Built Environments
18. Wildlife Road Crossing Structures

DEFINITION

Wildlife road crossing structures (WRCSs) are infrastructure built with the joint goals of increasing habitat connectivity across roads and reducing wildlife–vehicle collisions. These structures can take many forms and are sited and designed differently depending on the type of wildlife present in the nearby ecosystem (FHWA 2011). Different forms of WRCSs fall along a continuum of gray to green infrastructure; all include some form of gray infrastructure, but most also use natural infrastructure (FHWA 2011). Roads are direct threats to wildlife because of the potential for wildlife–vehicle collisions that cause individual mortalities, but also because roads fragment wildlife habitat and can limit natural wildlife movement patterns throughout a landscape (Bissonette and Cramer, 2008). Wildlife–vehicle collisions can result in both personal injury and property damage (Huijser et al. 2007). WRCSs are therefore installed to protect human life and property and maintain healthy wildlife populations.

TECHNICAL APPROACH

When designing a road, the first step to minimize wildlife disruption is to try and avoid impacting certain sensitive or essential habitats or connectivity corridors. When avoidance is not possible, WRCSs are the next-best option to reduce impacts to wildlife and risks of wildlife–vehicle collisions. There are three primary steps to installing a WRCS, summarized below from the Federal Highway Administration's Wildlife Crossing Structure Handbook (FHWA 2011).

1. **Habitat connectivity planning**: The first step to creating successful WRCS is to do a landscape-level assessment to understand what habitats the road is impacting, which wildlife species use those habitats, and which species are most likely to be impacted by the road. Habitat connectivity planning can either be done at the project level (specific to a particular road project) or, preferably, at the system level (taking into account the broader regional road network). System-level planning allows for an assessment accounting for how the regional road network impacts wildlife movements. Connectivity planning may include a regional landscape assessment of wildlife connectivity needs within a transportation corridor. If possible, predicted climate-induced range shifts of wildlife species should be incorporated into the connectivity plan to ensure that WRCSs are designed with likely future scenarios in mind. Connectivity planning often involves wildlife movement modeling, collection of field data on wildlife locations and movements, and/or roadkill data. The connectivity planning stage will help make decisions about how many WRCSs to install and where to site them. For more information on connectivity planning and the types of data needed for these types of assessments, see Chapter 3 of the Wildlife Crossing Structure Handbook. For an example of a connectivity plan at a state level, see an example plan created for North Carolina (Sutherland et al. 2022).

2. **Selection of appropriate WRCS design type(s):** There are two primary types of WRCS: *overpasses* and *underpasses* (Figures 1–2). There are multiple subtypes of both over- and underpasses, and selecting which types to use and how to space them depends on the goals of the WRCS, the type of wildlife expected to use them, and the landscape topography. Some of the most common WRCS forms can be found in Table 18.1. For more information on how to select a WRCS design, see Chapter 4 of the Wildlife Crossing Structure Handbook.

3. **Installation of WRCS**: The final step is installation of the selected WRCS type(s). It is possible that, in addition to the WRCS, there will also be installation of wildlife-behavior–modifying structures to encourage use of the WRCS and/or discourage crossings in areas where WRCS do not exist. These behavior-modifying structures include installation of fencing, planting or removal of vegetation with high nutritional value in particular locations, intercept feeding (placement of food sources), and aversion techniques including use of lights, lasers, water sprays, or mirrors (Huijser et al. 2007). It is typically most efficient and effective to install WRCS during road construction; however, it is also possible to retrofit existing roads to allow for wildlife crossings (USFS and NPS, 2017).

Figure 18.1 Wildlife underpass in San Diego County, CA

Photo courtesy USFWS Pacific Southwest Region

Figure 18.2 Wildlife overpass in Arizona

Photo courtesy USFWS Pacific Southwest Region

OPERATIONS AND MAINTENANCE

Maintenance of each WRCS listed in Table 1 will differ. Maintenance details for each structure type can be found in the entries of Appendix C of the Wildlife Crossing Structure Handbook. Example maintenance activities include irrigating vegetation on the crossing structures during the first few years of operation, repairing damage to gray infrastructure components, and removing obstructions to underpass structures.

FACTORS INFLUENCING SITE SUITABILITY

- ✓ **Existing wildlife corridor:** WRCS should be placed in locations where wildlife would naturally travel (e.g., in riparian areas, along ridgelines) and in locations important for landscape connectivity (FHWA 2011).
- ✗ **Steep slope:** Areas with steep slopes are not well-suited to WRCS (FHWA 2011).

Table 18.1 Common types of WRCSs

Overpass Designs	Underpass Designs
Landscape bridge: Designed exclusively for wildlife use. Because of their large size, they are used by the greatest diversity of wildlife and can be adapted for amphibian and reptile passage	***Viaduct or flyover:*** The largest of underpass structures for wildlife use, but usually not built exclusively for wildlife movement. The large span and vertical clearance of viaducts allow for use by a wide range of wildlife. Structures can be adapted for amphibians and reptiles, semiaquatic, and semiarboreal species.
Wildlife overpass: Smaller than landscape bridges, these overpass structures are designed to meet the needs of a wide range of wildlife from small to large.	***Large mammal underpass:*** Not as large as most viaducts, but the largest of underpass structures designed specifically for wildlife use. Designed for large mammals, but small- and medium-sized mammals readily use them as well.
Multiuse overpass: Generally the smallest of the wildlife overpasses. Designed for mixed wildlife and human use. This wildlife crossing type is best adapted in human-disturbed environments and will benefit generalist species adapted to regular amounts of human activity and disturbance.	***Multiuse underpass:*** Design similar to large mammal underpass; however, management objective is co-use between wildlife and humans. Design is generally smaller than a large mammal underpass because of the type of wildlife using the structures, along with human use. These structures may not be adequate for all wildlife, but usually result in use by generalist species common in human-dominated environments (e.g., urban or periurban habitats). Large structures may be constructed to accommodate the need for more physical space for humans and habitat generalist species
Canopy crossing: Designed exclusively for semiarboreal and arboreal species that commonly use canopy cover for travel. Meets the needs of species not built for terrestrial travel that generally have difficulties crossing open, nonforested areas	***Underpass with waterflow:*** An underpass structure designed to accommodate the needs of moving water and wildlife. These underpass structures are frequently used by some large mammal species, but their use depends largely on how they are adapted for animals' specific crossing needs. Small- and medium-sized mammals generally use these structures, particularly if riparian habitat or cover is retained within the underpass
	Small- and medium-sized mammal underpass: One of the smaller wildlife crossing structures. Primarily designed for small- and medium-sized mammals, but species use will depend largely on how the crossing may be adapted for their specific crossing needs
	Modified culvert: Crossing that is adaptively designed for use by small- and medium-sized wildlife associated with riparian habitats or irrigation canals. Adapted dry platforms or walkways can vary in design and are typically constructed on the lateral interior walls of the culvert and above the high-water mark.
	Amphibian and reptile tunnels: Crossing designed specifically for passage by amphibians and reptiles, though other small- and medium-sized vertebrates may use as well. Many different amphibian and reptile designs have been used to meet the specific requirements of each species or taxonomic group

Adapted from the Wildlife Crossing Structure Handbook

TOOLS, TRAINING, AND RESOURCES FOR PLANNING AND IMPLEMENTATION

Name and Link	Resource Type	Year	Authors/ Authoring Organization	Geography	Description	Resource Includes: Design/Construction Guidance?	Site Selection?	Monitoring Guidance?	Example Projects?
Wildlife Crossing Structure Handbook: Design and Evaluation in North America	Guidebook	2011	US Department of Transportation, Federal Highway Administration	North America	This guide provides details on placement and selection of appropriate types of WRCS	✓	✓	✓	—
US DOT Wildlife Crossing Structures Portal	Website	n.d.	US Department of Transportation	National	This portal contains links to WRCS resources specific to particular regions of the United States, including assessments of structure effectiveness	✓	✓	—	—
Wildlife and Roads: Decision Guide and Project Database	Tool and database	n.d.	Utah State University, USGS, National Academies Transportation Research Board	National	This website contains a decision guide that helps users plan and implement WRCS projects. It also contains a database of WRCS projects in the US.	✓	✓	✓	✓
Evaluation of the Use and Effectiveness of Wildlife Crossings	Report	2008	National Academies Transportation Research Board	National	This report contains a literature review that explores the development of a tool that guides the selection, configuration, and location of WRCS	—	✓	—	—
Wildlife Vehicle Collision and Crossing Mitigation Measures	Guidebook	2007	US Department of Transportation, Federal Highway Administration; Montana Department of Transportation	Written for Montana, but most information is broadly applicable	This report reviews 39 mitigation measures that help reduce wildlife–vehicle collisions and provide habitat connectivity for wildlife crossings. The guide is focused on structures for large terrestrial mammals.	✓	✓	✓	—

Name and Link	Resource Type	Year	Authors/ Authoring Organization	Geography	Description	Resource Includes: Design/Construction Guidance?	Site Selection?	Monitoring Guidance?	Example Projects?
Measures to Reduce Road Impacts on Amphibians and Reptiles in California	Guidebook	2021	California Department of Transportation, University of Montana, Herpetofauna Consultants International	Written for California but most information is more broadly applicable	This best management practices guide describes practices for retaining or improving habitat connectivity for amphibians and reptiles in California	✓	✓	✓	—
Highway Crossing Structures for Wildlife: Opportunities for Improving Driver and Animal Safety	Report	2021	US Forest Service	National	This report reviews a vision for designing a road network that incorporate WRCS for human and wildlife benefits. It includes a description of common challenges faced when installing these structures	—	✓	—	✓

LIKELY BENEFITS AND OUTCOMES

Primary objectives for each strategy are highlighted.

Social and Economic

- **Public health and safety:** It has been estimated that wildlife–vehicle collisions with deer alone result in more than 200 human fatalities, 29,000 human injuries, and more than $1 billion in property damage each year in the United States (Conover et al. 1995). WRCS help reduce the likelihood of collisions that can cause human injury or mortality.

Ecological

- **Supports wildlife:** Road infrastructure is a direct threat to wildlife both because of the potential for wildlife–vehicle collisions that cause individual mortalities, but also because roads fragment wildlife habitat and can limit natural wildlife movement patterns throughout a landscape. In some cases, highways are a movement barrier that can reduce survival probability of a particular wildlife population as a result of habitat restrictions and/or limited gene flow (Bissonette and Cramer 2008; Huijser et al. 2007; Ament et al. 2021). WRCSs are intended to support wildlife by reducing these negative effects of roads and highways. Additionally, as wildlife range shifts occur as a result of climate change, WRCSs can help animals to shift their ranges accordingly (Ament et al. 2021).

- **Increased habitat connectivity:** WRCSs help sustain wildlife populations and ecosystem integrity by connecting habitats at a local scale (Ament et al. 2021).

BARRIERS AND SOLUTIONS FOR PRACTITIONERS

Common Barriers

Several barriers are common across many of the nature-based solutions strategies; these are described in more detail in Section 1 of the Roadmap. Additional notes about the barriers specific to wildlife road crossing structures are included here.

- **Expense**
- **Capacity:** Large-scale transportation plans often do not include considerations for WRCSs, and additional efforts must be made to ensure wildlife mitigation measures are included in road planning and design. Additionally, resource constraints often make it difficult to sufficiently coordinate and plan to install WRCSs (Ament et al. 2021).
- **Public opinion**
- **Conflict with other land uses**
- **Regulation**
- **Lack of effectiveness data**

Community

- **Administrative constraints:** Roads often cross jurisdictional boundaries and coordination across agencies, governments, and landowners is often required to install WRCSs (Ament et al. 2021).

EXAMPLE PROJECTS

Name and Link	Location	Leading Organizations	Techniques Used	Size	Cost	Duration	Project Description	Climate Threats Targeted	Lessons Learned or Adaptive Management
Idaho State Highway 21 Underpass	Idaho	Idaho Transportation Department, Idaho Department of Fish and Game	Underpass and associated fencing	Not provided	Not provided	Not provided	A location along Idaho State Highway 21 near Lucky Peak Reservoir was identified as an important wildlife migration corridor for deer and elk. The underpass was built to reduce wildlife-vehicle collisions.	No	No
Banff Wildlife Overpasses	Trans-Canada Highway, Canada	Parks Canada	WRCS including six wildlife overpasses with native plants and associated fencing and 38 wildlife underpasses	Not provided	Not provided	Not provided	Overpasses were part of a large effort in the 1980s to reduce wildlife–vehicle collisions	No	Have reduced wildlife–vehicle collisions by 80%
Colorado State Highway 9	Grand County, Colorado	Colorado Department of Transportation	A series of wildlife crossings plus wildlife funnel fencing along 10 mi of State Highway 9. It included two overpasses, five underpasses, and 10 mi of fence	Along 10 mi of highway	~$10million	Not provided.	Implemented to reduce wildlife–vehicle collisions with mule deer and elk	No	The project is considered a success, and is projected to pay for itself in 22 years as a result of reduced collision costs

Bolding indicates DOI affiliates.

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