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Characteristics of Moose-vehicle Collisions in Anchorage, Alaska, 1991–1995

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Moose have successfully adapted to Anchorage's urban environment, using greenbelt areas for shelter, forage, and protection from nearby predator populations. However, the proximity of moose to people poses unique hazards: a motor vehicle colliding a moose may cause significant injury and vehicle damage. The annual Moose Vehicle Collision (MVC) rate increased during the study period from 40 to 52 MVCs per 100,000 registered vehicles in Anchorage, a significant ($X^2 = 7.8$, $p < 0.01$) increase of 23%. Of 519 reported MVCs, 23% resulted in injury to 158 people, with no human fatalities. Collisions were 2.6 times more likely to have occurred in the dark ($n = 375$, [72%]) than during daylight hours. An MVC on a dry road was twice (95% CI: 1.29, 3.08) as likely to have resulted in an injury as an incident on a slick road. MVCs may be prevented by: reducing speed limits around greenbelt areas, brighter vehicle headlights, placement of street lights in known moose areas, underpasses for wildlife at known crossings, and snow removal to reduce berm height in areas of high moose concentrations. Published by National Safety Council and Elsevier Science Ltd

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INTRODUCTION

Man's manipulation of the environment has played a significant role on the moose (*Alces alces gigas*) population in the Anchorage area. Moose were uncommon in Anchorage before 1940. Construction of the Fort Richardson Military Reservation and the development of Anchorage during World War II resulted in the widespread clearing of mature spruce forests. The local moose population soon increased as preferred foods such as birch, willow, and other

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browse (Schwartz, Rausch, & Gassaway, 1994) flourished in the areas cleared for development. The moose population continued to increase in the late 1940s and 1950s as more forests were cleared in postwar homesteading activities and population levels have remained high since then (Alaska Department of Fish and Game, 1995).

The local population of moose in the Anchorage area has adapted well to urban life. Currently, an estimated 450 moose live in the Anchorage area year-round (Alaska Department of Fish and Game, 1994); however, when winter snow accumulation begins to hamper movement and cover forage, additional moose move down from nearby mountains and the population is estimated to double (Alaska Department of Fish and Game, 1995). The abundance of food, shelter, and protection from nearby wolf packs make Anchorage an attractive environment for moose in the winter. Nonetheless, as the population of Anchorage grows, conflicts between humans and moose have become more common.

The instinctual response of moose to a perceived threat is not to flee. This behavior has survival benefits in interactions with wolves, but clearly is not advantageous during an encounter with a motor vehicle (Child, Barry, & Aitken, 1991). A motor vehicle colliding with this largest (360–725 kg) member of the deer family can cause significant injury to vehicle occupants and damage the vehicle.

METHODS

At the request of the Municipality of Anchorage, we enumerated all automobile and truck collisions with moose that occurred between 1991 and 1995. To characterize these moose-vehicle collisions (MVC) in Anchorage, the records of all motor-vehicle collisions involving a moose in Anchorage were obtained from the Municipality of Anchorage, Department of Public Works, Traffic Engineering Division. Completeness of reporting was assessed by comparing numbers of records obtained from the Alaska Department of Fish and Game. Collision variables for time, seasonal variation, and road conditions were analyzed. Denominator data for rates were based on 1993 State of Alaska, Department of Public Safety, vehicle registration data. Information was not available to differentiate between occupational (i.e., commercial vehicles and vehicles used for business) and non-occupational motor vehicles (i.e., privately owned vehicles).

Alaska's northern latitude causes the hours of daylight to vary to a greater extent than elsewhere in the United States. The seasonal variation of sunlight in Anchorage ranges from less than six hours of daylight in the winter to more than 19 hours of daylight in the summer. Therefore, we calculated the daylight status at the time of each MVC. In addition, a spot map pinpointing the geographic location of all reported MVCs was constructed. This helped identify areas in Anchorage at increased risk for MVCs.

Snow depths greater than 70 cm can impede the movement of moose and force them to use roads and plowed areas as travel corridors, thus increasing the risk for an MVC. Therefore, snow depth measurements provided by the Natural Resources Conservation Service, United States Department of Agriculture, were reviewed for three sites in the Anchorage area.

RESULTS

During the 5-year study period there were 519 reported MVCs in Anchorage: 23% ($n = 120$) resulted in injury to a vehicle occupant, injuring 158 people (range 1–5). There were no human fatalities. The annual MVC rate increased during the study period from 40 to 52 MVCs per 100,000 registered vehicles in Anchorage, a significant ($X^2 = 7.8$, $p < 0.01$) increase of 23%; however, there was no increase in the proportion of injury MVCs. The overall motor-vehicle crash rate remained stable during the study period. MVCs accounted for 2% of all crashes in Anchorage during the study period.

The eight-hour period between 6:00 p.m. and 1:59 a.m. accounted for 55% ($n = 285$) of the MVCs; a smaller peak ($n = 81$ [16%]) occurred between 6:00 a.m. and 8:59 a.m. These hours correspond to the high volume traffic times in the Anchorage area and include the morning and evening commutes. A disproportionate number of injury MVCs occurred between 8:00 p.m. and midnight ($n = 48$ [40%]).

Saturday was the most frequently cited day for an MVC ($n = 90$ [17%]) and Wednesday the least ($n = 58$ [11%]). A crash occurring on Saturday was 1.5 times (95% CI: 1.07, 2.15) more likely to result in injury than those on other days of the week.

The months with the least amount of daylight (December and January), were the most frequently cited for a collision to occur ($n = 154$ [30%]); September and October were the most frequently cited months for an injury incident ($n = 35$ [29%]). However, February had the greatest proportion of injury collisions (n = 13 [38%]) and December had the lowest (n = 7 [10%]).

Collisions were 2.6 times more likely to have occurred in the dark (n = 375 [72%]) than during the daylight hours; 61% (n = 229) of the collisions that happened in the dark occurred on unlit road surfaces (i.e., no street lights near the incident). Stratification of MVCs by daylight status and/or vicinity of street lights revealed that injuries were proportionate to the number of MVCs, not to daylight or street light status.

Periods of reduced visibility due to weather (i.e., rain, snow, and fog) were present in only 18% (n = 95) of all collisions and in 16% (n = 19) of the injury incidents. Slick road conditions (i.e., wet, snow, and slush) were present for 54% (n = 280) of all MVCs during the study period. However, only 41% (n = 49) of the injury incidents occurred on slick roads. An MVC on a dry road was two times (95% CI: 1.29, 3.08) more likely to have resulted in an injury as an MVC on a slick road.

Using information obtained from the spot map, major east-west commuter roads from the suburbs in the foothills east of the city and areas adjacent to greenbelt and park areas were identified as places of increased risk for MVCs. Injury collisions occurred more frequently in areas with higher speed limits (Figure 1).

The winter snow depths varied significantly from the reported 30-year average in 1994 and 1995, the years with the highest number of MVCs. In 1994, snow depths were deeper than normal and consistently greater than 70 cm in all reporting areas. In 1995, snow depths were less than the 30-year mean, with no reported snow depths greater than 70 cm throughout Anchorage.

There was substantial under-reporting of MVCs in the Anchorage area. The Alaska Department of Fish and Game reported 648 moose killed by motor vehicles in Anchorage during the study period; however, only 519 (80%) were recorded by the Municipality of Anchorage. In addition, many moose-vehicle encounters may have also resulted in the swerve-and-miss category where the vehicle misses the moose and subsequently crashes into trees or other fixed barriers off the roadway. Thus, the true number of motor-vehicle accidents due to moose may even be higher.

DISCUSSION

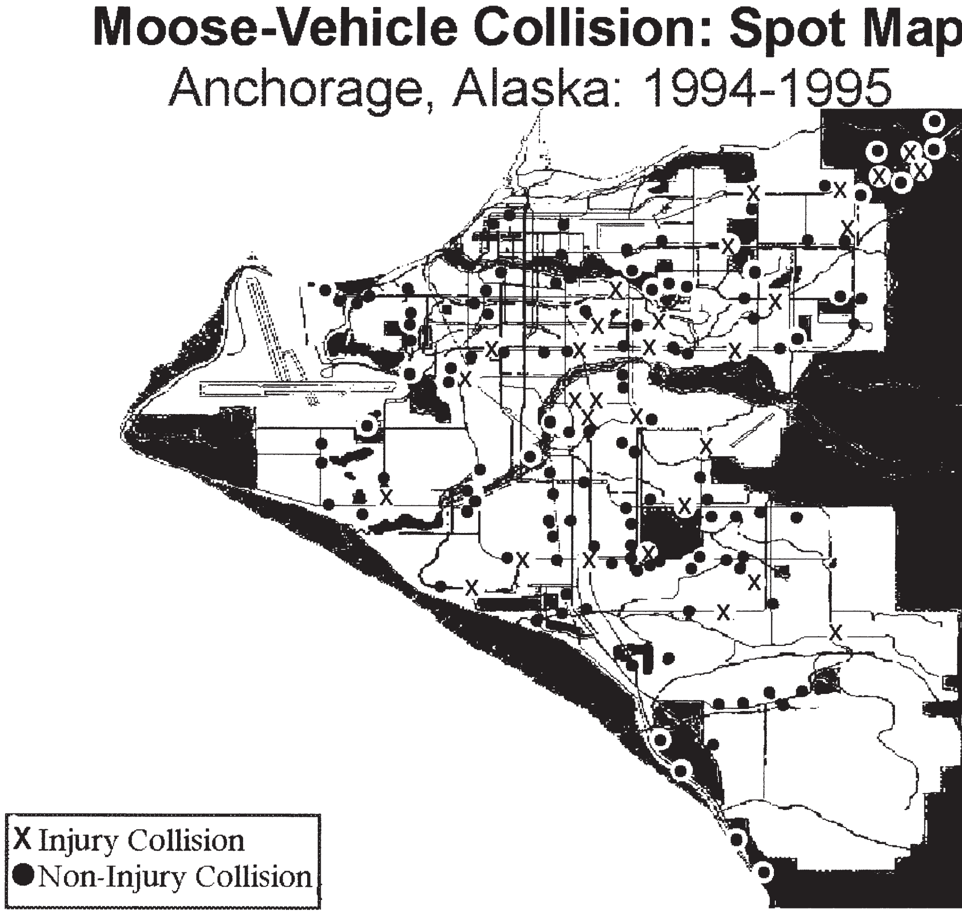
In rural areas of Alaska, 20% of all MVCs result in injury and 0.5% result in a human fatality (Thomas, 1995). Extrapolating using the 519 reported collisions, one would expect to see three such human fatalities and 104 injuries in Anchorage during the study period. However, there were no fatalities during the study period and 120 injury incidents. The lack of human fatalities in Anchorage suggests overall speeds at the time of collision may be lower than on rural Alaskan highways. The 10% (n = 16) excess in injury collisions in Anchorage could be due to decreased seatbelt use and increased vehicle occupancy rates in urban settings; these are areas that require further investigation.

The National Highway Traffic Safety Administration reports that nationally 4% of all collisions are with animals and account for 0.3% of all fatalities and 0.7% of all injuries (National Highway Traffic Safety Administration [NHTSA], 1995). The thirty-three fold increase in injuries in MVCs when compared with other animal-vehicle collisions nationally is due to the moose's high center of gravity and large body mass. The moose's long spindly legs elevate the undersurface of the abdomen above the level of the hood of many vehicles. When a motor-vehicle collides with a moose, the vehicle knocks the legs out from under it, and the vehicle's momentum causes it to be swept up the hood and into the windshield (Rattey & Turner, 1991). This mechanism of injury has been reported to result in a disproportionate number of injuries to the head and neck of vehicle occupants (Sutton, 1996).

Nationally, the direct cost (medical care, vehicle repair/replacement, lost wages, etc.) associated with vehicles damaged in motor-vehicle crashes was $5,574 (National Highway Traffic Safety Administration [1994 data], 1997). The direct costs associated with moose-vehicle collisions during the study period in Anchorage was approximately ten million dollars based on an estimated cost per collision of $15,150 (Thomas, 1995). Extrapolating these costs show that MVCs are responsible for approximately 5% of all costs associated with motor-vehicle crashes in Anchorage while MVCs account for only 2% of the crashes.

While it remains unclear why the number of MVCs increased during the study period, several possibilities exist. The increase may be the result of increased human activity and housing development on the fringes of the city. In addition, motorists may be driving faster due to improved road maintenance (i.e., snow plowing) that may have improved winter driving conditions in Anchorage.

FIGURE 1



The record amount of snow fall in 1994 and the lack of snow in 1995 may explain the dramatic increase in MVCs during the last two years of the study period. In 1994, snow depths were consistently deeper than 70 cm throughout the city; thus, moose may have been forced to use plowed roadways as travel corridors and encounters between vehicles and moose would have increased. The lack of snow in 1995 may have allowed more moose calves to survive as forage and browse would have been easier to obtain throughout the winter months. Calves make up the highest proportion of moose involved in MVCs (Alaska Highway Safety Planning Agency [AHSPA], 1992), and an increase in the calf population could account for the increased number of MVCs.

To reduce the high number of injuries and the costs associated with MVCs, intervention strategies need to be implemented and evaluated for effectiveness. Possible intervention strategies could include: increasing a driver's ability to see moose along the roadway, controlling or reducing access of moose to the roadway, and reducing speed limits in areas adjacent to parks and greenbelts as well as other areas identified as high-risk. Moose are difficult to see at night. Their dark bodies don't reflect much light and they seldom look directly at oncoming vehicles; therefore, there is no eye shine reflection of headlights typical of other deer. Increasing visibility by upgrading older vehicles' headlights with halogen bulbs and keeping headlight lenses clean are inexpensive ways to decrease the number of MVCs. In addition, the placement of street lights in known high density moose areas may also decrease the occurrence of MVCs.

The reduction of snow berm heights along plowed roadways is another option that may help to reduce MVCs. By reducing snow berm heights along roadways drivers would be more able to see moose on the side of the road and may prepare themselves by slowing down. Anchorage currently pushes snow back off the road at an estimated cost of $500 per mile; to push it back, scrape it up, blow it into trucks, and haul it to a snow dump costs $2,500 per mile (Freedman & Withey, 1996). Due to these costs, snow berm removal is unfeasible on all streets; however, it should be seriously considered for areas known for high rates of MVCs.

Fencing and the redirection of wildlife through underpasses are site-specific solutions that may be implemented in areas known for high MVC. In the early 1980s, the Glenn Highway between Anchorage and Eagle River had the highest rate of MVCs in Alaska. During the three years after fencing and lighting a 3.3-mile stretch, MVCs declined by 95% (McDonald, 1991). Fencing is expensive and is not an option in all areas.

The proximity of moose to people in the Anchorage area is a growing concern. With the proper implementation of intervention strategies in known problem areas and the continual evaluation of new and innovative strategies, the number of MVCs could be reduced.

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