SAFE CROSSINGS FOR WILDLIFE



Photos: Washington State DOT, Oregon DOT

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Above: A bear in Washington State and a coyote in Oregon pause while using wildlife crossing structures. Two National Cooperative Highway Research Program (NCHRP) projects focused on wildlife connectivity solutions for mammals, amphibians, and reptiles.

In two recently completed research topics of the National Cooperative Highway Research Program (NCHRP) Project 25-25, researchers investigated ways to mitigate the effects of roadways on habitat connectivity and facilitate wildlife passage. The research examined current national practice to help transportation planners and practitioners lessen the effects of the roadway network on biodiversity and to improve roadway safety.

Safe Crossings for Small Animals

Fences and crossing structures are the most commonly installed wildlife mitigation measures. Fences keep animals off the road and guide them toward crossing structures—underpasses or overpasses that allow the animals to move safely across the road. Although transportation agencies have been integrating these practices into road construction projects more and more, the structures' details and effectiveness are not fully known. Historically, large animals have received the most attention, but the effectiveness of road mitigation for small animal species—amphibians, reptiles, and mammals smaller than a coyote—has largely been overlooked (see box, page 31).

Principal investigators Marcel Huijser, Western Transportation Institute, and Kari Gunson, Eco-Kare International, worked with WSP USA company Louis Berger on NCHRP Project 25-25, Task 113, "Road Passages and Barriers for Small Terrestrial Wildlife: Summary and Repository of Design Examples." Researchers synthesized the knowledge base of mitigation measures for small animals in North America by compiling a comprehensive database of technical reports, books, conference proceedings, and peer-reviewed publications and by conducting an expert-based survey.[1]

The literature and expert surveys showed that the most common method

[1] All summary documents, including a repository of technical drawings and relevant photos, are available at https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4337.



Photo: The Wetlands Institute

A diamondback terrapin considers whether to attempt to scale fencing installed along a roadside. Just tall enough so that the terrapin cannot climb over, exclusion fencing helps keep these small animals safe from vehicle strikes.

for providing safe passage for small animals was the installation of designated crossing structures during road upgrade projects. For amphibians and reptiles, these structures often were installed at grade with the road with slots on top to allow penetration of light, air, and moisture inside the tunnel. Box structures also are commonly used for small animal passage.

CULVERTS AND CROSSING STRUCTURES

Drainage culverts, suitably located and sized, offer enormous opportunities for small-animal passage. These can be adapted for terrestrial passage for land-dwelling creatures by incorporating a terrestrial bench, or elevated walkway alongside the structure. In three cases, overpasses were at least partially or completely designed for small animal species: in the Netherlands, amphibians; in Canada, snakes; and in Washington State, small animals.

Projects monitored the effectiveness of the structures at least 77 percent of the time. In almost half of the cases, however, the effectiveness in reducing the barrier effect of roadways—that is, how effective the structures were at providing connectivity—was unknown because most of the monitoring studies only evaluated the use of the structures by the target species. The studies did not collect information about the number of unique individuals that used the structures nor did they evaluate the proportions of males versus females or juveniles versus adults. This information is important to help evaluate whether small-animal populations indeed benefit from crossing structures. The authors suggest more-detailed monitoring that is aimed at evaluating effectiveness rather than just documenting wildlife use.

Other recommendations included structure maintenance for wildlife permeability, for example, annually clearing vegetation growth at entrances and removing trapped debris inside the structures. Crossing structures often are required to be sufficiently close to each other to accommodate shorter movement distances for smaller animals—otherwise these individuals may perish when moving alongside barriers.

FENCING AND BARRIERS

Exclusion fencing and barriers were evaluated 67 percent of the time, primarily by counting the number of living and road-killed animals within the enclosed section of road. Twenty-three studies reported an average roadkill reduction of 65 percent.[2] Fencing ineffectiveness was caused primarily by gaps in the fence; washouts or barrier deterioration; improper design of the barrier for target species, that is, animals could climb over or under them; or animals crossing at or beyond the fence ends.

Barriers only remained functional for an average of 2.2 years, typically after monitoring studies were completed. Barrier ineffectiveness was mostly due to wear and tear: small holes, gaps, vegetation growth, erosion, and partial fence collapse. In some cases, however, barriers

[2] Minimum 16 percent; maximum 100 percent; standard deviation 31 percent.



Photo: Washington State Department of Transportation

Contractor crews finish installing the sections of the eastbound portal of the wildlife overcrossing on I-90 east of Snoqualmie Pass in Washington State.



Photo: British Columbia Ministry of Transportation and Infrastructure

Before the British Columbia Ministry of Transportation and Infrastructure installed a protective culvert in 2014, the millions of migrating juvenile Western toads—a species of concern in Canada—had no safe way to traverse Highway 6 near Summit Lake. Species data such as age and sex are important to help determine the effectiveness of a crossing structure.

did not exclude target species effectively and, in many cases, were not adequately designed or installed to persist in the roadside environment—that is, to withstand snow removal and mowing activities.

Recommendations included providing robust materials such as concrete or metals and plastics, along with recommended installation guidelines that would not pose a safety hazard for motorists or animals. In addition, adaptive management is required to integrate recommendations from monitoring studies to improve overall barrier effectiveness.

Compensatory Mitigation Credits

For many wildlife species, the connectivity impacts of highways can be mitigated effectively by wildlife crossings and other connectivity enhancements. Mitigation crediting instruments and agreements could provide a novel approach that state departments of transportation (DOTs) could use to promote the construction of wildlife crossings and other enhancements.

In *NCHRP Web-Only Document 280: Valuing Wildlife Crossing and Enhancements for Mitigation Credits*, researchers Phillip Baigas and Edward Samanns, WSP USA, and Marcel Huijser and Robert Ament, Western Transportation Institute, sought to identify quantitative methods and approaches for establishing the mitigation values of wildlife overpasses, underpasses, bridges, and culverts for habitat connectivity and how that value is translated to mitigation credits.

The research found very few examples of quantitative valuation of wildlife connectivity mitigation from state DOTs. A survey of practitioners found that only a handful of states are starting to develop crediting and valuation systems for wildlife crossings and that only one project in California, the Laurel Curve Wildlife Habitat Connectivity Project, has a pilot credit agreement associated with a standalone wildlife crossing.[3]

CHALLENGES AND OPPORTUNITIES

According to survey respondents, a major impediment to developing a crediting approach was a lack of regulatory requirements and processes requiring compensatory mitigation. Respondents surmised, however, that credit programs would create financial incentives for state DOTs to fund connectivity enhancement actions; provide flexibility on the best mitigation location; contribute to the restoration of lost connectivity; and be useful for situations in which providing connectivity mitigation as a standalone project is cost-prohibitive.

[3] For more information, see https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=142107.

The survey respondents and literature review identified several categories of potential metrics to value wildlife connectivity mitigation, including the following:

1. **Condition-based connectivity metrics**, or types of measurements based on the physical, chemical, and biological attributes of a system, such as the highway footprint area within the highway-crossing zone used by focal species.
2. **Function-based connectivity metrics**, or types of measurements based on wildlife habitats and ecosystem processes, such as the number of individuals of focal species crossing the highway or the habitat quality of connected or fragmented habitat.
3. **Model-based connectivity metrics**, or types of measurements based on computer models that combine elements of function- and condition-based metrics to estimate wildlife connectivity, such as species distribution models, animal movement models, and habitat-based population viability models.
4. **Avoided-cost metrics**, or types of measurements based on the economic value of wildlife, human life, or property, such as reductions in insurance settlements from wildlife–vehicle collisions (WVCs).

Practitioners generally supported using function-based metrics to value mitigation credits for wildlife crossings and other connectivity enhancements. They acknowledged, however, that using function-based metrics to quantify pre- versus post-construction wildlife values would require extensive biological data, which are costly to obtain. In contrast, using condition-based metrics to value wildlife connectivity mitigation would be more straightforward but would not measure the ecological gain from the connectivity action.

Similarly, model-based metrics to value wildlife connectivity are not linked explicitly to the ecological gain that would result from a wildlife crossing structure or other connectivity enhancement, but these



Photo: Alderleaf Wilderness College

Safe road crossings for amphibians, reptiles, and smaller mammals, like the red fox, offer ample opportunity for study.

metrics can incorporate robust ecological data sets and results from prior modeling efforts to predict potential ecological gain for multiple species.

Lastly, many state DOT practitioners surveyed have used avoided-cost metrics (for example, reduced WVCs) in cost–benefit models to prioritize wildlife connectivity enhancement actions based on the predicted improvement in motorist safety and wildlife conservation. Several practitioners pointed to avoided-cost metrics as among the most practical metrics for monetarily valuing wildlife connectivity mitigation credits, because most state DOTs have roadkill data-collection protocols in place and maintain databases of WVCs.

CASE STUDIES

The research team conducted interviews with 13 practitioners from four state DOTs and wildlife agencies to discuss case studies of wildlife connectivity mitigation in California, Colorado, and Florida. These interviews offered insight into various approaches to value wildlife crossings and enhancements for mitigation credits. Practitioners in California described how the advance mitigation framework developed by Caltrans has provided the opportunity to invest in a standalone wildlife connectivity mitigation project via advance mitigation credit creation.

The Laurel Curve Credit Agreement was a proof-of-concept effort to demonstrate the framework for developing credit agreements for wildlife crossing structures. It showed how credits generated from a wildlife crossing could be applied as compensatory mitigation to satisfy future transportation project permit conditions. Although other function- or model-based metrics could have been used—at least in concept—a condition-based metric was straightforward, repeatable, and inexpensive to calculate.

A California Department of Fish and Wildlife program also facilitates mitigation credit agreements for wildlife connectivity enhancement actions through a voluntary, nonregulatory regional planning process. Respondents from the agency anticipated that future mitigation credit agreements would consider other factors to quantify ecological gain, such as improved access to breeding sites or improved gene flow. Whatever the metrics and methods used to calculate mitigation credits for wildlife connectivity enhancement actions, the practitioners interviewed generally agreed upon the importance of consistent quantification of the benefits to focal species from wildlife connectivity mitigation (credits) and the impacts of transportation projects requiring compensatory mitigation (debits).

Ideally, the metrics used to calculate wildlife connectivity mitigation credits would be easy to measure, based on the focal species' biology, and would result from collaboration and agreement among stakeholders.

Wildlife Crossing Literature

Peer-reviewed literature on wildlife crossings began appearing regularly in the 1970s. The number of published studies is increasing steadily; over the past 10 years, 68 studies for amphibians and reptiles and 25 studies for small animals have been conducted.

Practices shared by TRB and U.S. researchers have inspired further international research, such as the 2019 African Conference for Linear Infrastructure and Ecology in Kruger National Park, South Africa.



Photo: Christine Gerencher

Foraging for grass, a white rhinoceros blocks the roadway in Kruger National Park, South Africa, during a park tour of African Conference for Linear Infrastructure and Ecology attendees in 2019.