

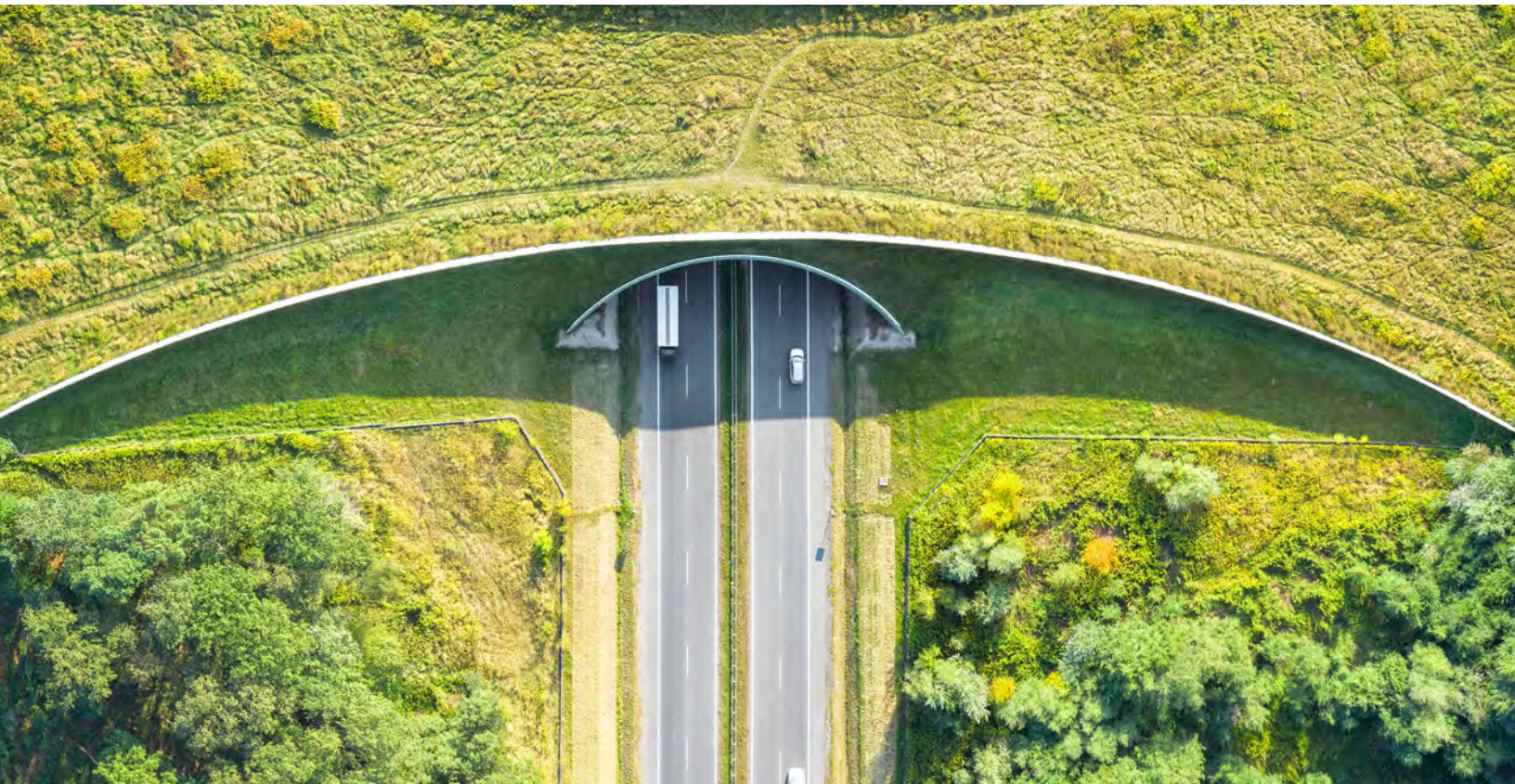


A Toolkit for Developing Effective Projects Under the Federal Wildlife Crossings Pilot Program

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This document highlights best practices, examples, and resources for designing effective wildlife crossing projects in accordance with the criteria for the federal “Wildlife Crossings Pilot Program.”

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TABLE OF CONTENTS

What is the “Wildlife Crossings Pilot Program”?.....	4
Other Fish and Wildlife Provisions in the Bipartisan Infrastructure Law.....	8
Suggestions for Getting Involved.....	13
A Reader’s Guide to this Toolkit.....	14
List of Grant Criteria.....	15



What is the “Wildlife Crossings Pilot Program”?

The Infrastructure Investment and Jobs Act ([H.R. 3684](#)), which became law in November 2021 (Public Law 117-58, also known as the “Bipartisan Infrastructure Law”), provided new federal funding for projects and research to reduce wildlife-vehicle collisions (WVCs) and improve habitat connectivity. One of the key provisions is the establishment of a new, \$350-million (total) Wildlife Crossings Pilot Program (WCPP) for fiscal years 2022 through 2026 (FY22-FY26).

This is a competitive grant program with criteria evaluation, review, and selection by the Federal Highway Administration (FHWA). Information in this section is based on FHWA’s [FY 2022-2023 Notice of Funding Opportunity](#) (NOFO) and [WCPP webpage](#), including the Questions and Answers document.

The primary purpose of the WCPP is to encourage states to adopt “wildlife-vehicle collision safety countermeasures” (Sec. 11123(b)(1)). To that end, Congress directed the U.S. Department of Transportation (USDOT) to distribute funds to projects that reduce the number of wildlife-vehicle collisions and improve terrestrial and aquatic habitat connectivity.

The first application cycle, which included \$111.85 million in awards available for the combined first two years of the program, occurred in the summer of 2023. Future NOFOs will be available for the remaining fiscal years under the Bipartisan Infrastructure Law (FY24, FY25, and FY26).

Photo credit: Alan Nyiri





Nevada Department of Wildlife

Who is eligible?

Eligible Applicants — State transportation agencies and federal land management agencies are allowed to directly apply for a grant under the program. Metropolitan planning organizations, units of local governments, tribes, and regional transportation authorities (or public authorities with a transportation function, such as port authorities) are also eligible to receive grants, but they must document that they consulted with the relevant state transportation agency (except tribes if project is on tribal land). Any group of these “eligible applicants” can also jointly apply for funding. Additionally, the legislation states that, “to enhance consideration of current and reliable data, eligible entities may obtain guidance from” a state fish and wildlife agency (Sec. 11123(b)(1)).

Eligible Partners — Grant funding, once received, may be provided to “eligible partners,” including the entities listed above, as well as foundations, non-governmental organizations, institutions of higher education, and other federal, tribal, regional or state government entities (or any group of “eligible partners”). A grant recipient that enters into a partnership via a project agreement must establish measures to verify that the eligible partner (or partners) receiving funds comply with the requirements of the WCPP.

At least 60 percent of the grant funding will go towards projects located in rural areas. All locations not designated as urban [in this FHWA's 'Adjusted Urban Areas' map](#) will be considered rural.

What kind of projects or activities are eligible?

The WCPP provides funding for construction and non-construction projects that reduce WVCs and improve habitat connectivity.

Construction projects include activities related to the construction of infrastructure, including: building, replacing, reconstructing, or rehabilitating structures (e.g., overpasses, underpasses, and fencing), including construction contingencies and operations; completing preliminary engineering and design work; conducting environmental reviews, permitting, and mitigation; preserving or restoring habitat; acquiring real property and rights-of-way; and conducting project monitoring.

Non-Construction projects can include planning (e.g., studies to identify corridors and barriers), research (including tracking and mapping), public outreach, feasibility analyses, and analysis of WVC impacts and reduction measures.

What are the application merit criteria?

In evaluating applications, FHWA will use the merit criteria set forth in the NOFO, which are as follows:

*There are two **primary** merit criteria of equal importance; Criterion # 1.1: Reduction of Wildlife Vehicle Collisions, and Criterion #1.2: Improvement of Terrestrial and Aquatic Habitat Connectivity. They evaluate the extent to which the proposed project is likely to: 1.1) protect motorists and wildlife by reducing the number of WVCs, and 1.2) improve terrestrial and aquatic habitat connectivity.*

*There are six **secondary** merit criteria, though an application does not need to meet all, looking at the extent to which the proposed project of an eligible entity is likely to accomplish the following:*

Criterion #2.1: Leveraging Investments — to leverage Federal investment by encouraging non-Federal contributions to the project, including projects from public-private partnerships.

Criterion #2.2: Economic Development and Visitation Opportunities — to support local economic development and improve visitation opportunities.

Criterion #2.3: Innovation — to incorporate innovative technologies, including advanced design techniques and other strategies to enhance efficiency and effectiveness in reducing WVCs and improving habitat connectivity for terrestrial or aquatic species.

Criterion #2.4: Education and Outreach — to provide educational and outreach opportunities.

Criterion #2.5: Monitoring and Research — to include monitoring and research to allow FHWA or others to evaluate, compare effectiveness of, and identify best practices in selected projects.

Criterion #2.6: Survival of Species — to benefit birds, fish, reptiles, mammals, and amphibians that are Federally Threatened or Endangered Species and species that are Proposed or Candidates for listing.

In addition to the primary and secondary merit criteria, FHWA will also assess project readiness and financial completeness; technical capacity and experience; environmental review and permitting risks; and alignment with Administration priorities, including safety, climate, equity, and job creation. Further details can be found in the NOFO. For guidance specifically on how to incorporate climate resilience considerations into planning and designing wildlife crossing structures, view the [“Joint Statement Regarding Climate-Informed Wildlife Crossings”](#) from transportation, conservation, and climate experts.

What is the federal cost share and what are the match requirements?

The non-federal match (or “cost share”) is the portion of the project costs not paid using federal funds. Awardees must provide at least 20 percent of the total project cost as a non-federal match unless a verified exception applies. Exceptions include an upward adjustment or sliding scale in states containing federal and nontaxable Indian lands, which would reduce the percentage of match required. Further information on the proportion of “federal share payable” for a given applicant can be found in 23 U.S.C. § 120.

All matching funds must come from non-federal sources, unless specifically authorized by Congress. For instance, funds awarded under the Tribal Transportation Program and Federal Lands Transportation Program can be used toward the match if the project provides access to tribal or federal lands. In-kind or cash contributions can be used for the match requirements. Previously incurred costs or expended or encumbered funds are not eligible for the match requirement.

Other Fish and Wildlife Provisions in the Bipartisan Infrastructure Law

“Wildlife Crossing Safety” Policy Elements

In addition to the WCPP, the “Wildlife Crossing Safety” section of the new statute (Sec. 11123(c)(1)) of the Infrastructure Investment and Jobs Act) contains a suite of policy provisions meant to reduce wildlife-vehicle collisions (WVCs) and improve habitat connectivity. The legislative language directs USDOT to:

- Update and expand the 2008 “Wildlife Vehicle Collision Reduction Study,” including the Report to Congress and the Best Practices Manual. Create workforce development and training courses for transportation and fish and wildlife professionals, based on the WVC Reduction Study.
- Develop a standardized methodology for collecting and reporting wildlife collision and carcass data. Provide a template to help states voluntarily implement the guidance.
- Establish guidance that includes a threshold to determine whether a highway should be evaluated for potential projects to reduce WVCs and improve habitat connectivity.
- Consult the 2011 FHWA “Wildlife Crossing Structure Handbook” when developing design criteria for new construction or rehabilitation of a federal highway.
- In consultation with state transportation agencies, determine if upgrades to bridges and tunnels should include measures to improve habitat connectivity. Train bridge and tunnel inspectors to assess passage for terrestrial and aquatic species.



Additional Funding Opportunities

Along with providing dedicated funding in the WCPP, the Bipartisan Infrastructure Law stipulates that wildlife crossing projects are eligible for funding under a suite of other federal transportation programs. Below are key additional funding opportunities. For an updated version of this funding table, see this [resource online](#).

To learn more about these provisions and how to take advantage of these additional funding opportunities, see the FHWA [overview](#) of the Bipartisan Infrastructure Law, the Center for Large Landscape Conservation’s [web page on wildlife crossings and the Bipartisan Infrastructure Law](#), [resources provided by ARC Solutions](#), and the joint [Wildlife Crossings](#) website.

Program Title	Total Funding Amount	Funding Type	Federal Cost Share	Eligible Recipients	Habitat Connectivity & Wildlife-Vehicle Collision (WVC) Eligibility	Example Awarded Projects with Wildlife Crossings Components
Bridge Formula Program	\$27.5B (including \$825M for Tribal transportation facility bridges)	Formula	See 23 USC § 120; up to 100% for Tribes	State, Local, Tribal, Federal	Funding for bridge replacement, rehabilitation, preservation, protection, or construction projects on public roads. The set-aside for tribal transportation facility bridges can be used to plan, design, engineer, and construct bridges, as well as to replace, improve, or rehabilitate bridges. Given that the definition of "construction" for federal-aid highways in 23 USC § 101 now includes "improvements that reduce the number of wildlife-vehicle collisions, such as wildlife crossing structures," related measures are presumably eligible project expenses.	No known relevant examples.
Bridge Investment Program	\$12.5B (including \$100M set-aside for planning, feasibility analysis, and revenue forecasting grants and \$200M for Tribal transportation facility bridges)	Discretionary	50-90%	State, Metro/Regional, Local, Tribal, Federal	Funding for projects to replace, rehabilitate, preserve, or protect one or more bridges on the National Bridge Inventory. Up to 5% annually may go towards replacing or rehabilitating culverts for purposes of improving flood control and aquatic habitat connectivity. The set-asides also include eligibility for projects to replace or rehabilitate culverts to improve flood control and habitat connectivity for aquatic species. Additionally, environmental mitigation is an eligible expense.	In 2022, Flathead County (Montana) secured \$240,000 in Bridge Investment Program funding for bridge improvements, including wildlife connectivity improvements. Source: https://www.fhwa.dot.gov/bridge/bip/planninggrants2022FY_2022_BIP_Planning_Grant_Award_Fact_Sheets.pdf
Federal Lands Access Program	\$1.5B	Formula	100%	State, Local, Tribal	Funding to improve transportation facilities that access the federal estate on infrastructure owned (or maintained) by states and local governments, with an emphasis on high-use federal recreation sites and federal economic generators. Environmental mitigation (during planning, engineering, construction, etc. phases) efforts that reduce WVCs and maintain habitat connectivity on or adjacent to federal lands are eligible.	In 2017, the Idaho Department of Transportation received \$2.8 million in Federal Lands Access Program funds to build a wildlife overpass on State Highway 21, with \$220,000 in matching funds from a public-private partnership including Idaho Department of Fish and Game, the U.S. Forest Service, Army Corps of Engineers, the Western Federal Lands Highway Division, non-governmental organizations, and local cities and counties. Source: https://itdprojects.org/projects/cervidaeoverpass/

Federal Lands Transportation Program	\$20M cap for connectivity projects	Formula	100%	Federal	Funding for the U.S. Fish and Wildlife Service (\$180M), National Park Service (\$1.7B) and the U.S. Forest Service (\$130), as well as a competitive grant program for other federal land management agencies for improvements to roads, bridges, trails, transit systems, and other transportation facilities. Projects that reduce WVCs while maintaining habitat connectivity, including constructing, replacing, maintaining, or removing culverts and bridges are eligible for funding (up to \$20M total per year).	In recent years, the Texas Department of Transportation, in coordination with the US. Fish and Wildlife Service, constructed a series of wildlife underpasses, primarily for ocelots, around the Laguna Atascosa National Wildlife Refuge using \$2 million in Federal Lands Transportation Program funds. Source: https://highways.dot.gov/federal-lands/programs-planning/tip/cfl-transportation-improvement-program
Forest Service Collaborative-based Aquatic-focused, Landscape-scale Restoration Program	\$80M	Direct Federal Spending			Five-year projects (up to \$5M each) to restore water quality or fish passage on federal and non-federal lands, including tribal forest land or rangeland. For five-year projects to restore fish passage or water quality.	All funded proposals listed here: https://www.fs.usda.gov/managing-land/natural-resources/collaborative-aquatic-landscape-restoration
Forest Service Legacy Roads & Trails Remediation Program	\$250M	Direct Federal Spending			Funding to decommission and repair roads and trails to mitigate detrimental impacts to sensitive ecosystems and watersheds. Eligible activities include replacing or installing bridges and culverts (or low-water trail crossings), addressing public safety of roads and trails, restoring unneeded roads and trails to a more natural state, addressing storm-damaged areas, and removing or replacing barriers to aquatic organism passage.	In 2009, the Clearwater National Forest in Idaho used \$310,000 of Legacy Roads funding, along with \$1.5M in matching funds, to restore access to 28.7 miles of aquatic habitat and reduce the risk of a culvert failure and potential sediment input into an 13.7 miles habitat downstream. This built off a long history of efforts with the Nez Perce Tribe to address fish passage barriers and reduce erosion from roads. Source: https://www.fs.usda.gov/restoration/Legacy_Roads_and_Trails/results.shtml
Highway Safety Improvement Program	\$15.6B	Formula	Generally up to 90%	State	Funding for projects that reduce fatalities and serious injuries on public roads	In 2015, Colorado Department of Transportation used Highway Safety Improvement Program dollars to construct a series of wildlife underpasses along US-160. Source: https://safety.fhwa.dot.gov/hsip/reports/pdf/2015/co.pdf
National Culvert Removal, Replacement & Restoration Program	\$1B	Discretionary	Up to 80%	State, Local, Tribal	Dedicated funding to address aquatic organism passage.	Grants not yet awarded.

National Infrastructure Project Assistance (Mega) Program	\$5B	Discretionary	60-80%	State, Metro/Regional, Local, Tribal	Funding for large, complex projects with national or regional economic, mobility, or safety benefits. While habitat connectivity and WVC projects are not listed explicitly as eligible activities, projects with such measures have recently received funding under this program.	In 2023, the North Carolina Department of Transportation was awarded a \$110-million Mega grant to replace the Alligator River Bridge on U.S. Highway 64. The project includes wildlife crossing structures and directional fencing to improve habitat connectivity between the north and south areas of the roadway and reduce wildlife-vehicle collisions. Source: https://www.transportation.gov/sites/dot.gov/files/2023-01/MEGA%20FY%202023%20Combined%20Fact%20Sheet.pdf
Nationally Significant Federal Lands & Tribal Projects	\$275M	Discretionary	Generally up to 90%; up to 100% for Tribes	State, Metro/Regional, Local, Tribal, Federal	Funding for the construction, reconstruction, and rehabilitation of nationally significant federal lands transportation projects and tribal transportation projects on a federal lands transportation facility, a federal lands access facility, or a tribal transportation facility. Eligibility for wildlife-related projects is similar to FLTP, FLAP, and TTP.	In 2023, the Confederated Salish and Kootenai Tribes in Montana were awarded a \$30.5-million Nationally Significant Federal Lands & Tribal Projects grant to update and rehabilitate U.S. Highway 93. This includes constructing a multi-span bridge over Post Creek and other wildlife-vehicle collision reduction infrastructure. Source: www.charkoosta.com/news/cskt-awarded-30-million-in-federal-funding/article_fc57da42-112e-11ee-8e8c-cb874ba49313.html
Nationally Significant Multimodal Freight & Highway Projects (INFRA)	\$8B	Discretionary	Generally 60%	State, Metro/Regional, Local, Tribal, Federal	Funding for multimodal freight and highway projects of national or regional significance that improve the safety, efficiency, and reliability of the movement of freight and people in and across rural and urban areas. Projects that increase safety on freight corridors with significant wildlife crossings on the roadway are eligible.	In 2022, the Colorado Department of Transportation (CDOT) received a \$100-million INFRA grant for highway improvements on Interstate-70. The project includes construction of a wildlife underpass and directional fencing, "the first major wildlife crossing to be constructed along the I-70 Mountain Corridor, and it will allow wildlife to safely cross underneath the interstate at a location which has historically been a hotspot for wildlife related crashes," according to CDOT. Source: https://www.codot.gov/news/2022/november/i70-geneseewildlifecrossingprojectbegins
Pollinator-Friendly Practices on Roadsides & Highway Rights-of-Way Program	\$10B authorized	Discretionary	100%	State, Tribal, Federal	Funding for projects to benefit pollinators on roadsides and highway rights-of-way, including planting native seeds. While not a stated purpose, such projects often have the effect of improving habitat connectivity.	Grants not yet awarded.
Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation (PROTECT) Program	\$7.3B \$1.4B	Formula Discretionary	Generally up to 80%; up to 100% for federal or Tribes	Formula: State Discretionary: State, Metro/Regional, Local, Tribal, Federal	Funding for efforts to mitigate the risk of recurring damage from extreme weather and natural disasters. "Protective features" that increase the size or number of drainage structures, replace culverts with bridges, lengthen or raise bridges, and upsize culverts are eligible. Such activities have the potential to improve habitat connectivity.	Grants not yet awarded.

Rebuilding American Infrastructure with Sustainability & Equity (RAISE) Program	\$7.5B	Discretionary	Generally 80%	State, Metro/Regional, Local, Tribal	Funding for surface transportation projects of local and/or regional significance that improve safety, sustainability, equity, economic competitiveness, mobility, and community connectivity. Replacing or rehabilitating a culvert or prevent stormwater runoff for the purpose of improving habitat for aquatic species is an eligible activity.	In 2023, the Douglas North Crossing Project in Juneau, Alaska was awarded a \$16.5M RAISE grant for a bridge project that includes improvements for over 40 culverts to enable fish passage. Similarly, the Navajo Nation in Arizona received \$20M for Phase II of the N15 Highway Reconstruction Project, which includes installation of properly sized culverts and livestock underpasses. Source: https://www.transportation.gov/raisegrants/raise-2023-fact-sheets
Rural Surface Transportation Grants	\$2B	Discretionary	Generally 80%	State, Metro/Regional, Local, Tribal, Federal	Funding for highway, bridge, or tunnel projects, highway safety improvement projects, etc. that improve and expand the surface transportation infrastructure in rural area transportation systems (areas with a population of less than 200,000) to increase connectivity, improve the safety and reliability of the movement of people and freight, and generate regional economic growth and improve quality of life. Wildlife infrastructure is eligible, including tunnels and detection systems.	No known relevant examples.
Surface Transportation Block Grants	\$72B total (including \$7.2B set-aside for transportation alternatives)	Formula	Generally 80%	State, Metro/Regional, Local, Tribal, Federal	Funding for federal-aid highways, bridges on any public road, and transit capital projects. Design, construction, monitoring, maintenance of wildlife crossing structures or projects/strategies designed to reduce WVCs are eligible. The set aside for transportation alternatives funds smaller-scale projects, such as recreational trails, community improvements (e.g., historic preservation and vegetation management), and environmental mitigation related to stormwater, habitat connectivity, and vehicle-caused wildlife mortality.	In 2010, a public-private partnership secured a Transportation Alternatives grant that—when matched with a State Wildlife Grant and from the U.S. Fish and Wildlife Service and private dollars—funded construction of underpasses and fencing to provide safe passage for amphibians during their seasonal migration across the Monkton-Vergennes Road in Vermont. Source: https://www.burlingtonfreepress.com/story/news/2016/03/28/hundreds-saved-new-vermont-salamander-crossing/82336084/
Tribal Transportation Program Safety Fund	\$3B	Discretionary	Up to 100%	Tribal	Funding for projects to improve transportation safety and public road access to and within tribal lands. Measures to reduce WVCs while maintaining habitat connectivity, including constructing, replacing, maintaining, or removing culverts and bridges, are eligible for funding.	In 2022, the Southern Ute Tribe contributed \$1.3 million in Tribal Transportation Program funding for studies and research into additional wildlife crossing structures on US-160, complementing investments from the Colorado Department of Transportation out of their Highway Safety Improvement Program dollars. Source: https://www.codot.gov/news/2022/august/us160-wildlife-overpass-completion
Wildlife Crossings Pilot Program	\$350M	Discretionary	Generally 80%	State, Metro/Regional, Local, Tribal, Federal	Dedicated funding for projects that aim improve habitat connectivity and reduce WVCs.	Grants not yet awarded.

Suggestions for Getting Involved

State transportation agencies: Establish an understanding of the extent to which your agency has undertaken or is willing to undertake projects to reduce wildlife-vehicle collisions and improve habitat connectivity. Examine the status of wildlife data collection and of internal policies, politics, and other key considerations related to wildlife crossing and habitat connectivity projects.

Other state, local, tribal, regional, and federal agencies: Determine whether your agency has a [formal partnership agreement](#) with the state transportation agency outlining the official process for cooperating on wildlife and transportation issues. If such a partnership does not yet exist, explore opportunities for beginning to share data and collaborate on projects. Consider, for instance, hosting a joint wildlife and transportation summit.

Other “eligible partners”: As described above, foundations, non-governmental organizations, and institutions of higher education can also enter into a project agreement to receive funding from a grant recipient (e.g., a state transportation agency). Explore whether there is already a state or regional coalition that focuses on wildlife and transportation issues, such as those in [Montana](#), [Virginia](#), and [Colorado](#). If not, consider reaching out to existing partnerships in other states to glean lessons learned and embark upon establishing a similar partnership in your area. Groups like [land trusts](#) can be important partners in these efforts.

State legislators: Connect with your state transportation and wildlife agencies. Determine what staff capacity and resources are needed to advance these efforts, such as liaison positions between wildlife and transportation agencies. Consider [relevant state legislation and policies](#) related to science, planning, funding, best management practices, and partnerships for wildlife and transportation projects. Finally, [set up a fund](#) to begin pooling non-federal funding to contribute to the project.

Individuals seeking to stay apprised of the latest WCPP developments can subscribe to the FHWA email update list [here](#).



A Reader's Guide to this Toolkit

The following material in this toolkit identifies each criterion listed in the WCPP and an associated list of select best practices, examples of how they have been applied, and key resources for learning more about the principles of designing and implementing wildlife crossing projects. For each criterion, the Center for Large Landscape Conservation (CLLC) has included the following components:

- Criteria — *using language from the WCPP NOFO*
- Select best practices — *recommendations compiled by CLLC from review of road ecology literature and materials*
- Examples — *some of the most relevant examples of how a specific set of best practices have been applied in designing, funding, constructing, and monitoring successful wildlife crossing projects*
- Key resources — *relevant publications with supporting evidence and more detailed recommendations from wildlife and transportation experts, compiled by CLLC from review of road ecology literature and materials*

The options and suggestions outlined here do not reflect statutory or regulatory guidance. These recommendations are based on CLLC's expertise, examining road ecology literature, and consulting experts in the field. CLLC is not suggesting that eligible applicants and partners should adopt every single best practice within a section. Rather, this toolkit offers a menu of potential options for consideration in designing wildlife crossings projects and proposals under the WCPP.

LIST OF GRANT CRITERIA

A note on navigation: This toolkit is designed and intended as an interactive resource. Click on a title in the List of Grant Criteria to proceed to that section within the document.



Reduction of Wildlife-Vehicle Collisions and Improvement of Habitat Connectivity



Leveraging Investments



Economic Development and Visitation Opportunities



Innovation



Education and Outreach



Monitoring and Research



Survival of Species



Reduction of Wildlife-Vehicle Collisions and Improvement of Habitat Connectivity

Criteria

Criterion #1.1: The extent to which the proposed project is likely to protect motorists and wildlife by reducing the number of WVCs.

Criterion #1.2: The extent to which the proposed project is likely to improve terrestrial and aquatic habitat connectivity.

Best Practices

- *Undertake analyses to identify and prioritize locations for mitigation.* Some analyses examine only wildlife-vehicle collision (WVC) data, while others also include wildlife movement and habitat data. A project will address safety and conservation needs most effectively if locations with the highest collision risk and/or highest conservation priority are identified.
 - *Include multiple data sources and types.* WVC hotspots and locations with high value for habitat connectivity do not always overlap, so data on both a) locations of WVCs and b) areas of habitat connectivity or wildlife movement patterns are important. Traffic and landscape characteristics, such as volume and speed of vehicle traffic on roads, help further assess the risk of WVCs.
 - *Include landscape-scale, long-term habitat considerations.* To benefit habitat connectivity, project locations should take into consideration the context of the broader landscape, including locations that can reduce movement barriers between protected areas, currently identified habitat connectivity areas, locations where habitat is likely to remain intact over time, and/or locations where multiple species would benefit. Long-term security of the lands on either side of wildlife crossing opportunities and their functioning as habitat and wildlife corridors for multiple species are critical to the long-term benefits of the crossing infrastructure.
 - *Consider additional criteria during prioritization and decision-making.* Further technical and social information helps inform decision-making, such as the present and future status of land adjacent to the crossing structures, political viability, key partner support, and technical feasibility.
- *Create standardized, transparent planning and implementation processes* to identify problem areas for WVCs, prioritize actions, and create cost-effective solutions. Including procedures and/or operations that promote consideration of wildlife within various divisions of state transportation agencies ensures that wildlife is considered in all relevant aspects of transportation decisions and projects. By codifying them into transportation planning processes, there is a stronger probability these procedures and/or operations will persist through budget and political fluctuations.



Reduction of Wildlife-Vehicle Collisions and Improvement of Habitat Connectivity

- *Select appropriate mitigation measures.* There are many tools that can reduce WVCs and improve habitat connectivity, including wildlife underpasses or overpasses, bridges, culverts, or animal detection systems. While design considerations are site- and species-specific, there are some key best practices:
 - The most effective solutions are wildlife crossing structures combined with fencing that funnels wildlife toward the safe crossings. Without fencing, the structures are less effective. Relatedly, fencing without structures allowing animals to cross the road safely does not provide for wildlife movement and habitat connectivity.
 - Designing crossing structures to meet the movement and habitat needs of multiple species creates the most impact for biodiversity. Different species respond differently to wildlife crossing structure placement, design, and size.
 - Protection and management of the land surrounding a crossing structure should provide suitable habitat for the long term.
 - Not all projects must involve the creation of new infrastructure; retrofitting existing infrastructure to create safe passage opportunities (e.g., upsizing culverts to allow for successful fish passage as well as for larger animals to cross under the road) can be one of the most expeditious and cost-effective approaches to improving habitat connectivity and reducing WVCs.
- *Adopt design and construction standards—and ensure that adaptive management is included in those standards.* Consider standardized designs for wildlife crossing structures and associated infrastructure, such as wildlife fencing and escape ramps, to deploy proven techniques. Then, cater these plans to the specific site locations and species needs. Furthermore, incorporating adaptive management principles into design and construction to respond to changing conditions remains essential.
 - There is no single approach to the construction of wildlife crossing structures, but generalities can be made. Some projects are completed during a discrete period of time, while others are part of phased construction over several years. The phased approach, along with monitoring and evaluating performance, can allow for adjustments to design and construction in the subsequent phases.
- *Leverage partnerships.* Working together with multiple entities across jurisdictions that have pertinent datasets, policies, authorities, and funding pools will ensure a project is relevant, feasible to implement, and has lasting impact. Time and energy should be taken to ensure the right experts, decision-makers, and stakeholders are engaged.



Reduction of Wildlife-Vehicle Collisions and Improvement of Habitat Connectivity

Examples

- [Montana Wildlife and Transportation Partnership Planning Tool](#) (2023)
- [West-wide Study to Identify Important Highway Locations for Wildlife Crossings](#) (2023)
- [New Mexico Wildlife Corridors Action Plan](#) (2022)
- [Arizona Statewide Wildlife-Vehicle Conflict Study](#) (2021)
- [Blackfeet Nation Animal-Vehicle Collision Reduction Master Plan](#) (2019 and 2022)
- [New Jersey - Connecting Habitat Across New Jersey \(CHANJ\)](#) (2019)
- [Incorporation of Wildlife Crossings into TxDOT's Projects and Operations](#) (2019)
- [Teton County Wildlife Crossings Master Plan](#) (2018)



Reduction of Wildlife-Vehicle Collisions and Improvement of Habitat Connectivity

Key Resources

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Leveraging Investments

Criteria

Criterion #2.1: The extent to which the proposed project is expected to leverage Federal investment by encouraging non-Federal contributions to the project, including projects from public-private partnerships.

Best Practices

- *Develop partnerships.* Partnering with a variety of groups is important for leveraging funds and reducing the financial burden for any one entity. Interested parties and successful partnerships may include state fish and wildlife agencies; local governments; tribal governments; fish and wildlife conservation groups; outdoor recreation groups (including hunting and angling organizations); other non-governmental organizations; private landowners; land trusts; and livestock producer groups. Identifying and addressing the concerns and shared interests of these stakeholders early in the process will help foster broad financial and social support.
- *Identify the available suite of non-federal funding sources.* These sources can include other public funds available through state and county programs, as well as private funds from private philanthropy, corporate philanthropy, organizations, and individuals.
 - Consider ways partners can fund components of the project using their own funding streams. In particular, partners may have access to grant opportunities (e.g., requests for proposals from environmental foundations), open space conservation programs, and other funding sources for mitigation that offsets the ecological impacts of development.
- *Establish processes to engage with partners and receive external funds.* Set up clear processes for government agencies to engage partners in supporting and financially contributing to a project. Wildlife crossings have generated substantial philanthropic interest in recent years and creating donation mechanisms, such as a foundation or fund, for efficiently channeling those private dollars is key to securing diverse funding sources.



Leveraging Investments

Examples

- Examples of partnership coalitions:
 - [Staying Connected Initiative](#)
 - [Safe Passage I-40 Pigeon River Gorge Wildlife Crossing Project](#)
 - [Virginia Safe Wildlife Corridors Collaborative](#)
 - [Colorado Wildlife & Transportation Alliance](#)
 - [Montana Wildlife and Transportation Partnership](#)
- Wildlife crossing at Liberty Canyon/US Highway 101 in California: The vast majority (estimated 80%) of the cost for the [Liberty Canyon wildlife overpass](#) is being privately funded.
- Wyoming funding tools:
 - [Wyoming Wildlife Conservation License Plate](#): Monies received go to the WYDOT Wildlife Crossing Fund to be used for efforts related to the transportation system, such as wildlife crossings, wildlife road signage, and game fences. Donations have been made by [conservation organizations](#).
 - The WYIdlife Fund, a nonprofit partner of the Wyoming Game and Fish Department, launched a [Pooled Migration Fund](#) to help voluntary conservation of private working lands and Tribal lands in big game migration corridors.
 - [Teton County Special Purpose Excise Tax](#) — In November of 2019, Teton County, Wyoming voters passed a ballot measure authorizing a special purpose excise tax to generate \$10 million for wildlife crossing structures and related tools.
- Oregon has established a specialty license plate called the [Watch for Wildlife License Plate](#). Monies received from the plate sale and renewal fees are received by a Watch for Wildlife Fund with the Oregon Wildlife Foundation that will support projects that help wildlife migrate safely within their range and between habitat patches.
- Wildlife connectivity legislation enacted in California in 2021 sets up a [compensatory mitigation credit scheme](#) that allows California Department of Fish and Wildlife to issue the California Department of Transportation credits for wildlife crossings that can be used for future transportation projects requiring environmental mitigation.
- Pima County, Arizona, [dedicated \\$45 million of its local sales tax revenues](#) to conserve and restore “critical wildlife linkages” through measures such as building wildlife crossings.



Leveraging Investments

Key Resources

Ament, R., S. Jacobson, R. Callahan, and M. Brocki, eds. 2021. [Highway crossing structures for wildlife: opportunities for improving driver and animal safety](#). Gen. Tech. Rep. PSW-GTR-271. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA, U.S.

ARC Solutions. 2020. [Wildlife crossing success stories in the Western states](#). ARC Special Publication.

Kociolek, A.V., R. Ament, R. Callahan, and A.P. Clevenger. 2015. [Wildlife crossings: the new norm for transportation planning](#). Institute of Transportation Engineers (ITE) Journal 85(4): 45-47.

McGuire, T.M., A.P. Clevenger, R. Ament, R. Callahan, and S. Jacobson, eds. 2020. [Innovative strategies to reduce the costs of effective wildlife overpasses](#). Gen. Tech. Rep. PSW-GTR-267. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA, U.S.

Paul, K., A. Breuer, and A. Wearn. 2023. [Land trusts and wildlife crossing structures: A toolkit detailing how land trusts can contribute to highway infrastructure projects for wildlife](#). Center for Large Landscape Conservation, Bozeman, MT, USA.



Criteria

Criterion #2.2: The extent to which the proposed project is expected to support local economic development and improve visitation opportunities.

Best Practices

- **Undertake a comprehensive wildlife crossing structure cost-benefit analysis.** Cost-benefit analyses can estimate the costs of wildlife-vehicle collisions (WVCs) at specific locations and the benefits of mitigating the impacts of roads on wildlife.
 - Increasingly, such cost-benefit analyses are being applied by transportation agencies. Assessments that address the safety and financial benefits of reducing WVCs provide information important for convincing decision-makers to invest in measures to provide safe passage for wildlife.
 - Cost-benefit analyses can demonstrate how reducing WVCs and carcasses on highways helps reduce economic impacts and lower insurance claims by decreasing property damages and the number of injuries (including fatal ones).
 - Cost-benefit analyses are also increasingly taking into consideration the value of the wildlife conserved by reducing road mortality. The outdoor recreation industry—a key economic driver in many states—relies in part on healthy wildlife populations. New metrics are emerging to capture not only the consumptive values of wildlife (e.g., hunting) but also the passive use or intrinsic values of wildlife. Projects that reconnect habitats and allow wildlife to safely cross roads sustain wildlife-related recreation and thus support local economies.
- **Consider proposing a wildlife crossing project on a highway to provide safer access to public lands for outdoor recreationists, natural resource industries, and communities that depend on resources within those lands.** Providing safer passage for motorists and wildlife on these highways can benefit these communities as well as connect important habitat. Additionally, such wildlife crossing projects may be eligible for additional federal funding under the Federal Lands Transportation Program and Federal Lands Access Program.
- **Plan to employ local firms, engineers, road ecologists, and construction crews** to design and build a wildlife crossing project. To ensure opportunities for local hiring and for current and future public engagement, this should be planned early on in project development.
- **Use local construction materials.** The Infrastructure Investment and Jobs Act has a “Buy America” requirement that any iron, steel, manufactured products, and construction materials purchased for projects using federal funding under the new statute must be produced domestically (Sec. 70914). Sourcing such materials as locally as possible would promote the economic development of the community where the project is built.



Examples

- Wyoming's [Wildlife Tourism for Tomorrow](#) business partnership
- [Colorado's Wildlife Prioritization Studies](#), which include benefit-cost tool and analysis
- University of California at Davis's [Wildlife Crossing Calculator](#)

Key Resources

Duffield, J. and C. Neher. 2022: [Incorporating wildlife passive use values in collision mitigation benefit-cost calculations](#). Transportation Pooled Fund Study, TPF-5(358). Nevada Department of Transportation, Carson City, NV.

Huijser, M.P., J.W. Duffield, C. Neher, A.P. Clevenger and T. McGuire. 2022. [Cost-benefit analyses of mitigation measures along highways for large animal species: An update and an expansion of the 2009 model](#). Transportation Pooled-Fund Project TPF-5(358). Nevada Department of Transportation. Carson City, NV.

Huijser, M.P., J. Duffield, A.P. Clevenger, R. Ament, and P. 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.

U.S. Department of Transportation. [Federal Lands Transportation Program](#).

U.S. Department of Transportation. [Federal Lands Access Program](#).



Criteria

Criterion #2.3: The extent to which the proposed project will incorporate innovative technologies, including advanced design techniques and other strategies to enhance efficiency and effectiveness in reducing WVCs and improving habitat connectivity for terrestrial or aquatic species.

Best Practices

Wildlife mitigation strategies have been deployed for many decades and thus effective measures have been well-documented. There are numerous resources describing proven technologies. Yet there is substantial opportunity to offer a wider array of effective measures, improve existing techniques and designs, and explore cost-effective alternatives.

- *Understand existing knowledge on the range of effective mitigation tools.* Options for reducing WVCs include wildlife crossing structures (overpasses and underpasses), fences, electrified barriers, and animal detection/driver warning systems. Establish an understanding of conventional approaches.
- *Explore innovative approaches to wildlife crossing structure design, engineering, and materials.*
 - Recently, fiber-reinforced polymer (FRP) composite materials have been used in wildlife crossing structures. There are many benefits to using FRP materials over conventional ones for wildlife crossing infrastructure. For instance, the composite materials have a high strength-to-weight ratio and exceptional durability, allowing for reduced costs in the transportation of materials, construction, and maintenance. These materials are also more climate resilient, resisting corrosion in the face of increasingly frequent and extreme weather events.
 - Structural solutions such as prefabricated bridges, precast arch elements, and steel structural elements are cost-effective and efficient options for addressing stand-alone wildlife crossing structures, especially in the absence of opportunities to upgrade existing structures. Installation can be accomplished quickly and with minimal disruption to traffic flows.
 - Geosynthetic reinforced soil technologies and alternative fill materials like geofoam help reduce weight loads, which helps to minimize structural fill.
- *Consider the use of innovative monitoring and data collection tools.* These include:
 - Camera/video systems that use artificial-intelligence-supported animal detection and classification software.
 - Mobile device applications for wildlife crash and carcass data collection and other new tools that can be used by transportation agency staff, citizens, and stakeholders to accurately and precisely locate problem areas.
 - Data collection tools to keep track of long-term maintenance needs for wildlife crossing structures and fencing.



Examples

- Mobile device applications, including:
 - [ROaDS](#) (Roadkill Observation and Data System) smartphone app
 - [Watch for Wildlife](#) smartphone app
 - [Highway 63 Alberta Wildlife Watch](#) smartphone app
- [Federal Highway Administration's Accelerated Bridge Construction](#) initiatives
- A "[Joint Statement Regarding Climate-Informed Wildlife Crossings](#)" from transportation and ecology experts contains numerous examples of wildlife crossing planning and design innovations that improve infrastructure resilience.

Key Resources

Andrews, K., Callahan, R., Cramer, P., Cross, M., Dodd, N., Duncan, L., Gagnon, J., Kintsch, J., Krosby, M., Littlefield, C., Seidler, R., Skroch, M., Suraci, J., Sutherland, R., Wearn, A. 2023. [Joint statement regarding climate-informed wildlife crossings](#).

ARC Solutions. [New materials: Can exploring new materials change how we engineer our highways?](#)

Bell, M., D. Fick, R. Ament, and N. Lister. 2020. [The use of fiber-reinforced polymers in wildlife crossing infrastructure](#). Sustainability 12(4): 1557.

Bell M., R. Ament, D. Fick, and M. Huijser, editors. 2022. [Innovative fiber-reinforced polymer structures for wildlife, bicyclists, and/or pedestrians - Final report](#). Transportation Pooled Fund Study, TPF-5(358). Nevada Department of Transportation, Carson City, NV.

Clevenger, T. and M.P. Huijser. 2011. [Handbook for design and evaluation of wildlife crossing structures in North America](#). Department of Transportation, Federal Highway Administration, Washington D.C., U.S.

Huijser, M.P., E.R. Fairbank, and K. Paul. 2022. [Best practices manual to reduce animal-vehicle collisions and provide habitat connectivity for wildlife](#). Transportation Pooled Fund Study, TPF-5(358). Nevada Department of Transportation, Carson City, NV.

McGuire, T.M., A.P. Clevenger, R. Ament, R. Callahan, and S. Jacobson, eds. 2020. [Innovative strategies to reduce the costs of effective wildlife overpasses](#). Gen. Tech. Rep. PSW-GTR-267. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA, U.S.



Criteria

Criterion #2.4: The extent to which the proposed project will provide educational and outreach opportunities.

Best Practices

- *Provide peer learning opportunities to share lessons learned.* It is valuable for transportation and natural resource professionals to have opportunities to share their expertise and experiences with addressing wildlife-vehicle collisions (WVCs) and habitat connectivity. Consider hosting webinars, workshops, roundtables, conferences, and meetings that provide the transfer of state-of-the-art knowledge.
- *Consider convening a wildlife and transportation workshop to catalyze efforts and share information.* Several states have initiated workshops or summits between state wildlife and transportation agencies as well as key stakeholders. These events often lead to new formal partnerships and plans for addressing WVCs and habitat connectivity.
- *Educate and inform the public.*
 - *Identify affected stakeholders and develop an outreach and engagement plan* that provides ample opportunities for them to share their interests and concerns.
 - *Work with communications staff and key messengers to raise public awareness about the project, the need it addresses, and the benefits it will provide.* Partner with community leaders and organizations that have relationships with key stakeholders and may be able to act as liaisons or trusted messengers.
 - *Partner with educators to teach students about the project.* Work with teachers, museums, academic institutions, and other education professionals to develop relevant and engaging content about the project that can be conveyed in school settings. Wildlife crossing projects provide the opportunity to teach students about road ecology, engineering, and habitat connectivity, as well as to engage students through citizen science (e.g., collecting roadkill data) and field trips.
 - *Use a range of outreach options and formats.* There are many effective outreach tools such as websites, “story maps,” videos/movies, webinars, and lesson plans for teachers. Work with partners to convey information in multiple modalities, employing visual storytelling techniques whenever possible to draw in diverse audiences.



Examples

- Films or videos
 - Conservation Corridor's [compilation of outreach/education videos](#) about transportation ecology around the world
 - Nevada Department of Transportation partnership [ReConnecting Wild: Restoring Safe Passage](#) film
 - I-90 Wildlife Bridges Coalition [Cascade Crossroads](#) film
 - Florida Wildlife Corridor [Expeditions and Documentaries](#)
- Summit County Safe Passages [story map](#)
- CLLC and ARC Solutions' Roadways and Wildlife [infographic](#) and Corridors vs. Crossings [infographic](#)
- The [#saveLAcougars](#) campaign
- Wild I-70 [audio tour](#)
- National Park Service's Connected Conservation webinar series — Improving Roads for People and Wildlife [webinar](#)
- Collaborative summits
 - Wyoming Wildlife and Roadways Summit (2017 and [2021](#))
 - [Montana Wildlife and Transportation Summit](#) (2018)
 - [Colorado Wildlife and Transportation Summit](#) (2017)

Key Resources

Anderson, H., K. Dow, R. Lok, P. Jamshid- Moghadam, J. Lawson, C. Murphy, and M. Smirnova. 2021. [Green infrastructure toolkit: Enhancing the co-benefits of landscape connectivity](#). Ryerson University, Toronto, Ontario, Canada.

Haddock, R. 2014. [Trans-Canada highway wildlife and monitoring research, final report 2014 \(Part C: Communications and Outreach\)](#). Prepared for Parks Canada Agency, Radium Hot Springs, British Columbia, Canada.



Monitoring and Research

Criteria

Criterion #2.5: The extent to which the proposed project will include monitoring and research to allow FHWA or others to evaluate, compare effectiveness of, and identify best practices in selected projects.

Best Practices

- *Monitor before, during, and after construction of wildlife crossing structures and associated infrastructure.* This is important to assess effectiveness of measures for reducing wildlife-vehicle collisions (WVCs) and improving habitat connectivity. Monitoring across project phases also helps identify cost-effective designs for specific contexts and species.
 - *Monitor for a sufficient length of time to evaluate project effectiveness.* Monitoring WVCs and wildlife use of crossing structures for five years prior to construction and five years afterwards is recommended by some researchers. It can take several years for wildlife to become comfortable using new crossing structures; wildlife tend to exhibit a learning curve.
 - *Determine the extent of monitoring or research needed.* For standard mitigation strategies and designs, monitor and compare pre- and post-construction WVC rates to evaluate effectiveness. Consider undertaking more in-depth research if a project uses novel mitigation strategies or addresses species for which there is limited available data, such as smaller species, threatened and endangered species, reptiles, or pollinators. Universities or consulting firms can often provide valuable assistance with more in-depth monitoring or research.
- *Integrate project monitoring with project maintenance.* Monitoring studies and regular check-ups on wildlife crossing structures, fences, escape ramps, guards and other project elements provide information critical to proper maintenance and design of the infrastructure.
 - *Consider including feedback from maintenance crews in project design and monitoring plans* to identify emerging structural or technical issues with the project as soon as possible. Maintenance teams are critical to the planning, design, construction, and care of infrastructure to increase efficacy and minimize long-term maintenance needs.

Examples

- Banff Wildlife Crossings [Project website](#)
- US 93N Wildlife Crossing Research [Project website](#)



Key Resources

Ament, R., S. Jacobson, R. Callahan, and M. Brocki, eds. 2021. [Highway crossing structures for wildlife: opportunities for improving driver and animal safety](#). Gen. Tech. Rep. PSW-GTR-271. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA, U.S.

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Huijser, M. P., W. Camel-Means, E. R. Fairbank, J. P. Purdum, T. D. H. Allen, A. R. Hardy, J. Graham, J. S. Begley, P. Basting, and D. Becker. 2016. [US 93 North post-construction wildlife-vehicle collision and wildlife crossing monitoring on the Flathead Indian Reservation between Evaro and Polson, Montana - Final report](#).

Michael Baker International. 2021. [Arizona statewide wildlife-vehicle conflict study final report](#). 2021. Prepared for Arizona Department of Transportation.



Survival of Species

Criteria

Criterion #2.6: The extent to which the proposed project is expected to benefit birds, fish, reptiles, mammals, and amphibians that are Federally Threatened or Endangered Species and species that are Proposed or Candidates for listing.

Best Practices

- *Identify focal species threatened by roads.* In 2008, there were 21 federally listed threatened or endangered animal species in the U.S. that were deemed species for which road mortality is a major threat to survival, as documented in the WVC best practices manual as part of the report to Congress (Huijser et al. 2008). These included Lower Keys marsh rabbit, Key deer, bighorn sheep (peninsular California), San Joaquin kit fox, Canada lynx, ocelot, Florida panther, red wolf, American crocodile, desert tortoise, gopher tortoise, Alabama red-bellied turtle, bog turtle, copperbelly water snake, eastern indigo snake, California tiger salamander, flatwoods salamander, Houston toad, Audubon's crested caracara, Hawaiian goose, and Florida scrub jay. Note that this list has not been updated since 2008 and does not include Proposed or Candidate species.
- *Use species-specific data.* Most WVC data relates to large, common wild mammals such as deer. Human safety-oriented projects generally focus on those datasets. Collision data on medium-sized and small-sized mammals and species groups, such as amphibians, reptiles and birds, are typically not recorded consistently or at all. If a primary project goal is to benefit species listed under the Endangered Species Act or that are otherwise rare, it is important to use species-specific data in planning and designing measures to reduce their road mortality or enhance their habitat connectivity.
 - Targeted efforts and additional data collection such as road mortality surveys for small or rare species may be warranted. Monitoring may need to be done with high frequency and slow speed, as carcasses of small or rare species may disappear quickly.
 - Spatial analyses can be conducted to determine where mitigation measures may be warranted, using suitable habitat or potential population viability. It is important to recognize that the road may have caused reduced population persistence in the area and thus there may be important habitat impacted by roads that is not currently occupied by the species.
 - If possible, focus on both current road mortality hotspots as well as historic roadkill hotspots, as the population may now be depleted such that a previously important location or population no longer shows up as a hotspot for collisions. If those data are not available, locations for mitigation may need to be based primarily on suitable habitat or corridors, rather than carcass and crash data, which are usually scarce for rare species.
- *Select locations based on the focal species,* rather than in combination with large, common wild mammals. Road sections with high WVC rates will likely be different from road sections that are mortality hotspots for rare species or otherwise connect important habitat for them.



Survival of Species

- *Ensure the crossing structure design suits the species.* Find best practice documents and research indicating species-specific design considerations. A one-size-fits-all approach is less likely to function for rare and sensitive species. Also consider the characteristics of the habitat surrounding the structure; undisturbed, native, and natural habitat near and at the crossing structures is especially important for rare and sensitive species.

Examples

- Florida panther — [Wildlife crossings](#) and [outreach efforts](#)
- Mojave desert tortoise — [Safe passage efforts](#)
- Canada lynx — [Memorandum of Agreement](#) — [In-Lieu Fee Lynx Mitigation Strategy](#) between Federal Highway Administration, Colorado Department of Transportation, and U.S. Fish and Wildlife Service

Key Resources

Adams, P.J., M.P. Huijser, and S.C. Getty. 2023. [An assessment of existing and potential future mitigation measures related to grizzly bears along US Highway 93, Flathead Indian Reservation, Montana, USA.](#) Confederated Salish and Kootenai Tribes, Pablo, Montana, USA.

Blanchard, E., Z. Wurtzebach, E. R. Fairbank, R. Callahan, M. Brocki, A. Keil, and F. Deffner. 2023. [Policy report: Challenges and opportunities for implementing conservation measures for Mojave desert tortoise along roads.](#) Under guidance of Mojave Desert Tortoise Transportation Ecology Task Force.

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Huijser, M.P., P. McGowen, A.P. Clevenger, and R. Ament. 2008. [Wildlife-vehicle collision reduction study: Best practices manual: Report to Congress.](#) No. FHWA-HEP-09-022. U.S. Department of Transportation, Federal Highway Administration, Washington D.C., U.S.

Huijser, M.P., J. Fuller, M.E. Wagner, A. Hardy and A.P. Clevenger. 2007. [Animal-vehicle collision data collection. A synthesis of highway practice.](#) NCHRP Synthesis 370. Project 20-05/Topic 37-12. Transportation Research Board of the National Academies, Washington DC, USA.