MULTIPLE-USE CROSSING STRUCTURES FOR PROVIDING WILDLIFE HABITAT CONNECTIVITY

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ABSTRACT

Despite increasingly constrained funding for wildlife crossings, there are still numerous opportunities to provide wildlife connectivity across highways. These opportunities are available in every state and location, including urban, rural and suburban areas, for existing highways as well as those undergoing major reconstruction. The authors outline options for better utilization of potential wildlife crossings for structures whose primary purpose is for pedestrians, bicycles, livestock, farm equipment, streams, rivers and secondary road crossings as well as recommended structure dimensions for species groups. Also, there is an on-going requirement to rebuild many aging highway bridges and there are thousands of existing structures that could be modified to improve wildlife habitat connectivity, reduce wildlife mortality and animal/vehicle collisions. The 201 inventory for bridge replacements is 66,749 structures nationally. The cost of providing habitat connectivity for structures designed for other purposes is usually a fraction of single-purpose wildlife crossings. In Oregon and Washington it is estimated that there are over 10,000 culverts on Federal land that need replacement for salmon and other aquatic species passage. Similar opportunities exist in most other states. Many of these projects can be accomplished on a cost-share basis with DOT's, land management agencies, fish and wildlife agencies and civic groups.

INTRODUCTION

Certainly one of the most cost efficient ways to provide wildlife crossings and wildlife connectivity is to use highway crossing structures provided for other uses. However logical this sounds, agencies rarely consider wildlife crossings when designing other types of crossings. Taking advantage of existing structures or for structures which primary use is not wildlife could be the single greatest contribution to habitat connectivity in the next 50 years. Using highway crossings designed for other primary purposes is common in Europe (Bank et al 2002). Examples of highway and road crossings designed for other uses include:

Highway Bridges Crossing Rivers and Streams

The 2012 FHWA National Bridge Inventory cites 66,749 bridges as ‘structurally deficient’. Bridges that are unsafe or deficient will be scheduled to be replaced as funds allow. Many of these bridges are long past their design life, so it is reasonable to assume that bridges replaced now will last potentially into the next century. Thus, the bridge replacement program is an excellent opportunity to design wildlife features into the new structures.

Existing highway bridges present a great opportunity for developing wildlife and aquatic organism habitat connectivity. Unfortunately, most highway bridges are not designed for both a stream crossing and wildlife or aquatic organism habitat connectivity. Applying some forethought and science to bridge design would provide relatively cheap and effective habitat connectivity for hundreds of species. There are thousands of opportunities to improve wildlife habitat connectivity, reduce wildlife mortality, reduce animal/vehicle collisions and improve highway safety waiting for engineers and biologists to apply “wildlife-friendly” measures. There are some agencies that are systematically evaluating wildlife habitat concerns when evaluating bridge replacement projects. Most notable is Oregon Department of Transportation “Fish and Wildlife Friendly Bridge Replacement Program” where they reviewed more than 350 bridges that will need repairs or replacement and determined which structures would provide fish (aquatic organisms) and wildlife passage benefits. Part if the process was an agreement with resource agencies on “Green Bridge” standards. ODOT plans to save money in the long run by reducing ESA consultation timeframes and costs as well as simplified resource coordination (FHWA September 2004). The use of similar processes in other states is encouraged so that opportunities are identified before planning and implementation takes place. Designing wildlife crossings into highway bridges is also consistent with FHWA’s Eco-Logical approach (FHWA 2006). Also see the Wildlife Crossing Structure Handbook Design and Evaluation in North America for design recommendations (Clevenger and Huijser 2011).

Figure 1. One of two span bridges on I-90 near Nine Mile exit that provided habitat connectivity for many species including wolves and grizzly bears. This fencing was modified by Montana Department of Transportation to facilitate wildlife movement. Photo by Ruediger.

Specific “wildlife-friendly measures” (structures that facilitate movement of fish and other aquatic organisms) include providing a dry natural stream bank within the bridge dimensions where wildlife could cross under the highway; providing a natural stream bottom where aquatic organisms can move; providing adequate height for target species and providing wing-fencing so wildlife are funneled into the crossing. The width of the structure should be capable of containing the stream at average bank full level, or greater, without unnatural restrictions that would cause accelerated water velocities.

Figure 2. Bridge on Highway 55 near Eagle, Idaho that would provide adequate space for aquatic and terrestrial species. Collisions with deer and other species could be reduced by providing wing-fencing. Photo by Ruediger.

A general guideline for wildlife friendly bridge height is (Ruediger and DiGiorgio 2007):

Large land mammals (including Elk/Moose):	12 feet or higher
Deer, black bear and similar size animals:	10 feet, or higher
Medium sized mammals such as coyotes, bobcats:	4 feet, or higher
Small mammals, such as raccoons and opossum:	3 feet or higher

Bridge width will vary based on the size and morphology of the stream or river, but should be at least a few feet wider than average "bank-full" high water. This width would provide for potential wildlife and aquatic organism movement at all seasons except for extreme flood events.

Bridges across rivers and streams provide crossings along natural movement corridors (riparian areas) for many wildlife species. In areas where stream crossings are frequent, there may not be a necessity for other wildlife crossings. Bridge crossings would likely benefit wildlife in urban, suburban and rural environments and can provide an ecologically effective mosaic of streamside "green spaces" and parks as described by Gary Evink in his 1998 ICOET paper entitled "Ecological Highways".

Figure 3. Bridge over the Clark Fork River in Missoula, MT provides adequate space for aquatic and terrestrial species, as well as a hiking trail on each side. Deer and small mammals commonly use this bridge to avoid crossing the busy 4-lane highway. Photo by Ruediger.

Ecological Solutions to Culverts on Forest Roads and Highways

The impacts that round culverts have had on stream morphology, fish and other aquatic organism passage and wildlife habitat connectivity has been profound. In recent years, there has been an increased awareness and evolving science on the effects that culverts have on stream channel stability and aquatic organisms, especially fish listed under The Endangered Species Act - such as salmon and trout. In terms of cold water fishes, there is now a realization of stream velocity barriers, jumping or height barriers and water depth barriers. Many of the issues created by culvert use affect other native non-salmonid fishes as well, but are often unknown or ignored. The impacts of culvert barriers on amphibians and aquatic reptiles (mainly turtles) is somewhat known in the transportation and biological communities, but has only recently been addressed in road building in the U.S and Canada. Still far behind in terms of knowledge and road standards are the aquatic invertebrates, which are usually the most common species and often involve more biomass on a stream than fishes, or other aquatic vertebrates. In addition to the barriers listed for fish, many other aquatic species can be adversely affected by the absence of bank and edge habitat or discontinuity of channel substrate.

How extensive the potential problems are can be clearly seen from a past study on the effects of fish passage from culvert use on National Forest lands in Oregon and Washington. A study conducted by the USDA Forest Service indicated that “about 90% of nonbridge (mostly culvert) crossings were considered to be at least partial barriers to anadromous fish passage.” And, this did not consider the passage requirements of other aquatic organisms that often have more restrictive movement abilities (GAO 2001).

Figure 4. Good example of a "culvert replacement" arch on the Fremont-Winema National Forest. This structure great improves aquatic organism and small mammal passage. US Forest Service photo.

Alternatives to round culverts for small stream crossings are well known, but must compete with the lower cost of round culverts, plus the bureaucratic simplicity that culvert installation and replacement often provides. In some agencies, round culverts can be installed or replaced with minimal engineering oversight or involvement. Bridges and arch type crossings usually are almost always more expensive, more time consuming and require more engineering design, approval and other expertise than installation of round culverts. This makes use of more ecologically suitable bridges or arches difficult for many State DOT’s and land management agencies to justify.

A good reference for stream crossing for any biologist or engineer is Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings (USFS 2008).

Highway Bridges over Secondary Roads

Bridges over secondary forest and county roads are common on larger highways and the Interstate system. Often, the larger highway will have a bridge where the secondary roads cross underneath. Secondary road crossings are common on BLM, US Forest Service and other public lands – or for county roads. These crossings can provide valuable habitat and population connectivity opportunities without having to provide a "stand alone" wildlife crossing. The value of these crossings is variable, often based on the amount and timing of traffic patterns. On some remote Forest road crossings, traffic is either non-existent or sparse during certain periods such as winter or spring break-up. Even on remote county roads traffic at night may be absent. At such times, these structures can be a valuable asset to wildlife needing to cross high-traffic volume highways.

Figure 5. Highway bridge over a county road on US 6 near Price, Utah. This bridge will be provided with fencing to funnel wildlife under the highway. The path was created by wildlife crossing under the structure. Photo by Ruediger.

To be effective forest or secondary road crossings usually must be fenced so that wildlife must use the crossing structure. This usually involves wing-fencing, but on some highways, such as Interstate 70 in Utah, continuous wildlife fencing is provided between a series of Forest Service road crossings and a stand-alone wildlife crossing. Various studies suggest that the use by wildlife of Forest and secondary road crossings is less than well-designed stand-alone wildlife crossings, as might be expected. Forest and secondary road crossings do have traffic, often fairly high traffic volume, as well as other human use patterns that affect wildlife use. Their size and location is strictly based on traffic needs, not wildlife. And, there can be associated fencing to control livestock and other animals that hamper wildlife use. The species using these crossings may be limited as well to deer, black bear, coyotes and other species that habituate easily to a human environment. Some species such as elk may rarely use these crossings.

Figure 6. Deer crossing under I-70 in Utah. A number of Forest Service roads crossed the highway and have been fenced so deer can safely cross. Deer and elk collisions have been reduced from several hundred a year to almost zero. Photo by P. Cramer and UDOT.

Nevertheless, if the discord elements can be overcome, these crossings can provide valuable crossings sites for wildlife. Some of the elements that often can be modified to increase wildlife use include:

1. Provide wildlife fencing to encourage or require animals to use the structures.

2. Remove cattle guards or provide end-arounds for wildlife use.

3. Simplify livestock and right-of-way fencing so that fence crossings are minimized and ensure that fences at wildlife crossing points are "wildlife friendly."

4. Consider developing water or other attractants (vegetation) that encourage wildlife use.

5. Consider placing woody debris and/or rocks to encourage small animal use.

If there is an opportunity to influence the original design of a new secondary road crossing, use available wildlife crossing technology to the extent needed or allowed. This includes such measures as:

1. Increase the width to allow a natural pathway for wildlife use.

2. Consider sloping bridge sides verses vertical walls. Wildlife will often use the sloping sides with natural earth fill.

3. Encourage the use of natural earth verses “hardened” sides. Place rocks and woody debris to encourage small animal use.

4. Provide wildlife fencing where necessary and coordinate livestock and right-of-way fencing to provide “wildlife friendly” fencing at crossing points.

5. Consider wildlife attractants to encourage use.

Secondary road crossings used for wildlife connectivity are common in Europe. They could be much more widely used in the U.S. and Canada.

Figure 7. The Lava Butte project south of Bend, Oregon incorporated a wildlife lane into an existing underpass that was originally for vehicle use only. Logs and boulders were added to promote wildlife use. Photo by Jacobson.

Bike, Pedestrian and Equestrian Trail Developments

A recent trend throughout the U.S. and Canada is expanding various trail developments. These have become more common under “context sensitive design” frameworks where highways serve communities in more ways than simply moving traffic from point A to point B. Bike, pedestrian and equestrian trails often traverse parks, woodlands and other open spaces and provide an opportunity to provide wildlife friendly crossing points as well. Ideally, these factors will be integrated into a livable designed community concept that provides for people’s needs as well as providing a pleasing environment providing for many native plants and animals (see the following section).

Figure 8. A trail and bike path bridge under a 4-lane highway in Missoula, MT. Is adequate in size to provide for deer, black bear and other smaller mammals. Photo by Ruediger.

Some cities, towns and communities have trail systems that could provide opportunities to provide wildlife crossings. Many foot and bike trails are heavily used in the day, but nearly abandoned at night or early morning. This provides opportunities for wildlife that is conditioned to living around people.

Figure 9. Bike path and trail going under I-70 near Vail Pass in Colorado. The multi-span bridge provides plenty of space for bikers, hikers and wildlife to pass under the highway. Photo by Ruediger.

Retrofitting Non-Wildlife Crossing Structures

Retrofitting has become a buzz-word often used among road-savvy biologists and ecologists, but not implemented in relationship to the opportunities presented. No matter where biologists or engineers work or live there are situations, usually many, where some retrofitting of existing structures could benefit wildlife habitat connectivity, reduce wildlife mortality or improve highway safety. Many of these can be improved with very little funding. The primary objective in the near future should be the education of biologists, engineers and planners at all levels and affiliations as to how to identify potential opportunities, generate support of resource and transportation agencies and elicit community support to get projects underway. And finally, to take action!

Retrofitting projects can be simple or complex in funding and implementation. The simpler projects are great ways to get community groups involved in the actual improvement of their local wildlife habitats while learning about the serious conditions that habitat fragmentation has caused locally, regionally and nationally. The more complex projects require more skill and technical knowledge, but they often are bargains compared to the coordination and funding required for stand-alone wildlife crossings. And, they can usually be accomplished without a major highway reconstruction project. In times of declining budgets, retrofitting makes common sense and can lead to significant ecological improvements that will last for decades or centuries.

PLANNING OUR CONSERVATION LEGACY

With all the benefits that can be attained using existing crossing opportunities, the challenge is developing a systematic approach where wildlife connectivity is considered in all bridge planning efforts. This includes assessment of the biological need for connecting all of our conservation properties. At the broad-scale, this includes ensuring National Forest, BLM, National Wildlife Refuge, state lands and local lands are interconnected. At the local community and county levels this requires that open space, parks, flood plains and other useful wildlife habitats are developed thoughtfully, with wildlife and natural plant communities in mind.

The problem if all the effort is applied to “retrofitting” is that the biological world can be unraveled faster than repairs can be made. Back in 1998, Gary Evink gave us the concepts for designing “Ecological Highways.” This was a far-sighted vision that has been partially realized. Where biologists and engineers must head to now is towards ecological communities, counties and state and national planning that seriously considers wildlife and aquatic habitat connectivity. These concepts should be exposed to primary, secondary and college level students so that our broad citizenry understands where we must go – and why we must evolve if our conservation lands are to remain highly productive. We started ICOET with a relatively narrow vision that a few biologist and ecologist had. This vision has transitioned into a better knowledge between transportation and ecological entities and between engineers, planners and biologists. The new challenge is to expand the limits of our knowledge to those who do not understand or realize the importance of wildlife, plant and aquatic habitat connectivity to future human and natural environments on our planet.

BIOGRAPHICAL SKETCHES

Bill Ruediger is a wildlife biologist and operates a transportation/wildlife consulting business: Wildlife Consulting Resources. He retired in 2006 after 35 years with the US Forest Service. His last position was the Ecology Program Leader for Highways, a National level position. Bill has worked with numerous State Departments of Transportation and resource agencies on wildlife habitat linkage analysis and designing effective wildlife crossings. Bill has successfully completed over 35 transportation/ecology projects since 2006. He has also worked with agencies or groups in Canada, Europe and Africa on wildlife crossings and transportation issues. Bill has authored or co-authored 32 published papers on wildlife, carnivores, aquatic organisms and highways. He, or the projects he has worked on, have received nineteen National and Regional awards including the “Environmental Leadership Award” from FHWA, the first time this award has been presented to a non-transportation agency person. He has a BS in wildlife management from Utah State University and a Master’s degree in Forestry from University of Idaho. He is a co-founder of the International Conference on Ecology and Transportation.

Sandra Jacobson provides specialized technical expertise and training on transportation ecology nationally. Affiliations include ICOET Steering Committee Member; National Academy of Science--Transportation Research Board Committee on Ecology and Transportation; expert panel member for the Congressionally-mandated report on animal/vehicle collisions; transportation task force member for the Western Governors’ Association Initiative on Wildlife Movement and Crucial Habitat; member of the Technical Advisory Committee for the

international ARC Wildlife Crossings Design Competition. A frequent conference speaker on road ecology, she developed and teaches the credited course called Innovative Approaches to Wildlife and Highway Interactions. She developed and edits the recently renovated Wildlife Crossings Toolkit website.

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