MOOSE MORTALITY ON HIGHWAYS AND RAILWAYS IN BRITISH COLUMBIA

Kenneth N. Child[1], Sean P. Barry[1] and Daniel A. Aitken[2]

[1]Ministry of Environment, 1011 Fourth Avenue, Prince George, British Columbia, V2L 3H9; [2]Biology Department, College of New Caledonia, Prince George, British Columbia, V2N 1P8.

ABSTRACT: A minimum of 1,200 moose, approximately 10% of the provincial annual allowable harvest, may die on the highways and railways in British Columbia each year. The impact of collision on moose population dynamics is unknown. Research of moose behaviour in moose-vehicle and moose-train encounters is recommended to more fully understand the collision problem, the demographic implications of collision losses, and to enable the discovery of solution(s) to this management problem.

ALCES VOL. 27 (1991) pp.41-49

Accidents involving moose with motor vehicles or trains occur frequently in British Columbia. Some accidents result in property damage, human death or serious injury and substantial losses of animals (Walker *et al.* 1978, Child and Stuart 1987). Studies by Stuart (1984) suggest that about 200 moose are killed on the major highways in British Columbia each year. These moose-vehicle collisions occur most frequently between 1800 hr and 0200 hr, under poor to no light condition, on straight and relatively flat stretches of highway and at speeds in excess of 80 km/hr (Stuart, 1984). An unknown number of moose are also killed or crippled on mining, logging and rural roads.

Mundy and Sumanik (1967) suggested that at least 200 moose are killed yearly on Canadian National Railway in the central interior of British Columbia. King and Sumanik (1978) estimated that nearly 600 moose were killed on the tracks during the severe winter of 1968 and Child (1983) reported that fatalities could exceed a thousand moose in record snow fall winters in the central interior.

Moose fatalities within transportation corridors can be of such magnitude in some years to warrant review of harvest allocations and recreational objectives. Until recently, collision losses of moose have been considered of little consequence to the resource, to management programs and to recreational opportunity. But with increasing volumes of traffic flow, proliferation of new transportation facilities, increasing costs of property damage, human injury and death, and increasing recreational demands, the recurrent problem of moose collisions is receiving more attention.

This paper reviews available information on moose-vehicle and moose-train collisions in British Columbia, some of the mitigation measures attempted to reduce collisions along highways and railways, and the implication of collision as a mortality factor on moose management programs and recreation. Recommendations are presented that address the need for better quantification of collision events, establishment of data collection standards, and research on moose behaviour.

METHODS

Moose-vehicle collisions are monitored by the Wildlife Branch of the B.C. Ministry of Environment, Victoria. Accident reports from the Ministry of Transportation and Highways (MoTH) and from the Royal Canadian Mounted Police (RCMP) are forwarded monthly to the Wildlife Branch, Victoria. The combined accident reports give an indication of trends of moose-vehicle accidents in the province (Walker *et al.* 1978). Collision reports list date of accident, species, number and sex of animals and location of the accidents to the nearest "mile post". These reports were collated on annual and monthly bases. For the period 1987-1990, vehicle accident reports from the RCMP were unavailable and therefore not included in this analysis. Therefore, the 1987-1990 results may underestimate the magnitude of collisions.

Wildlife-train collisions are reported daily by Canadian National (CNR), Canadian Pacific (CPR), and BC Rail (BCR) and summarized monthly by the Wildlife Branch, Victoria. Collision reports indicate date of accident, species, number and sex of animals and location of the accidents to the nearest "mile post". The railway collision reports were collated to determine annual and monthly patterns of moose-train collisions in the province. The proportion of moose killed by the three Rail Corporations over the 7 year period and the rate of kill per year per 1000 km of track were calculated.

Eight regions of the B. C. Fish and Wildlife Branch (Fig. 1) were canvassed for their opinions on the magnitude of moose-vehicle and moose-train collisions in their respective regions. The biologists indicated relative impact of these incidental mortalities on regional moose management programs, trends in collisions over the previous 5 years, a subjective assessment of the reliability of information and adjustments to annual allow-

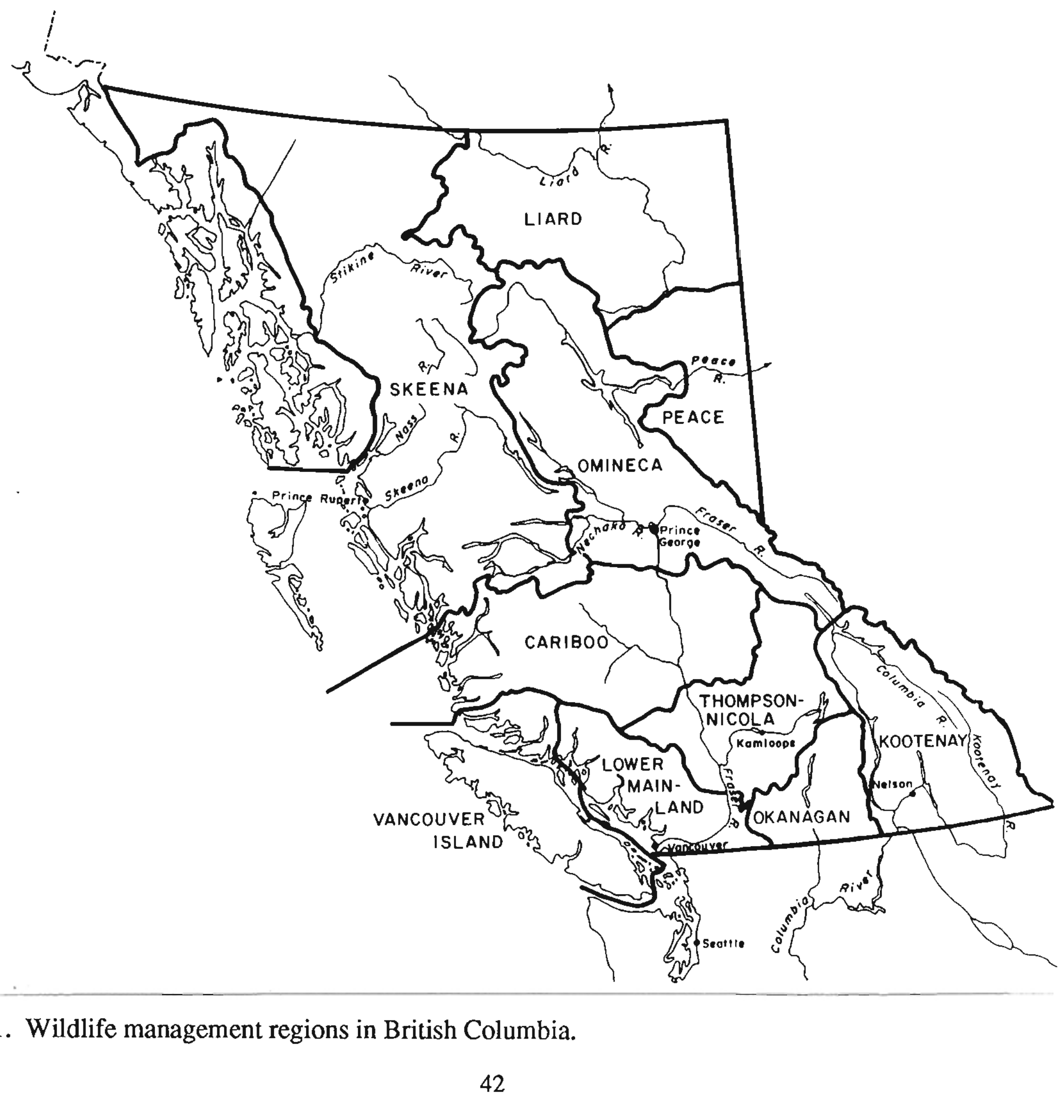

Fig. 1. Wildlife management regions in British Columbia.

able harvests (AAH) and hunting regulations. Regional moose population estimates were obtained from the Provincial Moose Statement for British Columbia, 1990-1995 (Hatter *et al.* 1990).

RESULTS

Moose-Vehicle Collisions

Moose-vehicle collisions have ranged from 111 in 1983 to 234 in 1990 (Fig. 2). Moose-vehicle collisions occur year round, with the majority of kills of moose occurring in late November, December and January (Fig. 3).

An unknown number of moose are also killed on mining, logging and rural roads. The magnitude of these losses cannot be reliably estimated since no data base exists. However, anecdotal information suggests that collisions of moose along these roads in some regions might be comparable to reported numbers of moose killed on the highways.

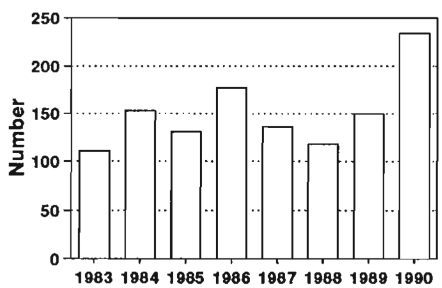

Fig. 2. Annual moose-vehicle collisions for the period 1983-1990.

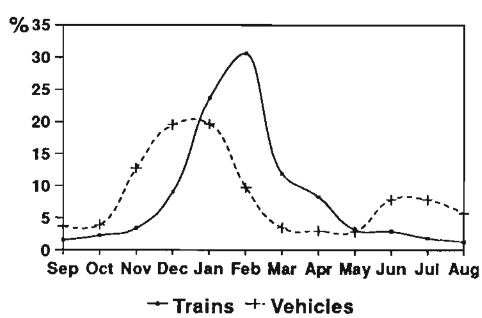

Fig. 3. Average monthly moose collisions for the period of 1983-1990.

Moose-Train Collisions

From 1983-87, total kills on all railways ranged from 40 to 100 moose. However, the number of kills increased to average 200 moose annually from 1988-90. Reported moose-train collisions are increasing on all rail lines (Fig. 4).

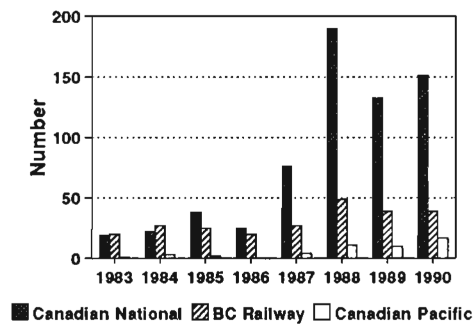

Fig. 4. Annual moose-train collisions reported by railway Corporations for the period 1983-1990.

The number of moose-train collisions during the summer season (June to September) are reportedly low. These collisions increase through the fall months and early winter, peak in January and February and then, rapidly decrease in frequency through February, March and April (Fig. 3). Fifty-four (54)% of all reported collisions occur in January and February.

Nine hundred and forty-nine (949) moose-collisions were reported by the three Rail Corporations from 1983 to 1990. Of these collisions, 655 (69%) occurred on the CNR, 246 (26%) died on the BCR and the remaining 48 moose (5%) on the CPR. The rate of kill/year/1000 kilometres also differed for the three rail lines (CNR 39.8, BCR 14.8, CPR 3.1).

Regional Management Perspectives

Responses from regional biologists are summarized in Table 1. On a provincial basis, estimated road and rail kills equal about 9.1% of AAH; road kills (643) represent about 5.5% of the provincial AAH whereas rail kills (409) represent about 3.6% of the provincial

Table 1. Regional estimates of moose collision mortality and its implications to moose management programs.

Region	Population 1990	AAH[1]	Collisions		Trends		Data[2] Rel.	Mgmt[3] Imp.	AAH[4] Adj.
			Hwy	Rwy	Hwy	Rwy			
Lower Mainland	85	0	0	0	ind	ind	L	n/a	no
Thompson-Nicola	7500	600	30	25	S	S	L	no	10%
Kootenay	7300	260	30	45	S	S	L	yes	no
Cariboo	22000	2750	20	30	S/I	S/I	L	no	no
Skeena	66000	1500	120	230	S	S	L/M	yes	6%
Omineca	23500	2800	150	150	ind	ind	L/M	yes	4-20%
Peace	27000	2500	183	14	ind	ind	L	yes	no
Liard	24500	1200	180	ind	ind	ind	L	no	4%
TOTALS	177,885	11,610	713±	494±					

ind = indeterminable; S = stable; I = increasing; L = low; M = moderate; H = high

1 Annual allowable harvest
2 Data reliability
3 Management implications
4 Adjustment to annual allowable harvest

AAH. The perceived number of moose-vehicle collisions increase from the southern to the northern regions of the province. Moose-train collisions are thought to be relatively low across the province, except in the Omineca and Skeena. Based on the biologist's responses, 80% of moose-vehicle and 48% of moose-train collisions are believed to occur in the central and northern regions (Omineca, Peace, Liard). Moose-vehicle and moose-train collisions are believed equal in occurrence in all regions except Skeena, Peace and Liard. Biologists suggest that collisions are localized along highways and railways where transportation corridors cross wintering ranges. Trends in collisions are believed stable in four of the eight regions but are unknown in Omineca, Peace and Liard regions where road kills outnumber rail kills. In Skeena, by contrast, rail kills of moose outnumber road kills.

Biologists are split on the management importance of collision losses. Regional estimates of collision losses range from 1.8% of AAH (Cariboo) to 28.9% of AAH (Kootenay). No adjustments to AAH are made in the Lower Mainland, Kootenay, Cariboo or Peace regions while adjustments from 4% to 20% are made in other regions.

DISCUSSIONS AND MANAGEMENT IMPLICATIONS

Moose-Vehicle Collisions

The estimated numbers of moose killed on the highways have not changed substantially since Stuart's report in 1984. But, the estimates of regional biologists are 3 times higher than Stuart's estimates. The reported number of vehicle collisions from MoTH may underestimate by two to six times the actual number of moose kills (Mike Kent, Manager, Environmental Services Section, MoTH., Victoria, B.C., pers. comm.) because some injured moose leave the site, or are quickly removed, salvaged or scavenged. If so, road kills may number from 400 to 1200 moose annually.

A number of methods are being used to reduce moose-vehicle collisions. Wildlife crossing signs have been erected at strategic locations along major highways to warn motorists of the hazards of high speed travel through areas of known moose summer and winter concentrations. Reflectors are positioned on sections of major highways in the Kootenay and Okanagan regions to discourage ungulates (deer, elk and moose) from crossing highways. Exclusion fencing and underpasses are strategically located on the Coquihalla Highway, Phases II and III, from Merritt to Kamloops, and from Merritt to Peachland, B.C. in the Okanagan and Thompson-Nicola regions to direct migrations beneath the roadbed at traditional crossings (Clayton Resources Ltd. 1989). The inclusion of these wildlife crossing structures was possible because wildlife collision risks were identified and crossing facilities were included in the initial design stage. Highway construction is generally discouraged in moose wintering areas in the Thompson-Nicola. Motorists in the northern regions are regularly advised by the local media to drive cautiously and be on the alert for moose on the highways during the spring and winter seasons. Motorists are using ultrasonic warning devices on their vehicles and reporting fewer encounters with moose (Child and Foubister 1986). No known preventative measures are practised on either logging, mining or rural roads to reduce collision risks, except possibly, driver caution.

Moose-Train Collisions

Reported losses from the Rail corporations and opinions of biologists are nearly equivalent. Moose-train collision reports generally underestimate collision losses. Hartman (1962) suggested that methods of data collection generally underestimate the number of moose fatalities on the CNR tracks in the central interior (Omineca and Skeena) but indicated no correction factor. Marshall (1987) searched for moose carcasses along a 210 km section of the CNR railway in the Skeena region and concluded that CNR reports document only 58% of actual kills. For instance, in 1986, a total of only 36 moose collisions were reported by CNR (Fig. 4). Marshall (pers. comm.) however, estimated that 106 kills had occurred in the Skeena along the CNR between Endako and Smithers while CNR had previously reported 62 fatalities along the same section. The reports conflict. Collision reports from the Rail Corporations seemingly understate the problem by providing minimum estimates because "hits", that is, those moose that leave the tracks to die elsewhere (Sumanik 1972) are not reported or not all kills are reported. Consequently, biologists estimate that a minimum of 500 moose may be killed on the railways annually.

CNR and BCR report high losses of moose per 1000 km of track. The CPR losses of moose per 1000 km seem lower. Reports of annual kills per 1000 km may be misleading since they include numerous kilometres of track in areas with relatively low moose numbers. It is necessary then to consider quantifying moose kills on a different scale. Otherwise, these ratios might minimize or mask impacts of rail kills on local moose populations.

Several recommendations have been made to better quantify numbers, locate kill sites and to reduce collision potential (Child 1983, Child and Stuart 1987, Marshall 1987). Reporting of moose-train collisions has improved but accuracy and reliability of data needs improvement. The method and standards of reporting are currently under review (I. Hatter 1991 pers. comm.). Kill sites have yet to be mapped provincially to locate zones of high collision frequency. In the interim, BCR and CNR have tried to reduce moose-train collisions by improving snow maintenance, experimenting with plowed escape routes, manipulating light and horn signals to frighten moose, and by reducing the speed of trains. Success is reportedly low for all efforts tried (Gilchrist 1986).

Regional Perspectives on Collision Mortality

Regional biologists generally disregard collision mortality when preparing moose management plans or setting harvest objectives. For most, the low ranking of collision mortality and the low numbers of reported moose kills does not warrant management attention. Adjustments to the AAH and/or the regulations, if made, are therefore subjective and conservative. However, a minimum of 700 moose may die on the highways and 500 may die on the railways each year. On a provincial basis, collision losses seem inconsequential since they represent 0.7% of the estimated provincial moose population.

From a regional perspective however, these losses equal 0.6% to 1.0% of regional moose population estimates. But, these losses represent 10.4% of the provincial AAH (Table 1) and range from 1.8% to 28.9% of regional AAH. Only in the Thompson-Nicola and possibly the Omineca do AAH adjustments match collision losses. The Thompson-Niclola makes a 10% reduction in AAH. This reduction corresponds to their perception that collisions equal about 9.2% of AAH. By contrast, the Peace and in the eastern portion of the Kootenay region, although collision losses are believed important, no adjustments to AAH are indicated, despite collision losses representing 7.9% of AAH in the Peace and 28.9% of AAH in the Kootenay region. In the western portion of the Kootenay region, no antlerless seasons are advertised to account for collision mortalities (G. Woods, pers. comm.). In the Liard, on the otherhand, the AAH is for bull moose only and since only 38 of the estimated number of road kills (108) are believed to be bulls (J. Elliott, pers. comm.), collision losses represent about 3.8% of AAH which matches the reported adjustment of 4 percent.

An assessment of collision on a population basis tends to trivialize collision as a mortality factor. But, if assessed against AAH, for accessible populations, collision could become of greater management importance. The impact of collision mortality may therefore be more severe than previously thought. Estimated losses may be even higher if fatalities on logging and mining roads are also considered. Clearly, collsion is a major source of mortality.

Theoretical Considerations and Research Needs

Moose-vehicle and moose-train collision fatalities cannot be objectively analyzed because of the nature of the data base. Without better information it becomes obvious, as Child and Stuart (1987) concluded, that "collision fatalities as a source of moose mortality will remain unknown and most likely ignored, forgotten or treated as inconsequential to current management efforts. Resource losses, recreational reductions and resulting property losses and damages also will remain a matter of guesswork and speculation".

The frequency of moose-vehicle collisions peak earlier in the winter (December, January) than moose-train collisions (January, February) suggesting that resident and migratory populations run a gauntlet of collision risks on their winter ranges. Moose run the same gauntlet again when they move to summer ranges (Fig. 3).

Conventional wisdom has sought solution through planning and design of transportation corridors, vegetation management, physical barriers and traffic control. But collisions continue and may increase as traffic volume increases. Management of vegetation likely augments the risk of collision by maintaining early seral vegetation along roads and rails,

Table 2. A comparison of railway and highway corridors to optimal characteristics of moose habitat in the sub-boreal spruce ecotype.

Characteristic	Ideal	Railway	Highway
Opening width	<100m	30m	30-50m
Vegetation	early seral	early seral	early seral
Water	natural	ponds	ponds
Salt licks	natural	possible	salt pools
Distance to cover	50m	15m	15-25m
Snowfree habitat	forest	railbed	roadbed
Snow intercept	forest canopy	plowing	plowing

and salting of roads, as practised, compounds the problem (Fraser and Thomas 1982). In areas where intensive silviculture (herbicides) is practised, habitat compression may displace moose into favourable habitats found within the corridors. Highway and railway corridors might become "ecotonal traps providing moose with maximum edge and many of the seasonal habitat components associated with glaciated landforms and riparian habitats (Table 2). As such, transportation corridors represent an environment of high collision risk to moose.

Perhaps the collision problem could be alternatively investigated from another perspective, the "umvelt" of moose (Bubenik 1987). Rather than focusing effort on habitat (nutzwelt) manipulations to tease moose from railways or roadways, perhaps a research focus should discover first, those releaser-stimuli in the social world (mitwelt) of moose that elicit avoidance-flight responses and second, to determine if moose perceiving these same signals will avoid trains and automobiles.

Bubenik (1987) stated that "fully mature and healthy moose stand their ground when confronting wolves and inexperienced moose generally run and are killed". Moose behave in a similar fashion to approaching locomotives, vehicles and wolves (Child 1983, Hatler 1983, Surrendi 1983, Stringham 1973). Normalbehaviours are of low survival value when a moose is on the tracks or highway, especially at night, when a confusion-blinding effect of headlights "hypnotizes" moose and negates normal flight responses. Bubenik (1987) suggests that "fighters" may be the first to be killed by collision because they have little fear of moving objects, whereas the "runners" flee and escape. More study is needed to determine if a differential behavioral response exists.

Moose can be "frightened" by horn blasts and flee to avoid collisions. This response suggests that there may be opportunity to simulate a sound stimulus to elicit an avoidance/flight response in moose to vehicles and locomotives. The use of ultrasonic devices on locomotives in Ontario (Muzzi and Bisset 1990) and investigations with similar devices on automobiles in British Columbia (Child and Foubister 1986) suggests that the desired avoidance response by moose to trains and vehicles might be achievable through integration of the visual and auditory modes, in spite of the fact that moose have some difficulty in conceptualizing moving objects (Bubenik 1987). Damas and Smith (1982) suggested that an acoustic key stimulus might be determined for moose and applied to reduce collisions. Unless biologists address this mortality factor from a new perspective, the solution(s) may remain undiscovered. Increasing public demands for recreation, subsistence, culture, trophy and viewing necessitate a reassessment of collision mortality. Biologists, railway and highway engineers and planners should co-operatively address this problem. Otherwise local moose populations will be impacted, recreation may become more restricted and public costs may escalate.

RECOMMENDATIONS

1. An integrated data base is needed to quantify collision fatalities.
2. Collection standards should be established to improve data reliability.
3. A study of moose behaviour is needed to describe moose-vehicle and moose-train encounters.

ACKNOWLEDGEMENTS

We thank Dawn Jackson for formatting the manuscript, Marney Roberts for drafting the map, and the regional biologists for completing the questionnaires. S. Oosenbrug and an anonymous referee reviewed the manuscript.

REFERENCES

BUBENIK, A.B. 1987. Behaviour of moose (*Alces alces* ssp) of North America. Swedish Wildl. Suppl. 2: 333-366.

CHILD, K.N. 1983. Railways and moose in the central interior of British Columbia: A recurrent management problem. Alces. 19: 118-135.

_______, and L.J. FOUBISTER. 1986. A preliminary study of the effectiveness of ultrasonic warning devices in reducing wildlife-vehicle collisions. Unpublished B.C. Ministry of Environ. Rpt. Fish and Wildlife Branch, Prince George.

_______, and K.M. STUART. 1987. Vehicle and train collision fatalities of moose: Some management and socio-economic considerations. Swedish Wildl. Research, Suppl. 1: 699-703.

CLAYTON RESOURCES LTD. 1989. Wildlife fencing and control on the Okanagan connector highway. A benefit cost analysis. A report for the Environmental Services Section and the Highway Engineering Branch, Ministry of Transportation and Highways, Victoria. 32 pp.

DAMAS AND SMITH. 1983. Wildlife mortality in transportation corridors in Canada's National Parks. Impact and mitigation. Consultant's report to Parks Canada, Ottawa. 397 pp.

FRASER, D. and E.R. THOMAS. 1982. Moose-vehicle accidents in Ontario: Relation to highway salt. Wildl. Soc. Bull. 10(3): 261-265.

GILCHRIST, L.M. 1986. The Canadian National Railway's effects on large ungulates in northern British Columbia. B. Sc. Thesis. University of British Columbia. pp.

HARTMAN, F. 1962. Report: Moose mortality - C.N.R. Locomotives, Prince Rupert to Red Pass. Unpub. rep., Min. of Environ., Prince George, B. C.

HATLER, D.F. 1983. Concerns for ungulate collision mortality along surface route. MacLaren Plansearch Corporation, Vancouver. 47 pp.

HATTER, I. K. CHILD, and H. LANGIN. 1990. Provincial moose statement for British Columbia, 1990-1995. Wildlife Branch, Ministry of Environment. Victoria. 54 pp.

KING, D. and K. SUMANIK. 1978. A personal communication in: Guiget, T. 1978. Wildlife related motor vehicle accidents in British Columbia. A preliminary assessment of the problem based on a review of motor vehicle accident report forms. Unpub. rep., Min. of Environ., Victoria, B.C. 9 pp.

MARSHALL, R. W. 1987. Moose/train collision project. Fish and Wildlife Report. Smithers, B.C. 29 pp.

MUNDY, K. and K. SUMANIK. 1967. *in:* Highlights of N.E. Section of Wildlife Society Meeting. Proc. N. Am. Moose Conf. Workshop 4: 1-3.

MUZZI, P.D. and A.R. BISSET. 1990. The effectiveness of ultrasonic wildlife warning devices to reduce moose fatalities along railway corridors. Alces 26: 37-43.

RAUSCH, P. A. 1956. The problem of railroad moose conflicts in the Susitna Valley, 1955-56. A Preliminary Report. U.S. Fish and Wildlife Service Report. 19 pp.

STRINGHAM, S.F. 1973. Mother-infant relations in moose. Naturaliste can., 101: 325-369

STUART, K.M. 1984. Wildlife-vehicle accidents in British Columbia, April, 1982 - March 1983. Ministry of Environment Report. 37 pp.

SUMANIK, K.M. 1972. Dispersion of moose (Alces alces andersoni) during winter in central and northern British Columbia. B.C. Fish and Wildlife Branch Reg. Rpt. 14 pp.

________, and D. DEMARCHI. 1977. Dispersion and relative abundance of moose in northern British Columbia. Proc. N. Am. Moose Conf. Workshop 13: 252-257.

SURRENDI, C. 1983. Preliminary report on wildlife mortality along C.N. rights of way, and observation on habitat quality in Jasper National Park. Report to Canadian National Railways. Corsal Enterprises Ltd., Edmonton, Alberta. 46 pp.

WALKER, J., T. GUIGUET, and G. SMITH. 1978. Wildlife related mortality and vehicle accidents in British Columbia. A preliminary assessment of the problem based on a review of motor vehicle accident report forms. Ministry of Environment Report. 16 pp.