

Right of Way

GIVING ANIMALS SAFE PASSAGE ACROSS ROADWAYS

By Patricia Cramer, Ph.D., and Shauna Leavitt



Credit: Donna Barry

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Credit: Mary Ann Lowe

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Wildlife has typically been the loser when it comes to roads. By some estimates, there are more than 1.5 million wildlife-vehicle collisions (WVCs) each year in the United States. In Canada four to eight large animal collisions occur each hour, according to the British Columbia Conservation Foundation. Such incidents have risen as highways have spread, with fatal consequences for both humans and animals. The Highway Loss Data Institute reported 223 human WVC fatalities in 2007 in the U.S., double the number that occurred in 1992.

Wildlife biologists around the world are increasingly concerned about how roads, fences, walls, and other “linear infrastructure” are fragmenting habitats to the detriment of wildlife. To address the issue and discuss solutions, the Environment Institute of Australia and New Zealand hosted a symposium in May of this year titled “[Breaking the Barriers: Engineering Solutions to Ecological Problems](#).” More than 200 experts from four nations gathered to discuss the latest research, strategies, and structures designed to minimize wildlife-vehicle collisions. “It is imperative that study results and practices that are both successful and unsuccessful are communicated as quickly and effectively as possible,” says John Bissonette, a keynote speaker at the event and head of the U.S. Geological Survey’s Utah Cooperative Fish & Wildlife Research Unit.

The need for safe wildlife crossings has grown steadily since 1956, when the signing of the U.S. [Federal-Aid Highway Act](#) launched the interstate

highway system, a boon to commerce but a lethal gauntlet for wildlife. The U.S. built its first wildlife crossing in the early 1970s, with Canada closely following, particularly in its national parks (see box, page 58). Throughout North America there are now more than 700 terrestrial crossings and thousands of aquatic crossings—a vast improvement for wildlife, but still insufficient to help animals navigate the spreading tangle of roads.

Assessing the Options

Given the age of our highway infrastructure, thousands of bridges and culverts will need to be replaced in the next decade. This presents an opportunity to create new, more-permeable structures that allow wildlife to pass unimpeded. The challenge for highway engineers and wildlife managers is to assess the scientific data and choose among crossing structures that vary widely in form and function (see sidebar, page 59), from simple rope ladders over roads to expansive vegetated overpasses for migratory herds. Among the options:

Overpasses. These structures allow wildlife to move unimpeded over the flow of traffic. They’re typically designed with natural soil and vegetation planted on bridges over highways, or as soil pathways running over the tops of highway tunnels. Favored by elk, bighorn sheep, and other large mammals, overpasses tend to be chosen as a mitigation approach in migratory corridors and national parks, where the wildlife species and their perceived value are high enough to warrant the cost.

Crossing in Safety



River otter, Florida



Badgers, British Columbia



Porcupine, Montana



Bobcat, Florida



- **Advantages:** Built above the noise and sight of traffic, a vegetated overpass gives the appearance of a more contiguous landscape as wildlife approach the road. These structures have proven to work for a wide range of large animals, from prey species such as deer, elk, and moose, to predators such as grizzly bears.
- **Disadvantages:** The biggest drawback is the initial cost, which generally tops \$1 million and can reach \$4 million or more. Once the structure is completed, however, the maintenance costs tend to be relatively low. Concrete overpasses typically only require maintenance every 15 to 20 years, says Marcel Huijser, a research ecologist with the [Western Transportation Institute](#) in Bozeman, Montana.

Underpasses. Wildlife underpasses are structures built to allow wildlife to pass under the flow of traffic, typically designed as either bridges or culverts. Culvert underpasses may be box-like concrete structures, oval tunnels made of corrugated steel plates, or prefabricated arches pieced together. Most species, from bears and pumas to reptiles and fish, will use underpasses, though research shows that elk vastly prefer bridge underpasses rather than culverts. It's critical for smaller species and ungulates that the underpass has a natural floor. If the floor is concrete or metal, amphibians, for example, can dry out or absorb harsh chemicals from metals or runoff. In addition, hoofed animals show a distinct preference for natural walkways, even if they are below a running stream.

- **Advantages:** Typically underpasses can be integrated into transportation projects more easily than overpasses because they're easier and less costly to build, ranging from \$500,000 to \$1 million. They can be built in many types of

landscapes, and they're highly effective for a wide range of species (see photos below). A recent review of dozens of studies of underpasses across the U.S. and Canada shows that 74 out of 76 underpasses studied allowed successful passage for their target species (Cramer, unpublished data).

- **Disadvantages:** Species such as elk, pronghorn, and bighorn sheep consistently refuse to use culvert underpasses in much larger numbers than those that use them. Culvert length is a limiting factor. According to preliminary data from Utah State University, prey animals tend to avoid culverts longer than 180 feet. At one culvert of over 160 feet long, fully 34 percent of approaching mule deer "repelled," or turned away from the tunnel (Cramer, unpublished data). Conversely, passages of 120 feet or less had steady use, with repel rates of about 15 percent or less. Culverts with the highest deer use and close to a 0 percent repel rate were only 60 to 70 feet long. These data suggest that ungulates will instinctively avoid long, dark culverts, perhaps wary that a predator hides in the shadows.

Fencing. Though not a crossing structure per se, fencing excludes animals from entering roadways and often funnels them to safe crossings. It plays a crucial role because animals would rather use traditional routes than new, unfamiliar crossing structures. Fences that are at least eight feet high may extend along a highway for anywhere from 100 feet to several miles. One-way escape ramps along fencing systems also help improve effectiveness and reduce wildlife mortality ([Bissonette and Hammer 2000](#)).

- **Advantages:** Studies show that fencing increases the use of crossing structures. One study found that roadside fencing boosted elk use of crossings by 60 percent ([Dodd et al. 2007](#)).



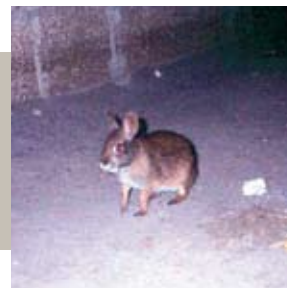
Black bear,
Florida



White-tailed deer,
Montana



Coyote,
Montana



Marsh rabbit,
Florida

Credits: River otter by Jamie Barichivich; Badgers by Steve Towers; Porcupine, white-tailed deer, and coyote by Kerry Foresman; Bobcat and black bear by Florida DOT; Florida marsh rabbit by Jamie Barichivich and Laura Smith



- **Disadvantages:** Fencing can prevent the daily, seasonal, and dispersal movements of animals, which can block their access to critical resources and thereby reduce the long-term viability of certain animals in a region ([Federal Highway Administration 2008](#)). Fencing therefore *must* be accompanied by wildlife crossings that allow the full spectrum of wildlife species and age classes

Banff Sets the Bar

For 25 years, Banff National Park in Canada has been the focus of innovative efforts to mitigate the wildlife impacts of the Trans-Canada Highway (TCH). Because of the varied types of wildlife crossing structures in Banff and extensive research about their effectiveness, Banff leads the world in highway mitigation, design criteria for wildlife crossings, and connectivity studies for wide-ranging animals at a landscape scale.

As a researcher with the Western Transportation Institute at Montana State University, I've been conducting studies of Banff's roadway mitigation efforts for more than 13 years. To date I've documented 11 species of large mammals using 23 wildlife crossings more than 185,000 times, including grizzly and black bears, wolves, lynx, cougars, wolverine, moose, elk, and bighorn sheep. Banff's crossing structures, as well as extensive fencing along the TCH, have proven highly successful, cutting overall large-mammal vehicle collisions by more than 80 percent ([Clevenger et al. 2009](#)).

New DNA-based research on hair samples snagged at Banff's 23 crossings will help reveal the link between highway mitigation, gene flow, and population viability. This and other ongoing research about the performance of Banff's mitigation efforts has trans-boundary significance, providing agencies in both the U.S. and Canada with science-based data to make informed decisions about future mitigation planning.

– By Tony Clevenger, Ph.D., Senior Research Scientist, Western Transportation Institute, Montana State University

to move unimpeded to food, water, mates, and safety resources. Otherwise, local populations may become extirpated.

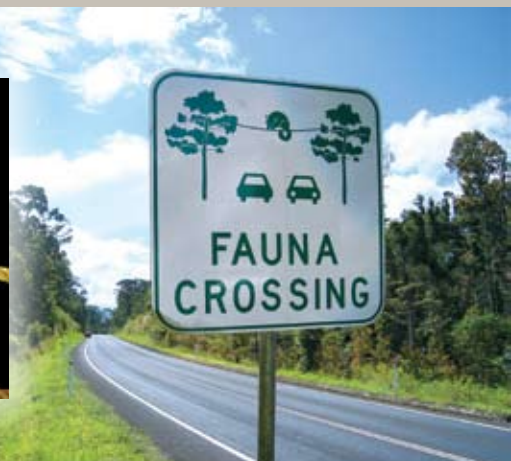
Detection Systems. These are the newest tools to help prevent wildlife-vehicle collisions. Detection devices sense that large animals such as elk are on or near a road, and then activate electronic signs that warn oncoming drivers. “Area-cover” sensors use microwave radar to detect large animals within a quarter of a mile, while “break-the-beam” sensors detect animals that break a signal between a transmitter and receiver. Detectors are now being used in states such as Idaho, Wyoming, Arizona, and Washington, typically along rural two-lane roads.

- **Advantages:** Detection systems can be located where hundreds of deer or elk are known to move across a road annually, either in natural patterns or at the end of wildlife fencing. They also have a relatively low initial cost averaging about \$65,000 per mile for a stand-alone system along both sides of a road. Research shows that detection systems are effective at cutting vehicle collisions with large mammals by anywhere from 50 to 91 percent ([Huijser and Kociolek 2008](#)).
- **Disadvantages:** Ongoing maintenance costs can be high, and the payoff is uncertain. A study in Wyoming found that drivers slowed down with a warning system, but only by an average of five miles per hour. Drivers should be traveling 45 mph or less to control vehicles enough to avoid a crash, yet drivers in the detection-system zones clocked in at over 60 mph ([Gordon et al.](#)

A sign along the Palmerston Highway in North Queensland, Australia, indicates the beginning of a series of rope crossings that allow a safe route for arboreal rainforest mammals such as the lemuroid ringtail possum (*Hemibelideus lemuroides*).



Courtesy of Nigel Weston, James Cook University



Credit: David Francis



Structured for Safety

Across North America and around the world, nations are devising overpasses, underpasses, fencing corridors, and other means to provide safe highway crossings for wildlife and to warn drivers to use caution. Here is a sampling of some of the most-effective options.



Credit: Kari Gunson

Vegetated overpass. In Canada's Banff National Park, wide overpasses planted with natural vegetation allow ungulate herds, wolverines, and many other species to safely cross the Trans-Canada Highway.



Credit: Patricia Cramer

Open median. Two underpasses flanking a broad, fenced median along Utah's I-15 enable mule deer and other animals to safely navigate under one of the state's busiest corridors.



Credit: Patricia Cramer

Bridge underpass. Near Missoula, Montana, white-tailed deer explore a new bridge underpass. It's one of more than 55 wildlife crossings along Montana's U.S. 93, North America's most-mitigated road for wildlife.



Credit: Patricia Cramer

Culvert underpass. A bull moose emerges from a culvert underpass that runs below U.S. 89-91 near Logan, Utah. Natural flooring makes such culverts far more inviting for animals large and small.



Credit: Patricia Cramer

Fences. Metal fencing helps funnel mule deer safely across Utah's I-15 overpass, North America's first wildlife overpass, built in 1975. Fences exclude wildlife from roadways and guide them toward crossings.



Credit: David Bryson, Electrobraid

Detection devices. When large animals such as elk or deer trigger this solar-powered detection system along a wildlife crossing area near Payson, Arizona, flashing lights warn motorists to slow down and use caution.



2004). Finally, detection devices only spot larger animals, so smaller species such as raccoons or bobcats are still at risk.

Tapping Expert Advice

To plan and construct any wildlife mitigation project, highway engineers and wildlife managers need scientific data about effective crossings. Fortunately, government agencies and others have been investing in programs to share wildlife-mitigation research, and these efforts have given rise to several recent reports that offer guidance on how to select, construct, and evaluate crossing structures.

In 2008, for example, the U.S. Federal Highway Administration (FHWA) published the “[Wildlife Vehicle Collision Reduction Study](#),” a comprehensive best-practices manual that offers practical guidance on how to plan large-scale regional projects, set mitigation priorities, assess mortality hot spots, create site-specific crossing designs, monitor results, and find funding. Photographs and construction drawings illustrate various crossing

structures, explain installation, and suggest what’s suitable for different species, making this a vital hands-on guide.

Also in 2008, the National Cooperative Highway Research Program (NCHRP) published the results of a three-year study titled “[Evaluation of the Use and Effectiveness of Wildlife Crossings](#),” which offers start-to-finish guidelines for the selection, configuration, location, evaluation, monitoring, and maintenance of wildlife crossings. Among its findings:

- Bigger is usually better. Elk appear to require larger openings than most other mammals. Ungulates tend to prefer overpasses while certain carnivores prefer underpasses, and deer in urban or suburban settings use structures that are far smaller than those used by ungulates in more natural landscapes.
- In underpasses, small mammals may need cover in the form of logs, rocks, and bushes; pronghorn need open, natural conditions; and fish, especially juveniles, need culverts that do not rise more than two body lengths above natural water levels, with culvert bottoms approximating natural riverine conditions.
- Passages need to be seen by wildlife as they approach. Passage placement in a straight line of sight works better than those placements below or above the approach levels.
- Researchers should monitor a new passage for at least three years after construction. Wildlife often take at least two years to adapt, especially if they use the area only for seasonal migration.

Spawned by the NCHRP project, the “[Wildlife and Roads](#)” website offers a valuable online decision guide with numerous links, GIS tools, and details about how stakeholders can plan and create wildlife crossings. By using such tools, and by working with local wildlife biologists at every step of the process, highway planners can create roads that are safer for motorists and more permeable for wildlife across ecosystems. ■

This article has been reviewed by subject-matter experts.



To see a gallery of additional photos, and to link to videos from the “Breaking the Barriers” symposium, go to www.wildlife.org.

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