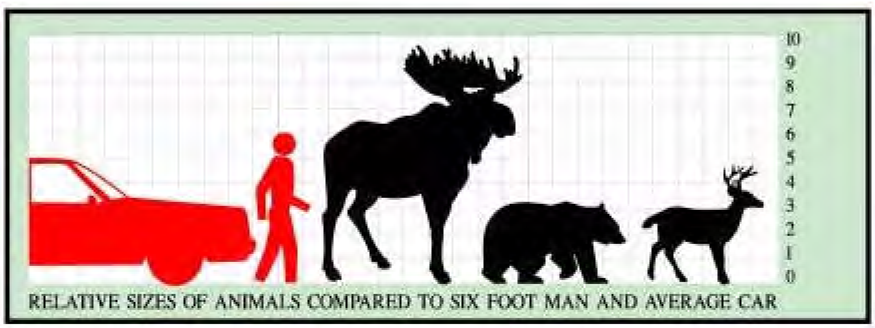
Collisions Between Large Wildlife Species

And Motor Vehicles In Maine

Interim Report



Maine Interagency Work Group on Wildlife/Motor Vehicle Collisions:

Maine Department of Transportation
Maine Department of Inland Fisheries and Wildlife
Office of the Secretary of State
Maine Department of Public Safety
Maine Turnpike Authority

April 2001

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Executive Summary

- In 1998, an interagency work group was formed to address the issue of crashes between wildlife and motor vehicles. Members represent the Maine Departments of; Transportation, Inland Fisheries and Wildlife, Public Safety, the Office of the Secretary of State, and also the Maine Turnpike Authority.

- Crashes with large wildlife species are increasing while the number of all other types of crashes is dropping. Over 14,900 have occurred from 1996 to 1998. This total is from official police reported crashes and does not include those not officially reported.

- Estimated costs of animal/vehicle crashes in Maine were over 97 million dollars and resulted in eight human fatalities from 1996 though 1998.

- Causes for animal/vehicle crashes can be attributed to three general factors:
  1) Behavior and natural history of the animals,
  2) Site conditions, and
  3) Behavior and actions of drivers.

- In order to focus its efforts on workable mitigation methods, the group performed a literature search on crashes and mitigation technologies. Most of the technologies have not been evaluated or have shown limited success. Animal/vehicle crashes may be reduced with some of the mitigating techniques reviewed. However, there is no single solution.

- Mitigative methods researched include: fencing, lighting, overpasses and underpasses, pavement marking, reflective devices, vegetation management, repellents, optical obstructions, optical warning devices, increased harvest, speed limit alteration, driver education, highway design modification, audible warning devices, thermal sensors, and electric field differential sensors.

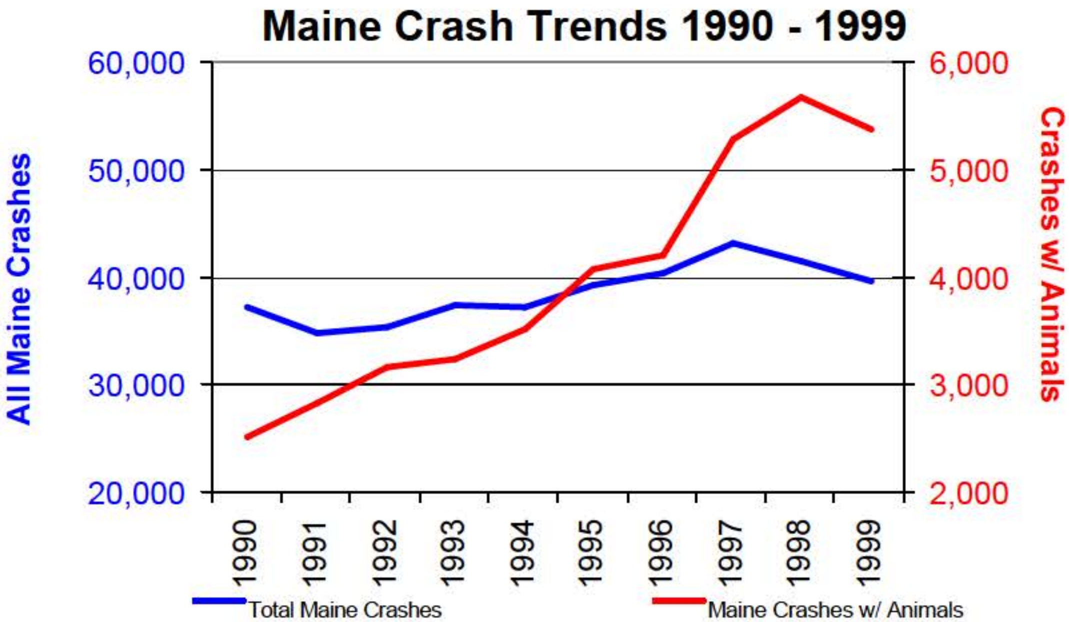
- Reported collisions involving animals and vehicles were mapped statewide. The group visited several locations exhibiting the highest numbers of crashes with moose to determine if there were any evident similarities that could be addressed to reduce the number of crashes. While most sites possessed wetland characteristics at or near the crash locations, no other similarities were noted.

- The group developed a public education program that includes curricula for driver education, posters detailing information about and locations of moose collisions throughout the state, newspaper articles and an upcoming brochure. Using funds provided by an Outdoor Heritage Fund Grant, the group partnered with Ursus, Inc. of Waterville, Maine, in creating a safety video entitled *Hidden Dangers.* The video has been distributed to all driver education instructors and is now part of the driver education curriculum. Several public service announcements were also developed and limited airtime has been provided.

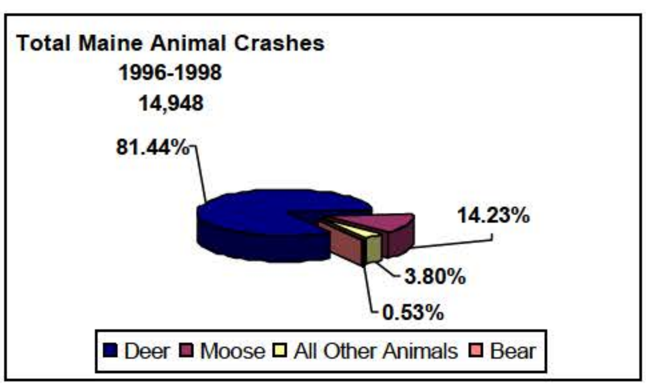
- Future efforts of the group include: compare high crash locations with Biennial and Six-Year Transportation Improvement Plans; develop cost-benefit models for justification to implement mitigating techniques; implement and monitor demonstration projects of selected mitigating methods; collate and review information on deer and bear crashes; monitor location changes in high crash locations; and continue to refine and expand the education/awareness program. The results of these additional efforts will be compiled in subsequent reports.

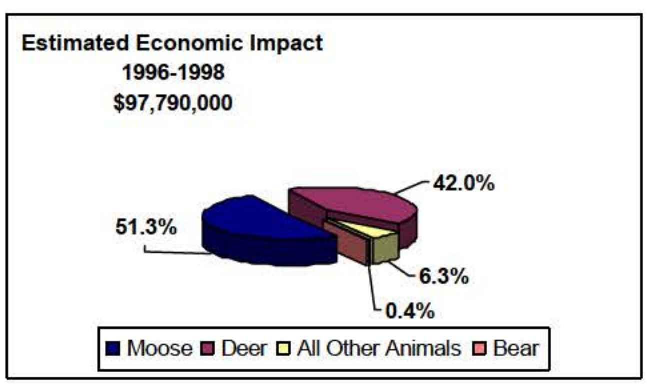
Introduction

Collisions between large wildlife species and motor vehicles represent a significant safety concern for transportation and wildlife agencies. Recent data indicates that while the number of vehicle crashes are dropping overall, encounters between animals and vehicles are increasing. Wildlife/vehicle collisions represent 14% of the total reported crashes in Maine.[1] These collisions result in injury or death to the traveling public, loss of wildlife and economic losses. Eight human fatalities occurred in the 1996-1998 period studied for this report. Economic losses involved in collisions of large wildlife and vehicles in the same time period are estimated at over $97,000,000.



Data from Maine police-reported crashes for the 1996-1998 study period (Appendix A) show that collisions between various wildlife species and vehicles are occurring at an increasing frequency. A total of 14,948 collisions were recorded from 1996-1998. The number of animal-vehicle crashes is likely much larger than indicated as many crashes involving smaller animals remain unreported. Similarly crashes that result in little or no vehicle damage likely are not reported.





[1] Source: Police reported crashes in Maine for the period of 1996-1998. Maine Department of Transportation

Implementing the Work Group

In response to public concerns with the problem, including several recent articles in the periodical press (Maine Sunday Telegram, Bangor Daily News, Ellsworth American, Presque Isle Star), an interagency work group consisting of representatives of the Maine Department of Inland Fisheries and Wildlife (IF&W) and Maine Department of Transportation (MDOT) was formed in February 1999. Initial project funding was provided through MDOT's 2000-2001 Biennial Transportation Improvement Plan[2] in the amount of $100,000. Additionally, IF&W procured a grant from the Outdoor Heritage Fund for $10,570 to produce a video for use by driver educators. As the need for educating the traveling public became evident, the Maine Department of Public Safety, Office of the Secretary of State and the Maine Turnpike Authority joined the work group in the fall of 1999.

The merits of pursuing involvement in an interstate study initiated by the Oregon DOT were discussed. The original proposal called for utilizing 75% of the project budget to participate in evaluating a potentially small field of new technological solutions. The work group decided that the proposed technological interstate study could result in high implementation and maintenance costs, and could require highly trained personnel. The group therefore decided it would be more prudent to utilize their resources in Maine to reach their objective of a broad-based solution to the problem.

In efforts to further define the problem, the group refined crash data and identified the locations of wildlife/vehicle collisions in Maine. This data was then mapped using Geographical Information Systems, illustrating not only individual collisions, but also locales where the densities of crashes were the greatest (High Crash Locations or HCLs). In May 1999, the work group met to review the crash data and develop a project direction. The first priority of the group would be to review methods previously utilized by others. Because moose placed Maine drivers at the greatest risk and showed the greatest tendency to be involved in vehicle collisions during the approaching summer months, emphasis was placed first on that species.

The mission of the work group is to further define the problem and recommend methods and procedures to reduce the number of vehicle/animal crashes.

The Problem

The advent of modern transportation infrastructure has caused changes to habitat occupied by various wildlife species. The results are both positive and negative.

Maine was once contiguous for resident wildlife with their habitat almost unaltered by man. The first roads were built to connect isolated human populations and to provide access to outside markets. These were mostly widened paths through the forest. Traffic volumes were low and consisted of relatively slow-moving vehicles powered by domestic animals. While mishaps between vehicles and wildlife may have occurred, they were uncommon.

[2] MDOT Project Identification Number 007770.00

Some wildlife adapted to the roads and likely used them as travel corridors themselves, especially in areas where the roads traversed rough or inhospitable terrain.

The invention of the mass-produced automobile created a demand for further improvement of early roads. As the volume of motorized traffic and the number of roads also increased, considerations for increased speed and safety were factored into road design. Roadways were widened, vegetation cleared, and many, near urban centers, paved. With the capacity for increased speed, drivers became more concerned with the conditions on the roadway rather than those adjacent to it. The roads bisected formerly connected wildlife habitat resulting in blocked passage for some species. Essentially the road fragmented habitats into smaller units which were previously contiguous. Species with large home ranges residing in fragmented habitat follow their traditional travel patterns and these animals will continue to cross the roadway and be exposed to traffic and its effects.

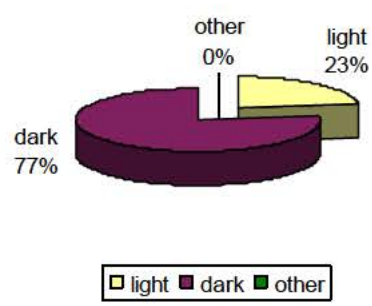
Development of highway corridors also altered the composition of the vegetation in these areas. The trend has been removal of large, woody vegetation, which is commonly replaced by grass, shrubs, and other forbs. These habitat changes are favorable for some species, but not for others.

The probability of an animal making contact with a vehicle varies in proportion to many factors including:

- The number of drivers and their speed of travel;
- The habitat or lack of it adjacent to the system; and
- The number and collective behaviors of the species of animal.

Additional conditions that affect crashes include; weather, time of day, time of year and geographic area of the state.

Deer Crashes By Time of Day 1996-1998

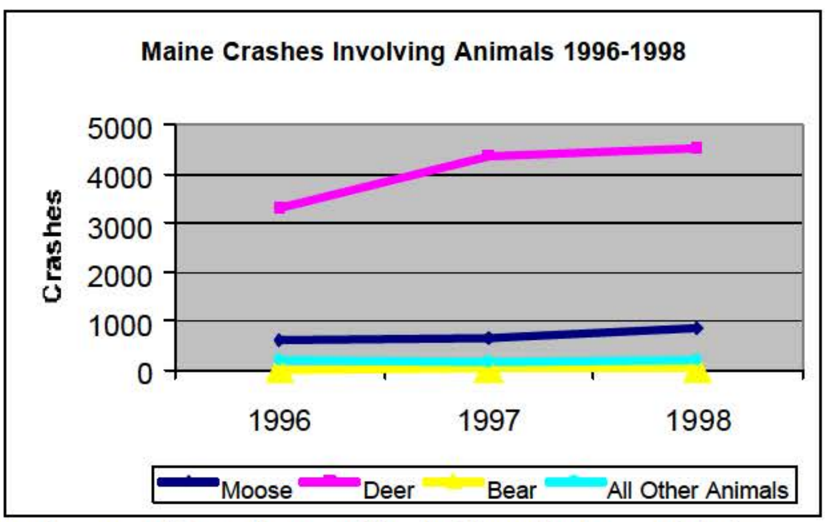


Traffic volume has increased nationwide and certain wildlife species such as white-tailed deer and moose have increased in number in Maine. Recent findings by IF&W indicate that the moose population is high, within the habitat carrying capacity, and expected to increase with the current level of harvest. This situation is similar to many other states and provinces. Population estimates for the size of the moose and deer vary because direct counts of animals over an area as large as Maine are impractical. There are a number of relative methods by which population estimates are determined. Accuracy of the methods differs but comparison of numbers furnished by the methods allows wildlife managers to estimate population size within accepted confidence limits.

Statewide numbers of moose have increased since population estimates were first undertaken in 1900. These numbers reflect a general relationship between the moose and their preferred habitat of second-growth or regenerating forest interspersed with open and wet areas. As logging and abandonment of agricultural areas increased during the early part of the 1900's, the area of select habitat also increased. The regenerating shrub and forest landscape provided abundant habitat that resulted in population indices indicating an average increase in size of 3% per year. Increases in sighting rates however, indicate that there may have been increases of up to 15% during the 1980's. Although moose censuses have not been conducted recently, indications are that the winter population is approximately 29,000 animals, although some authors caution that this number may be high.

Deer populations in Maine are at the historical high. In the past 15 years, the wintering herd has increased from about 160,000 animals to more than 331,000. During the period from 1996 through 1998, the herd increased from approximately 265,000 to its current high. Deer can exploit a variety of habitat types. During most of the year, they prefer 'edge' habitat such as forest borders, matrices of fields and woodlands and swamp margins. In winter, deer congregate in stands of conifers and make packed snow trails to browse areas.

Surveys distributed by the interagency work group revealed that several other transportation and wildlife agencies have or are considering efforts to reduce animal/vehicle crashes. Of those agencies that have made efforts, very little monitoring of the methods has yet occurred. The effectiveness of many of the methods used is therefore indeterminate. However, knowledge of the issue is increasing both in the U.S. and Canada. Requests for information, survey participation and coordination on the wildlife/vehicle collision issue have increased within the past two years and at least two International conferences have convened on this topic.



Historically, the combined efforts of regional wildlife personnel or game wardens from IF&W and traffic engineers from MDOT entailed placing signs either after a collision occurred or in response to public concerns. Along the US Route 201 corridor between West Forks and Jackman, Maine additional crash reduction techniques including an olfactory deterrent, rumble strips and site-specific sign placement have been utilized. Given that recent data shows crashes with animals continue to increase, these alternatives appear to have had limited effect.

Since collisions involving smaller animal species such as coyote or fox do not usually result in serious property damage or injury to humans, these collisions are not well documented.

In a recent three-year study, data shows that reported crashes with smaller animals are only 3.8% (586 crashes) of a 14,948 composite total of all animal/vehicle collisions. It is unknown if the small or "other" animal mortality on roadways is resulting in a significant reduction of their populations.

Vehicle crashes with larger wildlife species including moose, deer, and bear commonly cause greater economic loss and injury than smaller species, and are the focus of the work group. A total of 14,380 crashes with large wildlife were reported in the 1996-1998 study-period. Deer collisions are the most frequent vehicle/animal crash type, totaling 12,173 (81.4%). Moose collisions total 2,127 (14.2%) and those with bear total 80 (0.5%).

Collisions with moose tend to cause the greatest vehicle damage, personal injury and human death due to their tall stature and heavy weight (upwards of nine feet tall and weighing over 1000 pounds). Moose are of particular concern in motor vehicle crashes because the bulk of their bodies are generally above the hood level of most automobiles. When struck, their bodies almost always intrude into the passenger compartment with devastating results. For this reason, crashes involving moose have been the work group's highest priority to date.

Efforts and Results Through 2000

Determine High Crash Locations

Crash locations were identified and mapped statewide for moose, deer and bear for the period of 1996-1998. In addition to plotting the number of crashes for each crash location, High Crash Locations (HCLs), defined as those locations exhibiting a high number of crashes per vehicle mile traveled, were plotted. A total of 37 moose HCLs were identified. A significant finding is that crashes with moose are common in southern Maine and not limited to less populated northern areas. From this information, an educational poster mapping moose/vehicle crashes was developed for distribution to driver education programs, tourist information facilities, vehicle registration offices, fishing and hunting license offices and other suitable locations statewide. High demand for the "1996-1998 Moose Map" resulted in a second printing. To date over 600 moose maps have been distributed.

Survey Other Agencies

State and Provincial Departments of Wildlife and Transportation were surveyed to determine what efforts have been undertaken and how well those measures worked. Responses were received from 3 Wildlife and 11 Transportation agencies. The survey showed that several states and Canadian provinces are addressing the issue of collisions between wildlife and vehicles with efforts similar to Maine.

Evaluate Current Data

Data from reported collisions involving moose, deer, bear and other species from 1996-1998 are presented in Appendix A. Significant findings include:

- Most crashes (over 70%) involving moose occur at night in unlit areas between the hours of 7 p.m. and midnight, and during the months of May through August, peaking in June (over 20% of all crashes).
- Most crashes with moose occur where the speed limit is 50 to 55 mph.
- Nearly 60% of crashes involving moose occur on level, straight roads.
- Over 70% of the crashes with moose occurred in clear weather on dry roads.
- Nearly twice as many out-of-state drivers (20%) were involved in crashes involving moose as compared to all other crashes.
- Crashes with deer peak in October through December, particularly in November.

It is likely, based on the findings noted above, that many moose/vehicle crashes are caused by drivers who exceed the safe speed for effective headlight distance. Additionally, because moose are dark colored, and their eyes are well above the typical vehicle headlight illumination, drivers typically cannot see the moose until it is too late to take evasive action.

Investigate High Crash Locations

In August 1999, a site review of 14 of the moose HCLs was undertaken. No 'point source' or single crossing location was apparent at any of the HCLs. The usual habitat included varying types of wetlands either adjacent to or within 50 meters of the roadway. While distinct wildlife travel corridors were noted at some sites, all of the sites showed evidence of dispersed moose activity of varying intensity of use in close proximity to the roadway.

Determine Control Factors

An extensive literature search was undertaken to identify and evaluate control factors used to reduce animal/vehicle collisions. Two members of the work group attended the Third International Conference on Wildlife Ecology and Transportation (ICOWET) held in Missoula, Montana, to participate in discussions of existing and developing solutions. A bibliography of the literature examined is attached. One recurring suggestion noted in many papers is a need for further research and evaluation of methodologies employed.

Three factors emerged as central themes to reduce wildlife/vehicle crashes:

1) Controls on the animals;
2) Controls on the crash site; and
3) Controls on the driver/vehicle.

Methods utilized and the control(s) affected are shown in Table 1.

Table 1

Method	Animal Control	Site Control	Driver Control
Fencing	x	x	
Lighting		x	
Marking (signage and striping)			x
Reflecting devices (mirrors and reflectors)	x		
Alternatives to road salt	x	x	
Intercept feeding	x	x	
Repellents	x		
Optical obstructions			x
Clearing Right of Way		x	
Increased harvest	x	x	
Reduction of speed limits			x
Driver education			x
Road drainage modification	x	x	
Audible/visual warning devices	x		x
Break beam laser	x		x
Thermal sensors	x		x
Electric field differentials	x		x
Underpasses/Overpasses	x	x	

Each of the major factors were discussed, both in relation to what methods have been used within each factor and the subsequent success of that factor. It became evident that many of the methods attempted were not adequately monitored to statistically demonstrate their effectiveness. Additionally, many techniques were a single application or single site effort with no basis for comparison to determine if a reduction in collisions resulted from the application.

Controlling animal behavior varied relative to specific site habitat characteristics, the time of year, time of day, age of animal, and species. These behaviors exhibited themselves as a complex composite for which no clear factor can be controlled to reduce collisions. Controlling or modifying site conditions also resulted in varying degrees of success. Educating drivers through awareness programs was identified as a factor that could most effectively bring a reduction in animal/vehicle crashes.

Select Candidate Locations

Identification of locations to install selected methods is underway. The work group has discussed and approved the interaction of MDOT division traffic engineers and IF&W regional biologists to evaluate and relocate existing signs to appropriate locations while other methods are being developed for specific sites. A project on Route 4 in Phillips (MDOT PIN 9205.00) that encompasses the location of the state's highest crash sites for moose is in preliminary design stage. Alternative mitigating methods are being discussed for inclusion in this project.

Public Education and Awareness

The group, working in partnership with Ursus, Inc of Waterville, Maine, contributed content and funding for a video presentation for driver's education concerning the dangers of large animals on roadways entitled “Hidden Dangers”. Currently, the video has been completed and delivered to the Bureau of Motor Vehicles for inclusion in driver education curricula, to the Department of Human Services, the Bureau of Insurance and the Federal Highway Administration. Several public service announcements for public release have been developed and have received limited airplay. The “1996-1998 Moose Map” in poster format detailing the nature, location, and economic impact of wildlife/vehicle collisions is in distribution. In addition to those agencies involved in the work group, maps have been sent to the Federal Highway Administration, the Androscoggin Valley Council of Governments, several state legislators, citizens and businesses. The work group is also developing another map/poster to illustrate the extent of deer/vehicle collisions and an informational brochure.

Control Methods Analysis

The following sections summarize methods used by various entities to control or reduce the number or severity of collisions between large wildlife species and motor vehicles. The positive and negative aspects of each alternative are described.

Fencing

Fencing has been used by eleven states including Maine. Eight of the eleven states that use fencing evaluated the effectiveness of the structures and all but one found fencing effective in reducing crashes with animals. Fencing costs $8-12 per linear foot to install and must be well maintained, at an additional cost, to be effective over time. Recent installations in conjunction with other methods discussed have successfully reduced moose crashes at several sites in Alaska.

Fencing can function as a 'trap' if not adequately installed or maintained, increasing the probability of an animal being struck by a vehicle. Animals caught within the fencing become stressed both by traffic and with the inability to escape, which may result in the death of the animal. Fencing can also negatively impact wildlife by eliminating existing wildlife travel corridors. To reduce the negative impact, fencing can be used with passage structures (discussed below). Fencing is most effective when used in areas with a 'geographic' limiting factor, where distinct changes in topography are utilized to create passage areas.

Positive	***Negative***
• Specifications for design are well documented • Installation costs are relatively low in comparison to other methods	• Maintenance costs can be high • Can trap animals within highway right-of-way • Widespread application is impractical • Can eliminate travel corridors and increase habitat fragmentation

Passage Structures

Underpass and overpass structures are used in seven states and Banff National Park, B.C. Of the two states that monitored the structures, both indicate they were successful in reducing collisions with large wildlife. Passage structures are also being used with greater frequency in Europe, where past transportation development has severely fragmented habitat for most of the native wildlife species. Monitoring efforts are underway in a variety of locations in Canada and Europe.

Passage structures can be placed specifically for wildlife crossings or incorporated with stream crossings. They can be used in conjunction with other alternatives such as fencing and habitat alteration. Passage structures are expensive in comparison to other alternatives, especially if the placement of the structure is proposed solely for wildlife crossings. Costs approach those of a bridge of equal size. When combined with fencing, passage structures can be very effective.

Incorporation of a wildlife passage into existing structures has been used on a limited basis by several transportation agencies. The main benefit is its relatively low cost. Culverts are usually limited to crossings for smaller animals, though there are some existing structures large enough to accommodate larger species. Maine has installed two wildlife passage culverts on a project in the town of Frankfort. In East Dixfield and Dexter existing structures formerly used as cattle crossings have been modified for use as wildlife crossing structures. Monitoring efforts are underway to assess use by wildlife.

Positive	***Negative***
• Useful for site specific applications, such as distinct wildlife travel corridors or areas of high activity • Incremented cost increase can be low when incorporated at stream culvert locations	• Installation costs can be high • Choice of crossing location limited • Maintenance costs approximate those of a bridge of similar span

Reflectors

Numerous types of wildlife reflectors and mirrors are available on the market. The objective of this method is to place the devices at regular distances to form a 'fence of light' caused by reflections from vehicle headlights. If one of the reflectors is damaged or removed, the 'fence' will, in effect, end up with a gap in it. Additionally, research on the visual acuity of deer is inconclusive regarding their ability to perceive certain wavelengths of light. Maintenance costs to replace or reset and calibrate reflectors can approach the cost of installation over time. Many states, provinces, and countries have used some manner of reflector to repel wildlife from roadsides. Most of the installations have not been evaluated or were monitored by the reflector manufacturer. Results have not indicated a subsequent reduction in crashes. Three states are currently monitoring several brands of reflector systems. The Interagency Group will follow up on these studies.

Positive	*Negative*
• Have been used over long distances • Represents a low tech, relatively non-obtrusive control method	• Costs of installation and maintenance can be high • Effectiveness has not been proven

Highway Design and Maintenance

The existing transportation infrastructure represents a significant factor in wildlife habitat fragmentation. Highway routing and design have potential as a mitigation method for reducing encounters between large wildlife species and vehicles. With coordination efforts between natural resource interests and road design and construction engineers there is potential for creating a highway project development process that considers site-specific mitigation techniques in the design sequence.

Many current construction and maintenance methods actually draw wildlife to the highway corridor. Early cooperation within MDOT and between natural resource agencies can greatly assist in identifying the location of habitat areas of concern. This would allow for the time necessary for incorporation of site-specific techniques into the project development process at reasonable cost. This approach also has positive impacts on natural resources and could help reduce construction impacts to wetlands and historic or archeological sites.

Positive	*Negative*
• Wildlife habitat protection potential • Cost savings for cooperative solutions • Overall better early project definition	• Competing interests • Could result in increased project costs

Deicing Agents

Excessive levels of salt can harm vegetation and aquatic habitats and may attract certain species. Increasingly, more effective use of road salt is occurring through use of velocity spreaders, road temperature sensors and other technological advances. The driving forces for salt use are public safety, economics and the ease of application. Research is active in developing alternative chemicals that approximate the action of salt at a comparative price. At present, however, it does not appear that use of chloride-based compounds will decrease. There may, however, be possibilities of limiting the salt availability to wildlife by concentrating spring salt runoff to a specific location and then identifying the location to the driving public. Details are yet to be addressed.

Positive	*Negative*
• Roadways are less slippery for the driving public • Alternative chemicals are being researched • Road salt is becoming more widely used	• Some species are attracted to sodium chloride-based compounds • Road salt is becoming more widely used • Alternatives are currently cost prohibitive

Habitat Manipulation

Habitat manipulation or modification is a technique or set of techniques implemented to create habitat conditions which can either enhance certain areas to make them desirable for animals or to make the area less desirable to target species. One limitation of this approach is that even in areas not considered to be discrete travel corridors, animals will still randomly cross roads. What might work to reduce crashes in one location might create conditions inducing wildlife to cross in greater numbers in another location.

Some methods use preferred vs. non-preferred food types, such as non-preferred food plants grown in the right-of-way. Other methods used for right-of-way modification include: clearing, deterrent plantings, burning or mowing practices. These techniques have potential, but research is needed to determine how habitat features and landscapes affect animal species near roadways. Ontario has had some success with filling in roadside “wet” areas used by wildlife, but this can be expensive and can also pose environmental permitting problems. Maine has proposed similar filling methods, but these were curtailed by permitting issues.

Positive	***Negative***
• Includes a variety of methods: lure crops, intercept feeding, right-of-way vegetation types and clearing, and adjacent land uses	• Many of the sub-methods are unproven, research is ongoing, but much more needs to be done • Requires diligent maintenance

Biological and Chemical Repellents

Most wildlife species have a well-developed sense of smell. Animals use smell to discern the scent of predators and they often avoid areas with 'unnatural' odors. Repellents use these behaviors to elicit avoidance response. Two types of repellents are available; those associated with natural enemies and those associated with an unnaturally bad smell. Several states have utilized chemical repellents to limited success. Maine has experimented with the use of wolf urine (predator avoidance), and rotten-egg (unnatural odor) on the U.S. Route 201 corridor. The effectiveness has not been documented, however.

Positive	***Negative***
• Elicits natural avoidance response in the animal	• Relatively high cost if used over long distances • Currently effective over short distances • Animals can adapt to its presence • Short-term, must be reapplied at intervals

Auditory Repellents

This method generates and emits ultrasonic sound waves that cause an alert or fleet response to an animal in or near the roadway. The first response causes the animal to stand still, which may result in a negative outcome if the animal remains in the roadway. Alternatively, the animal's fleet response may cause it to run toward or into the roadway rather than away from it. Very few objective reports exist regarding the effectiveness of auditory repellents. There is no clear evidence that deer or moose can actually hear ultrasonic sound, or what their reaction is if they can hear these types of sounds.

Positive	***Negative***
• Low cost • Cause an alert response in the animal	• Several commercial products are available, with little documentation of their effectiveness • May cause the animal to run into the roadway

Warning signs

Many states, provinces and European countries have used signs as a means to reduce vehicle/wildlife collisions. Very few of these entities have evaluated the method and most agencies find the benefits are limited at best. Benefits of signage are its low cost relative to other methods and installation can be done in a relatively short time. One negative aspect is driver complacency to signs over time. In Maine, signs are commonly used after a wildlife collision has occurred at a specific location, at high crash locations, and also in response to public or agency concern. The type and use of signs in Maine is limited or restricted by roadside sign laws.

The current wildlife warning sign is a yellow, diamond shape consistent with other highway warning signs. Informal surveys with transportation and wildlife professionals indicate that most drivers disregard signs after they have been in place for an extended time. Some states and provinces have taken a dynamic sign approach and several have been discussed in the work group including evaluating active and lighted signing, vehicle activated signs, variable message signs, and animated signs.

Specific sign locations may need to vary over time due to changes in one or more of the controlling factors (number of animals or vehicles). Most large species of animals show definite seasonality in their time of contact with motor vehicles. Installing signs just prior to the times when certain species are most likely to be prevalent near roadways (e.g., moose in June), and removing or closing the signs after peak times might increase effectiveness. The work group discussed warning signs that could be opened or closed seasonally. Conversely, liabilities may be involved if a crash occurs during the 'off season', when the sign is closed.

Positive	***Negative***
• Relatively low costs for installation and maintenance in most instances • Low impact on the environment • Articulated signs may capture driver attention	• Drivers become 'acclimated' to signs over time • Placement rationale has varied • Many designs yet to be investigated

Highway Lighting

Alaska experienced good results when it installed lights in conjunction with other technologies such as fencing and signage along sections of roadway with a high incidence of crashes. Although some animals avoid light, lighting does not prevent animals from crossing the roadway. Lighting does give drivers a longer reaction time, especially during peak night crash times. Cost of installation and maintenance is relatively low and lights can be relocated if site conditions change. Lights can only be used cost-effectively at sites with power lines nearby or with self-charging power supplies.

Lighting has been used on numerous occasions and shown to be effective in high crash locations. Effectiveness may be enhanced by increasing contrast, such as supplemental lighting on roadsides rather than the road. Although deer, moose and bear are active nocturnally, they may avoid lighted areas. Used in conjunction with other methods, lighting may be effective. However, lighting roadways may not be well accepted, particularly in remote natural areas.

Positive	***Negative***
• Low to moderate installation and maintenance costs when used prudently • Animals may avoid lighted areas • Increased effectiveness when used with other methods.	• Limited to installation in areas with power • Contrast between animal and roadway is not always sufficient • Extensive use could become costly

Population Management

IF&W has the legal authority to manage and set regulations to control both moose and deer populations in Maine. Current methods involve recreational hunting with controlled harvest while trying to balance other social objectives. Some issues with this method are: numerous sub-populations of animals to be controlled, a decreasing number of recreational hunters, other deer/moose management issues, social and biological carrying capacity, and location of the herd or individuals to be removed. Additionally, the hunting season for moose occurs after the peak period of moose activity.

Positive	*Negative*
• May be effective in short-term reduction of crashes, but it is a complex issue • Low cost, in most cases	• Animals will repopulate good habitat • Social acceptance may limit effectiveness

Limiting speed

There is little doubt that reducing speed in areas during times of high wildlife crash potential is effective in reducing collisions. Since differing species show a distinct seasonality in the times when collisions occur, the justification for a full-time speed reduction is difficult. Reducing nighttime speeds may be desirable but not a workable solution. The difficulty in implementing this method is justifying regulatory need and ensuring that the traveling public adjusts their speeds accordingly (enforcement and education issues). Increased presence of law enforcement personnel may be a temporary remedy, but due to a need for cost justification and limited personnel, it is not feasible for consideration as a long-term or permanent solution.

Positive	*Negative*
• Effective in providing additional response time to drivers, or for animals to escape • Installation costs low	• Implementation costs high • Slows mobility • Difficult to enforce due to limited resources

Automotive Technology

The automotive industry is currently evaluating the use of forward projecting heat sensing devices to identify objects in the roadway. This technology is not widely available yet. Examples of current technological improvements include infrared sensors (‘night vision’) on Cadillac Deville models and other high-end vehicles, and other developing ‘smart vehicle’ technologies. Some European vehicles (Saab) have “moose safety” features with the frame structure modified to protect riders during a collision with a moose.

Positive	*Negative*
• As technology develops, may be available on lower priced models • Increases driver response time, does not affect animal.	• An emerging technology usually available only on high-end models

Emerging Technologies

Several projects are currently underway to test and evaluate systems using break-beam laser, optical obstructions, and heat determinants with limited applications undertaken to date. Applications may require highly trained personnel to install, calibrate and maintain the equipment. Costs may be reduced as the technology develops. Logistics such as topography and vegetation growth are issues.

Positive	***Negative***
• Varies based on type of technology	• High cost of implementing emerging technologies • Logistics of topography and vegetation growth issues

Driver Education and Public Awareness
Many countries, provinces, and states, including Maine, have some form of educational program for drivers concerning wildlife collisions. Many wildlife crashes occur from excessive speeds or the driver attempting to avoid a collision with an animal. Maintaining safe speed for road conditions and keeping in control are key components, as are detection, response, and considerations of wildlife habitats and habits. Driver education and public awareness can be incorporated into all of the above methods with human/vehicle collision issues.

Positive	***Negative***
• Can be used for drivers of all ages and experience • Can involve discussion of all of the preceding issues	• Costs vary and will need to be evaluated over time • It is very difficult to change driver behavior

Work Group Recommendations

It is the intent of the work group to actively investigate and implement solutions to reduce collisions between wildlife and vehicles. In order to achieve success, the groups' efforts must be supported and embraced by the government and people of the state of Maine, and also by those who visit the state. Attention to driving conditions both on the road ahead and along the side of the highway is probably the best way to avoid an encounter with wildlife. Continuing an educational and awareness program discussing these issues should be a part of any solution implemented.

The group recommends developing protocols to utilize existing federal funds for mitigating vehicle/animal crash problems. The Transportation Equity Act for the 21st Century (TEA 21) has specific language for funding activities that reduce 'wildlife habitat fragmentation' as part of transportation 'enhancement' funding. Further, it states that it is up to the individual states to develop protocols for utilizing funding. One of the challenges for the work group is to develop and promulgate a rationale to use this funding in Maine.

The work group recommends new wildlife warning signs be developed following the Manual of Uniform Traffic Control Devices (MUTCD) standards. The group further recommends that innovative designs or ideas be considered. Sign designs and locations should be monitored over time and design changes should also be made in response to safety indicators.

The group recommends that regional and district wildlife professionals work with MDOT division traffic engineers in evaluating current sign locations within their respective regions and authorize that group to change sign locations as they deem necessary. Additionally, cooperation between highway design and wildlife groups on future road designs should include consideration of the wildlife issues discussed here and also beyond those required by law.

Planned 2001 Activities of the Work Group

- Overlay current HCL data with current and upcoming Biennial and Six-Year Transportation Improvement Programs to identify candidate projects in which to implement new strategies to reduce wildlife/vehicle crashes
- Develop cost-benefit models for various crash reduction alternatives
- Identify sites and appropriate site-specific methodologies for crash reduction
- Collate and review data on crashes involving deer and bear in Maine
- Continue an active program to identify crossing locations, both via crash analysis and field review and monitor changes in HCLs
- Continue to refine educational awareness programs
- Undertake a program of innovative and dynamic sign design
- Develop short and long term programs for direction of efforts
- Conduct detailed evaluations of all approaches
- Prepare an annual report outlining activities, accomplishments and recommendations

Concluding Remarks

The information presented in this report has shown that crashes between motor vehicles and large wildlife species is a safety problem that is growing in significance. Human and wildlife losses are unacceptable and may continue to increase. The problem is complex in both cause and in regard to implementation of effective solutions. In its efforts, the interagency work group has found that no one simple solution exists to substantially reduce the existing number of crashes. Future work of the group will focus on implementing and testing a variety of methods that show promise at current high crash locations.

The problem of large wildlife/motor vehicle collisions encompasses more than just the driver, the site, the animal and the crash itself. Underlying ecological and anthropogenic activities interact in ways yet to be investigated. The placement of transportation structures can cause varying degrees of habitat fragmentation on both local and landscape scales. Habitat fragmentation is any effect that causes habitat areas to become disconnected from other adjacent habitat. Hence, the old joke about 'why did the animal cross the road' takes on some very serious implications in relation to wildlife/vehicle crashes. The current state of the science concerning fragmentation, its causes, effects, and solutions, is one of the premier issues in conservation biology.

To address the problems caused by habitat fragmentation, much research has been directed towards reconnection of formerly adjacent habitat. The formal name for this effort is called habitat permeability. Many of the techniques used to recreate habitat connections also help to keep animals out of transportation corridors. In Europe, the degree of habitat fragmentation has resulted in catastrophic losses to many species of wildlife due to the massive network of transportation infrastructure. To address habitat fragmentation, 11 European nations have joined to form the Infra Eco Network, Europe (IENE). As a part of project development, all of the transportation agencies within the network have access to IENE's resources, and are required to involve the agency in project coordination.

The United States has not yet reached the critical level of habitat fragmentation and related issues that currently exist in Europe. The European example, however, shows the extent of the effects of large-scale human development, and subsequently the effects of transportation infrastructure on wildlife. Preserving habitat by reducing fragmentation, along with other strategies summarized in this report will help protect wildlife, the environment, and in turn reduce the loss of human lives and the associated economic losses. From both biological and safety standpoints, addressing the problems of habitat fragmentation, the rise in animal/vehicle collisions and implementing solutions to solve these problems may be one of the most significant challenges faced by transportation agencies and state and municipal planners in the coming years.

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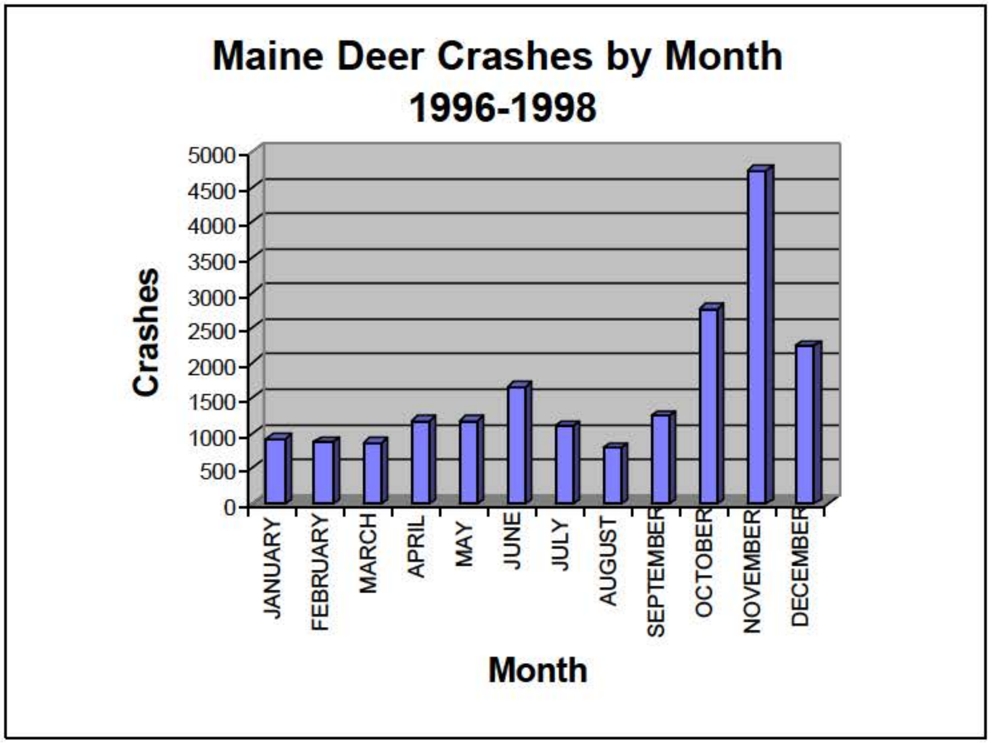
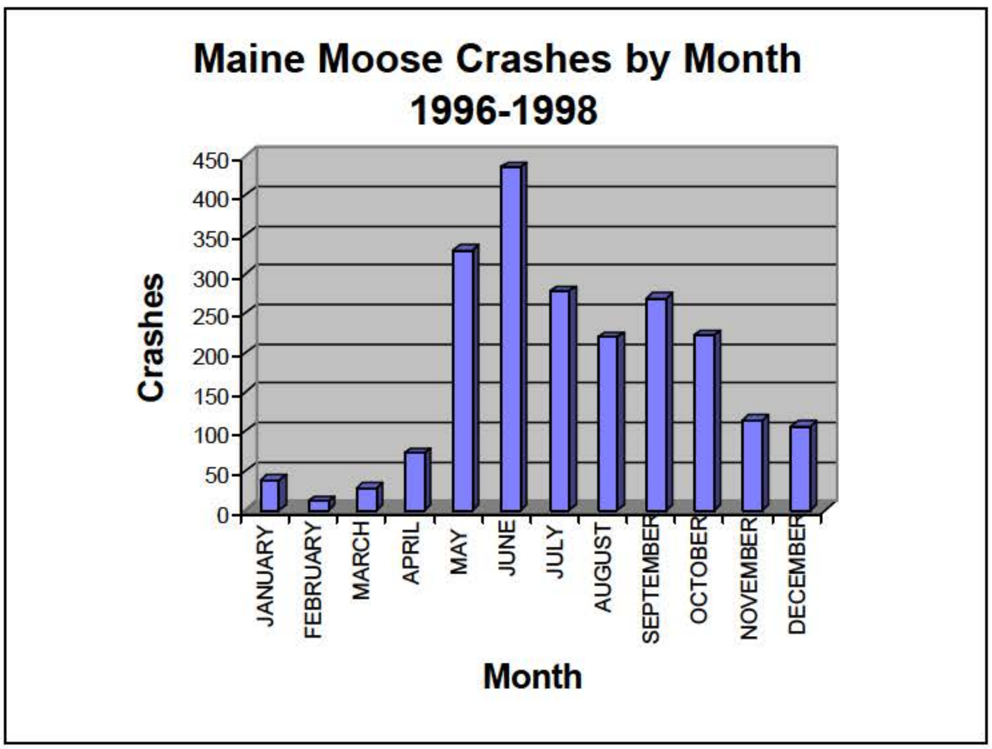
Appendix A

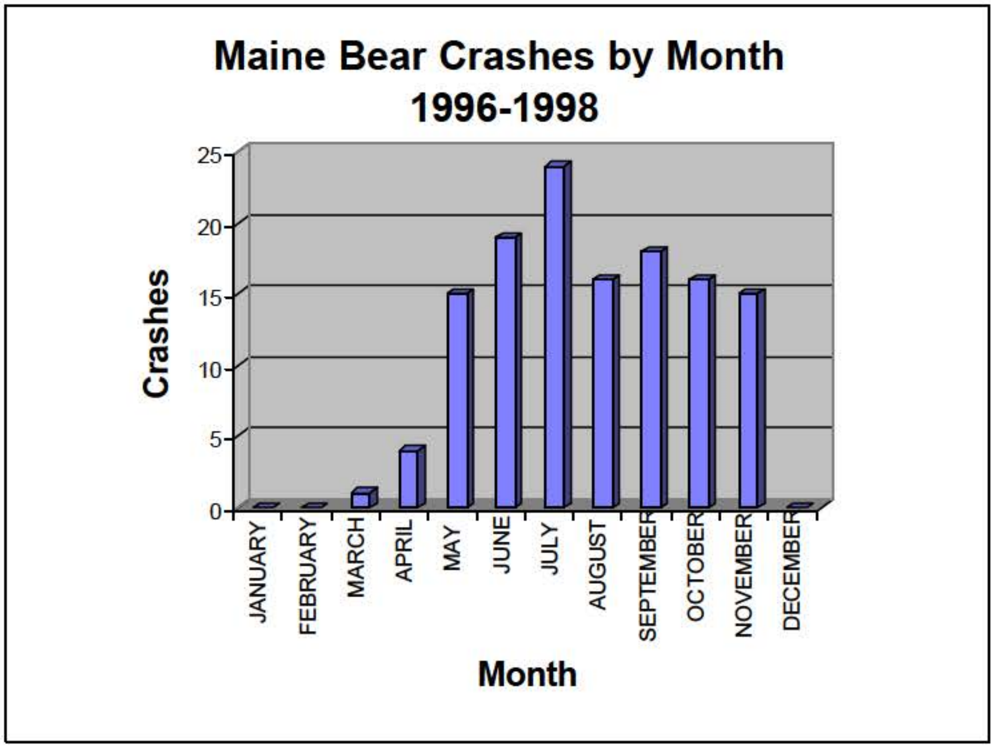
Data Summaries: Crashes involving motor vehicles and large wildlife:

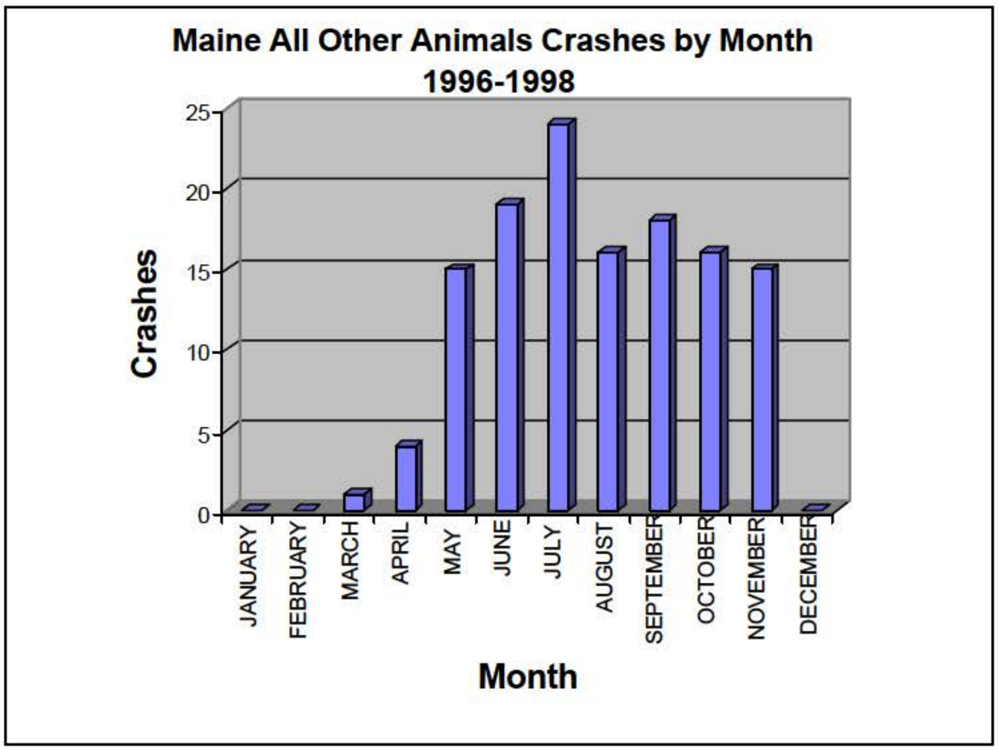
1996-1998

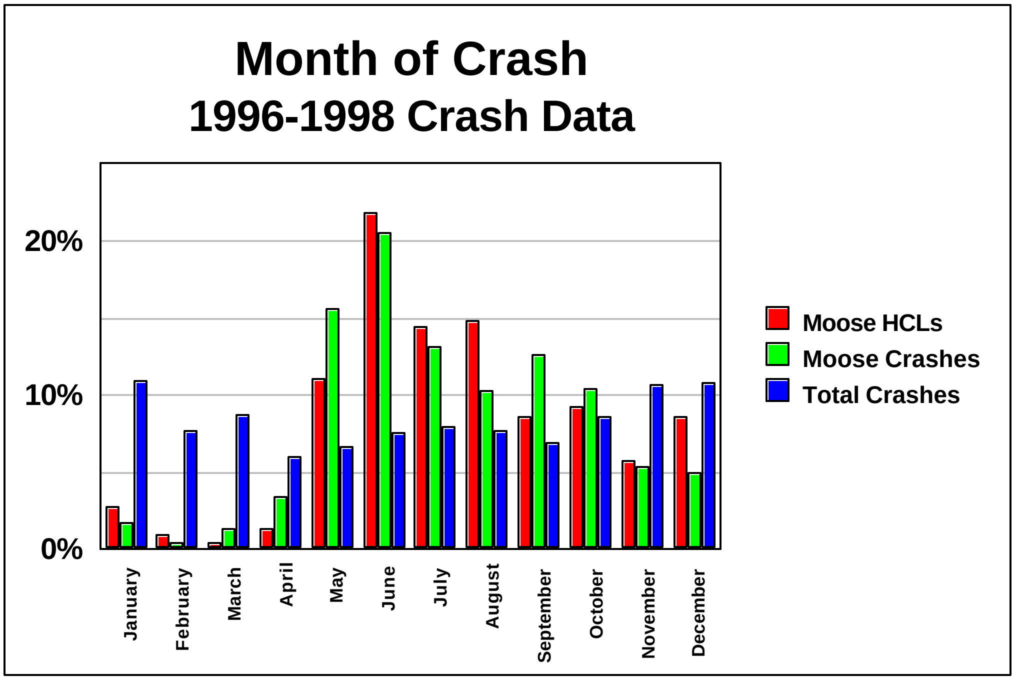
Note: In all graphics, HCL is an acronym for High Crash Location. HCLs are the areas with the highest density (5 or more crashes within a road segment) of motor vehicle/moose collisions. The locations of HCLs are shown as yellow squares on the map shown in Appendix B.

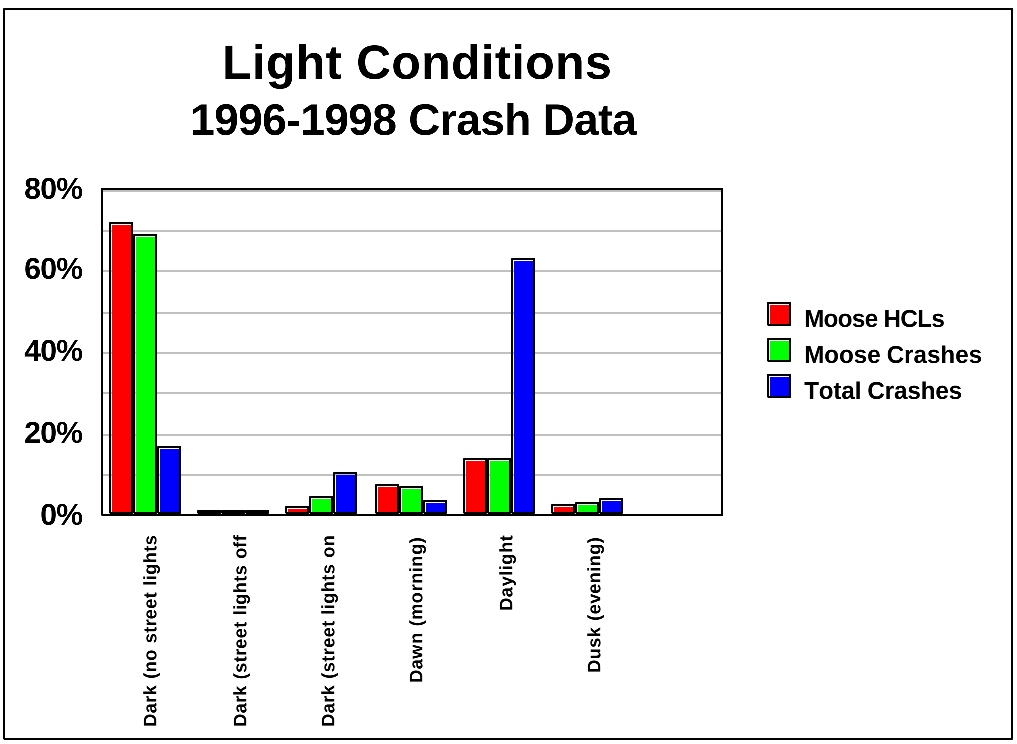

Maine Deer Crashes by Month
1996-1998
Crashes
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
Month

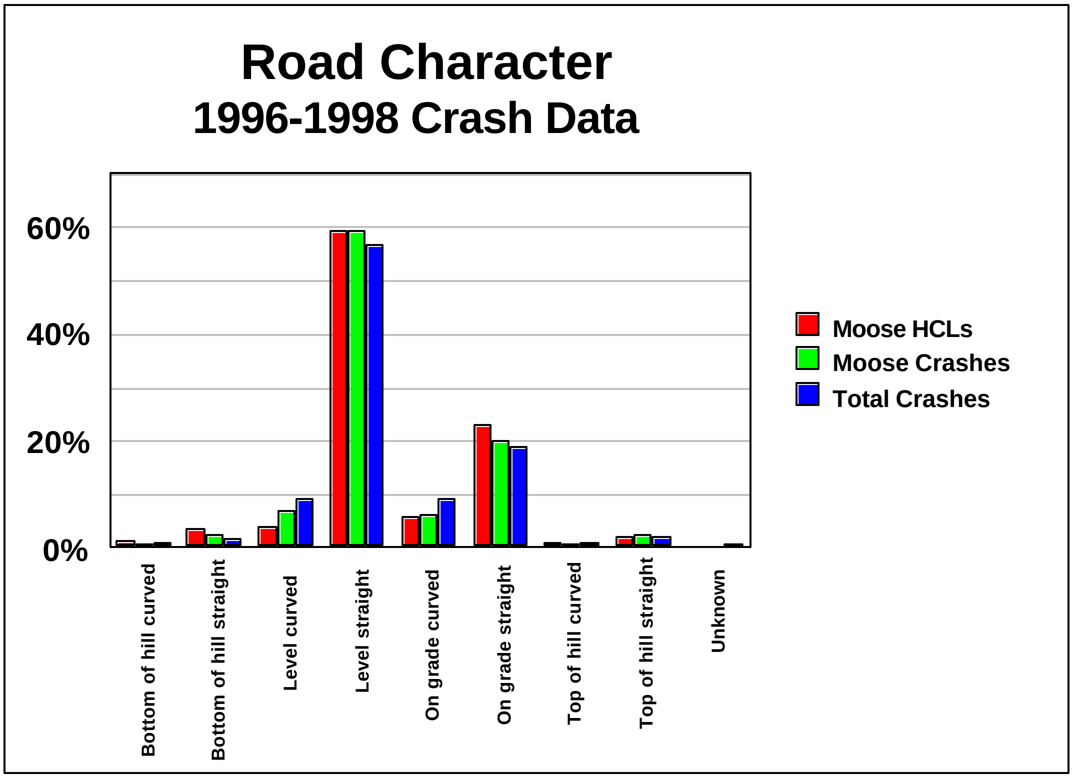

Maine Moose Crashes by Month
1996-1998
Crashes
450
400
350
300
250
200
150
100
50
0
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
Month

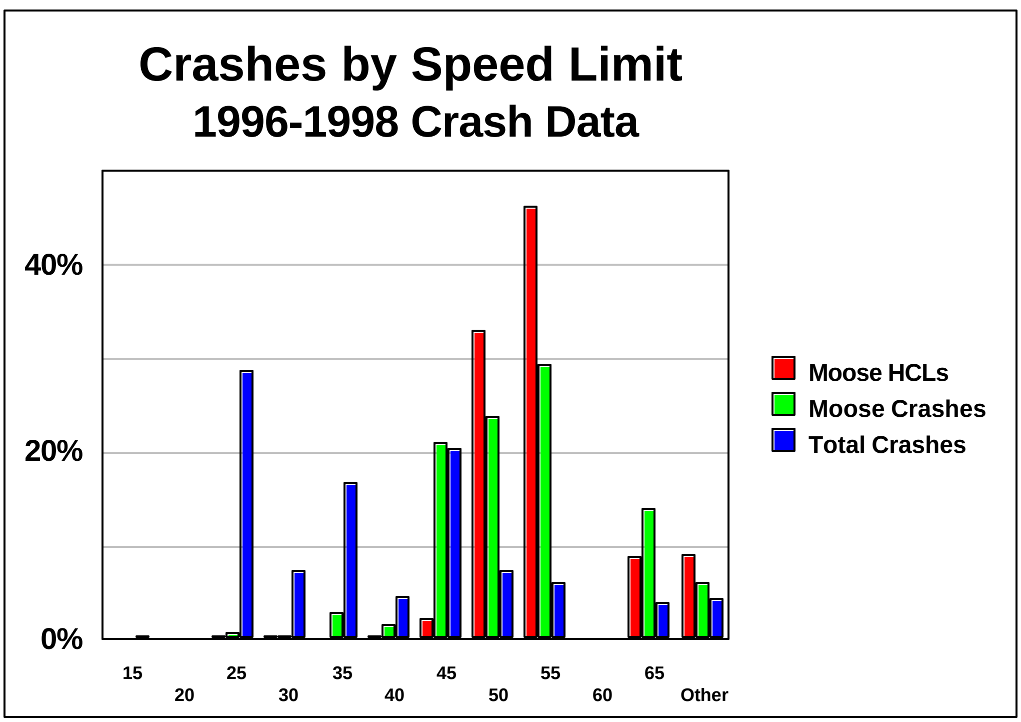

Maine Bear Crashes by Month
1996-1998
Crashes
0
5
10
15
20
25
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
Month

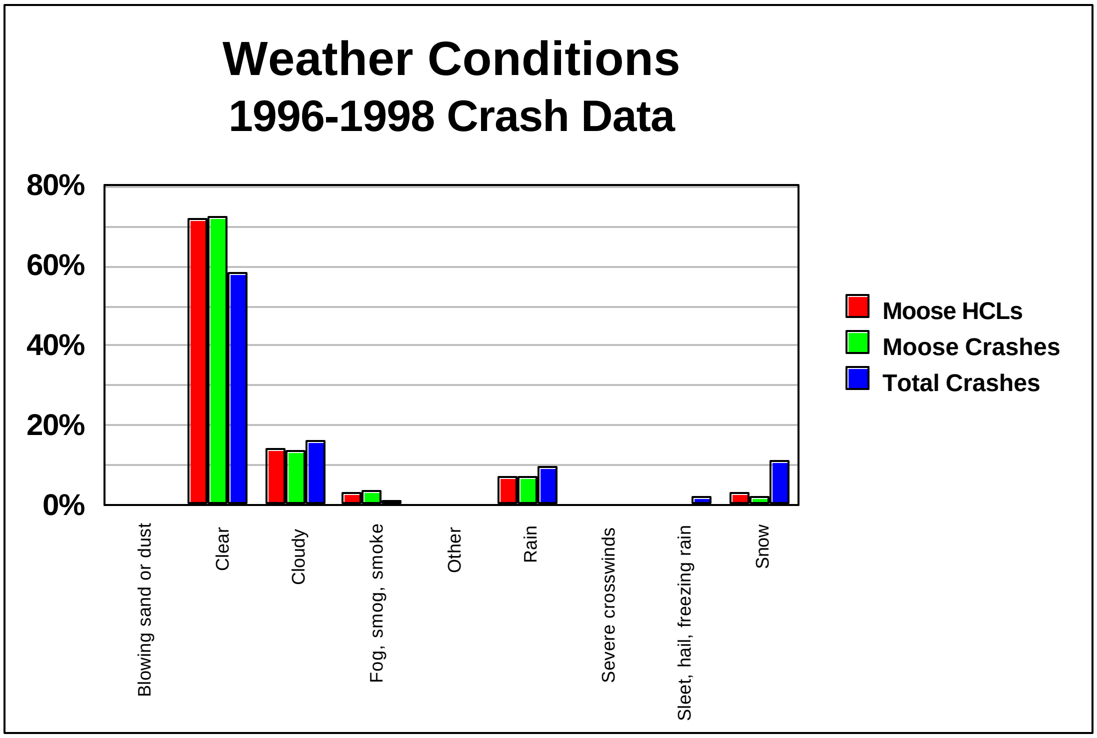

Maine All Other Animals Crashes by Month
1996-1998
Crashes
0
5
10
15
20
25
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
Month

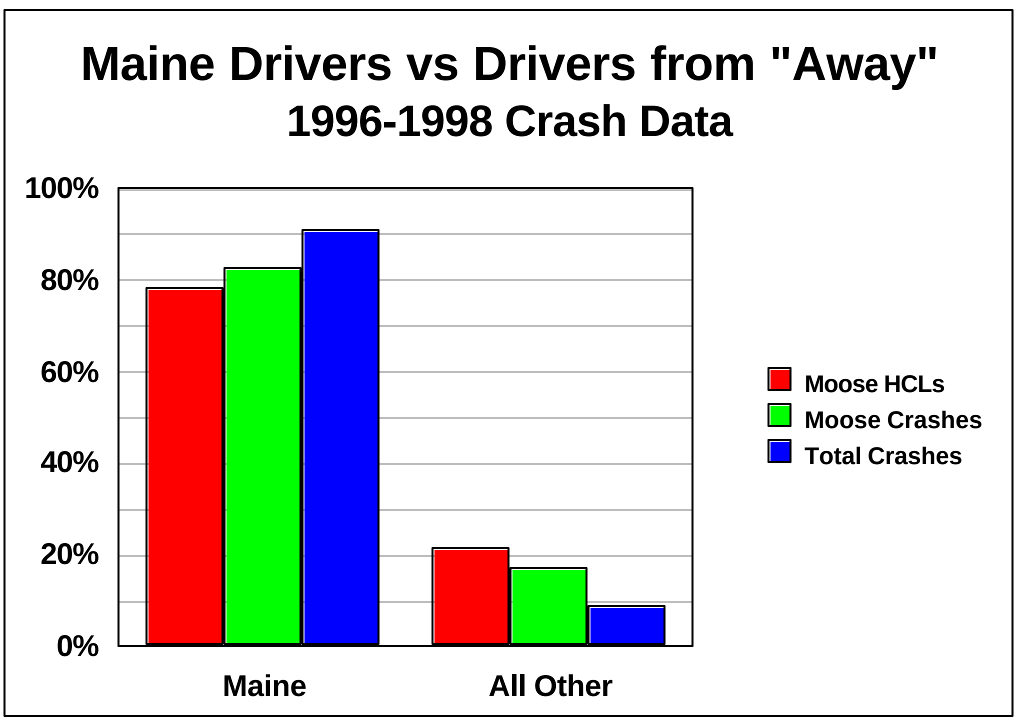

Month of Crash
1996-1998 Crash Data
20%
10%
0%
January
February
March
April
May
June
July
August
September
October
November
December
Moose HCLs
Moose Crashes
Total Crashes

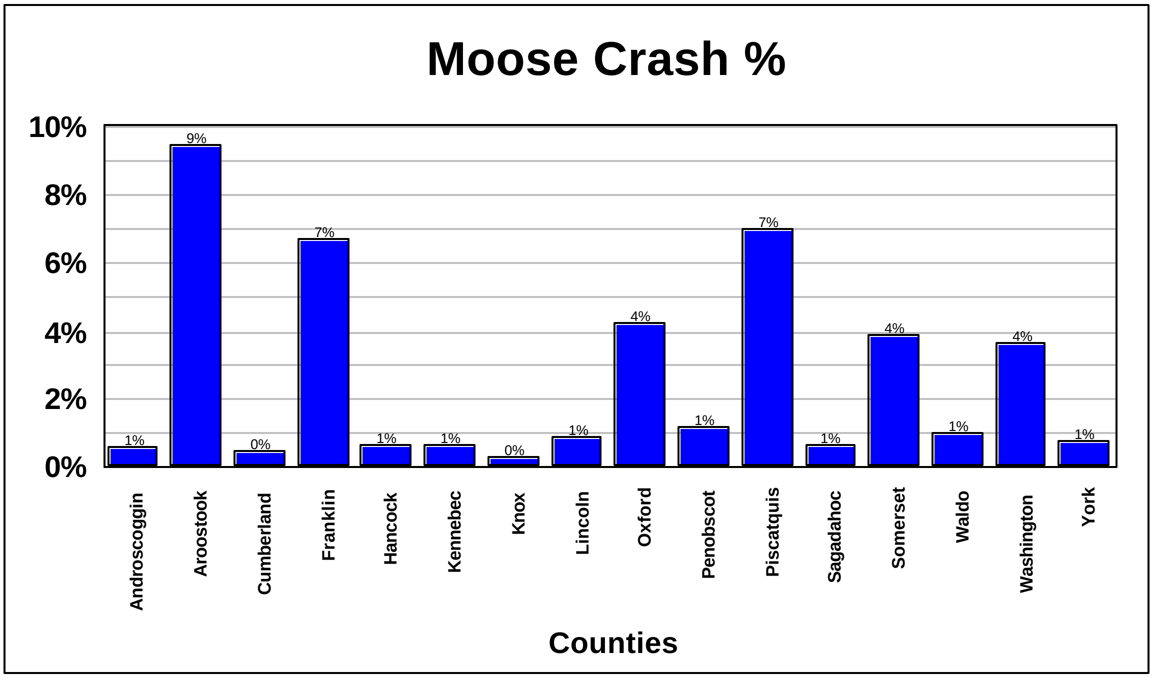

Light Conditions
1996-1998 Crash Data
80%
60%
40%
20%
0%
Dark (no street lights
Dark (street lights off
Dark (street lights on
Dawn (morning)
Daylight
Dusk (evening)
Moose HCLs
Moose Crashes
Total Crashes

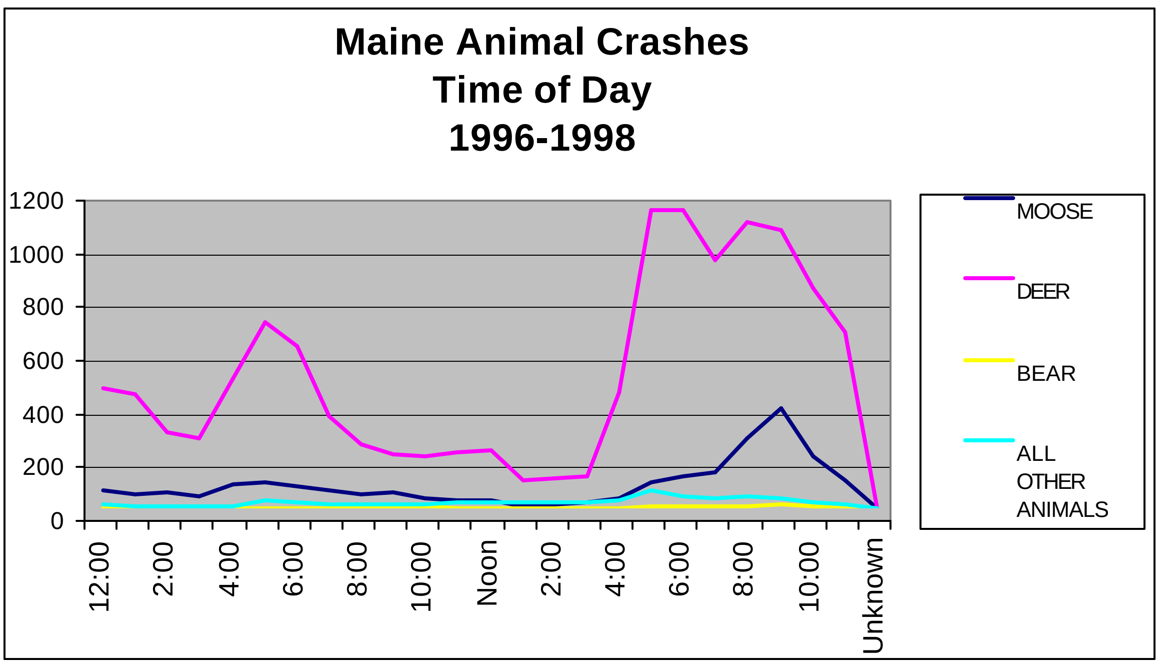

Road Character
1996-1998 Crash Data
60%
40%
20%
0%
Bottom of hill curved
Bottom of hill straight
Level curved
Level straight
On grade curved
On grade straight
Top of hill curved
Top of hill straight
Unknown
Moose HCLs
Moose Crashes
Total Crashes


Crashes by Speed Limit
1996-1998 Crash Data
40%
20%
0%
15
20
25
30
35
40
45
50
55
60
65
Other
Moose HCLs
Moose Crashes
Total Crashes


Weather Conditions
1996-1998 Crash Data
80%
60%
40%
20%
0%
Blowing sand or dust
Clear
Cloudy
Fog, smog, smoke
Other
Rain
Severe crosswinds
Sleet, hail, freezing rain
Snow
Moose HCLs
Moose Crashes
Total Crashes


Maine Drivers vs Drivers from "Away"
1996-1998 Crash Data
100%
80%
60%
40%
20%
0%
Maine
All Other
Moose HCLs
Moose Crashes
Total Crashes


Moose Crash %
10%
8%
6%
4%
2%
0%
1%
9%
0%
7%
1%
1%
0%
1%
4%
1%
7%
1%
4%
1%
4%
1%
Androscoggin
Aroostook
Cumberland
Franklin
Hancock
Kennebec
Knox
Lincoln
Oxford
Penobscot
Piscatquis
Sagadahoc
Somerset
Waldo
Washington
York
Counties


Maine Animal Crashes
Time of Day
1996-1998
1200
1000
800
600
400
200
0
12:00
2:00
4:00
6:00
8:00
10:00
Noon
2:00
4:00
6:00
8:00
10:00
Unknown
MOOSE
DEER
BEAR
ALL
OTHER
ANIMALS

Maine Highway Crashes Involving Animals by County 1996-1998					
COUNTY	**MOOSE**	**DEER**	**BEAR**	**ALL OTHER ANIMALS**	**Total**
ANDROSCOGGIN	66	728	0	41	835
AROOSTOOK	559	504	32	42	1137
CUMBERLAND	133	1839	1	67	2040
FRANKLIN	235	432	2	12	681
HANCOCK	38	763	4	32	837
KENNEBEC	88	1356	1	57	1502
KNOX	11	382	0	17	410
LINCOLN	27	322	0	15	364
OXFORD	210	615	7	26	858
PENOBSCOT	168	1559	26	70	1823
PISCATAQUIS	111	321	2	9	443
SAGADAHOC	19	305	0	9	333
SOMERSET	208	878	0	42	1128
WALDO	32	639	0	28	699
WASHINGTON	93	223	3	29	348
YORK	129	1307	2	72	1510
Total	2127	12173	80	568	14948

Maine Highway Crashes Involving Animals by Month 1996-1998					
MONTH	**MOOSE**	**DEER**	**BEAR**	**ALL OTHER ANIMALS**	**Total**
JANUARY	38	553	0	45	636
FEBRUARY	11	482	0	35	528
MARCH	28	446	1	32	507
APRIL	72	727	2	43	844
MAY	331	760	8	45	1144
JUNE	436	1011	12	57	1516
JULY	279	686	16	48	1029
AUGUST	220	474	9	47	750
SEPTEMBER	270	695	12	47	1024
OCTOBER	222	1638	9	56	1925
NOVEMBER	114	3110	11	55	3290
DECEMBER	106	1591	0	58	1755
TOTAL	2127	19574	128	568	14948

Appendix B

Map of motor vehicle/moose crashes in Maine

1996 - 1998

CRASHES INVOLVING MOOSE

1996 -1998

MOOSE VEHICLE CRASH FACTS IN MAINE 1996-1998

	MOOSE	OTHER ANIMALS
NUMBER OF CRASHES	2,126	12,810
NUMBER OF CRASHES WITH INJURIES OR FATALITIES	494	876
NUMBER OF HUMAN FATALITIES	0	0
NUMBER OF HUMAN INJURIES	647	959
ESTIMATED ECONOMIC IMPACT	$50,168,000	$47,073,000
ESTIMATED IMPACT PER CRASH	$23,601	$3,676

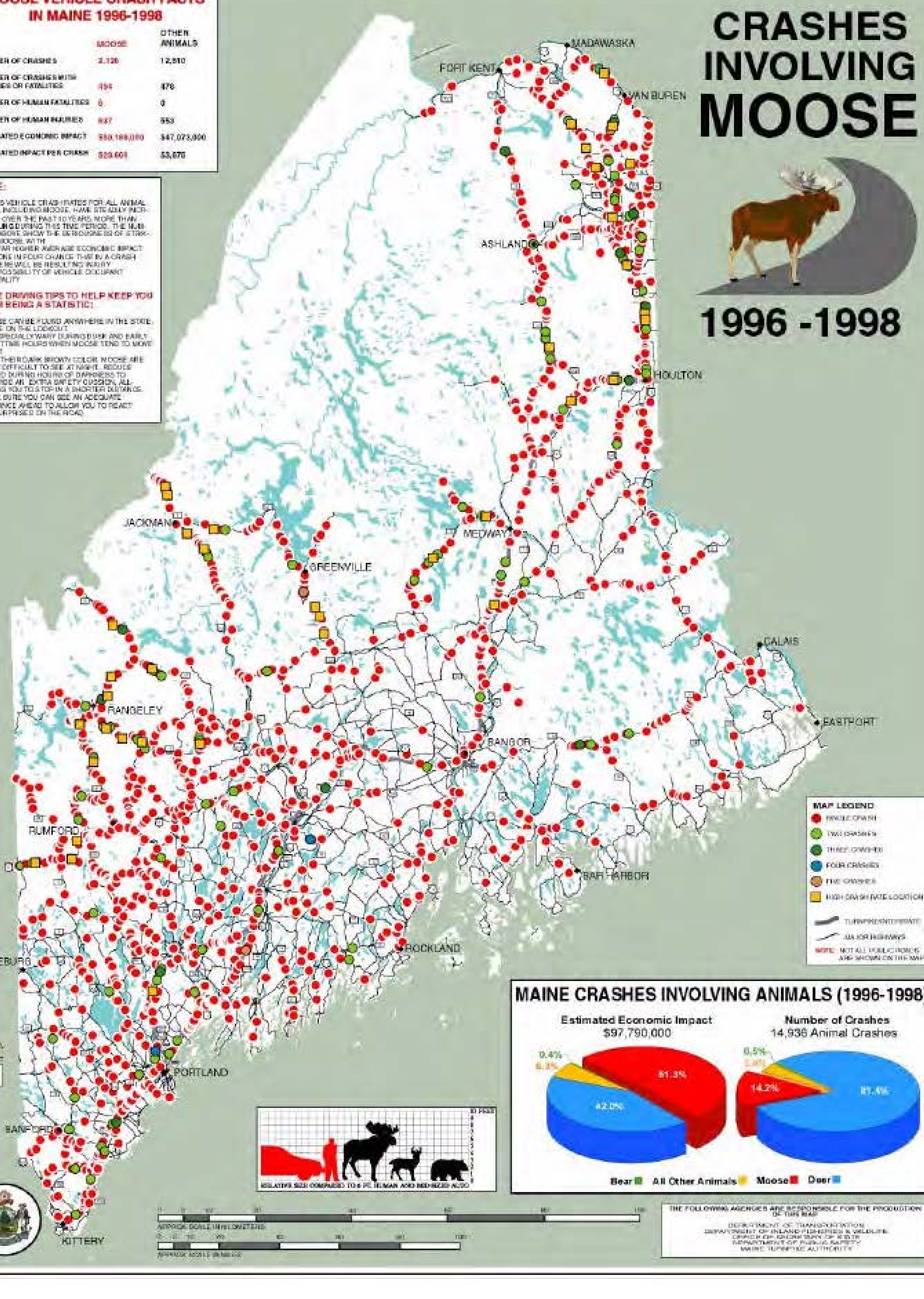
NOTE:

MAINE'S VEHICLE CRASH RATES FOR ALL ANIMAL TYPES, INCLUDING MOOSE, HAVE STEADILY INCREASED OVER THE PAST 10 YEARS, MORE THAN **DOUBLING** DURING THIS TIME PERIOD. THE NUMBERS ABOVE SHOW THE SERIOUSNESS OF STRIKING A MOOSE, WITH:

- A FAR HIGHER AVERAGE ECONOMIC IMPACT
- A ONE IN FOUR CHANCE THAT IN A CRASH THERE WILL BE RESULTING INJURY
- A POSSIBILITY OF VEHICLE OCCUPANT FATALITY

SOME DRIVING TIPS TO HELP KEEP YOU FROM BEING A STATISTIC:

- MOOSE CAN BE FOUND ANYWHERE IN THE STATE, SO BE ON THE LOOKOUT.
- BE ESPECIALLY WARY DURING DUSK AND EARLY NIGHTTIME HOURS WHEN MOOSE TEND TO MOVE MOST.
- WITH THEIR DARK BROWN COLOR, MOOSE ARE VERY DIFFICULT TO SEE AT NIGHT. REDUCE SPEED DURING HOURS OF DARKNESS TO PROVIDE AN EXTRA SAFETY CUSHION, ALLOWING YOU TO STOP IN A SHORTER DISTANCE.
- MAKE SURE YOU CAN SEE AN ADEQUATE DISTANCE AHEAD TO ALLOW YOU TO REACT TO SURPRISES ON THE ROAD.



THE FOLLOWING AGENCIES ARE RESPONSIBLE FOR THE PRODUCTION OF THIS MAP

DEPARTMENT OF TRANSPORTATION
DEPARTMENT OF INLAND FISHERIES & WILDLIFE
OFFICE OF SECRETARY OF STATE
DEPARTMENT OF PUBLIC SAFETY
MAINE TURNPIKE AUTHORITY