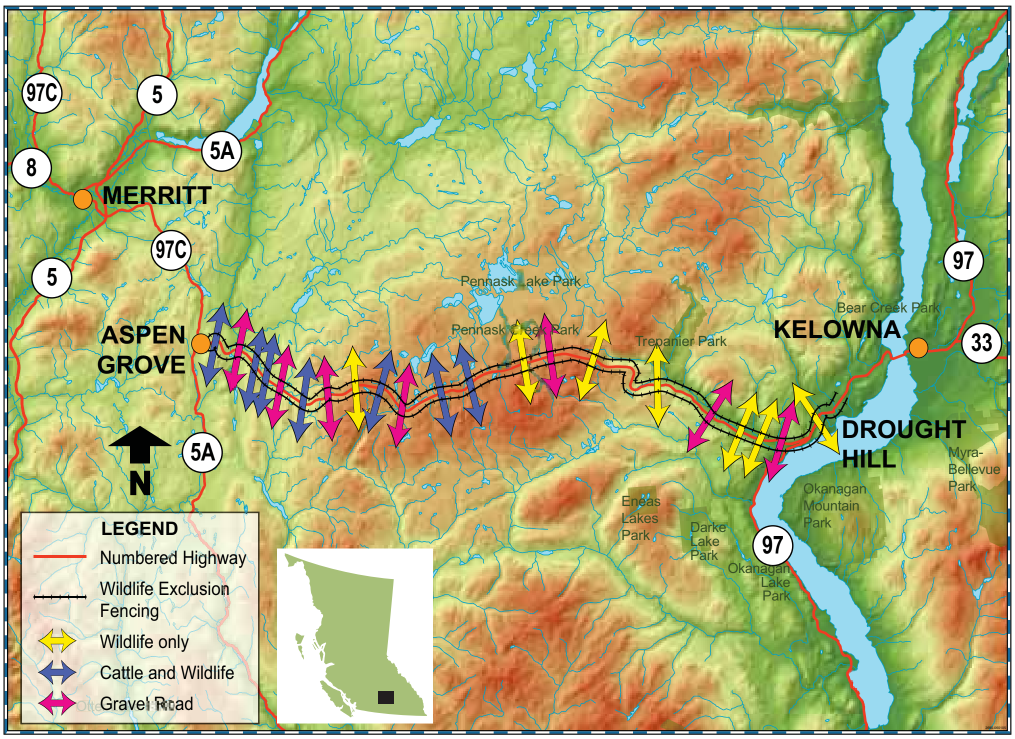
of the Province in summer. By the time the Pacific Ocean airflows move into this area, they have already lost most of their moisture on the west facing slopes of the coastal mountains. Periodically in the summer, hot and dry air advances from the United States to the south. This produces clear skies and very warm temperatures. Since there is no effective physical barrier in the north, in the winter and early spring there are frequent outbreaks of cold, dense Arctic air. These events are less frequent in this area than on the plateaus further north. At higher elevations, the western portion of the highway is subject to cold winter temperatures and heavy snowfalls. At lower elevations, nearer Okanagan Lake, the eastern portion of the highway experiences warmer winters with considerably less snowfall.

Mule deer are the most abundant large ungulate in this area, although the white-tailed deer has been extending its range westward from the Okanagan Basin and the Okanagan and Shuswap highlands. Moose are not originally native to this area, but migrated southward from the centre of the Province as forests of the north Cariboo were opened up by farming, logging and roadbuilding activities (Shewchuk, 1998). Moose are now dispersed throughout the area and can been seen in both open grasslands and upland swamps (Shewchuk, 1998). Bighorn sheep, both native California bighorn and the introduced Rocky Mountain bighorn, occur on the rugged grasslands throughout the Thompson and Okanagan valleys and in the Clear Ranges. Smaller mammals characteristic of the area include: spotted bats, pallid bats, Nuttall's cottontails, white-tailed jack rabbits, Great Basin pocket mice, and western harvest mice.

The Okanagan Connector was opened in 1990. It is a controlled access free way with no "at grade" intersections. Prior to its construction, the seasonal ranges and movements of moose were extensively studied between 1987 and 1989. Fourteen cow moose were radio-collared and relocated a total of 1212 times during this period (Gyug and Simpson, 1989). A fixed wing aircraft and helicopter were used to estimate population numbers. The studies were able to identify migration behaviour that varied from some moose remaining in one location all year round; other moose had distinct winter ranges, but combined summer fall ranges; while, yet other moose had distinct winter, summer, and fall ranges. Moose were found to pass through a 7 m (22.75 ft) diameter culvert. Tracking counts showed the passage rate by moose was 17%. Moose were found to migrate away from higher elevation habitats where snow depths exceeded 70 cm. Moose preferred lower elevation riparian or mixed deciduous-evergreen habitats where forage was abundant and thermal or security cover was available in nearby forests.

Underpasses for critical moose passage in winter range were determined to be 6.5 m (21.3 ft) by 7.4 m (24.3 ft) (Abrams, 1986). Deer underpasses were determined to be 4.2 m (13.8 ft) by 3.7 m (12.1 ft). The installed cost in 1989 for wildlife mitigation for the Okanagan Connector was estimated to be CAN$7 million. For this project, BCMoT spent CAN$500,000 on wildlife and mitigation studies (Stuart, 1989). Annual wildlife-vehicle collisions for the entire alignment were estimated to at 500 deer and 100 moose. A total of 40 moose collisions were estimated for the 30 km (18.6 mi) section of highway annually. There are approximately 82 km (51 mi) of wildlife exclusion fencing constructed on the Okanagan Connector on both sides of the highway. The fencing was designed to control moose, as the primary species, based on the size and weight of these animals, and deer, as the secondary species, based on their large population in the area (Figure 4.12).

Map 4.3 – Location of the wildlife exclusion system between Aspen Grove and Drought Hill.



As part of the exclusion system, a wildlife overpass was constructed near Trepanier Creek. It was the first wildlife overpass constructed in Canada (Figure 1). Although the overpass closely resembles the wildlife overpass built in Utah, the first wildlife overpass built in North America, it was designed independently. Since the wildlife exclusion system was constructed on the Coquihalla Connector Freeway (Highway 97C) in 1990 to 1998, no wildlife accidents were recorded in either the westbound or eastbound lanes of the highway which are protected by wildlife exclusion fencing.

Highway 97

Extending almost 3,200 km, Highway 97 is one of the longest north-south highways in North America. It connects the City of Weed, in northern California to the Town of Watson Lake and the Alaska Highway, in the southeastern Yukon. From the late-1900s, in southern British Columbia, Highway 97 evolved on the terraces and benches above the western shores of Okanagan Lake.

The section of Highway 97 located between Peachland and Summerland is located in the Southern Interior Ecoprovince of British Columbia, the only ecoprovince in the Province that is part of the Dry and Semi-arid Steppe Highland ecodivisions. The southern end of the Okanagan Valley in British Columbia represents the northernmost extension of the Western Great Basin of North America. The area is located between the leeward ranges of the Coast Mountains, and the western side of the Okanagan and Shuswap highlands. Winters are cold and the summers are often very hot. This is one of the warmest and driest areas of the Province in summer. The Coast Mountains act as a barrier to the moist westerly air flow (Tourism British Columbia, 2006). Periodically, there are hot, dry air arrives from the United States, to the south, in the summer. This produces clear skies and very warm temperatures. The southern portions of the Interior Plateau, including the Okanagan, Similkameen, and Thompson River Valleys, experience the Province's hottest summers, with temperatures often in the 30°C (86°F), occasionally rising above 40°C (104°F). In the winter and early spring, outbreaks of cold, dense Arctic air are common because there is no effective physical barrier in the north.

Highway 97 between Peachland and Summerland.

The area is very arid as it receives an average of 25 cm (8.9 in) to 40 cm (15.7 in) of precipitation and 2,000 hours of sunshine annually. (British Columbia Ministry of Environment, 2007). Low annual rates of precipitation, hot summers, and very mild winters create a number of different of semi-arid habitats. The dry grasslands and open pine forests in this area provide a vital landscape corridor between the shrub-steppe habitats of the Columbia Basin in Washington State in the south and the grasslands of the Thompson and Nicola valleys to the north and west.

The South Okanagan and Lower Similkameen has long been recognized as a providing a variety of habitats for unique species, many of which are found nowhere else in British Columbia or in the rest of Canada (British Columbia Ministry of Environment, 2007a, 2007b, 2007c, 2007d). The Okanagan Valley also has more species of plants and animals living here than in most areas of both British Columbia and Canada. The dry shrub grasslands of this area support a great variety of wildlife, including many of British Columbia's most rare and endangered species. There area is primarily habitat for mule deer but includes white-tailed deer, moose and mountain goats (Hope et. al., 1991). While mule deer are the most abundant large ungulate, the white-tailed deer has been extending its range westward from the

Okanagan Basin and the Okanagan and Shuswap highlands. Bighorn sheep, both native California bighorn and the introduced Rocky Mountain bighorn, occur on the rugged grasslands throughout the Okanagan Valley and in the Clear Ranges. Spotted bats, pallid bats, Nuttall's cottontails, white-tailed jack rabbits, Great Basin pocket mice, and western harvest mice are characteristic small mammals.

From the late 1980s to the mid-1990s, the number of deer-related motor vehicles accidents occurring between Summerland and Peachland began increasing. In 1999, BCMoT partnered with the Insurance Corporation of British Columbia (ICBC) and Summerland Sportsmens' Association and the Peachland Sportsmen's Association, affiliated associations of the British Columbia Wildlife Federation, to construct a wildlife exclusion fence on the west side of Highway 97 between Bentley Road and Deep Creek. While BCMoT supplied fencing materials, ICBC contributed CAN$128,000 and the sportsmen's associations provided construction labour and on-going maintenance. Most Ministry wildlife exclusion installations involve the construction of fencing on both sides of a highway. However, due to the topography of this area, with steep banks on the east side of the highway, a decision was made to construct fencing on only the west side of the highway (Figure 4.14).

The fence along this section of Highway 97 is only 15 km (9.3 mi) long and represents the BCMoT's shortest wildlife exclusion installation (Figure). However, the installation has proven to be very effective, dramatically reducing the incidence of deer-related motor vehicle accidents. The installation also demonstrates how a fence installed on one side of a highway can be successful, if suitable physical landscape features can be incorporated into the design.

Map 4.4 – Location of the wildlife exclusion system between Peachland and Summerland.

Vancouver Island Highway (Highway 19)

The Vancouver Island Highway (Highway 19) runs for most of the length of the eastern coast of Vancouver Island. From Victoria to Port Hardy, the highway extends over 500 km (310 mi). Between 1989 and 2002, after extensive planning and preliminary, functional and detailed design stages, major upgrades to the highway were made. The longest section of the Vancouver Island Highway Project (VIHP), the Inland Island Highway, stretches from Parksville to Campbell River through an environmentally-sensitive area. The route includes new freeway and expressway alignments with numerous connectors and interchanges. The longest bridge on Vancouver Island, the Tsable River Bridge, was built on this section. The Inland Island Highway included the construction of 150 km (93 mi) of new 4-lane, limited access, divided highway between Victoria and Campbell River.

The Inland Island Highway is located on the leeward side of the Vancouver Island Ranges. After passing eastward over the Vancouver Island Mountains, Pacific Ocean surface air flow descends producing clearer and drier conditions than those found on the west side of the island. As a consequence, this area has the greatest annual amounts of sunshine in British Columbia (Pojar, Klinka and Demarchi, 1991a, 1991b). The moderating influence of the waters of the Strait of Georgia also produces local temperatures among the mildest in Canada. The climate on the East coast of the island is characterized by mild winters and warm summers. Precipitation ranges from 0.8 m (2.6 ft) to 2.5 m (8.2 ft) per year and rainfall is greatest between October and March. Large accumulations of snow on the Vancouver Island Mountains produce some of the lowest treelines in the British Columbia. However, at sea level, while winters are usually wet, snow is not common every year. Typically, summers tend to be dry, especially between June and August. Summer droughts often last 5 to 6 weeks.

Vancouver Island Highway (Highway 19).

The temperate coniferous forests of Vancouver Island provide among the richest habitats in North America for mammals, amphibians and birds. Mule deer ("black-tailed") are the predominant ungulate. From wild and rural areas to urban golf courses and suburban developments, they are ubiquitous. Although relatively few in number in comparison to mule deer, a number of growing herds of Roosevelt elk are found at scattered locations. Although there have been sporadic reports of Grizzly bear, the primary large carnivores on the island are cougar and black bear. Smaller carnivores include river otters, mink and raccoons. These animals tend to be found near water, either along ocean shorelines and in estuaries, or along lake shores and river banks. Small mammals in the area include the Virginia opossum, marsh shrew, Trowbridge's shrew, shrew-mole, Townsend's mole, coast mole, Douglas' squirrel, and creeping vole. The highest diversity of birds in British Columbia are also found in this area. Of all species known in the Province, approximately 90% occur on Vancouver Island. Reptiles found in the area include the sharptail snake while the ensatina and Pacific giant salamander are the predominant amphibians. A number of alien species are also found here. These include the western pond turtle, eastern cottontail rabbit, bullfrog and green frog.

In 1999, the Mud Bay-Courtenay section of the Inland Island Highway was completed. Two years later, the highway was extended to Campbell River. Finally, in 2001, Highway 19 was extended from Courtenay along the last section of the new inland highway to the Campbell River Bypass. The new sections of the Inland Island Highway were constructed through or near, one of the world's most diverse ecosystems, ranging from rainforests, marshes, meadows, beaches, mountains, oceans, rivers and lakes creating habitats for many wildlife species. Special care was taken to ensure the footprint of the new sections of highway were as small as possible and measures were implemented to compensate for lost wildlife habitat. Extensive efforts were also made to protect the Roosevelt elk. At four locations along the Inland Island Highway, where alignment transected elk habitat, wildlife exclusion systems were constructed. Wildlife exclusion fencing and associated structures were installed on both sides of three sections of highway and on one side of one section. A total of 148 km (92 mi) of fencing was installed over 84 km (52 mi) of highway (Map 4.5).

Map 4.5 – Location of wildlife exclusion systems on the Vancouver Island Highway.