Moose–Motor Vehicle Collision: A Continuing Hazard in Northern New England

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BACKGROUND: Moose-motor vehicle collisions (MMVC) are especially dangerous to vehicle occupants because of the height and mass of the animal, which often collapses the roof and has a direct impact into the passenger compartment.

STUDY DESIGN: Public data on MMVC were obtained from the states of New England (NE), and trauma registry data from centers in NH and ME.

RESULTS: For all of NE, the annual incidence of reported MMVC has declined from a peak of >1,200 in 1998, but has still averaged >500 over the last 5 years, predominantly in ME, NH, and VT. Public education may have contributed to the decline, but the moose population has also apparently decreased due to environmental changes. In NE, MMVCs are most frequent in the summer months and evening hours. Maine data on crashes involving wild ungulates from 2003 to 2017 document 50,281 collisions with deer and 7,061 collisions with moose; 26 of the latter (0.37%) resulted in a human fatality. Logistic regression models demonstrate that vehicle occupant mortality, after controlling for multiple factors related to vehicle speed, is greatly increased when striking a moose rather than a deer (odds ratio [OR] 13.4, 95% CI 6.3, 28.7). In these data, there were no fatalities among occupants of Swedish cars, which are specifically engineered to tolerate MMVC. Three NH/ME trauma centers registered 124 cases of MMVC: median Injury Severity Score was 9; 5 patients died (4%); and 76 patients (61%) had injuries of the head, face, and/or cervical spine.

CONCLUSIONS: Moose-motor vehicle collisions remain a frequent and serious hazard to motor vehicle occupants in northern NE. Trauma services should recognize characteristic injury patterns. Continuing public education, cautious driving, and moose herd management are warranted. (J Am Coll Surg 2019;228:941–947. © 2019 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)

The Eastern or Taiga subspecies of moose (*Alces alces americana*) ranges south from eastern Canada to include the northern New England states in the USA. Moose populations in 2010 were estimated at 30,000 to 60,000 in Maine (ME), 4,500 in New Hampshire (NH), and 3,000 to 4,000 in Vermont (VT).[1] For these 3 states, the corresponding human populations were, respectively, 1,328,000, 1,316,000, and 626,000.[2] The moose generally avoid the humans, but occasionally they encounter them traveling at high speeds in motor vehicles, with potentially lethal results for both species.

An adult Eastern moose has a mass of approximately 360 to 600 kg (794 to 1,323 pounds), and a shoulder height of 185 to 195 cm (6.1 to 6.4 feet).[3] Consequently, the front of a passenger vehicle striking a moose will tend to impact its long legs, while the bulk of the animal collides with the windshield pillars ("A-pillars"), roof, and passenger compartment.[4] Such an event is usually fatal for the moose, and may be fatal for occupants of the vehicle, who characteristically suffer injuries to the head, face, and neck.

In 1996, a report from northern New England described the frequency and outcomes of moose-motor vehicle collisions (MMVC),[5] which were briefly updated for Maine in 2006.[6] The purpose of this article is to

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summarize the current epidemiology and epizootiology of MMVC in this region, review research findings from other parts of the world where similar issues are prevalent, and reiterate the importance of this type of injury as a combined challenge to Emergency Medical Services (EMS) systems, traffic safety engineers, and wildlife management.

METHODS

The annual incidence of MMVC by state was obtained from the Maine Department of Inland Fisheries and Wildlife, the New Hampshire Fish and Game Department, the Vermont Fish and Wildlife Department, and from published reports.[7,8]

Additional data on traffic collisions on public roadways within Maine involving any wild ungulate (moose or deer) were obtained from the Maine Department of Transportation, which maintains a public crash database and assisted with more detailed queries. Traffic data are not restricted to Maine residents, and record any (human) death occurring within 30 days of the crash, including deaths at the scene. These data were used to construct a logistic regression model predicting the occurrence of a human fatality, comparing the relative effect of collision with a moose vs a deer, while controlling for other factors. A separate analysis of traffic data evaluated the effect of vehicle manufacturer on MMVC outcomes.

Registries at level 1–2 trauma centers in Maine and New Hampshire were queried for cases of MMVC, sharing only limited data for statistical analysis. Institutional review boards (IRB) at 2 of these institutions confirmed that evaluation of these deidentified data was exempt from further IRB review. Injury Severity Scores were provided by hospital trauma registrars or were approximated from International Classification of Diseases (ICD) codes using the ICDPIC-R program.[9]

RESULTS

The annual number of MMVC in the New England states peaked in 1998 at more than 1,200, and has declined since that time (Fig. 1). The overall incidence still yields an average of 1 or 2 per day, the majority of which occur in the state of Maine. Data from 7,035 MMVC in Maine during the years 2003 to 2017 demonstrate that these events are most frequent just after sunset (with a secondary peak near sunrise) in the late spring and summer months (Fig. 2).

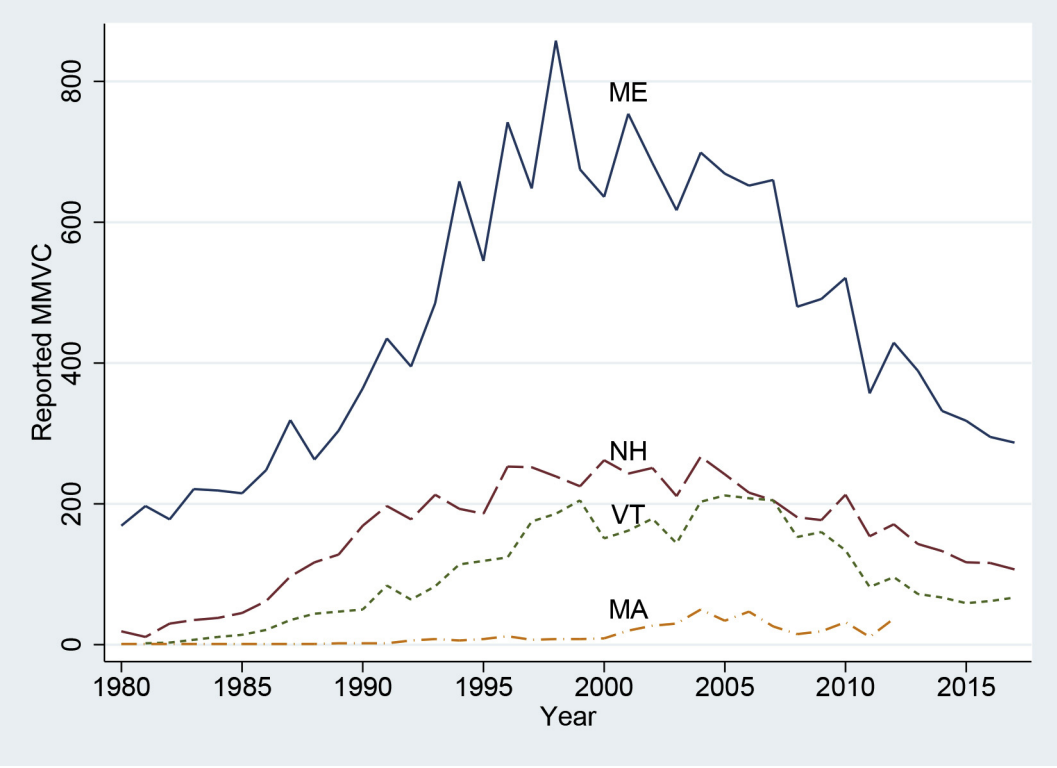

Figure 1. Annual incidence of reported moose-motor vehicle collision (MMVC) for northern New England states: Maine (ME), New Hampshire (NH), Vermont (VT), and Massachusetts (MA).

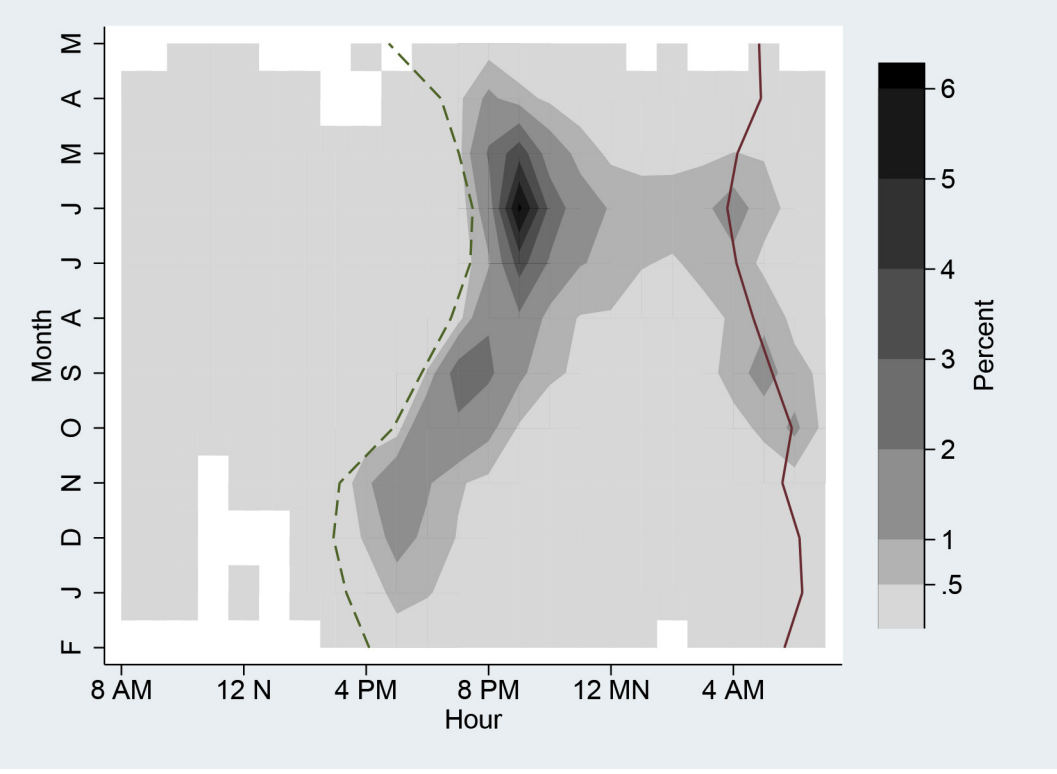

Figure 2. Relative frequency of moose-motor vehicle collision (MMVC) in Maine during different months and at different times of day, 2003 to 2017. Dashed line shows the approximate time of sunset and solid line shows the approximate time of sunrise, calculated for Greenville, ME (Moosehead Lake).

Among these 7,035 Maine MMVC, 1 or more human fatalities were reported in 26 (0.37%). For comparison, 50,281 deer-motor vehicle collisions were reported during the same time period, 10 of which resulted in a human fatality (0.02%). The mass and configuration of a moose compared with those of a deer result in the clear effect shown by the regression analysis in Table 1. After controlling for several factors attributable to vehicle speed, the odds that at least 1 vehicle occupant would be killed were more than 13 times greater if the vehicle struck a moose rather than a deer. Overall model fit was excellent based on a C-statistic of 0.92 and a Brier Score of 0.0006; a Hosmer-Lemeshow statistic was not calculated because of its acknowledged inutility with very large sample sizes.[10]

The vehicle manufacturer was identified for 7,656 vehicles involved in these Maine MMVC. There were no fatalities among the occupants of 158 Swedish vehicles (Volvo, Saab), compared with 25 fatalities among the occupants of 7,498 vehicles manufactured elsewhere (0.33%). This difference was not statistically significant using Fisher's exact test.

Registry data were obtained from Maine Medical Center (MMC, Portland, ME), Central Maine Medical Center (CMMC, Lewiston, ME), and the Dartmouth-Hitchcock Medical Center (DHMC, Lebanon, NH). Individual and combined summary statistics for 124 patients admitted after

Table 1. Results of a Logistic Regression Model Predicting the Occurrence of a Human Fatality in Maine Crashes Involving a Wild Ungulate

Variable	Odds ratio (95% CI)
Driver age 40–64 y vs other age	2.15 (1.07, 4.33)
Driver male vs female	2.95 (1.13, 7.66)
Driver impaired vs unimpaired	14.82 (5.52, 39.75)
Summer month vs other month	2.52 (1.28, 4.96)
Weekend day vs other day	1.97 (1.00, 3.89)
Midday hour vs other hour	2.92 (1.19, 7.18)
Moose vs deer	13.44 (6.29, 28.74)
Constant	0.000026

Driver impairment includes police-recorded drug or alcohol intoxication, physical or emotional disability, illness, or fatigue. Summer months include July, August, and September. Weekend days include Friday, Saturday, and Sunday. Midday hours include 11:00 AM through 4:00 PM.

Table 2. Characteristics of Patients Recorded in Trauma Registries of 3 Hospitals in Northern New England

				Head/neck		Died	
Hospital (years)	**n**	**n/y**	**ISS, median**	**n**	**%**	**n**	**%**
DHMC (1997–2017)	101	4.8	9	61	60	4	4
CMMC (2006–2015)	15	1.5	13	8	53	0	0
MMC (2013–2017)	8	1.6	14	7	88	1	13
Total	124		9	76	61	5	4

DHMC, Dartmouth-Hitchcock Medical Center; CMMC, Central Maine Medical Center; ISS, Injury Severity Score; MMC, Maine Medical Center.

MMVC are shown in Table 2. The median Injury Severity Score was 9; 76 patients (61%) had injuries of the head, face, and/or cervical spine, and 5 patients died (4%).

DISCUSSION

From the viewpoint of a surgeon in northern New England, MMVC are not rare and are not to be taken lightly. Because of the unique mechanism of injury, serious head and neck injuries must be anticipated, even when safety belts and airbags have been appropriately used, and ambulance personnel may need chain saws to dismember the moose carcass before extricating vehicle occupants. Moose-motor vehicle collisions may also result in "swerve-and-miss" injuries, where the moose is only partially hit and the car subsequently crashes into trees or other fixed barriers off the roadway.[11] For the latter, standard safety devices do offer protection; hence, it is useful to distinguish primary impact injuries (from hitting the moose) from secondary impacts (where the vehicle strikes other objects). Especially in the former, a systematic examination for maxillofacial fractures is important[12] because these result much more frequently from primary MMVC than from other types of vehicle crashes.[13]

The many summertime visitors to this area of the USA (and adjacent Canada), may look forward to the possibility of seeing *Alces alces americana* in the wild, but should drive with extra caution and lower speed, especially in the evening hours. Signs warning drivers to "Brake for Moose" should be heeded because the animal will instinctively face danger rather than avoiding it. The times at greatest risk for fatal MMVC (Table 1) are different from the times of most frequent MMVC overall (Fig. 2), demonstrating that life-threatening human injuries are related to speed and driver factors, as well as the presence of a moose on the road.[14] At night, even with high-beam headlights on a good road, most drivers cannot detect a moose at a distance further than 137 meters (449 feet), and therefore cannot react in a timely fashion if they are traveling at more than about 80 to 90 km/h (50 to 55 mph).[15] The absence of cleared ground along more rural roads reduces the reaction time, and animals approaching from the right side of the road are especially difficult to see.[16]

The decreasing overall incidence of MMVC in New England over the last 2 decades may be due, in part, to driver education and other measures put in place after attention was drawn to the alarming increase in the early 1990s.[5] However, the moose population in this area may also be decreasing,[1,8] which would clearly affect the probability of MMVC.[17] An intensive study of the moose population in Northern New Hampshire in 2002 to 2005 found that 41% of mortality after the neonatal period was due to natural causes including calf malnutrition in the winter months and parasites (especially winter ticks, *Dermacentor albipictus*); 26% of mortality was attributable to MMVC, and 18% to hunting.[18] Predation by black bears is also a significant cause of neonatal moose mortality in this region.[18,19] Climate change may be decreasing the availability of ideal moose habitat and/or increasing the frequency of epizootics due to ticks and other parasites, and may thereby temporarily or permanently modify the southern range of *Alces alces americana* as it has with other moose subspecies.[18,20,21]

There are several possible explanations for the seasonal variation in the incidence of MMVC. In the spring, yearlings may become confused and wander into roadways or urban areas after being driven away by their mothers, who are now preparing for the birth of new calves. During the fall mating season, the aggressive, erratic, hormone-driven behavior of the bull moose may also predispose it to vehicle encounters. However, the season of greatest risk to humans is the summer (Table 1), when there are many more of them traveling through the moose's backwoods habitat.

Ecotourism is economically valuable for the states of northern New England, and state governments seek to balance this benefit against the human risk due to MMVC. Moose hunting is an effective method of herd control, as well as another important industry, and is regulated in these states to maintain a sustainable harvest. Despite the reduction from historically high rates, MMVC remain frequent enough to be considered an

important problem. Furthermore, the reported incidence of MMVC is probably an undercount to some degree, in part because the ownership of a potentially valuable road-killed animal may be unclear.[7] The dressed weight of an adult moose carcass may be as much as 380 kg (838 pounds),[3] with a value of approximately $13.80/kg (although the meat cannot be legally sold).[22]

Management of the moose population, and especially its mutually harmful interaction with the human population, has been studied in ME[23,24] and NH,[18,19] but also benefits from the experience of other geographic regions where moose are abundant. Aerial surveys are the most accurate way to monitor moose populations,[24] although simply tracking harvest totals and incidental sightings may be more cost-effective.[22] Roadside fencing in high-volume areas may reduce MMVC, but entails relatively high expense,[23] may paradoxically trap animals on the roadway side of a fence,[16] and may create other ecological problems.[25] The local incidence of MMVC can be predicted from landscape characteristics such as wetland and forest types, which offers the possibility of modifying forestry practices to reduce MMVC.[19,23,26,27] Moose are attracted to the salt used for de-icing roads, which might be countered by draining roadside salt pools[28] or de-icing roads with a salt other than sodium chloride.[29] In general, moose do not consider roads to be high-quality habitat,[30] and might be influenced to avoid them if other artificial feeding sites were provided.[31]

Sweden has a moose population of more than 300,000[32] and had a 2010 human population of 9,416,000.[33] The annual number of reported MMVC in Sweden peaked at almost 6,000 in 1980; it has declined to about 4,500, but still results in 10 to 15 human deaths per year.[32] Swedish automobile manufacturers have therefore introduced numerous innovations including strengthened windshield pillars (A-pillars), animal/pedestrian sensors (potentially including infrared), automatic emergency braking, and testing with moose crash dummies.[16] As in our study, the effectiveness of these measures is hard to prove since the incidence of mortality overall is relatively low. A Swedish study of 22 human fatalities due to MMVC during 2005 to 2010 identified 5 (22.7%, 95% CI 7.8% to 45.4%) that were occupants of vehicles manufactured in Sweden,[34] while approximately 27% of all vehicles registered in Sweden were manufactured there.[33]

The Swedish automotive magazine *Teknikens Värld* periodically conducts a "moose test" (älgtest), with numerous domestic and foreign vehicles. This test determines whether the vehicle can tolerate a sudden evasive maneuver at moderately high speeds, as if to avoid a moose. Widely publicized failures have included the 1997 Mercedes A-Class and the 2013 Jeep Grand Cherokee.[35]

Moose-motor vehicle collisions continue to be a significant issue in Scandinavia, Russia, and Canada, as well as in northern parts of the US, and continued exchange of information among these areas will be important in order to further reduce death and disability. Furthermore, a similar problem has developed now that automobile travel is increasing in the Arabian Peninsula, due to another species of free-ranging animals that resemble moose in their size and shape: More than 600 camel-motor vehicle collisions (CMVC) occur in Saudi Arabia each year, with injury patterns similar to those with MMVC,[36,37] including human fatalities.[37,38] Lessons learned from MMVC are likely to be very relevant in addressing the problem of camel-motor vehicle collisions.

Although motor vehicle collisions with animals are a matter of concern in many geographic areas,[39,40] they are difficult for injury epidemiologists to study because the International Classification of Diseases (ICD) has not provided a specific way to code them in clinical databases or death certificates. Despite the increased specificity of ICD-10 compared with ICD-9, a vehicle striking an animal is still coded the same as a vehicle striking a (human) pedestrian. Perhaps ICD-11 will finally recognize the unique issues involved with vehicle-animal collisions.

The absence of a specific ICD code hampered the collection of hospital data for this study, which was therefore only possible at institutions willing to make special efforts, and has probably biased our clinical data toward more severely injured patients. The predominance of recorded cases from the Dartmouth-Hitchcock Medical Center probably reflects the longstanding interest in MMVC at that institution.[5] Traffic data compiled by the Maine Department of Transportation do not include crashes on nonpublic roads or those not reported to police. Similarly, data collected by wildlife management agencies may be undercounts for various reasons including those mentioned previously.

Despite these limitations in the data with respect to MMVC in northern New England, continuing public education, cautious driving, and moose herd management are clearly warranted. Trauma and Emergency Medical Services in this region should recognize characteristic injury patterns and support preventive efforts.

Author Contributions

Study conception and design: Clark, Sutton

Acquisition of data: Clark, Fulton, Ontengco, Lachance, Sutton

Analysis and interpretation of data: Clark, Fulton, Ontengco, Lachance, Sutton
Drafting of manuscript: Clark, Sutton
Critical revision: Clark, Fulton, Ontengco, Lachance, Sutton

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REFERENCES

1. Wattles DW, DeStefano S. Status and management of moose in the northeastern United States. Alces 2011;47:53–68.
2. Census US. Available at: 2010. https://www.census.gov. Accessed February 4, 2019.
3. Bubenik AB. Evolution, taxonomy, and morphophysiology. In: Franzmann AW, Schwartz CC, eds. Ecology and Management of the North American Moose. Washington DC: Smithsonian Institution Press; 1997:77–123.
4. Bjornstig U, Eriksson A, Thorson J, Bylund PO. Collisions with passenger cars and moose, Sweden. Am J Public Health 1986;76:460–462.
5. Farrell TM, Sutton JE, Clark DE, et al. Moose-motor vehicle collisions. An increasing hazard in northern New England. Arch Surg 1996;131:377–381.
6. Injuries CDC. from motor-vehicle collisions with moose–Maine, 2000-2004. MMWR Morb Mortal Wkly Rep 2006; 55:1272–1274.
7. Child KN. Incidental mortality. In: Franzmann AW, Schwartz CC, eds. Ecology and Management of the North American Moose. Washington DC: Smithsonian Institution Press; 1997:275–301.
8. DeStefano S, Wattles D. Moose-vehicle collisions in Massachusetts: the need for speed . . . reduction. Available at: http://www.netwc.org/uploads/2/0/9/4/20948254/stephen_destefano_-_mon_11am.pdf. Accessed February 4, 2019.
9. Clark DE, Black AW, Skavdahl DH, Hallagan LD. Open-access programs for injury categorization using ICD-9 or ICD-10. Inj Epidemiol 2018;5:11.
10. Paul P, Pennell ML, Lemeshow S. Standardizing the power of the Hosmer-Lemeshow goodness of fit test in large data sets. Stat Med 2013;32:67–80.
11. Rattey TE, Turner NE. Vehicle-moose accidents in Newfoundland. J Bone Joint Surg 1991;73:1487–1491.
12. Moos KF. Diagnosis of facial bone fractures. Ann R Coll Surg Engl 2002;84:429–431.
13. Kim S, Harrop AR. Maxillofacial injuries in moose-motor vehicle collisions versus other high-speed motor vehicle collisions. Can J Plast Surg 2005;13:191194.
14. Niemi M, Rolandsen CM, Neumann W, et al. Temporal patterns of moose-vehicle collisions with and without personal injuries. Accid Anal Prev 2017;98:167–173.
15. Rodgers AR, Robins PJ. Moose detection distances on highways at night. Alces 2006;42:75–87.
16. Ydenius A, Kullgren A, Rizzi M, et al. Fatal car to moose collisions: Real-world in-depth data, crash tests and potential of different countermeasures. Proceedings of the 25th International Technical Conference on the Enhanced Safety of Vehicles (2017) Available at: https://www-esv.nhtsa.dot.gov/Proceedings/25/25ESV-000294.pdf. Accessed February 13, 2019.
17. Rolandsen CM, Solberg EJ, Herfindal I, et al. Large-scale spatiotemporal variation in road mortality of moose: Is it all about population density? Ecosphere 2011;2:1–12.
18. Musante AR, Pekins PJ, Scarpitti DL. Characteristics and dynamics of a regional moose *Alces alces* population in the northeastern United States. Wildlife Biol 2010;16:185–204.
19. Scarpitti DL, Pekins PJ, Musante AR. Characteristics of neonatal moose habitat in northern New Hampshire. Alces 2007;43:29–38.
20. Monteith KL, Klaver RW, Hersey KR, et al. Effects of climate and plant phenology on recruitment of moose at the southern extent of their range. Oecologia 2015;178: 1137–1148.
21. Murray DL, Cox EW, Ballard WB, et al. Pathogens, nutritional deficiency, and climate influences on a declining moose population. Wildlife Monographs 2006;166:1–30.
22. Boyce MS, Baxter PW, Possingham HP. Managing moose harvests by the seat of your pants. Theor Popul Biol 2012; 82:340–347.
23. Danks ZD, Porter WF. Temporal, spatial, and landscape habitat characteristics of moose - vehicle collisions in western Maine. J Wildlife Mgmt 2010;74:1229–1241.
24. Kantar LE, Cumberland RE. Using a double-count aerial survey to estimate moose abundance in Maine. Alces 2013;49: 29–37.
25. Olsson MPO, Widen P. Effects of highway fencing and wildlife crossings on moose *Alces alces* movements and space use in southwestern Sweden. Wildlife Biol 2008;14:111–117.
26. Rea RV. Modifying roadside vegetation management practices to reduce vehicular collisions with moose *Alces alces*. Wildlife Biol 2003;9:81–91.
27. Seiler A. Predicting locations of moose-vehicle collisions in Sweden. J Appl Ecol 2005;42:371–382.
28. Leblond M, Dussault C, Ouellet J-P, et al. Management of roadside salt pools to reduce moose - vehicle collisions. J Wildlife Mgmt 2007;71:2304–2310.
29. Laurian C, Dussault C, Ouellet J-P, et al. Behavior of moose relative to a road network. J Wildlife Mgmt 2008;72: 1550–1557.
30. Dussault C, Ouellet J-P, Laurian C, et al. Moose movement rates along highways and crossing probability models. J Wildlife Mgmt 2007;71:2338–2345.
31. Eldegard K, Lyngved JT, Hjeljord O. Coping in a human-dominated landscape: Trade-off between foraging and keeping away from roads by moose (*Alces alces*). Eur J Wildlife Res 2012;58:969–979.
32. Seiler A. Trends and spatial patterns in ungulate-vehicle collisions in Sweden. Wildlife Biol 2004;10:301–313.
33. Statistika Centralbyrån. Available at: http://www.scb.se/en. Accessed February 4, 2019.
34. Krafft M, Kullgren A, Stigson H, Ydenius A. Bilkollision med älg - utvärdering av verkliga olyckor och krockprov. Available at: 2011. https://nyhetsrum.folksam.se/sv/files/2011/10/Folksam-algrapport-2011.pdf. Accessed February 4, 2019.
35. Teknikens Värld. Available at: http://www.teknikensvarld.se/algtest/. Accessed February 4, 2019.

36. Al Sebai MW, Al Zahrani S. Cervical spinal injuries caused by collision of cars with camels. Injury 1997;28:191194.
37. Ansari S, Al Moutaery K. An unusual cause of depressed skull fracture: case report. Surg Neurol 1999;52:638–640.
38. Al-Ghamdi AS, AlGadhi SA. Warning signs as countermeasures to camel-vehicle collisions in Saudi Arabia. Accid Anal Prev 2004;36:749–760.
39. Langley RL, Higgins SA, Herrin KB. Risk factors associated with fatal animal-vehicle collisions in the United States, 1995-2004. Wilderness Environ Med 2006;17:229–239.
40. Williams AF, Wells JK. Characteristics of vehicle-animal crashes in which vehicle occupants are killed. Traffic Inj Prev 2005;6:56–59.

Invited Commentary

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Dr Clark and colleagues have reviewed and highlighted the risks of moose-motor vehicle collisions in Northern New England and focused on the enormous number of overall animal-motor vehicle collisions in the US. The Federal Highway Administration estimates that there are 300,000 motor vehicle-animal collisions annually, resulting in 26,000 injuries and 200 deaths in the US per year. The authors have pointed out quite clearly that both moose and deer frequently become entangled with motor vehicles, occasionally resulting in fatality. Encounters with moose are 13 times more likely to be lethal than those with deer. We have all encountered animals on major and minor thoroughfares when driving. These creatures randomly appear out of nowhere and never seem to look both ways before crossing into your path. They now appear increasingly in urbanized areas, where you would least expect them. The random and unpredictable nature of the animals makes it very difficult to defend against these occurrences.

There are 2 methods of mitigating this problem. The first involves population control of the animal or the application of fencing, neither of which seem practical given the thousands of miles of highways in the US. The second, more practical method involves us as people. Impaired drivers (either through substance use or distraction) were 15 times more likely to be involved in a fatal crash with a moose. Awareness of risk is critical. Road signs are placed at sites of known animal crossings or where previous crashes have occurred. Motorists would be wise to heed these signs because the risk of a crash is heightened in these areas. Development of safer vehicles designed to withstand high-speed collision, and warning systems, which are increasingly mandated, could help.

The work by Clark and colleagues focuses on the significant risks of moose-motor vehicle collisions and will help raise awareness of this problem and make the roads safer for man and moose.