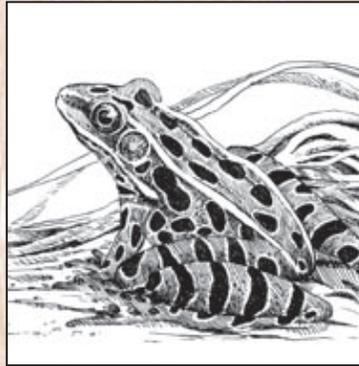


CONSERVING WILDLIFE



On and Around Maine's Roads

MAINE'S WILDLIFE HABITAT is some of the healthiest and most expansive in the Northeast. It's also threatened by an increasing number of roads.¹

Over the last 50 years, residential development has spread further and further from cities and towns into rural areas, requiring more roads and contributing to what is commonly referred to as “sprawl.” The great majority of new roads are private subdivision and local roads.

What these roads mean for Maine's wildlife is alarming: wildlife-vehicle collisions, commonly known as “road kill,” are the number one human cause of wildlife mortality in the United States. They're also the cause of many human injuries and fatalities. And what many people don't realize is that the impacts of roads on wildlife and surrounding habitat occur far beyond the pavement's edge.

The good news is that road planning and building strategies and wildlife-crossing structures can help make Maine roads less dangerous to wildlife and people.

This brochure outlines how Maine's local planning boards, comprehensive planning committees, local public works departments, regional transportation planning groups, and state transportation agencies can use these strategies to improve and maintain Maine's wildlife habitats.

How do roads affect wildlife and habitat?

Roads not only cause wildlife-vehicle collisions, they also fragment and destroy habitat.

A

HIGHLY EFFECTIVE network of roads keeps people mobile in the United States, taking us to work and school, to visit with friends and family, and to shop for goods that support our lives. We demand good roads for our safety and convenience, and we've

been willing to pay the costs. But what about the hidden costs?

Imagine if someone built a road separating your bedroom and kitchen. For species such as the wide-ranging moose, their “kitchens” (the ponds where they eat aquatic plants in summer) and “bedrooms” (uplands where they rest with their young) are often separated by roads.

Building and using roads often fragments and destroys habitat, and causes some wildlife to avoid it. It also brings humans into the area, with results such as wildlife-vehicle collisions. Roads also bring invasive species and chemical contaminants into the areas surrounding them.

Quite simply, the impact on some wildlife is disastrous. Over time, species sensitive to habitat disruption decrease in number. Fragmented habitat limits natural dispersal of young animals, which leads to a loss of genetic diversity in some animal populations. Numbers of species and individuals decrease overall and, at the extreme, species become locally and regionally extinct.

Estimates show 15 to 20 percent of the land base of the United States suffers ecological impacts from roads, because the effects of roads extend significantly beyond the road and its immediate surrounding area.² (See Figure 1.)

Direct Habitat Loss

WILDLIFE HABITAT IS DIRECTLY lost when roadbeds and associated rights-of-ways are constructed. Across the country, approximately 20 million acres (an area about the size of Maine) has been lost from the construction of four million miles of public highways, streets, and rights-of-way.

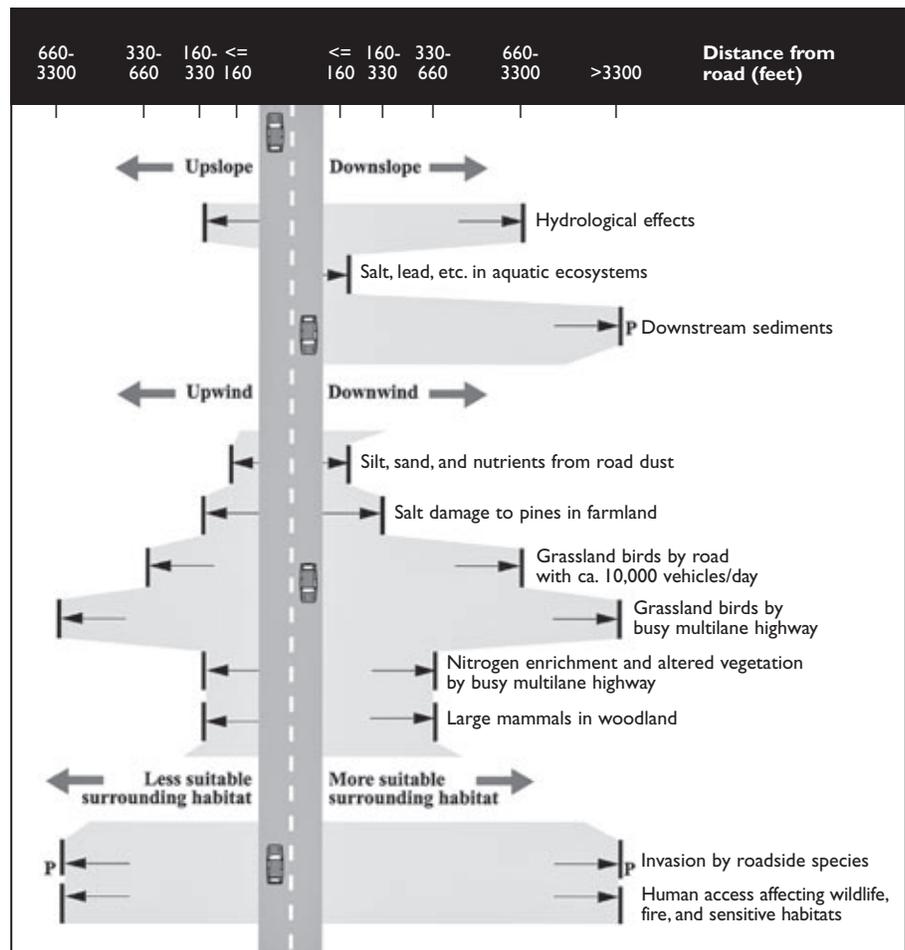


FIGURE 1. Sample distances of road-effect zones that affect wildlife habitat. Gravity (upslope/downslope), wind (upwind/downwind), and behavior or habitat suitability (less/more)—in addition to walls or hills near the road—produce greater effect-distances on one side of the road than on the other. Shaded areas = road-effect zone. Each effect typically extends outward along a stretch of road; (P) = an effect extending from a point on the road.

FROM ROAD ECOLOGY BY RICHARD T.T. FORMAN, ET AL. ©2003 ISLAND PRESS. REPRODUCED BY PERMISSION OF ISLAND PRESS, WASHINGTON, D.C.³



Bobcats need to move across a large landscape and are likely to disappear from habitat fragmented into smaller areas.

In Maine, the amount of habitat lost to public roads (22,750 miles) is approximately 115,000 acres, more than half the size of Baxter State Park. Roughly one-third of this acreage corresponds with the footprint of Maine's major roadways managed by the Maine Department of Transportation (MaineDOT) and the Maine Turnpike Authority (MTA); the remainder falls within the jurisdiction of Maine's nearly 500 municipalities and its Unorganized Territories. (These numbers don't include the approximately 44,000 miles of private and forestry roads in Maine.) A Maine study found that 210 pairs of breeding birds were displaced from every mile of the four-lane I-95 built in forested habitat. Most displaced birds will not breed successfully since adjacent habitat is usually occupied by other birds that vigorously defend their nesting territories against intruders. The intruders cannot find food or nesting sites. This represents a direct loss of habitat not only for the 210 pairs of breeding birds but also for the next generation of birds that would have lived there, leading to declines in total populations for the region.⁴

Habitat Fragmentation

WHEN A ROAD IS BUILT through large, formerly intact habitat blocks—whether forest, grassland, or wetland—it fragments them into smaller areas and isolates the animals within them. Some wildlife species can continue to thrive in relatively smaller habitat blocks. However, animal species that need to move across a large landscape, such as moose and bobcat, are likely to disappear from smaller habitat areas. Species such as wood thrush and northern parula warblers—which are especially sensitive to habitat changes, increased predation, or human disturbance—are likely to abandon fragmented habitat.

One study of traffic and wildlife showed that no small mammals moved across roads with average annual daily traffic volumes of over 11,000 vehicles per day—comparable to a busy two-lane highway in central Maine.⁵

Isolating animal populations into smaller groups by fragmenting their habitat reduces their genetic diversity and can lead to local extinction, and in some cases listing as an endangered species.

HOW DO ROADS AND TRAFFIC FRAGMENT HABITAT?

- ❑ Roads can create impassable barriers for terrestrial animals because of road width and altered habitat alongside roads.
- ❑ Roads constructed through wetlands and across streams can fragment habitat for aquatic animals.
- ❑ Culverts can restrict connections between habitat for fish and other aquatic animals.
- ❑ Noise, lights, and vehicle movements and emissions can restrict wildlife movement, particularly at high traffic volumes.

Habitat Avoidance

WILDLIFE EXPERTS BELIEVE traffic noise may be a major reason animals avoid habitat near roads. Other factors include visual disturbance, pollutants, and an increased numbers of predators.⁶

Traffic noise may interfere with breeding birds' ability to hear birdsong, which they rely on to attract mates and establish breeding territories. Because noise travels farther in open habitats, a decrease in population density adjacent to roads has been found to be greatest for grassland birds, less for birds in



Grassland birds, such as the meadowlark, may avoid habitat along noisy roads.



Collisions between vehicles and deer pose the greatest hazard for motorists, but do not put the deer population at risk.

deciduous woods, and least for birds in coniferous woods.^{7,8,9} Researchers have found that negative impacts on the density and nesting success of grassland birds extend more than a quarter mile from a rural road and more than a half mile from a highly traveled, four-lane highway.^{10,11}

Human Access and Land Use

WHEN NEW ROADS INCREASE access to Maine's undeveloped natural areas, they bring new opportunities for human activity such as development, agriculture, logging, mining, and the use of all-terrain vehicles. These activities can degrade, change, or even eliminate wildlife habitat.

New roads intended to alleviate congestion lead to increased residential and commercial development alongside the road, unless access is controlled. Private roads constructed to facilitate practices such as forestry, which may have relatively low impact on wildlife habitat, increase access to remote areas. As recreational use of these remote areas increases, and seasonal and permanent homes are built, road improvements are often expected—posing further threats to wildlife.

Chemical Contamination

CHEMICALS INTRODUCED ALONG roadways from vehicles, deicing salts, road surface wear, and herbicide and pesticide use can pollute wildlife habitat by providing a source of heavy metals, salt, organic pollutants, and excessive nutrients.¹²

Such water and soil pollution poses a lethal risk to wildlife that depend on the resources.

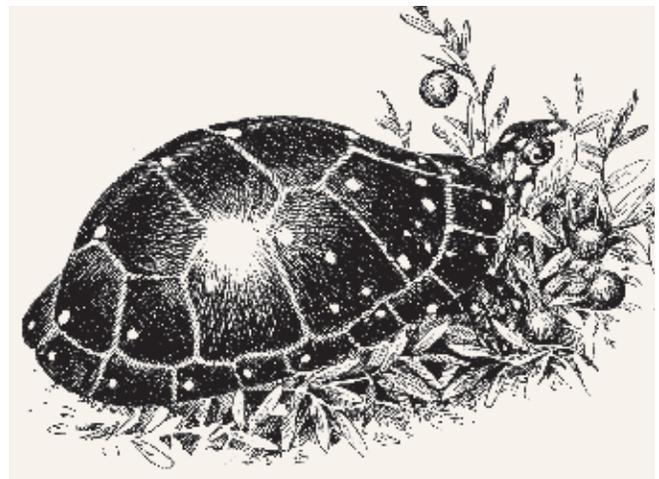
Contamination of soil, plants, and animals extends up to 66 feet from a road, and elevated levels of heavy metals often extend 650 feet or more from the road, occurring at greater concentrations along roads with high traffic volume.¹³ Aquatic systems are particularly vulnerable to contamination, which streams may carry over long distances. Road salt, particularly sodium chloride, is toxic to many species of plants, fish, and other aquatic organisms. Increased salt in the water often helps invasive plants grow. In addition, concentrations of salt along roadsides may attract deer and moose, increasing the risk of vehicle collisions.

Wildlife-Vehicle Collisions

THE TYPES AND NUMBER OF animals killed by vehicles is related to road width, traffic volume, and vehicle speed. For example, amphibians and reptiles have the highest mortality rates on two-lane roads with low to moderate amounts of traffic, whereas large and midsize mammals are more susceptible to collisions on two-lane, high-speed roads. Birds and smaller mammals are more at risk from collisions on wider, high-speed highways.¹⁴

It's important to note that roads through and adjacent to wetlands, ponds, and other waterways have some of the highest road-kill rates.^{15,16} With 85 percent of Maine's vertebrate species living in or using these habitats during some or all of the year, the need for animals to move safely from and around them is clear.

Although wildlife-vehicle collisions do not currently put the health of large-mammal populations such as deer and moose at risk, collisions between vehicles and large mammals pose the greatest hazard for motorists in Maine and should be minimized (see table on page 5).



For this spotted turtle, wildlife-vehicle collisions may lead to extinction.

However, for slower-moving species with lower reproduction rates and/or small populations, wildlife-vehicle collisions can be the major factor contributing to extinction. In Maine, this high-risk group includes the endangered Blanding's turtle and threatened spotted turtle, which regularly travel great distances between wetland feeding areas and upland nesting habitat. These turtles, which can live up to 75 years but do not breed until they are about 10 years old, have a very low rate of hatchling survival. Most of the turtles that cross roads are females traveling to and from nest sites.

Maine wildlife population models suggest that unless road kill can be substantially reduced, turtle extinctions in Maine are inevitable. Research that MaineDOT supports in southern Maine around Mount Agamenticus will help scientists and planners better understand the needs of these animals and develop some potential solutions.

Invasive Species

INVASIVE PLANTS AND ANIMALS that are not native to a region can seriously harm wildlife habitats. Invasive species spread rapidly and displace native species by outcompeting them for breeding sites, prey, and other resources. They can disrupt food webs, degrade habitats, and alter wildlife diversity.

Roadside erosion-control plantings, drainage ditches, maintenance and construction fill, automobiles and boats traveling from areas infested by invasive species, and animals traveling along roadways all provide a means for invasive species to disperse. Roadside erosion into wetlands and streams allows invasive species to gain a foothold as native vegetation is scoured or smothered by eroding soils. MaineDOT plants only native species on construction sites to reduce the spread of invasive species in Maine.

Maine Wildlife Species Most Vulnerable to Road Impacts

Species	Type of Road Impact	Reasons for Concern
Moose*	Vehicle collision	<i>From 2000-2004:</i> 14 human fatalities 3,391 accidents \$83 million economic loss
Deer*	Vehicle collision	<i>From 2000-2004:</i> 2 human fatalities 18,289 accidents \$62 million economic loss
Wide-ranging mammals: Moose, Bear, Bobcat, Fisher, Canada lynx	Road mortality Habitat loss Habitat fragmentation	Species loss on a local level
Riparian mammals: Mink, Otter	Habitat fragmentation Blocked riparian passage	Species loss on a local level
Low-reproducing/fairly wide-ranging mammal:** Porcupine	Road mortality	Species loss on a local level
Area-sensitive and declining birds:** Least flycatcher, Brown creeper, Wood thrush, Veery, Black-and-white warbler, Northern parula warbler, Chestnut-sided warbler, Canada warbler, American redstart, Rose-breasted grosbeak, Rufous-sided towhee, Upland sandpiper, Bobolink, Eastern meadowlark, Grasshopper sparrow, Vesper sparrow	Habitat fragmentation Habitat avoidance/disturbance	Decline in populations Species loss on a local level
Fish: Brook trout, American eel, Swamp darter	Habitat loss/fragmentation Blocked riparian passage Chemical contamination/ sedimentation	Population reduction Species loss on a local level
Slow-moving/slow-reproducing/wide-ranging turtles: Blanding's turtle, Spotted turtle, Wood turtle, Snapping turtle	Road mortality Habitat loss	State extinction Species loss on a local level
Amphibians: Spotted salamanders, Blue-spotted salamanders, Four-toed salamanders, Wood frogs, Leopard frogs	Road mortality Habitat loss Chemical contamination	Population reduction Species loss on a local level Disease/deformation

* MaineDOT, *Collisions Between Wildlife Species and Motor Vehicles in Maine 2000-04*

** Dan Harrison, personal communication

*** Maine Audubon, *Conserving Wildlife in Maine's Developing Landscape*

Planning and Building for Wildlife Conservation

With careful land-use planning, we can do a great deal to reduce the impacts of roads on Maine's wildlife.

MOVING PEOPLE ACROSS Maine does not have to occur at great cost to wildlife. Through engineering and land-use planning, we can do a great deal at the state, regional, and local levels to enhance public safety and protect wildlife habitat while planning, designing, constructing, and maintaining our transportation networks. The financial cost of these projects and solutions varies widely—from thousands, to hundreds of thousands, to millions of dollars. However, solutions such as wildlife crossings can save human life and property, are used over many decades, and are a relatively small percentage of the cost of highway projects. With advanced planning, some projects may be readily incorporated into new roads, or upgrades and maintenance of existing roads. Others may be beyond the scope of current funding and would require special funding.

Citizen Involvement Can Make a Difference

CITIZENS CAN ENCOURAGE road planning, design, construction, and maintenance that protect wildlife populations, and enhance safety and our quality of life by sharing road and wildlife information with their local planning boards and public works departments. *Beginning with Habitat* maps (see “Need More Information?” on page 8) and this publication about roads and wildlife are a good start.

Participating in planning at the local and regional level ensures that the habitat and transportation sections of a town's comprehensive plan are linked, and reflect habitat and road issues. Each town's comprehensive plan determines its future land-use decisions, including where new roads will be needed to support new growth. To become involved at the local level, attend municipal planning board public hearings on subdivision proposals involving road construction or modification, and request changes to the plan that will benefit wildlife. To become involved on the regional and state level, refer to the guide *Working Together to Build a Better Maine: Participate in the Maine Department of Transportation*



Culverts installed to allow brook trout to pass can also be designed to allow small mammals, reptiles, and amphibians to pass under roads.

Planning Process, available from MaineDOT and at www.maine.gov/mdot/public-involvement/publicinvolvement.php.

Road Planning and Construction Strategies

SPECIFIC STEPS CAN BE TAKEN to reduce impacts of roads on wildlife. Many have been used successfully elsewhere and others are being studied around the world. These recommendations were adapted in part from *Road Ecology*, a recent book authored by experts in this science.¹⁷

PLANNING

1. Use *Beginning with Habitat* maps to identify riparian habitats, high-value plant and animal habitats, and large blocks of undeveloped habitat in a project area. Steer development and road construction away from these important habitats to the greatest extent possible.
2. Where not possible to avoid important habitats, design and construct roads to minimize impacts to sensitive or fragile resources.
3. Develop and adopt town land-use plans and ordinances that promote village and neighborhood centers that reduce the

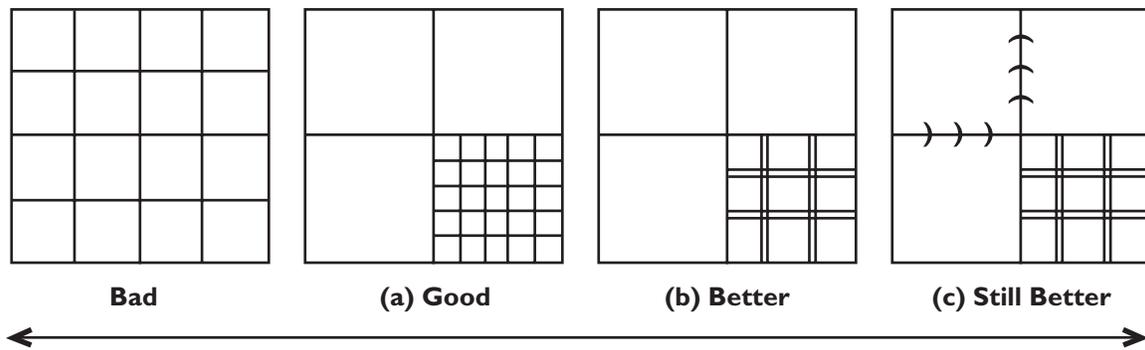


FIGURE 2: A hypothetical road network showing three principles for the ecologically best possible network. The principles: (a) Maintain a few large, roadless natural areas. (b) Concentrate the bulk of traffic onto a small number of large roads. (c) Connect habitat across roads that separate the large natural areas. \frown = wildlife crossing
FROM FORMAN, R.T.T. 2006.¹⁸ WITH PERMISSION.

need to drive for daily goods and services; discourage building new roads in rural areas; and prohibit approval of long, dead-end roads. As much as possible, accommodate increasing traffic by upgrading existing major roads instead of developing multiple new minor roads. (See Figure 2.)

4. Minimize the number of breaks for new roads and driveways off main roads in areas of unfragmented and high-value habitat to reduce leapfrog development.
5. Develop a regional map showing where wildlife can travel between large habitat areas separated by roads. Preserve these important wildlife travel routes through local land-use management or wildlife crossing structures. The *Beginning with Habitat* program is developing such information.
6. Identify locations on roadways, culverts, and bridges that can be restored or retrofitted with wildlife crossing structures to improve wildlife movement.
7. Compensate for unavoidable habitat loss and fragmentation by identifying opportunities to purchase and conserve high-value habitat in the region.
8. Site and design roads to reduce runoff of chemicals that can contaminate water and soil. In consultation with MaineDOT, reduce salt use and designate “salt free” zones where appropriate.

CONSTRUCTION

1. Install wildlife underpasses and overpasses (see insert “Wildlife Crossing Structures”) along existing roads to reduce habitat fragmentation and travel barriers, particularly in conservation lands, high-value habitat, and areas where wildlife travel.
2. Span streams or design culverts to mimic natural stream conditions so fish and other wildlife can pass under roads.
3. Use soil berms and vegetation as well as road surface improvements to mute noise and reduce other ecological disturbances that traffic creates for wildlife.
4. Use only native species for roadside plantings, erosion control, and slope stabilization. Plant maintenance-free native wildflowers and other plants along roadsides to prevent nonnative plant species from invading.

Wildlife-Friendly Road Planning and Projects Under Way in Maine

DURING ITS PLANNING PROCESS, MaineDOT routinely uses *Beginning with Habitat* and other habitat data to screen projects, as well as field visits to verify natural resources present at project locations. For large projects, such as the highway bypasses around Gorham and Presque Isle, MaineDOT studies not just the roadway but the entire transportation corridor, adjusting the final road alignment where possible to minimize impacts.

Where impacts to important habitats cannot be avoided, MaineDOT mitigates the negative effects of road building by conserving or restoring sites that have similar ecological functions and values. MaineDOT hopes to soon be a primary user of Maine’s new “in lieu fee” program that proactively identifies regional sites of statewide value to best meet the goal of habitat mitigation. This program, administered by Maine’s Department of Environmental Protection, will be the first of its kind in New England.

Ten years ago culverts were designed only to pass a stream under a road; today they are also designed to allow passage of fish and wildlife. As of 2006, MaineDOT is building Maine’s first large (13-foot-wide by 7-foot-high) concrete box culvert with a shelf inside to let small mammals, reptiles, and amphibians pass. This culvert, also designed to allow brook trout to pass, is on Bog Brook on Route 117 in Buckfield. In Phillips, in an effort to keep moose from bolting onto the road, MaineDOT began in 2006 to experiment with a five-foot-wide blanket of rocks along the shoulder in areas with many moose-vehicle collisions.

Maine Audubon works with MaineDOT and *Beginning with Habitat* to develop outreach materials and promote planning and projects that benefit wildlife and meet Maine citizen’s transportation needs.

Literature Cited

- 1 O'Hara, F. 1997. The Cost of Sprawl. Maine State Planning Office.
- 2 Forman, R. T.T. & L. E. Alexander. 1998. Roads and Their Major Ecological Effects, *Annu. Rev. Ecol. Syst.* 29:207-31.
- 3 Forman, R. T.T. et al., 2003. *Road Ecology: Science and Solutions*, Island Press, 481 pages.
- 4 Ferris, C.R. 1979. Effects of Interstate 95 on breeding birds in northern Maine. *J. Wildl. Manage.* 43:421-27.
- 5 McGregor, R., Derrane, S., Bender, D., & Fahrig, L. 2003. The Effect of Traffic Volume on Translocated Small Mammal Movement. In 2003 Proceedings of the International Conf. on Ecology & Trans., ed. by C. L. Irwin, P. Garrett, & K.P. McDermott. Raleigh, NC: Center for Trans. and the Envir., NC State U,
- 6 Forman & Alexander
- 7 Forman & Alexander
- 8 Reijnen, R., R. Foppen, C.T. Braak, & J. Thissen. 1995. The effects of car traffic on breeding bird populations in woodland. III. Reduction of density in relation to the proximity of main roads. *J. Applied Ecology*, 32:187-202.
- 9 Reijnen, R., R. Foppen, & H. Meeuwssen. 1996. The effects of traffic on the density of breeding birds in dutch agricultural grasslands. *Biological Conservation* 75: 255-260.
- 10 Bennett, A.F. 1991. Roads, roadsides and wildlife conservation: a review, In *Nature Conservation 2: The Role of Corridors*, eds. D. A. Saunders & R. J. Hobbs, Surrey Beatty & Sons, p. 99-117.
- 11 Van der Zande, W.J. ter Keurs & W.J. Van der Weijden. 1980. The impact of roads on the densities of four bird species in an open field habitat- evidence of a long-distance effect. *Biol. Conservation.* 18: 299-321.
- 12 Forman & Alexander
- 13 Ashley, E. P. & J. T. Robinson. 1996. Road Mortality of Amphibians, Reptiles and Other Wildlife on the Long Point Causeway, Lake Erie, Ontario. *The Canadian Field-Naturalist.* 110:403-412.
- 15 Forman & Alexander
- 16 Forman, R. T.T. et al., 2003. *Road Ecology: Science and Solutions*, Island Press, 481 pages.
- 16 Trombulak, S. C. & C. A. Frissell. 2000. Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities, *Conservation Biol.*, 14(1):2000, 18-30.
- 17 Forman, R. T.T. et al.
- 18 Forman, R.T.T. 2006. Good and Bad Places for Roads: Effects of Varying Road and Natural Pattern on Habitat Loss, Degradation, and Fragmentation. In Proceedings of the 2005 International Conf. on Ecology & Transportation, ed. By C.L. Irwin, P. Garrett, & K.P. McDermott. Raleigh, NC: Center for Transportation & the Environment, NC State U.
- 19 Donaldson, B.M. 2006. Use of Highway Underpasses by Large Mammals and Other Wildlife in Virginia and Factors Influencing Their Effectiveness. In Proceedings of the 2005 International Conf. on Ecology & Transportation, ed. By C.L. Irwin, P. Garrett, & K.P. McDermott. Raleigh, NC: Center for Transportation & the Environment, NC State U.
- 20 Forman, R. T.T. et al.

Need More Information?

Beginning with Habitat: (207) 287-8042,
www.beginningwithhabitat.org

Maine Audubon: (207) 781-2330, www.maineaudubon.org

Maine Department of Transportation: (800) 380-7822,
www.mainedot.gov

Defenders of Wildlife Habitat and Highways Campaign:
www.defenders.org/habitat/highways

Federal Highways: www.fhwa.dot.gov/environment/hconnect

Eco-Logical: www.environment.fhwa.dot.gov/ecological/eco_index.asp

International Conference on Ecology and Transportation:
www.icoet.net

River and Steam Continuity Project: www.streamcontinuity.org

Wildlife Crossing Toolkit USDA Forest Service:
www.wildlifecrossings.info

Wildlife and Roads: www.wildlifeandroads.org

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Maine Audubon works to conserve Maine's wildlife and wildlife habitat by engaging people of all ages in education, conservation, and action.

Wildlife Crossing Structures

Planning to avoid the need for wildlife crossing structures is the first step. But, in the right locations, wildlife crossing structures can effectively allow animals to move across roads.

BY MAKING IT POSSIBLE for animals to move across roads, wildlife-crossing structures help them maintain access to the different habitats they need and avoid wildlife-vehicle collisions. However, crossings can be expensive and only address some of the problems created by new roads. The first rule is to locate roads in the appropriate places. Wildlife crossing structures should not be used to justify inappropriately located new roads. But retrofitting existing roads, often with minor changes, presents a huge opportunity to reconnect and maintain habitats. Wildlife crossings are an emerging science and new information is rapidly becoming available. Some things to keep in mind are:

- ❑ Construction projects for wildlife are site specific, and their potential effectiveness needs to be assessed on a case-by-case basis, including up-front and long term maintenance costs.
- ❑ No one-size-fits-all solution exists for wildlife crossing structures; species prefer and adjust differently to various types of structures.
- ❑ Structures, such as fencing and culverts, need regular maintenance to be effective over time.
- ❑ Though some large wildlife crossing structures can be quite expensive, the most effective mitigation measure need not be the most expensive nor the most difficult to achieve.
- ❑ It's more economical to plan wildlife-friendly roadway expansion or major upgrade projects ahead of time than to retrofit an existing roadway.
- ❑ Ongoing resurfacing, bridge and culvert maintenance, and reconstruction often provide excellent cost-effective opportunities to mitigate for wildlife passage.

Crossing structures include directed fencing (barriers), signage, noise barriers, underpasses (small and large), and overpasses. The following illustrations from the United States Department of Agriculture Forest Service's Wildlife Crossings Toolkit show some of the common types and sizes of wildlife passage structures. For more information about wildlife crossing structures, visit www.wildlifecrossings.info.

FENCING

Fencing keeps animals—from deer and moose to frogs and turtles—off roadways while guiding them to designated crossing structures (see “Wildlife Underpasses”). Fencing, when combined with crossing structures such as overpasses or underpasses and escape ramps, is very effective in keeping

wildlife off roadways and providing habitat connections. For deer, fences are typically 7 to 10 feet high with fine mesh on the bottom 1 1/2 to 3 1/2 feet to prevent small animals from getting through. The fence may be buried 8-16 inches to prevent animals from digging under, or folded into an “L” shape that extends away from the base of the fence. Gaps or holes in the fence over 13 inches are enough for deer to get through.

Extensive fencing to keep deer and moose off controlled-access highways can be costly and must be used with escape ramps to allow animals to get out of the right-of-way areas alongside roads. Fencing does not work to keep large animals off urban or rural roads with numerous driveways.



Wildlife Overpass or Green Bridge

WILDLIFE OVERPASSES

A wide range of animals, from insects to large mammals including deer, use wildlife overpasses, or “green bridges,” that range in width from 66 to 1,000 feet (most are 98-164 feet). They are designed to resemble natural habitat, with native vegetation and in some cases even small ponds. These are most successful when combined with fencing to keep animals off the road and landscaping around the entrance to provide cover for approaching wildlife. Cost for these structures may be well over \$1 million. Two wildlife overpasses are being used successfully over the Trans-Canada Highway in Banff National Park. Wildlife passageways and fencing have reduced wildlife and vehicle collisions by more than 80 percent. Moose, deer, bears, snowshoe hare, marten, and other wildlife use these overpasses. For more details go to the Trans-Canada Highway Twinning Banff National Park of Canada web site, www.pc.go.ca/pn-np/ab/banff/docs/routes.

WILDLIFE UNDERPASSES

Many designs of small passages allow amphibians, reptiles, and small mammals to cross underneath roads. Dry tunnels two feet wide that are designed primarily for small and medium-size

mammals work well and are inexpensive. Culverts designed for amphibians range from 1 to 3 1/3 feet wide to up to 66 feet long. Concrete tunnels with earthen floors are most effective. Trenches, fencing, or curbs can direct animals to the underpass.

Waterway culverts with raised, dry ledges can help animals move along the waterway. These structures may be up to four feet wide and have ledges 1 1/2 feet wide. When replacing a culvert, use an arch shape or consider a span instead of a culvert to include some of the stream bank. Stream simulation is a new approach to culvert design to allow passage of fish and other aquatic animals and which can also be adapted to accommodate terrestrial wildlife. This method avoids constricting the stream channel and maintains the continuity of the stream bottom and hydrolic conditions by construction of a streambed within the culvert.

Large passages range from 6 1/2 to 16 feet wide for most large culverts to more than 330 feet for extended bridges or viaducts. Culvert passages may be made of metal or concrete, be bottomless (having a natural bottom) or continuous, and may be box, circular, arch, or elliptical in shape. Rocks, stumps, and plants may need to be added near the entrance to provide cover for animals moving through the underpass. Many species will use these large passages, including bear, bobcat, and moose. Deer tend to prefer passages that are at least 20 feet wide and 8 feet high with vegetation for cover nearby. The amount of light visible due to the width, height, and length of the tunnel (referred to as “openness ratio”) determines whether animals are willing to use the underpass.

When wildlife crossing modifications are added to bridge construction projects over water, costs can be a small percentage of the overall project budget, starting from \$200,000. However, costs can range to over \$1 million for wildlife underpass bridges over land. The cost of strategically placed underpasses can be more than matched by the savings from reducing vehicle collisions and loss of human life.¹⁹

DRIVER WARNINGS

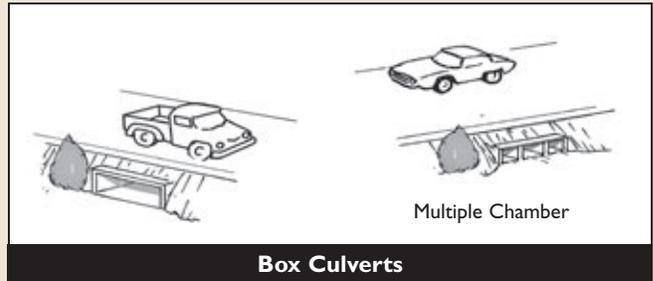
Traditional warning signs, like “Moose Crossing Next 3 Miles,” have had limited success preventing collisions with deer and moose. This is unfortunate since slower speeds in areas with high rates of collisions would result in significantly fewer collisions.²⁰ However, dynamic message signs (electronic signs with changing messages) with wildlife advisory messages are showing promise in reducing motorist speed, particularly at night. Turtle crossing signs are being tested in areas around Maine’s Mount Agamenticus with high concentrations of endangered Blanding’s and threatened spotted turtles.

NOISE BARRIERS

Vegetated earthen berms along roads bordering fields, wetlands, on overpasses, and above underpasses reduce highway noises disturbing to wildlife. They should be used

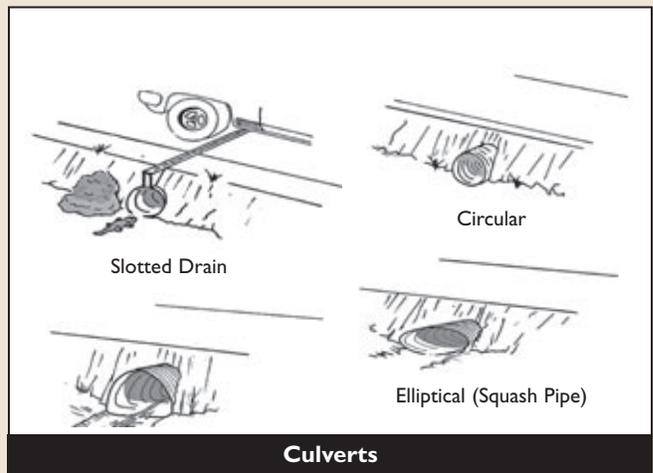


Wildlife Underpass Bridge



Multiple Chamber

Box Culverts

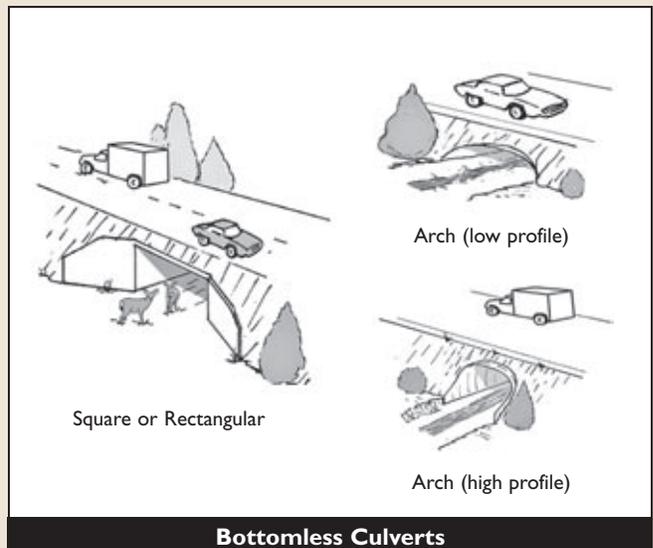


Slotted Drain

Circular

Elliptical (Squash Pipe)

Culverts



Square or Rectangular

Arch (low profile)

Arch (high profile)

Bottomless Culverts

judiciously to make sure they do not cause or exacerbate habitat fragmentation. Trees are natural noise barriers and should be left where they occur next to roads.