Summary document

Moose-vehicle collisions and their mitigation in Newfoundland

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Content

Background information

There are approximately 600-800 moose-vehicle collisions (MVCs) per year in insular Newfoundland resulting in an average 2 human fatalities annually (range: 0-4)[1, 3, 4, 5]. Collisions with moose result in human injury, fatalities and millions of dollars of property damage each year. A Newfoundland Department of Tourism pamphlet "Moose Vehicle Collisions" (n.d.) estimated the costs for vehicle damage alone at $1 million (assumed annual). At 750 MVCs per year, a 2001 study calculated annual losses of approximately $3.85 million annually (2001 dollars)[5]; however, to date there has been no comprehensive calculation of the financial impacts of MVCs in Newfoundland.

A Transport Canada report estimated the compensation cost per fatality in a wildlife-vehicle collision (WVC) in Canada as $1,560,000 (1996 dollars)[7]. A more recent study in the journal Ecology and Society has estimated the costs of MVCs at $US 30,760 per accident[6]. This estimate consists primarily of costs attributed to human injury, fatalities and property damage from accidents. Given the recent MVC statistics from Newfoundland of an average of 650 MVCs per year, multiplied by the estimated cost of each accident according to current cost-benefit analysis[6], the societal costs of accidents with moose in Newfoundland amount to approximately $20 million annually. This figure is conservative and underestimates the true societal value since accidents with <$1000 in property damage are generally not reported and do not appear in annual accident statistics[8, 9].

Moose densities in Newfoundland

Newfoundland is home to a disproportionately large part of the North American moose population, representing >10% of the total number of moose with <2% of the species range[10]. Moose densities in Newfoundland are reported to be the highest in North America[9]. According to current estimates approximately 125,000-150,000 moose live in Newfoundland today. This is not only the largest density of moose in North America but worldwide[1,2,10]. Moose numbers in Newfoundland have been increasing for the last 40-50 years. Moose densities range from < 1 to > 7 moose/km[3,5], however, the average density island-wide is roughly 1.7 moose/km[3,10]. The current system of moose management through a regulated fall hunt is not able to stabilize the growing population on the island[11,12].

Jurisdictions with similar transportation and resource management issues of moose and motorist safety (Quebec, Ontario, New Brunswick, Maine, Vermont) all have significantly lower estimated moose densities, well below 1 moose/km^2. Further, all of these jurisdictions have implemented a variety of standard as well as new mitigation techniques to reduce MVCs on their roadways in the last 10 years[13,14]. These measures include wildlife fencing and wildlife underpasses, which have not been implemented in Newfoundland.

Current mitigation policy

There is evidence that the government perceives that the public expectation is a consistent zero moose-vehicle fatality rate[1]. There is not a clear logic or explained reasoning for how this perception has resulted or why the government has taken it so literally. A policy to eliminate all MVCs is unrealistic. Even the most effective measures to mitigate WVCs are not 100% effective at reducing accidents[9]. Thus to begin with highway mitigation policy based on unrealistic performance target of eliminating MVCs and consistent zeros MVC fatality rates is destined to fail in meeting its goal.

The current government policy to reduce MVCs and increase motorist safety appears to be based entirely on three objectives: (1) increasing public awareness and targeted prevention strategies such as driver education; (2) enhanced highway signage; and (3) clearing of roadside brush[1,2,6].

The greatest emphasis of the mitigation strategy appears to rely on increasing public awareness. This strategy seems to be based on a published study from Newfoundland by Joyce and Mahoney[5], which recommended driver awareness programs as the only viable option for reducing MVCs in Newfoundland. The aforementioned study fails to recognize proven measures to reduce WVCs and MVCs at the time of writing[15,16,17]. Further, in the 11 years since the study was conducted, there have been significant improvements in developing effective techniques to reduce WVCs including moose[8].

Government policy and strategy with regard to MVCs and measures to reduce them can be summarized as follows for the 4 measures they have adopted[1,5].

(a) Regulated fall hunt: Only a drastic reduction in moose population on the island will result in a discernable reduction in MVCs. Since this is socially unacceptable the government will continue with its current system of regulated fall hunts and not increase quotas.

(b) Public awareness campaigns: This is the most important mitigation strategy for the government, relying on driver education and awareness to reduce the number of MVCs in Newfoundland. Mitigation measures can be grouped into measures that attempt to influence driver behaviour, measures that influence animal behaviour, and measures that attempt to physically separate animals from the road[7]. The government strategy relies entirely on influencing driver behaviour, resting sole responsibility for avoiding MVCs with the motorist (driver behaviour).

(c) Signage: Public awareness campaigns generally are combined with deployment of signage warning drivers in areas with consistent MVCs. Signage is probably the most commonly used method of mitigating WVCs[18]. Research has shown that there is little evidence that the presence of warning signs result in reduced WVCs (moose as well)[8]. However, seasonal wildlife warning signs, present at certain times of the year when animals cross roads, e.g., migratory species such as elk or mule deer, have shown to be effective reducing deer-vehicle collisions by 50%[8]. Moose do not migrate seasonally, therefore this technique may not be as effective in Newfoundland.

(d) Clearing brush from roadways: Motorist visibility may be improved by clearing roadside vegetation that may obscure animals approaching the road; however, such practices create prime foraging habitat for ungulates such as moose, by inhibiting forest succession and maintaining early seral shrub communities[19].

A critique of current mitigation policy

Of the three measures listed above, a public awareness campaign is the only measure currently implemented by Newfoundland Transportation that a recent US Federal Highway Administration (FHWA) review of wildlife-vehicle collision methods supports being implemented, where feasible and appropriate[8]. The review clearly indicates that clearing brush along roadsides is not a proven method to reduce MVCs and therefore should not be implemented until more rigorous research is conducted to evaluate the effect on collision rates. The third method used in Newfoundland, standard wildlife warning signage, was deemed entirely ineffective and strongly advised not to be used to mitigate MVCs. The suboptimal performance of these highway mitigation measures for wildlife have been known to transportation agencies for over 15 years[30].

The 2009 FHWA report is the most comprehensive work to date identifying techniques used to reduce WVCs and assessing their efficacy based on studies of performance and opinion of experts from transportation and resource management agencies in North America[8]. The report, however, recommends two methods for implementation that are not being used in Newfoundland but Newfoundland Transportation should be implementing in attempts to reduce MVCs: (1) wildlife fencing and (2) wildlife fencing with wildlife crossing structures (underpasses, overpasses). Both measures are routinely implemented by transportation agencies throughout North America today, including areas with problems of MVCs [6,13,14]. Fencing, alone or with crossing structures, is a proven technique and highly effective at reducing collisions with ungulate species (deer, elk, moose), reducing rates by as much as 95% in some areas[8,15,16]. Placement of fencing, with or without crossing structures, is not a random process but to be effective is aligned with areas of greatest concentration of MVCs. Studies in Sweden, Quebec, British Columbia and Vermont have shown that the risk of collision with moose can be reasonably predicted from data on landcover and road attributes, readily available from transportation agencies[20,21,22,23]. Animal-vehicle detection systems are also being used with fencing (with our without wildlife crossings) to keep animals off roadways and reduce WVCs[8].

Newfoundland Transportation has set the performance bar low by narrowly focusing their efforts on public awareness and driver education when there are other proven methods available today. The Transportation Association of Canada (TAC), which Newfoundland Transportation is a member, hosted the 2003 TAC Annual Conference in St Johns and dedicated an entire daylong session to a Wildlife Accident Mitigation workshop[24]. Seven transportation professionals from Newfoundland (consisting of engineers and planners) attended the mitigation workshop, including six staff from Newfoundland Transportation and Works (Transportation Association of Canada, unpublished data). Despite this venue having take place on the Island, Newfoundland Transportation has been reluctant to implement any new or proven measures to reduce MVCs on the Island other than pubic awareness campaigns[1].

Mitigation strategies, like Newfoundland’s, that rely on increasing public awareness are not generally effective, as drivers do not change driving habits if public awareness campaigns are of short duration[8]. Further, campaigns that run over longer periods do not sustain attention of drivers and are routinely ignored. Public awareness campaigns have had some success reducing WVCs but only in localized situations[8]; they have not proven effective in broad-scale applications over large geographic areas such as in Newfoundland, Quebec, Sweden or elsewhere.

There is evidence that Newfoundland government is not considering a reduction in moose numbers by significantly increasing moose harvest rates in the fall. This approach is mainly based on lack of perceived social acceptance and uncertainty regarding whether areas of high moose density are associated with high MVCs[1]. The current system of regulated fall hunts has little effect on stabilizing the moose population. MVCs are a result of multiple factors and not a single explanatory variable. Although past research in

Newfoundland has not been decisive in determining how important moose density contributes to MVCs (e.g., Joyce and Mahoney found that high MVC rates occurred in areas of low and high moose densities)[5], there is resounding concordance from studies elsewhere indicating that there is a positive correlation between moose densities and MVCs, particularly at a national scale (Andreas Seiler, Swedish Agricultural University, personal communication).

Thus, a strategy to reduce overall moose numbers on the island, and one aimed at reducing moose numbers in targeted areas with high MVCs, would likely result in a reduction of MVCs at both island and local scales. The burgeoning moose population in Newfoundland is having a significant impact on forest ecology, primarily balsam fir forests, impacting a suite of species that the forest health is dependent upon[10,12]. Management of moose population through a strategic plan aimed at reducing moose numbers in high density areas will have benefits beyond reducing MVCs but restoring forest health. Ultimately, effective mitigation of MVCs will depend largely on integrated management of the surrounding landscape and moose population, and to a much lesser extent on the increased awareness of individual motorists.

The Strategy Document on Moose Vehicle Collision prepared for the Department of Environment and Conservation[1] suggests that not all mitigation measures to reduce MVCs can be implemented in Newfoundland due to geography – "underpasses are not practical"; however, no explanation is given as to why underpasses cannot be constructed under highways in Newfoundland. Wildlife underpasses can be built nearly anywhere and where there may be issues of high water table there are engineering methods commonly applied worldwide when highways or other infrastructure are built below the water table (or phreatic zone).

The document also indicates that due to "length and remoteness of the provincial highway system" this precludes "extensive fencing and lighting". Effective mitigation of MVCs in Newfoundland does not require fencing the entire highway system, but targeting measures at specific locations where MVCs are consistent annually and problematic. With regards to lighting or power, lighting is not considered a mitigation measure to reduce MVCs nor does fencing or wildlife crossing structures require electricity for them to function and be effective[8].

The document also suggests that fencing is not feasible in Newfoundland due to its unique characteristics of "rough terrain, high snowfall and long linear nature of the MVC problem". Newfoundland is not the only location in the world with these 'unique' characteristics, but shares them with jurisdictions dealing with this problem in a logical and effective manner (Sweden, Quebec, New Brunswick, Nova Scotia). Effective mitigation measures such as fencing and wildlife crossing structures have been successfully implemented in areas of rugged terrain (multiple locations in the Canadian and US Rocky Mountains, Cascade Range in Washington State, mountains of northern Arizona, etc) and high snowfall (Washington State Cascade Range, northern Norway, Canadian Rocky Mountains, etc.)[16,25,26]. The long linear nature of the MVC problem is not unique to Newfoundland.

Numerous transportation agencies have successfully resolved the problem of MVCs occurring in a dispersed fashion throughout their jurisdiction; these characteristics are typical of MVCs in most areas. One example is a coherent and logical approach the Ministry of Transportation in Quebec has taken recently to mitigate a 150 km section of highway traversing prime moose habitat using fencing and wildlife underpasses[13]. Similar examples can be found in New Brunswick, Ontario, Sweden, Alaska, and other areas where moose populations and highways co-occur[8,14,21].

Best management practices

The continuing and unmitigated MVC problem in Newfoundland is serious with regard to public safety, ecosystem health, and the financial cost of the accidents to society. The problem is not new but has been readily apparent for more than a decade or more, concomitant with growing transportation infrastructure on the Island, increasing traffic volumes, and a vastly expanding moose population that is out of management control.

Efforts to mitigate collisions between wildlife and vehicles have been in use by transportation agencies since the 1970's[27,28,29]. For more than 10 years, appropriate techniques and measures were available to make policy and management decisions with regard to reducing MVCs in Newfoundland. The landmark publication of Romin and Bissonette[30] published in 1996, provided valuable management information regarding the efficacy of different measures designed to reduce deer-vehicle collisions. The performance of these measures is not different for reducing MVCs.

Unlike other long established areas of transportation research, managing conflicts between wildlife and transportation infrastructure draws from 20-30 years of emerging research and technologies. There are no industry standards for reducing WVCs that are part of the American Association of State Highway Transportation Officials (AASHTO) "Green Book" or recently released "Highway Safety Manual". That said, many state and provincial transportation agencies have developed their own "Best Management Practices" (BMPs) or "Technical Guidelines" for mitigating WVCs including MVCs in jurisdictions where collisions are problematic. The BMPs used by transportation agencies are not kept secret but readily shared among transportation professionals through a variety of means of technology transfer such as case studies, professional workshops (e.g., TAC 2003 in St John's, NL), peer-reviwed publications, internal technical publications (grey literature), and an assortment of professional meetings dedicated to mitigating highway impacts on wildlife populations.

There is evidence that within the last 10 years Newfoundland Transportation and Works has not implemented, or even tested in a pilot study, the most effective and proven measures to reduce MVCs on their roadways given the knowledge, experiences, and techniques available to their profession.

Do moose densities influence collisions?

The influence of moose densities has been discussed above. Moose density is one factor of several others (landscape, traffic volume, road design) that contribute to MVCs. However, moose density is a strong predictor of MVCs at large scales, such as national scale or island of Newfoundland (Andreas Seiler, Swedish Agricultural University, personal communication).

Nevertheless, at a broad-scale, a significant reduction in moose density would be required to likely see a reduction on MVCs at the same scale (Island of Newfoundland). However, moose densities are not uniformly distributed throughout the Island but are heterogeneous with varying densities found throughout. Similarly, moose habitat quality is heterogeneous and varies widely from poor to prime throughout Newfoundland, and is constantly changing due to current forestry practices implemented year-round. What was prime habitat yesterday may be converted rapidly to moderate or low quality habitat through forest cutting or other land conversion practices. Thus, it is apparent that successfully reducing MVCs in Newfoundland by the Department of Transportation and Works will require an integrated land management approach.

This integrated, landscape-based approach has been taken by numerous transportation agencies in North America in the last decade and is becoming standard practice as agencies are finding that the ecological effects of roads are not confined to the highway corridor[18]. This cooperation in Newfoundland will be required primarily from the Department of Environment and Conservation and Department of Natural Resources, however, municipal governments and other stakeholders will be critically important to the success of mitigation actions at the local level.

Is a 50% or greater reduction in serious MVC injuries possible?

"Serious injury" from a MVC is defined as someone being admitted to a hospital as an inpatient. Obtaining a 50% or greater reduction in serious MVC injuries should be obtainable by reducing the incidence of MVCs in Newfoundland. This can be done several ways, but the most straightforward is by utilizing current and effective mitigation practices throughout the Island, particularly where MVCs are most problematic.

As an example, fencing alone (or in conjunction with animal-vehicle detection systems or with crossing structures) has resulted in >50% reductions (up to 90-95% reductions for ungulate species such as moose) in WVCs in numerous locations in North America[7].

There is nothing special or exceptional about the MVC problem in Newfoundland that would lead one to believe that these high reduction (performance) rates would not occur for moose in the Newfoundland situation if planned, designed and implemented <u>correctly</u> by the Department of Transportation.

Mitigation cost - benefits

Mitigation measures aimed at reducing MVCs, provide many benefits, such as fewer motorist accidents that may include human injuries, deaths, and property damage.

A review of 13 different mitigation measures used by transportation agencies to reduce WVCs—such as wildlife warning signs, vegetation removal, fencing, and wildlife crossing structures—indicated estimated effectiveness can vary from as low as a 26 percent reduction in WVCs (seasonal wildlife warning signs) to a 100 percent reduction in WVCs (elevated roadway) [8].

Each mitigation measure has a different cost to implement and maintain and thus the selection of the appropriate mitigation measure should take into account the different safety and conservation goals as well as its effectiveness in reducing WVCs.

As the rates of WVCs in North America have increased over the past two decades, transportation and natural resource agencies are increasingly seeking to mitigate highways to increase motorist safety as well as provide for the conservation of wildlife[18].

To support their efforts, recent advances in evaluating the monetary costs and benefits of mitigation measures are helping decision makers, managers and the public better understand the trade-offs of investing in a variety of mitigation measures to reduce WVCs.

For mitigation to be cost-effective there needs to be a break-even point or a dollar value threshold.

A study published in the journal Ecology and Society in 2009 (referred to above in section 4), thoroughly detailed these values for deer, elk and moose in North America[6]. The number of deer–, elk–, and moose–vehicle collisions per kilometer per year were compared to the actual cost of different mitigation measures and the realized effectiveness of each mitigation measure.

For example, if a road section averages 4.4 deer–vehicle collisions per kilometer per year, a combination of wildlife fencing, under- and overpasses would be economically feasible, because the threshold value of 4.3 is exceeded. The threshold value for less costly mitigation of fencing and wildlife underpasses, however, is 3.2 deer–vehicle collisions per kilometre per year[6].

Because we know the cost of different mitigation measures per year and their effectiveness at reducing WVCs, it is possible to calculate the break-even point for sections of highway in Newfoundland with high MVC rates.

Compared to provinces primarily dealing with deer-vehicle collision problems, the cost of accidents involving moose in Newfoundland is a substantially higher cost to society.

The estimated costs of a deer-vehicle collisions is $6617 vs $30,760 for MVC[6]. Therefore the threshold value will be lower on Newfoundland highways, i.e., fewer MVCs per kilometre per year, compared to other provincial highways with problematic deer-vehicle collision rates.

Even less costly mitigation, such as wildlife fencing and animal-vehicle detection systems would provide significant cost-benefits and could be implemented on many sections of highway in Newfoundland.

Where key areas for moose movement across highways are identified, more costly mitigation (fencing and crossing structures) would still provide cost-benefits and pay for themselves in a relatively short period of time. As an example, the cost of wildlife mitigation (fencing and underpasses) on four highway projects to reduce MVCs in New Brunswick was estimated at $20 million (1999 dollars)[14], thus the same amount as the estimated financial and social costs of MVCs in Newfoundland for one year.

Clearly, there are many effective mitigation options available today that provide long-term cost benefits, which Newfoundland Transportation and Works could be implementing as standard practice to mitigate MVCs. The calculations to identify which sections of highway mitigation measures will provide cost-benefits is straightforward if their data is available on the frequency and location of MVCs on Newfoundland's highways.

Why isn't government current with highway mitigation practices?

The government documents and other materials that I have read are inaccurate with regard to the efficacy and feasibility of implementing measures to reduce MVCs on Newfoundland's roadways. They are not well researched nor do they contain current information regarding the state of the science of highway mitigation practices in Canada or North America. The information in the Strategy Document[1] is simplistic in how they explain their policy. The information that they present is considerably outdated and thus inaccurate with regard to current practices and misguided from a policy and management perspective.

Continuing from paragraphs 23-26, it is unclear to me why Newfoundland Transportation and Works has not implemented or even pilot tested mitigation measures in some problematic sections of highway. For many years now there has been a plethora of techniques that have been rigorously studied and results made available through a variety of venues ranging from conference proceedings to published scientific journals. As long ago as 1996, the Romin and Bissonette study[30] revealed the perceived and realized efficacy of different measures used by transportation agencies through agency questionnaires. They found that the measures used entirely by Newfoundland Transportation and Works to reduce MVCs - public awareness programs and wildlife signage - were believed successful by only 24% and 7% of the respondents, respectively.

The fact that 62% and 70% of the respondents were inconclusive about the efficacy of these two measures demonstrates the uncertainty with regard to how well these measures will result in reducing MVCs. On the other hand, in the same study fencing and wildlife crossing structures (underpasses, overpasses) were believed successful by 91% and 63%

of the respondents. None of the respondents were inconclusive about the efficacy of fencing, while only 25% were unsure of crossing structures.

This abovementioned information was published 15 years ago. Because up until recently there have not been transportation standards on reducing WVCs, transfer of technology gained from agencies and researchers has been the main method of communicating the state of practice and science. This has been done through a variety of ways and venues that are all well known to transportation professionals charged with mitigating road impacts on wildlife and increasing motorist safety.

The International Conference on Ecology and Transportation (ICOET) is perhaps the most important venue and gathering of transportation and resource management professionals in North America. ICOET began in 1996 and meetings take place every two years always in North America. The 9th ICOET meeting will take place in Seattle, Washington in August 2011. The Transportation Research Board (TRB) annual meeting in Washington, DC is attended by 10,000 transportation professionals worldwide each year. TRB created a Task Force on Animal-Vehicle Collisions in 2003, and is associated with the Committee on Safety Data, Analysis and Evaluation. The Committee on Ecology and Transportation began as a Task Force in 2002 and became a full standing committee in 2006. Clearly there are many technical and professional resources available today and have been available for many years (10 years or more) from which Newfoundland Transportation and Works could utilize in help managing their MVC problem. The efficacy of these measures has been known for many years.

Conclusions

1. MVCs have been a serious problem in Newfoundland for many years if not decades.

2. Moose densities in Newfoundland are one of the highest in the world, and clearly the highest in North America, and show no sign of stabilizing.

3. Newfoundland Department of Transportation and Works is not implementing current highway mitigation practices on highways that would lead to a reduction in MVCs and human injury and fatalities on Newfoundland’s roadways.

4. The Newfoundland government is misleading public and inaccurate when indicating that there is little to be done (practically nothing) other than rest sole responsibility on motorists to avoid collisions with moose (be aware and informed; slow down) and by clearing brush from sides of highways to increase driver visibility. The latter actually might exacerbate the problem by increasing moose densities in the highway right-of-way.

5. Proven mitigation methods are available today and have been for 10 years or more. These methods have been tested in different North American locations and landscapes, using rigorous research methods and their results have been published in international peer-reviewed journals and are common knowledge among

transportation practitioners in North America that are charged with reducing WVCs. There are best management practices being developed by transportation agencies on how to reduce WVCs (including MVCs) and this transfer of technology and expertise is shared through a variety of venues aimed at transportation practitioners in Canada and the rest of North America.

6. Many government authorities and jurisdictions in North America and elsewhere have actively implemented measures to reduce MVCs in the last 10 years and I can see no good reason why the Newfoundland Department of Transportation and Works is not currently implementing the most effective and proven measures to mitigate MVCs on their highways in the 21st century.

Footnotes

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APPENDIX

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Bio – Anthony P Clevenger

I have over 25 years of experience as a wildlife research scientist. I have carried out research during the last 14 years assessing the performance of highway mitigation measures designed to reduce wildlife-vehicle collisions and habitat fragmentation throughout Canada and the United States. My research is recognized worldwide as a major contribution to road ecology and solutions to mitigating highway impacts on wildlife populations. My long-term research assessing the performance of the Trans-Canada Highway mitigation in Banff National Park, Alberta, has proven to be of international importance. I have served as a member of the U.S. National Academy of Sciences Committee on *Effects of Highways on Natural Communities and Ecosystems*. Since 1986, I have published over 50 articles in peer-reviewed scientific journals and have co-authored three books including the landmark book, *Road Ecology: Science and Solutions* (Island Press, 2003) and recently, *Safe Passages*: *Highways, Wildlife and Habitat Connectivity* (Island Press, 2010). I am a graduate of the University of California, Berkeley, and I have a Master's degree from the University of Tennessee, Knoxville and a Doctoral degree in Zoology from the University of León, Spain. Since 2002, I have been a research wildlife scientist for the Western Transportation Institute (WTI) at Montana State University; however, still living in Alberta and continuing my primary research on mitigating transportation infrastructure effects in the Canadian Rocky Mountains and other parts of North America.