ECOLOGICAL CONNECTIVITY

GOAL

Provide or improve wildlife access and mobility across roadway facility boundaries and reduce vehicle-wildlife collisions and related accidents.

CREDIT REQUIREMENTS

Complete a site-specific wildlife assessment for the roadway project. Report the resulting impacts that the roadway has on surrounding major ecosystems, identifying all non-human life that is impacted by the roadway facility according to the best scientific knowledge available for the ecosystem. Both point scenarios below require approval of the project ecologist.

AND

Complete one of the two of the following options:

OPTION A - Existing Alignments ONLY (1 point)
Replace in-kind, retrofit, or upgrade any and all existing culverts and wildlife fencing structures deemed structurally deficient, damaged, obsolete, insufficiently sized, or otherwise inadequate.

OR

OPTION B - New and Existing Alignments (3 points)
Install new dedicated wildlife crossing structures and protective fencing (if needed) as recommended by the wildlife assessment. In addition, existing alignments must also replace in-kind, retrofit, or upgrade all existing culverts and fencing structures deemed structurally deficient, damaged, obsolete, insufficiently sized, or otherwise inadequate.

Details

Dedicated wildlife crossings are structural features of the roadway that are not used by motorized vehicles. Where deemed appropriate by an ecologist, crossings may be shared by non-motorized modes of transport. No points will be awarded in the following conditions:

1. For projects that maintain or rehabilitate existing ecological connections to out-of-date or current standards (i.e. routine maintenance of drainage culverts does not qualify).
2. Pre-existing ecological connectivity features: all new features or upgrades must be due to and completed as part of the roadway project.
3. Projects that add wildlife connectivity features where such features are clearly outside of the project context.
4. Projects located in a network that is systematically inadequate. However, points could be awarded for such projects where it is demonstrated that a program is in place at the owner-agency for systematic improvements on that network, and that this project fits this program.

EW-7

1-3 POINTS

RELATED CREDITS

- ✓ PR-1 Environmental Review Process
- ✓ PR-10 Site Maintenance Plan
- ✓ EW-6 Habitat Restoration
- ✓ AE-1 Safety Audit

SUSTAINABILITY COMPONENTS

- ✓ Ecology
- ✓ Experience

BENEFITS

- ✓ Restores Habitat
- ✓ Reduces Manmade Footprint
- ✓ Improves Access
- ✓ Improves Mobility
- ✓ Improves Human Health & Safety

DOCUMENTATION

1. Copy of the executive summary of the ecological study performed for the project. At minimum, this summary should contain:

   a. Site location map and site plan. Highlight locations, types and sizes of ecological connections in the facility.
   b. A list of non-human species identified. Include common name, Latin name, size, photos of the species, and highlight the largest species.
   c. The size of the connection required in order to accommodate the largest species identified above
   d. A list of planned new dedicated connections, new culverts and fencing to be installed, and any upgraded culverts and fencing installations.
   e. Signature of the project ecologist.

2. Photos of all culverts and fencing (new and upgraded, if any) and dedicated crossings after construction. Use a familiar object in the photo for scaling purposes (hammer, measuring tape, shovel, etc.) or provide scale on the image.

APPROACHES & STRATEGIES

- For existing projects, use roadkill data to identify key species in the project area. In addition, if underpasses or other similar structures exist for other purposes than ecological connectivity, monitor animal or aquatic organism movement through these passages.
- For new and existing projects, determine the makeup of animal populations in the area and migration patterns. Animal population data can be obtained from existing ecological records or by more traditional methods such as the analysis of tracks or other identifying animal features. Migration patterns can be predicted using GIS landscape data, GPS tracking collars, analysis of animal tracks, and most commonly through use of cameras along the proposed or existing roadway.

Example: Case Study - Banff National Park of Canada

Banff National Park in Canada Highway Fencing and Wildlife Crossings is an example of one of the first and most successful projects to accommodate terrestrial habitat connectivity. In response to high and rising traffic volumes, sections of the Trans-Canada Highway (TCH) have been upgraded from a two-lane to a four-lane divided highway in Banff National Park.

To reduce the negative impacts of a larger highway on wildlife populations in Banff National Park:

- Fencing has been installed on both sides of the twinned highway sections to prevent large animals from getting onto the highway. Vehicle-wildlife collisions have been significantly reduced.
- Wildlife underpasses and overpasses have been installed to connect vital habitats and help sustain biodiversity.
- In 1996, the highway mitigation research project began studying the impacts of roads on wildlife in terms of road mortality, wildlife movements and habitat connectivity in the Bow Valley. Research results are being applied in highway upgrade projects in the mountain parks and beyond, including other countries.

Examples of connectivity structures are shown in figures EW-7.1 and EW-7.2 below.

Figure EW-7.1: Wolverine overpass Figure EW-7.2: Deer using a bridge crossing
(http://www.pc.gc.ca/pn-np/ab/banff/docs/routes/sec3/page42_e.asp#redearth3)

For more information, visit: http://www.pc.gc.ca/pn-np/ab/banff/index_e.asp.

Example: Case Study – Interstate 90 Snoqualmie Pass East Mitigation Project

Interstate 90, which stretches across the northern United States, is currently undergoing a number of improvements along a five mile stretch between Hyak and Keechelus Dam including the addition of two lanes and a number of connectivity features. This stretch of highway is a vital corridor connecting eastern and western Washington State. To meet the ecological needs of the area, Washington State Department of Transportation has identified a number of Connectivity Emphasis Areas (CEAs) that link vital patches of aquatic or terrestrial habitat.

To facilitate connectivity across the roadway, these CEA's will feature:

- Bridges ranging from 120 to 900 feet in length as well as a number of culverts to preserve aquatic migratory ability and hydrologic function.
- Three over-road wildlife crossings combined with fences to direct animals to these locations.

For more information, visit: http://www.wsdot.wa.gov/Projects/I90/SnoqualmiePassEast/Default.htm.

POTENTIAL ISSUES

1. Identifying ecological connectivity requirements needs well-designed long-term studies. In many cases these may need to be conducted over multiple years.
2. Lack of ecological or species data.
3. Development conflicts with ecologically sensitive areas.
4. Design of connectivity structures that will be accepted and used by target organisms can be difficult.
5. For new projects, prior migration patterns and other animal and aquatic organism behaviors may be altered by the presence of the roadway. This should be carefully considered as a long term impact, especially during environmental review.
6. In general, cases where this credit may not be appropriate are rare, even in urban environments, but are heavily dependent on available ecosystem data. This data may not be available in urbanized ecosystems that are not closely monitored.
7. In rare cases, projects that have conducted an ecological study may determine that ecological connections will undermine the safety of human users.

RESEARCH

What is ecological connectivity?

Ecological connectivity is the relative ease with which dispersive and dynamic ecological processes (such as species migration, water movement, soil transmission, pollination, etc.) occur across various ecosystem boundaries (Interstate 90 Snoqualmie Pass Development Team 2006). In Greenroads, specifically, ecological connectivity refers to the movement of non-human organisms (wildlife and plant species) across various manmade ecosystem boundaries, such as roadways. An **ecological connection** is a deliberate attempt to provide a pathway for transmission of non-human life across, under, above, or through a roadway project footprint without impacting the safety of human users.

Consideration of and compensation for adverse effects on ecological connectivity are not specific requirements of the National Environmental Policy Act (NEPA) or state environmental laws. Instead, consideration of ecological connectivity is driven by stakeholders, regulatory and natural resource agencies such as the U. S. Army Corps of Engineers (USACE), Environmental Protection Agency (through Section 404 of the Clean Water Act), the U. S. Fish and Wildlife Service, federal land management agencies, or the state natural resources management agency.

Why is ecological connectivity important?

Migration ability is necessary to the survival of many species, and roads that disrupt vital habitat corridors have the potential to seriously debilitate an ecosystem. Animal crossing of traditional roads has huge costs in the form of human and animal life in addition to monetary losses. However, with careful planning, wildlife crossing can be effectively facilitated in a safe and non-disruptive manner. It is important to note that there is no single solution to every connectivity problem, and there is not necessarily a solution for every species that might be encountered on a project. When well researched and tailored to a specific project, connectivity features have the potential to create safer roads, improve habitat, and save money. Establishing or maintaining ecological connectivity for existing and new projects, respectively, will reduce the long-term ecological impacts of roads, help to sustain populations, and possibly reduce the need for legal protection for species.

Access & Mobility for Wildlife

Among the animal kingdom, there are few species that live in single, static ranges throughout their lifetimes. Suitable habitat for a specific species might only be found in small parcels throughout a region, which often forces a species to inhabit small isolated chunks of land. This population structure is defined as a **metapopulation**, or a group of small populations which make up the total population. Because of low **genetic variability** within these smaller populations, the threat of individual group extinction and the need for a constant food source, connectivity between different habitat patches is vital for the survival of many species (Freeman et al. 2005). Ilka Hansi, who extensively studied Glanville butterfly populations in one of the defining studies of population dynamics, concluded that the ability of smaller populations to be replaced by individuals from other groups is necessary to avoid extinction (Hanski, 1995).

Roadways and highways are long linear structures which can often separate animals from important destinations, resulting in a loss of ecosystem functionality for those that do not attempt to cross and a more direct hazard in the form of automobile collision for those that do. In the Appalachians, areas in which black bears commonly attempt to cross roads have significant mortality rates, while higher traffic roads deter bear crossing and force small, isolated populations threatened by low genetic variability (Donaldson 2007). In addition to terrestrial animals, population, genetic diversity, and long-term survival of many fish species can be significantly reduced by loss of migration ability, which can be hindered or prevented by typical culverts found at stream and river crossings. (Mirati 1999, Fitch 1995)

Human Safety

The crossing of roadways by animals has a very direct human cost as well. In 2002, an estimated 1.5 million collisions between automobiles and deer occurred in the United States, killing about 150 people and causing over $1.1 billion in vehicle damage. (Hedlund et. Al 2003) In this case, there is little threat to the survival of the species. In fact, the rapid growth rate of deer population indicates that this trend will worsen over time.

In most cases, the installation of wildlife passage structures has led to increased animal crossing and reduced collisions, and federal funding has been made available for such projects under the Transportation Equity Act of 1998. (Hartmann 2003) For mammal crossing the most effective crossing systems have been underpasses coupled with fencing to funnel animals to the appropriate point (Hedlund et. al 2003; Dodd et. al 2007). Important factors influencing the use of such underpasses include the height of the underpass, surrounding vegetation, and type of ground surface visible (Donaldson 2007; Dodd et. Al 2007). Underpass use is reported for deer alone in seven different states, and both underpasses and overpasses have been used to allow passage of elk, bear, panther, mountain goats, and salamanders (Hartmann 2003; Romin and Bissonette 1996). A series of underpasses and fencing on the newly reconstructed Arizona SR 260 is estimated to save $1 million dollars per year by preventing collisions (primarily with elk), which have been reduced 56% from 1992-1997 levels despite increased traffic volume. (Dodd et. Al 2007, Brown and Laird 1999) In Virginia, underpasses were effectively used by deer, raccoons, groundhogs, and a wide range of other mammals, birds, amphibians and reptiles, but were unable to allow the passage of black bears, one of the targets of the project. (Donaldson 2007) When properly researched and constructed, underpasses can provide critical passageways for animals, but there is no guarantee that a given population will be willing to use such structures without prior evidence.

Aquatic Connectivity

Culvert design for stream and river crossings can have an important impact on the ability of fish to successfully cross a roadway. High water velocities caused by steep slopes and narrowed flow are often impassable to certain fish species (Belford and Gould 1989). Because of this and other factors, the slope of a culvert plays a key role in the effectiveness of a crossing. Ideally, culverts will be placed at grade with the stream. Culverts at lower grade risk causing dangerous hydraulic jumps or outlet drops, while steep grades typically mean higher velocity flows (Fitch 1995). While bridges are the most effective way to eliminate impediment of fish travel, this is often a prohibitively expensive option. Well-designed culverts with controlled flow velocity placed at grade can successfully accommodate fish passage and are generally a more feasible alternative (Fitch 1995).

Additional Resources & Tools

- The most comprehensive review of relatively recent work for ecological connections and societal benefits is presented in a book called *Road Ecology: Science and Solutions* by R. T. T. Forman et al. (2003).
- The Federal Highway Administration's website called "Wildlife Protection and Habitat Connectivity" includes several hundred examples of projects implemented around the United States and Europe: http://www.fhwa.dot.gov/environment/hconnect/index.htm
- Current research, policy issues, and best practices are posted by North Carolina State University's Institute for Transportation Research and Education, Center for Transportation and the Environment "Wildlife Fisheries and Transportation Web Gateway" http://www.cte.ncsu.edu/cte/gateway/home.asp

GLOSSARY

Ecological connection	A deliberate attempt to provide a pathway for transmission of non-human life across, under, above, or through a roadway project footprint without impacting the safety of human users
Ecological connectivity	the movement of non-human organisms (wildlife and plant species) across various manmade ecosystem boundaries, such as roadways
Genetic diversity	The number of different kinds of genes that exist within a population or group. Populations with low genetic diversity are less likely to be able to adapt to changing environmental pressures and are therefore at higher risk of extinction.
Metapopulation	A population consisting of a number of smaller dispersed populations. Individual organisms typically move between smaller groups to maintain a healthy ecosystem.

Migration	Either a one time or repeating movement of a population from one range of habitat to another.

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