Research Note

Permeability of Existing Structures for Terrestrial Wildlife: A Passage Assessment System

From the WSDOT Research Office
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Elk moving under I-90 through the low-height, wide-span Cle Elum River bridge in central Washington, ©P. Cramer, J. Kintsch & WSDOT

Research Need: Improving Safety and Permeability for Wildlife

Animals moving across the landscape present a hazard to drivers and to themselves when their movements take them over a road. Sometimes, animals won't attempt a crossing if traffic volumes are high, preventing them from reaching important seasonal habitat or finding a mate. While new bridges and culverts with fencing specifically designed for wildlife passage (wildlife crossings) can be constructed to facilitate safe passages, new infrastructure may not always be economically feasible or constructed in a timely manner. In addition, the functionality of existing structures should be factored into the need for and design of new structures. The availability of a variety of safe crossing opportunities along a stretch of highway can contribute to the movement needs of the diversity of species that occur in most wild areas.

Many of the culverts and bridges that are currently part of Washington's transportation system may allow wildlife to pass beneath the roads. With small modifications, existing bridges and culverts may be upgraded to provide more effective passageways for wildlife and ecosystem processes at lower cost and on shorter time frames than needed for new wildlife crossings.

WSDOT needed a way to evaluate existing bridges and culverts to see if different types of animals could potentially pass through them.

The researchers created an assessment tool – called the Passages Assessment System, or PAS – to evaluate existing transportation infrastructure for its ability to facilitate wildlife movement from one side of a roadway to the other.

Washington State Department of Transportation

Understanding Wildlife and Roads: A Classification System

In developing the PAS, it became first necessary to refine our understanding of how landscape and structure characteristics affect a species' willingness to pass through a structure. The researchers developed a classification system for wildlife based on how different types of species move and behave, and how they perceive potential crossing structures. The resulting Species Movement Guilds provide a unique classification designed to facilitate an understanding of 'what works' for different types of wildlife. These Guilds help agencies evaluate the physical and environmental conditions and potential constraints to movement from the perspective of groups of species, and develop mitigation strategies that carefully consider the behavior and preferences of each target species. The Guilds provide an understanding of why certain species have specific requirements, and allow generalizations to be made across species in a given Guild, thereby efficiently informing project planning and design processes even when little data is available for a particular species.

Species Movement Guild	Typical Species of That Guild
Low Mobility Small Fauna	Invertebrates, frogs, toads, some salamanders
Moderate Mobility Small Fauna	Squirrels, raccoons, hares, weasels
Adaptive High Mobility Fauna	Black bear, bobcat, coyote, lynx
High Openness, High Mobility Carnivores	Grizzly bear, mountain lion, wolf
Adaptive Ungulates	Deer, moose, mountain goat
Very High Openness Fauna	Elk, bighorn sheep, pronghorn antelope
Arboreal Fauna	Flying squirrels, some bats
Aerial Fauna	Songbirds, raptors, bats

Black-tailed deer doe and fawns using the Mosquito Creek culvert under U.S. 101 in Washington ©P. Cramer, J. Kintsch & WSDOT

A Common Vocabulary to Describe Wildlife Crossings

A 'wildlife crossing structure' connotes many different structures from the smallest culverts that may provide passage for a salamander, to the space under an expansive highway viaduct. To characterize these distinctions, the researchers defined Structure Functional Classes, providing a breakdown of the types of road crossing structures that can function as passageways for wildlife under or over a roadway and the types of wildlife that may use these

Class Type	Class Name	Typical Species the Structure Type is Known to Pass
Class 1	Small Underpass	Amphibians, small mammals
Class 2	Medium Underpass	Coyote, bobcat
Class 3	Large Underpass	Deer, elk, black bear
Class 4	Extensive Bridge	Most wildlife – wary species
Class 5	Wildlife Overpass	Most wildlife, including birds
Class 6	Specialized Culverts	Reptiles & amphibians
Class 7	Canopy Bridges	Flying squirrels, arboreal rodents

structures. The critical dimensions for breaks between classes are dictated by engineering designs as well as the characteristics that define individual species' willingness to move through a structure. This classification of structure types can help transportation planners, biologists, and engineers to relate wildlife passage needs to a specific structure type or types using a common vocabulary.

Creating the Passage Assessment System

Combined, the Species Movement Guilds and Structure Functional Classes lay the foundation for evaluating the permeability of existing structures for wildlife. The researchers then developed initial evaluation criteria based on research in other states supplemented with published research and correspondence with colleagues to determine the factors that appear to influence wildlife passage and how they should be defined. These factors included structure dimensions, passageway substrate, vegetation cover, landscape attributes and human use, among other considerations.

The PAS was field tested along Washington roads in linkage areas identified in the Washington Wildlife Habitat Connectivity Analysis (See http://waconnected.org/statewide-analysis/). To complement and validate the field test, the team also conducted wildlife monitoring at seven locations using remote motion-triggered cameras. Data compiled through the monitoring effort served to refine an understanding of how wildlife used select culverts and bridges, which could then be generalized to other locations. The PAS was then tested by WSDOT biologists, the future users of the system, and the process was further refined. The PAS is a living document, able to be updated to incorporate new understandings of wildlife passage and behavior as they become available, and tailored to address regionally specific wildlife adaptations.

The PAS guides practitioners through a series of targeted questions designed to characterize a bridge or culvert relative to its potential to functions as a wildlife passage. The PAS complements existing tools WSDOT uses to identify important connectivity areas and design mitigation solutions that improve or restore permeability for native wildlife. While the Washington Wildlife Habitat Connectivity Analysis offers a broad-scale perspective of connectivity across the state, the PAS allows WSDOT biologists to assess permeability at the site scale, for example along targeted stretches of roadway identified as bisecting these landscape connections.

Using the Passage Assessment System

The PAS is composed of three sections: General Questions, Undivided Highway, and Divided Highway, as well as a User's Guide provided for additional reference. For each structure that is being evaluated the user will complete 1) the General Assessment Questions, and 2) either the Divided or Undivided Highway Assessment Questions, depending on whether the structure of interest is located on a divided or undivided highway.

Upon completing the PAS the user will be equipped to answer the question: 'can this structure be improved to accommodate passage for the target species present in this area?' It is possible, in some cases, that a given structure may be enhanced to accommodate one or several of the target species, but cannot be suitably improved to accommodate all target species.

Having determined that a structure can be enhanced for wildlife passage, biologists are then confronted with the question of how to enhance the structure to facilitate passage. Given the unique characteristics of every structure and the specific permeability objectives at each site, there is no simple answer to this question, however a number of commonly encountered situations are addressed in the accompanying Passage Enhancement Toolbox. This toolbox addresses a number of situations and provides examples of each. For example, at a location with a culvert that conveys water but could also be used by smaller animals, the toolbox describes shelves that can be installed inside the culvert to facilitate wildlife movement above the flow of water (see picture). Or, if the support slopes of a bridge are covered with large boulder riprap down to the stream bank, the site can be enhanced for wildlife movement by the installation of a dirt pathway through the riprap (see MN bridge photo). The user is encouraged to consider the range of possible enhancements and how they could be implemented at each site being assessed.

Racoon using a raised shelf as a dry pathway through a culvert under Highway 93 in Montana ©K. Foresman

Integrating PAS into Project Planning

The Passage Assessment System supports timely inclusion of wildlife passage needs from the onset of highway corridor planning, project planning and design. It offers potential cost-savings over new structures and minimizes project delays by identifying passage modifications that may be significantly less costly than anticipated. If existing culverts and bridges can be shown to pass wildlife, WSDOT can reduce future construction costs for wildlife crossings in those areas and prioritize areas that are lacking in potential crossings and need immediate mitigation. WSDOT may also begin using the PAS to identify areas where maintenance and daily operations activities could significantly improve existing infrastructure for wildlife movement outside of projects.

Dry pathway installed through riprap slope under a bridge in Minnesota ©P. Cramer

Contact Information

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