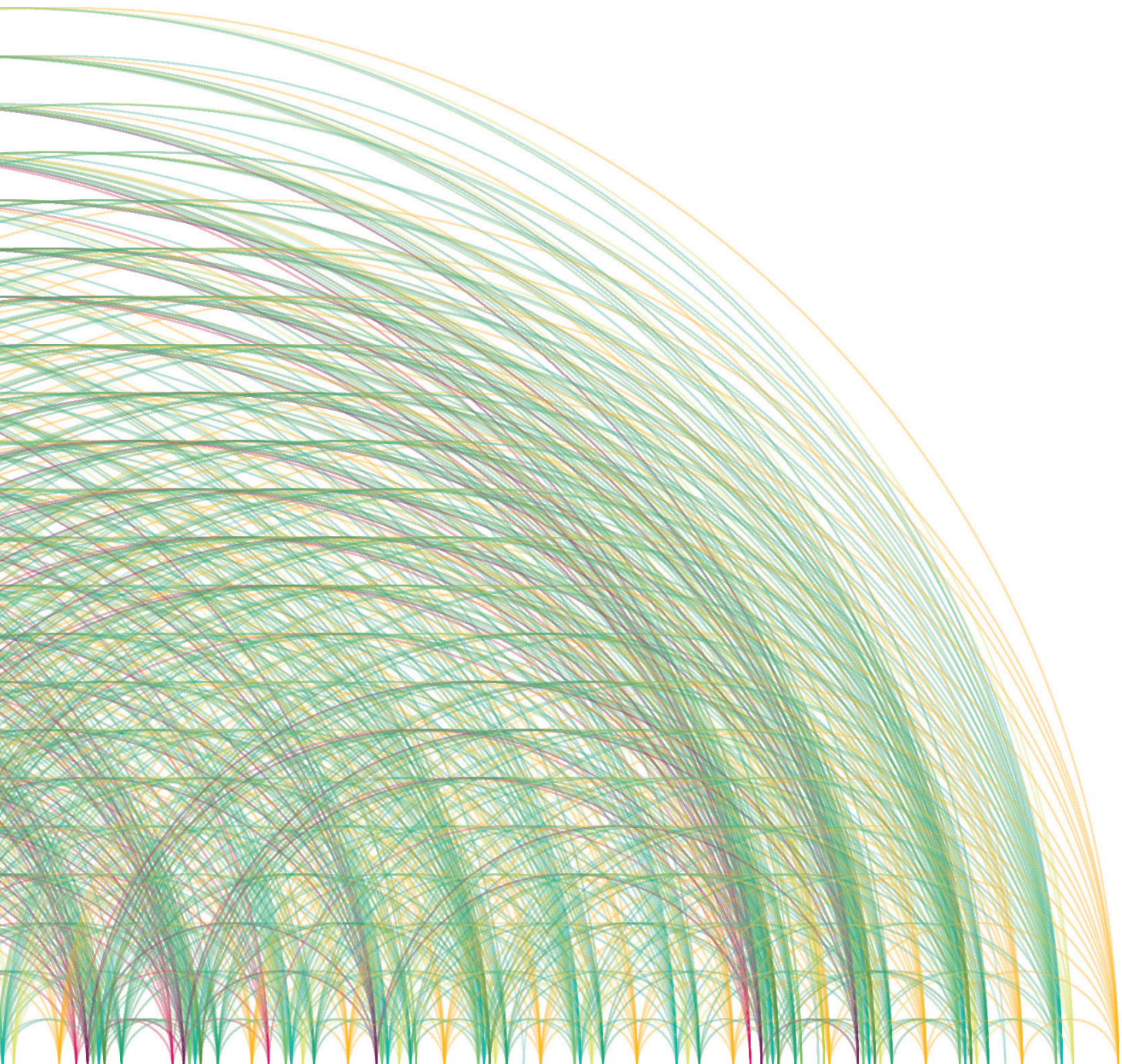


ARC  
SPECIAL PUBLICATION

**HIGHWAY CROSSING STRUCTURES FOR WILDLIFE:  
Benefits of a National Commitment to  
Increase Driver and Animal Safety**







For many years, transportation planners and wildlife biologists have sought effective solutions to address wildlife-vehicle collisions (WVCs) and the barrier effect of highways on wildlife movement.

Developed collaboratively by a team of engineers, ecologists, biologists, landscape architects and policy experts, this booklet summarizes the benefits and challenges to investing effort and funding to support a nationwide commitment to a systematic network of wildlife crossing structures to increase driver and animal safety.



# The high cost of wildlife-vehicle collisions

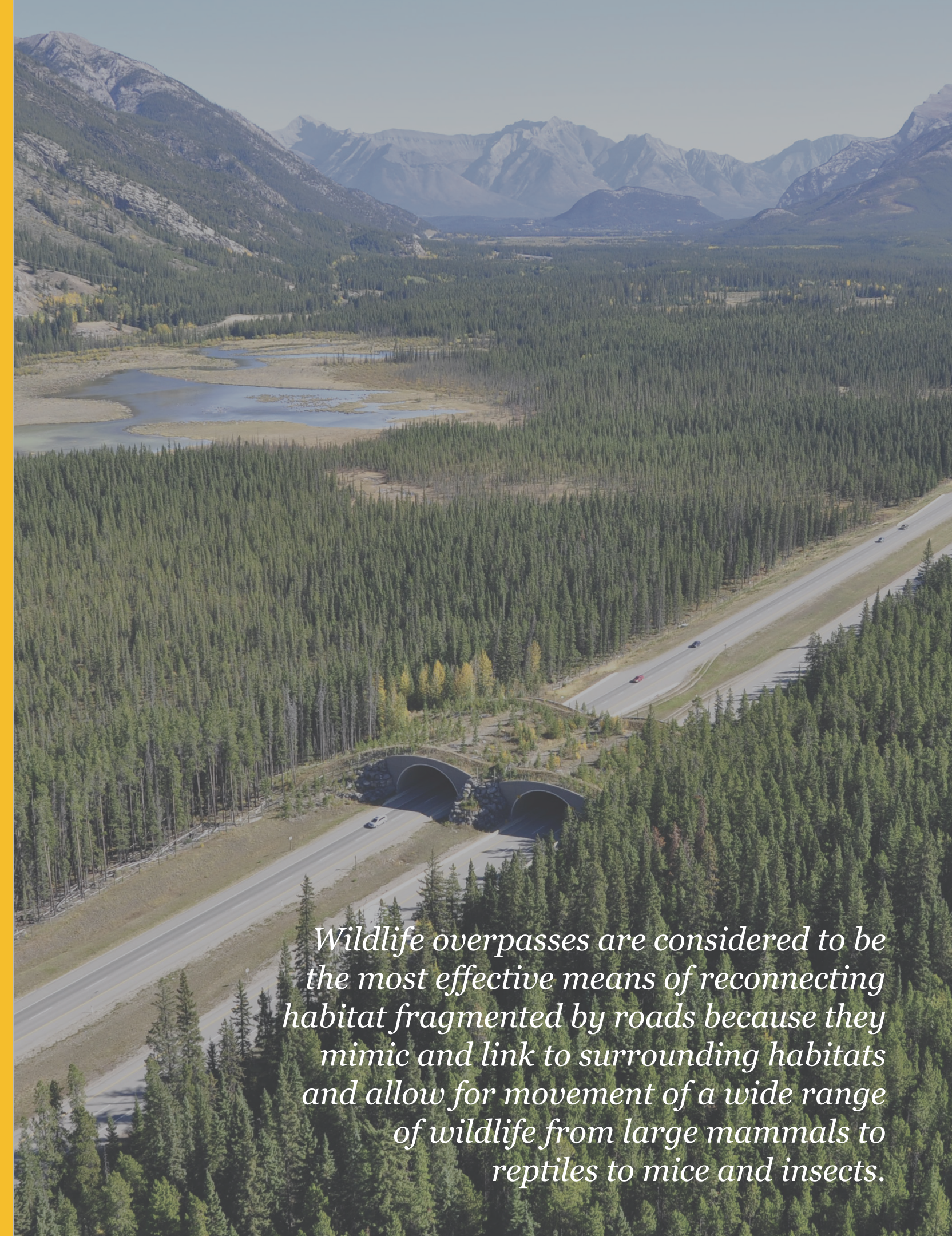
A quick glance at a United States road map reminds us that it is an amazing example of engineered infrastructure. A source of American pride, this network stretches more than 4,000,000 miles and allows us to transport ourselves and our goods to sustain our collective way of life. While an asset overall, roadways present a safety issue for drivers and are a major source of disruption for native wildlife, as evidenced by the estimated 1-2 million collisions that occur each year between motorists and large wildlife in the U.S. These collisions result in more than 26,000 human injuries and over 200 human deaths, at an annual cost to Americans of \$8 billion.<sup>†</sup> In addition to the human toll and the millions of animals that die each year in collisions with vehicles, millions more are prevented from accessing important parts of their habitat, jeopardizing our rich wildlife heritage.

Yet we know there are cost-effective solutions to this problem. Indeed, where the costs expended for mitigation are less than or equal to the expenses incurred due to the average costs of wildlife-vehicle collisions (WVCs) at a particular site, investing in well planned crossing structures can result in a cost savings to society.

## What is a wildlife crossing structure?

The term wildlife crossing structure describes a variety of structures that are designed or retrofitted to provide safe passage for wildlife above or below a highway (*Fig. 6*). Although wildlife crossing structures are not standardized designs, they can be categorized as two major types: overpasses and underpasses. Structures are usually built in combination with fencing to increase their effectiveness.

Each crossing is designed to serve the target species for a specific location or to accommodate the majority of species in an area. Wildlife crossing structures also may be designed from a motorist safety standpoint for target species, such as large ungulates like moose, elk, or deer, or for species with the highest conservation concern.



*Wildlife overpasses are considered to be the most effective means of reconnecting habitat fragmented by roads because they mimic and link to surrounding habitats and allow for movement of a wide range of wildlife from large mammals to reptiles to mice and insects.*

<sup>†</sup> Huijser, M.P., P. McGowen, J. Fuller, A. Hardy, A. Kociolek, A.P. Clevenger, D. Smith & R. Ament. (2008). Wildlife-vehicle collision reduction study. Report to Congress. No. FHWA-HRT-08-034. U.S. Department of Transportation, Federal Highway Administration, Washington D.C., U.S., [online] URL: <http://www.fhwa.dot.gov/publications/research/safety/08034/index.cfm>

Huijser, M.P., J. W. Duffield, A.P. Clevenger, R.J. Ament and P.T. McGowen. (2009). Cost-benefit analyses of mitigation measures aimed at reducing collisions with large ungulates in North America; a decision support tool. *Ecology and Society* 14(2): 15. [online] URL: [www.ecologyandsociety.org/vol14/iss2/art15/ES-2009-3000.pdf](http://www.ecologyandsociety.org/vol14/iss2/art15/ES-2009-3000.pdf)



# Do wildlife crossing structures work and how do they benefit people?

Wildlife crossing structures have a proven track record of promoting safe passage for wildlife across highways in North America. Whenever an animal uses a wildlife crossing structure to cross the highway, it eliminates the possibility of being hit by a vehicle.

Wildlife crossing structures generate a variety of benefits including:

**Increased motorist safety:** Unlike many large-scale problems facing society today, there are proven solutions to reduce WVCs and reweave our native habitats. Wildlife crossing structures designed or retrofitted to provide safe passage for wildlife above (overpasses) or below (underpasses) a roadway, coupled with fencing, have been shown to reduce WVCs by up to 97%.<sup>†</sup>

**Monetary savings:** Wildlife crossing structures reduce wildlife-vehicle collisions, thus effectively lowering the many costs to society. Where the total economic costs associated with WVCs along a given highway segment exceed the expense of building a wildlife crossing structure to allow animals to safely cross the road, it actually costs society less to solve the problem of WVCs than it costs to do nothing.<sup>†</sup>

**Connected habitats:** Wildlife crossing structures and fencing can greatly lessen the impact of traffic and provide linkages across highways to facilitate wildlife movement to ensure stable local and regional wildlife populations for a wide range of species (*Fig. 2*).

**Wildlife protection:** With 1-2 million large wild animals killed by vehicles every year, wildlife mortality can significantly impact populations and jeopardize long-term population persistence, especially for threatened and endangered species. By physically separating wildlife from traffic, crossing structures protect individual wild animals from death or injury.

**Genetically viable wildlife populations:** Highways can act as barriers that isolate wildlife populations and alter gene flow and diversity. A system of wildlife crossing structures can allow individual animals to disperse and mate with individuals in other populations, thereby promoting genetic diversity needed for maintaining genetically viable populations.

**Resiliency to climate change:** With changing climatic patterns and increasingly frequent extreme weather events that wreak havoc on transportation infrastructure, especially drainage structures, wildlife crossing structures can help increase resiliency.

**Social values:** Promoting safer highways can create a sense of motorist well-being and lessened worry when driving. When surveyed, the public repeatedly has placed an intrinsic value on public investments where our natural resources are protected and preserved, especially in the context of creating environmentally sensitive transportation improvements that meet the dual needs of safe highways and wildlife passage.

<sup>†</sup> Huijser, M.P., J. W. Duffield, A.P. Clevenger, R.J. Ament and P.T. McGowen (2009). Cost-benefit analyses of mitigation measures aimed at reducing collisions with large ungulates in North America; a decision support tool. *Ecology and Society* 14(2): 15. [www.ecologyandsociety.org/vol14/iss2/art15/ES-2009-3000.pdf](http://www.ecologyandsociety.org/vol14/iss2/art15/ES-2009-3000.pdf)



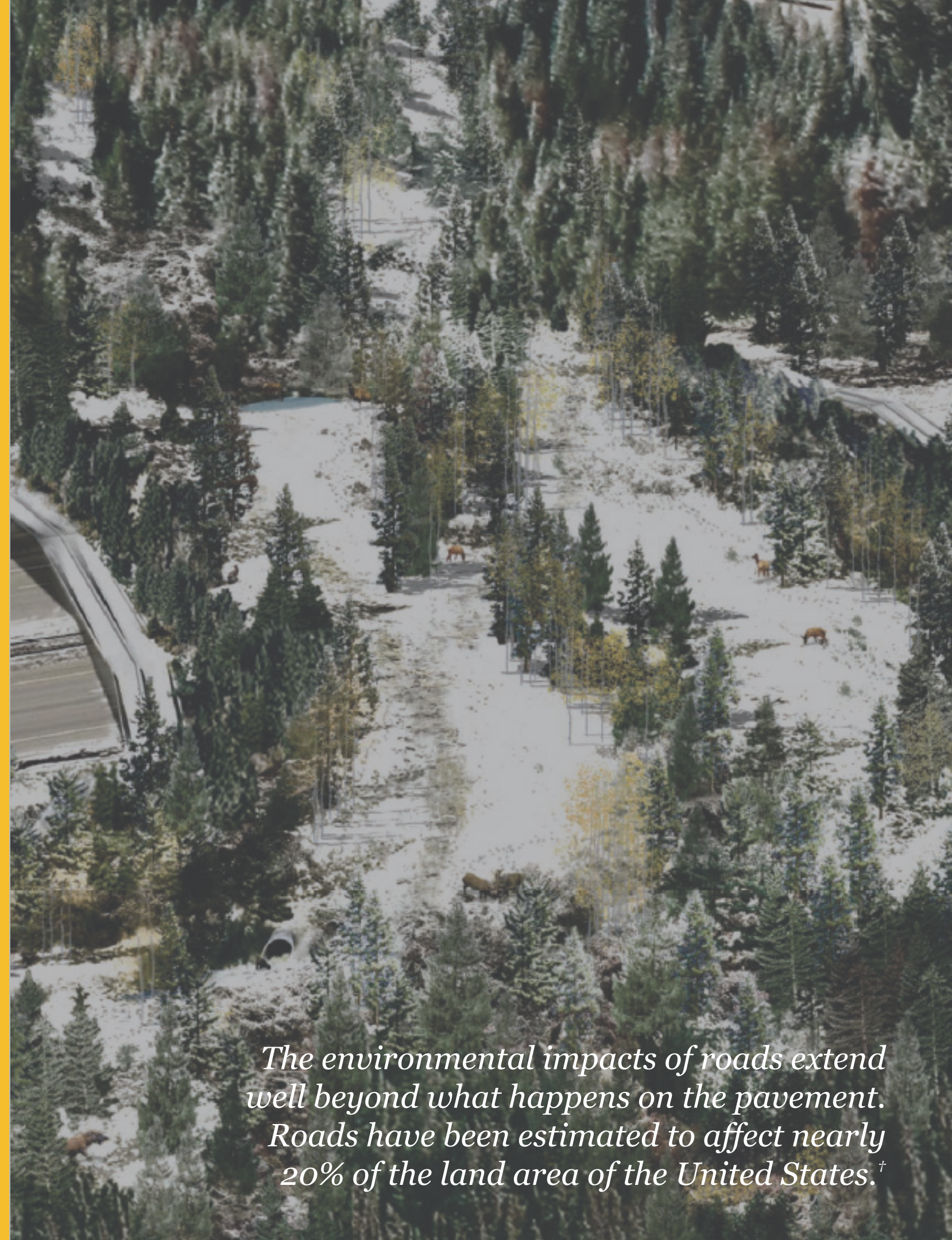


# What type of wildlife crossing structure is best?

It depends! The two main objectives of most, if not all, wildlife crossing mitigation efforts are to: (1) reduce vehicle collisions leading to human deaths and injuries, property damage and wildlife mortality and (2) connect habitats for wildlife populations. That said, no two projects have exactly the same mitigation needs. Each project has its own unique set of components – different wildlife species, landscape, management objectives and politics – specific to that locale; hence, there is no standardized solution.

Despite being a relatively new field of applied science, two decades of research reveal some consistent findings:

- Wildlife crossing structure design, size, and placement influence how different species respond to structures.
- Some species prefer large, open structures, while others prefer more constricted structures with less light.
- Wildlife crossing structures designed for multiple species maximize biodiversity conservation.
- Because animals often exhibit a “learning curve” of several years to find and habituate to wildlife crossings, performance evaluations need to be longer term to reliably assess effectiveness.
- Land management surrounding wildlife crossings is a key factor in determining their effectiveness; therefore, coordination in the short- and long-term between transportation agencies and adjacent land managers or owners is essential.
- Fencing keeps animals off the highway and directs them to structures, enhancing the effectiveness of wildlife crossing structures. In contrast, fencing alone (without crossing structures) creates a barrier that can keep animals away from important habitat areas.



*The environmental impacts of roads extend well beyond what happens on the pavement. Roads have been estimated to affect nearly 20% of the land area of the United States.<sup>†</sup>*



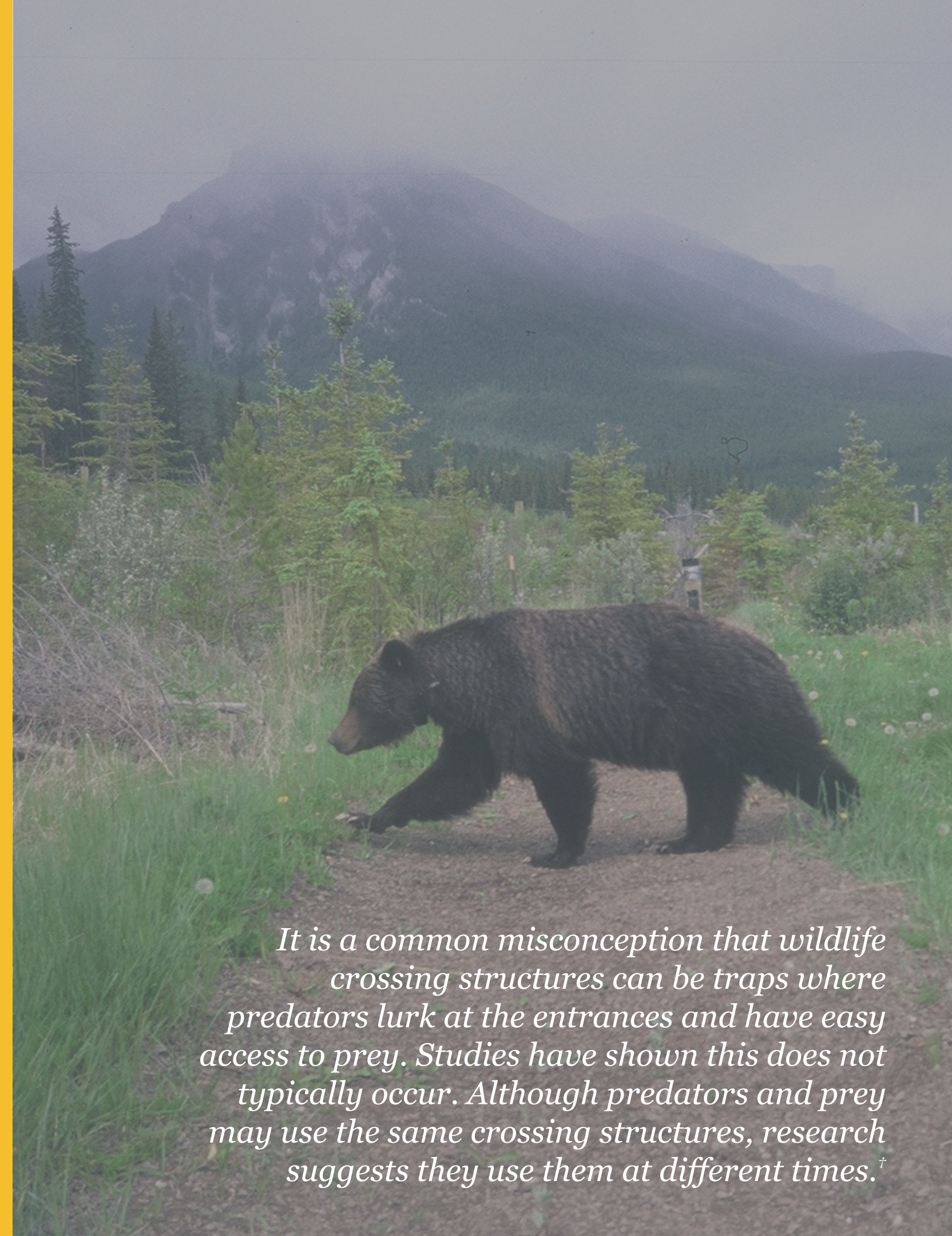
# Is there existing support for wildlife crossings?

Current U.S. transportation law provides explicit authority for federal, state, municipal and tribal managers to reduce the number of motorist collisions with wildlife and ensure connectivity among habitats disrupted by roads. It also requires state and metropolitan long-range transportation plans to address potential environmental mitigation and permits planners to develop programmatic mitigation plans at various scales encompassing multiple resources, such as wildlife habitat or aquatic resources.

Specifically, the following federal transportation programs permit managers to use program dollars to fund eligible wildlife-related mitigation, including the construction of wildlife crossing structures:

- Surface Transportation Block Grant Program (23 U.S.C. § 133).
- Highway Safety Improvement Program (23 U.S.C. § 148).
- Tribal and Federal Lands Transportation Programs (23 U.S.C. §§ 201-203).
- Federal Lands Access Program (23 U.S.C. § 204).

Although these statutory provisions may be used to support the construction of wildlife crossing structures, they do not require it. To be effective, wildlife crossing structures and fencing cannot be haphazardly or inexpertly placed. Planning and prioritization are essential to focus limited resources on locations exhibiting the highest collision risk and conservation priority. By prioritizing conservation improvements as early as possible using data-based planning, state transportation agencies can more effectively address state and regional conservation needs in the short- and long-term.



*It is a common misconception that wildlife crossing structures can be traps where predators lurk at the entrances and have easy access to prey. Studies have shown this does not typically occur. Although predators and prey may use the same crossing structures, research suggests they use them at different times.<sup>†</sup>*

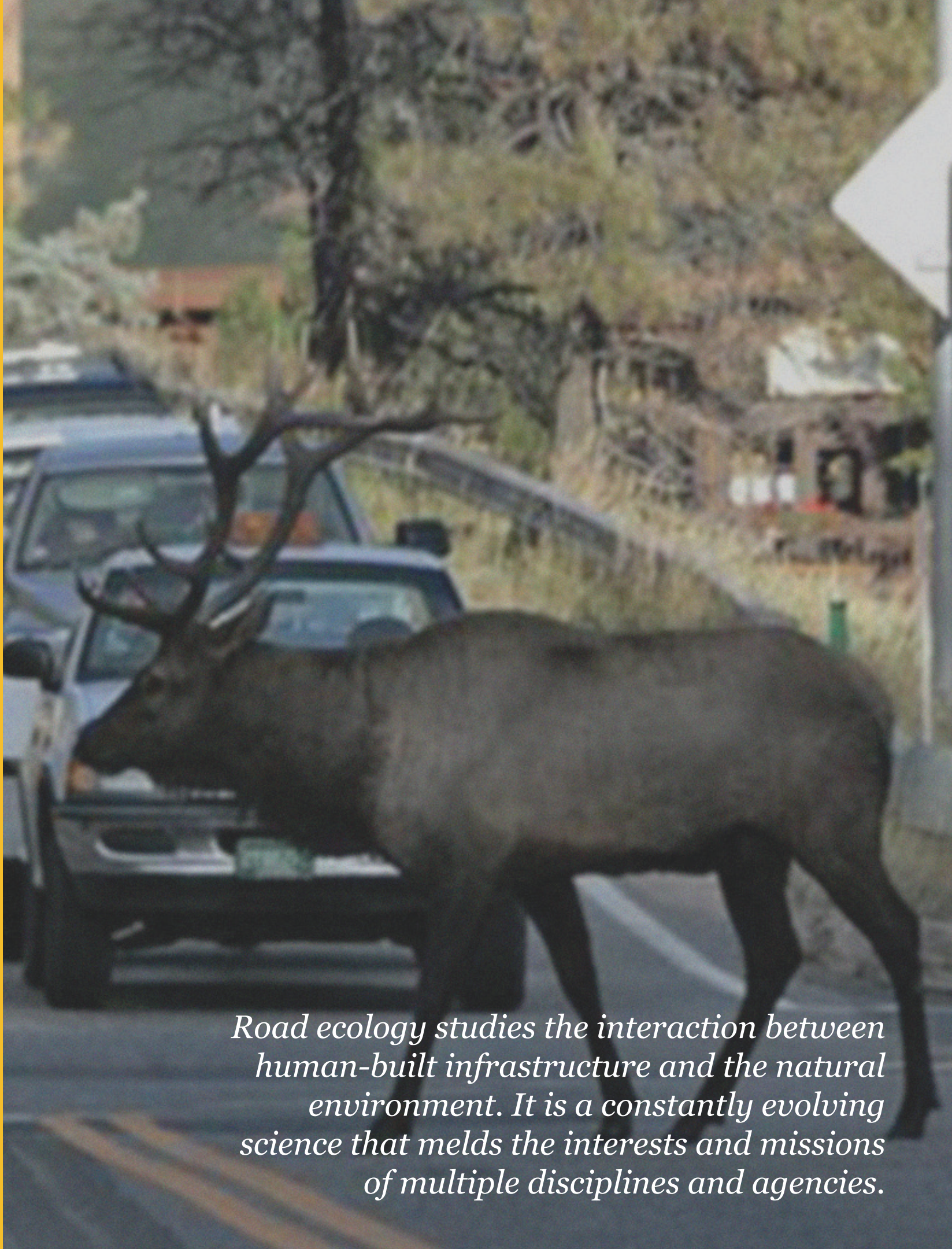


# What are the challenges to transforming the U.S. road network?

A systematic approach to mitigating wildlife impacts from highways is challenging because no single agency is responsible for sustaining the movement of animals across the landscape, and most especially across multiple jurisdictions and land ownerships. Key challenges to implementing a systematic approach to wildlife mitigation include:

- Federal and state transportation and land management agencies have missions, approaches and priorities that may not overlap.
- Long-range transportation plans generally do not include wildlife mitigation or crossing provisions.
- Federal and state natural resource agencies are often too resource or time-constrained to effectively participate in early coordination with transportation agencies.
- Timelines vary greatly among agencies and schedules for planning, projects and funding are often misaligned, such that mitigation opportunities are missed.
- While federal funds can pay for the construction of wildlife crossing structures, states bear the cost burden of maintenance.
- Agencies are not required to integrate mitigation to maintain or improve wildlife connectivity, except for certain wildlife or fish species listed under the federal Endangered Species Act.

In the face of these challenges, the most successful projects have resulted from partnerships among agencies, non-governmental organizations, and other stakeholders using interdisciplinary principles of engineering, ecology and design (*Fig. 3*).



*Road ecology studies the interaction between human-built infrastructure and the natural environment. It is a constantly evolving science that melds the interests and missions of multiple disciplines and agencies.*



# How can we enhance support for wildlife crossing structures?

In addition to existing support for wildlife crossing structures, there are a variety of other policy and funding improvements and activities that could further enhance motorist safety, reduce wildlife mortality and conserve habitat connections, including:

**Develop a standardized methodology for collecting and reporting wildlife-vehicle collision and carcass data and ensure public access to that data.** Improving the consistency, precision and transparency of data collection on wildlife-vehicle collisions can help transportation agencies establish performance metrics to ensure that funds are utilized effectively.

**Provide technical assistance and peer learning opportunities, including programs to work with and increase capacity for transportation agencies and local governments.** Technical assistance is a relatively low-cost activity that would allow practitioners to learn best practices, establish relationships, and identify new funding sources.

**Consider novel mechanisms to fund the costs of constructing wildlife crossing structures.** Having a highway wildlife program with funding at a level that allows transportation agencies to adequately address and reduce wildlife-vehicle collisions while providing for connectivity would appear to be a prudent and rationale investment of public funds.

**Enhance agency flexibility and access to funding for wildlife-highway conflicts.** For example, including an inflationary adjustment for public lands funding will enable land managers to better meet their agency missions and reduce the effect of roads on wildlife.

**Consider developing a demonstration program to prioritize and fund high-profile wildlife mitigation infrastructure projects across the U.S.** Funding for demonstration projects – with a preference for one project per state – could be added to existing federal and tribal transportation programs (*Fig. 4 & 5*)

**Develop guidelines to identify and prioritize wildlife mitigation projects.** Guidelines would further articulate the criteria for prioritizing problematic wildlife-vehicle collision areas, key wildlife habitat corridors and other important locations for wildlife mitigation.

**Encourage all jurisdictional levels of transportation agencies to manage for wildlife connectivity across highways.** Because the U.S. road network is so extensive, both small- and large-scale connectivity projects are needed to maintain or restore wildlife movement, and multiple small projects add up to large benefits to moving wildlife.

**Coordinate a common path forward among U.S. agencies.** By providing direction and offering creative and inspired guidance, top ranking agency officials can aid in aligning goals and objectives of the many agencies involved in transportation planning and projects.

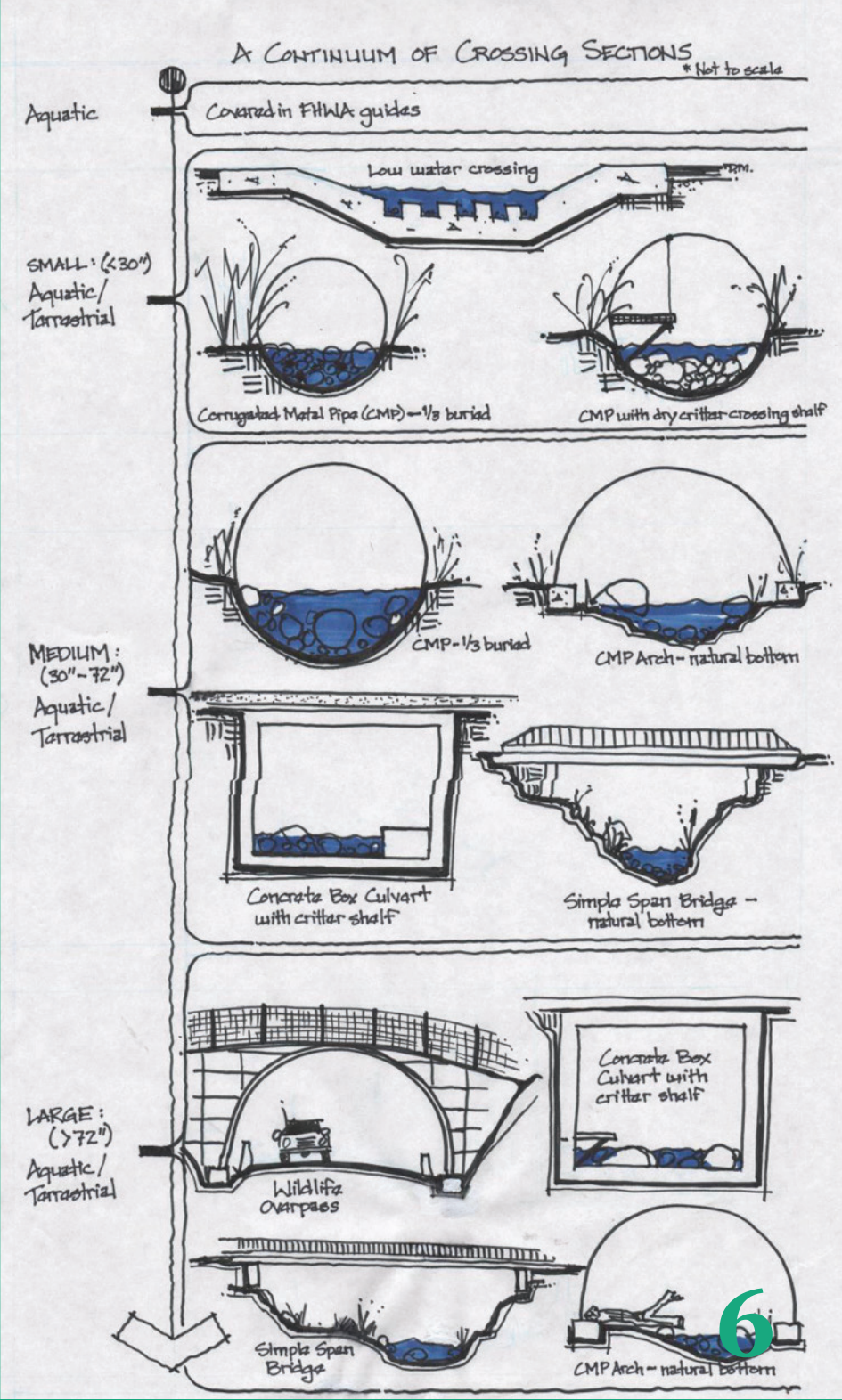
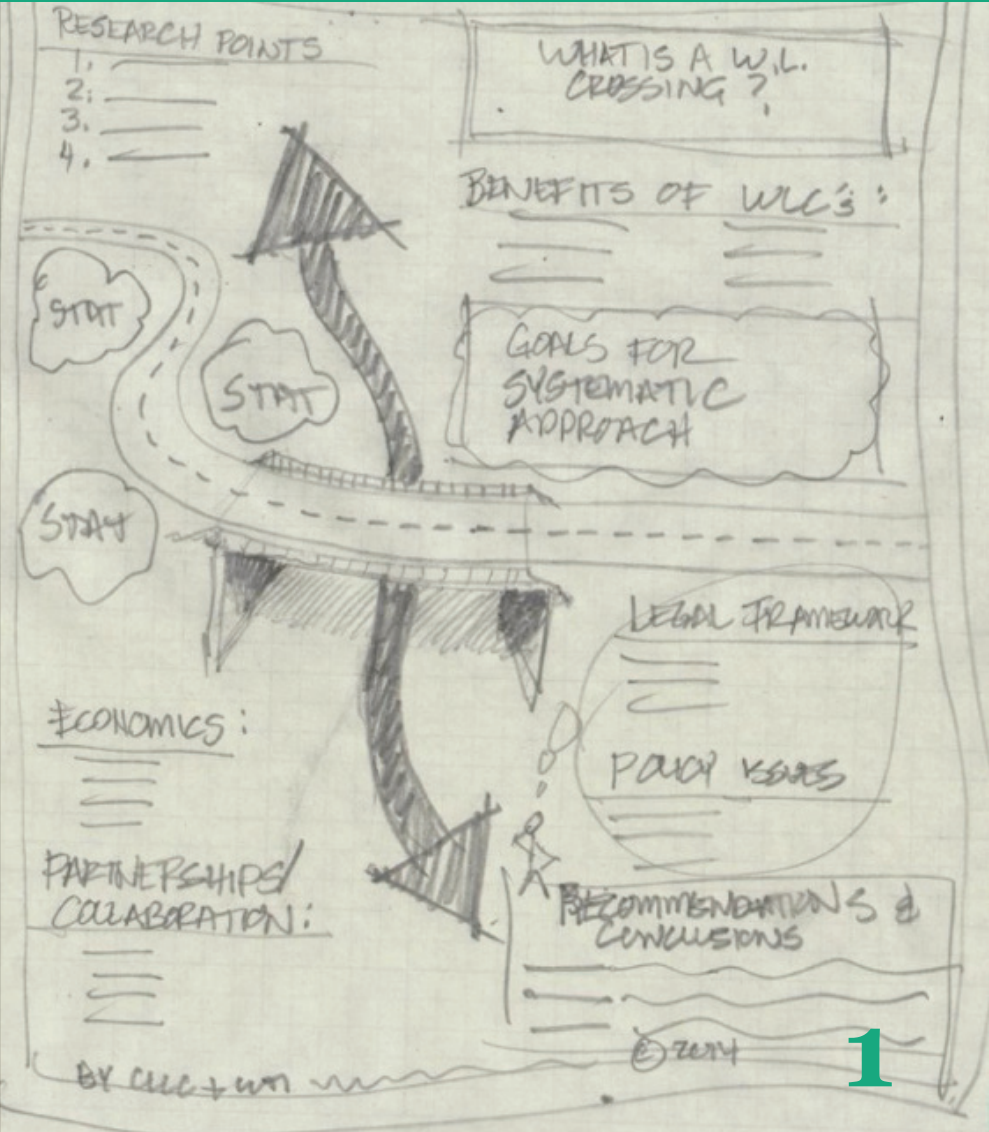
**Support investment in research and development by assuring an adequate percentage of each highway program is allocated to innovative wildlife mitigation solutions.** If it becomes well established that transportation and natural resource agencies are making a concerted effort to deploy mitigation for wildlife, then innovation for smarter, less expensive, more effective measures will be rewarded.

**Establish a standard performance metric to ensure that investments in wildlife mitigation lead to reductions in wildlife-vehicle collisions and improvements in habitat connectivity.** Establishing standard metrics for assessing the performance of wildlife mitigation measures is a simple, transparent way to ensure that funds allocated to curb this mounting safety hazard are utilized effectively.

**Work to increase awareness and understanding of the need for a more permeable transportation network across key groups in society.** Broadly speaking, key groups, including administrative leaders, transportation practitioners and the general public, would all benefit from a more complete understanding of the scientific, social and economic advantages of a systematic approach to wildlife mitigation.

**Educate and cross-train students and professionals by expanding educational opportunities related to road ecology principles and practices for both current and future workforces.** Educational opportunities and workforce training regarding wildlife mitigation need to be expanded both for current professionals and for engineers and natural resource students at U.S. universities and other institutions of higher learning.





1. Getting started: Capturing key components of a nationwide commitment to a systematic network of wildlife crossing structures during a May 2014 workshop (sketch courtesy of Darin Martens, workshop participant).  
2. This rough-skinned newt moves relatively short distances in its search for food and mates. However, it must have precise habitat conditions to survive (image courtesy of U.S. Forest Service, Betsy Howell).  
3. The result of a successful multi-agency partnership: Togwotee Corridor reconstruction, 50' diameter arch wildlife crossing structure during the flowering of yellow sweet clover, *Melilotus officinalis* (photograph courtesy of Darin Martens, workshop participant).  
4. Herd of elk crossing over Dry Creek Road less than one mile from U.S. Highway 89 in Paradise Valley, Montana. U.S. 89 provides access to the iconic Roosevelt Arch entrance to Yellowstone National Park (photograph courtesy of Renee Callahan, workshop participant).  
5. Black bear using an underpass on U.S. Highway 93 on the Flathead Indian Reservation in western Montana (photograph courtesy of Confederated Salish & Kootenai Tribes; Montana Department of Transportation; Western Transportation Institute, Montana State University).  
6. Examples of the wide range of wildlife crossing solutions (sketch courtesy of Darin Martens, workshop participant).



# Why now?

As scientific evidence of the harmful cumulative effects of habitat fragmentation, introduced invasive and exotic species, climate change, and pollution mounts, the window of opportunity to curtail our road network’s detrimental effects on wildlife is rapidly closing.

The time to act is now, in large part because of the consequences of not doing so. Every year our Nation fails to act results in an additional 200 lives lost and more than 26,000 injuries due to collisions involving wildlife, at an annual cost to Americans of more than \$8 billion dollars in collision-related expenses,<sup>†</sup> not to mention the millions of wildlife that die each year as a result of collisions, jeopardizing the rich wildlife heritage we as a Nation treasure.

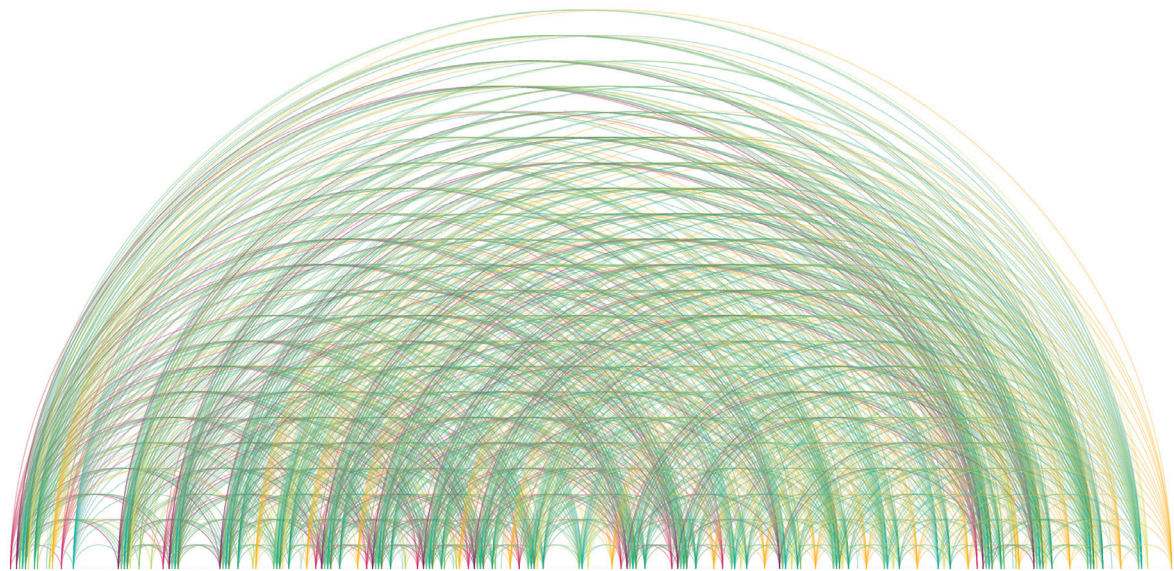
Unlike many large-scale environmental issues we face, proven solutions exist today. Creating a transportation system capable of co-existing with nature is a powerful gift to our Nation’s – and the world’s – future. The foundation for such a system has already been developed in our policies and direction, and it can be greatly advanced by implementing the recommendations proffered herein by experts in the field.

<sup>†</sup> Huijser, M.P., P. McGowen, J. Fuller, A. Hardy, A. Kociolek, A.P. Clevenger, D. Smith & R. Ament. (2008). Wildlife-vehicle collision reduction study. Report to Congress. No. FHWA-HRT- 08-034. U.S. Department of Transportation, Federal Highway Administration, Washington D.C., U.S., [online] URL: <http://www.fhwa.dot.gov/publications/research/safety/08034/index.cfm>

Huijser, M.P., J. W. Duffield, A.P. Clevenger, R.J. Ament and P.T. McGowen. (2009). Cost-benefit analyses of mitigation measures aimed at reducing collisions with large ungulates in North America; a decision support tool. *Ecology and Society* 14(2): 15. [online] URL: [www.ecologyandsociety.org/vol14/iss2/art15/ES-2009-3000.pdf](http://www.ecologyandsociety.org/vol14/iss2/art15/ES-2009-3000.pdf)

# ARC

NEW THINKING | NEW METHODS | NEW MATERIALS | NEW SOLUTIONS



ARC Solutions is an international network whose mission is to identify and promote leading-edge solutions to improve human safety, wildlife mobility and long-term landscape connectivity. We do this by fostering innovation in the placement, design and construction of wildlife crossings. We know these are solutions that work, and we seek to share this knowledge to build support for safe passage.

## ACKNOWLEDGMENTS

In 2013, ARC Solutions and the Western Transportation Institute at Montana State University (WTI) co-hosted a forum on Crossings and Culture as part of the International Conference on Ecology and Transportation, held in Scottsdale, Arizona. The number one recommendation resulting from that forum was to develop a manuscript to raise awareness about wildlife crossings and their proven effectiveness in reducing wildlife-vehicle collisions and improving habitat connectivity. The following year, ARC and WTI co-hosted a workshop (*Fig. 1*), attended by the participants listed below, to draft that paper. This manuscript is the result of that endeavor.

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Marta Brocki, Publication Design



