# Sustainable Mobility: Mitigating the Impact of Road Transport Infrastructure on Wildlife

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**Roads and traffic cause many casualties among the wildlife population *(illustration 1)*, in a range from hundreds of thousands to several hundred million animals annually depending on the country. This is an increasing global concern because global road expansion continues at an unprecedented rate and will mostly be concentrated in low-income countries where many of the planet's most biologically rich and environmentally important ecosystems are situated.**

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This issue is a major focus of PIARC TC3.4 *Environmental Sustainability in Road Infrastructure and Transport*, particularly of its working group 3.4.3 which has been investigating this topic during the 2019-2023 cycle in collaboration with Transport Canada.

While road infrastructure plays a crucial role in local, regional, and global economies, roads inevitably alter landscapes through space and time resulting in long-lasting effects. As people came to understand that roads have environmental impacts, a field of study emerged in the later half of the 20$^{th}$ century – the science of road ecology. **Road ecology** quantifies the extent and magnitude of ecological effects from road infrastructure and proposes solutions to mitigate them *[1]*.

Road ecology *(illustration 2)* provides valuable insights and considerations during the **Environmental Impact Assessment** (EIA), which is a process that examines all potential environmental consequences resulting from the implementation of a project *[2]*. It is important that environmental expertise agencies, such as ecologists, work in coordination with road planners and designers at every stage of the project cycle, starting right from the beginning. The EIA will evaluate which combination of mitigation measures will likely be the most effective given that they may not all be equally effective and may have differential effects on different species. The EIA should recommend **mitigation measures** that reduce as much of the environmental impacts as possible so that a project has the least adverse effects *[2]*.

*Illustration 1 – Animal mortality due to traffic*

## THE MITIGATION HIERARCHY: HOW TO MANAGE BIODIVERSITY RISK

The **Mitigation Hierarchy** is a systematic approach that fully integrates environmental considerations into road development. It is widely regarded as a best practice approach to manage biodiversity risk. This approach seeks to first avoid, then reduce, then restore or rehabilitate, and finally—when the previous options are exhausted—offset or compensate for road impacts to achieve "no net loss" in biodiversity *[2, 3, 4] (illustration 3)*:

- **Avoidance:** prevent environmental impacts by excluding them from project site consideration, e.g., full-site protection through project relocation or redesign.
- **Reduction:** minimise environmental impacts as far as it is practically feasible by reducing the duration, intensity or extent of activities that cannot be completely avoided, e.g., strategic habitat retention.
- **Restoration/rehabilitation:** leave affected areas, in which impacts could not be avoided or reduced, in

comparable or better conditions than prior to the project's activities, e.g., recovery of degraded habitats (Restoration/Rehabilitation is considered as Reduction measure in Europe).
- **Offsetting/compensation:** compensatory measures taken to offset any significantly adverse residual impacts that could not be avoided, reduced (and restored/rehabilitated) so that there is no net biodiversity loss or there is a net biodiversity gain, e.g., translocation and/or reintroduction of species.

Generally, greater emphasis is placed on the earlier steps of the Mitigation Hierarchy particularly when there are high value biodiversity components at play to reduce the risk of losing them *[2]*. In its application, there is no universally accepted consensus as to how or when to advance through this approach. The key is to have open discussions with stakeholders to establish consensus on when it would be appropriate to move to the next level of the hierarchy. The following would be important considerations for such discussions *[3]*:

- The importance or value of the biodiversity in question.
- The extent to which the biodiversity in question can be substituted or replaced using known techniques.
- The level of investment or effort associated with the different steps and whether this is proportional and appropriate to the benefits that would be gained for biodiversity.
- The benefits that would be gained for biodiversity in relation to the costs incurred in applying different steps of the Mitigation Hierarchy.

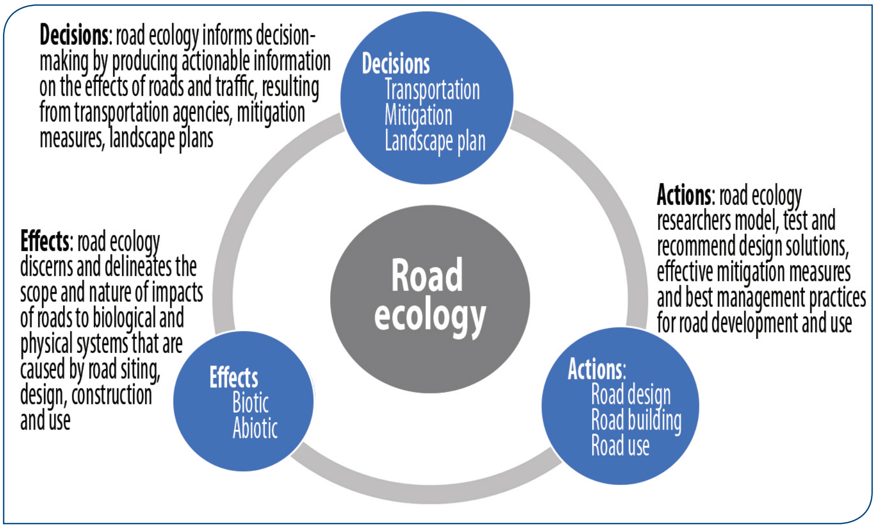


*Illustration 2 – Conceptual framework of road ecology (adapted from [1])*

## MITIGATION MEASURES: WHAT CAN BE DONE TO MINIMISE ROAD EFFECTS ON BIODIVERSITY

Transportation infrastructure severely modifies and fragments habitats, which cause biodiversity loss and environmental degradation. To mitigate the impacts of road infrastructure on habitats, measures can be taken to directly provide links between fragmented habitats along with those that aim to improve road safety and reduce the impacts of traffic on animal populations by reducing traffic-related mortality *[5] (illustration 4)*. Mitigation measures can involve a combination of these and can potentially minimise the effects of roads depending on their purpose and the biodiversity present in the area. However, the presence of mitigation measures in a proposed road project does not necessarily mean that all effects will have been mitigated and that the road project should go ahead *[2]*.

### Reducing mortality

The following measures are aimed at reducing the roadkills (or Animal Vehicle Collisions - AVC) number, thereby preventing the local extinction of vulnerable populations. For specifics as to how to design and build them, there are various handbooks available *[5, 6]*.

- **Fences**: physical barriers that reduce the mobility of fauna across transport infrastructure and designed to guide wildlife to the fauna passage.
- **Warnings**: driver signs to influence road users to change their behaviour by decreasing their speed and increasing their attention in the hope of reducing the risk of AVC.

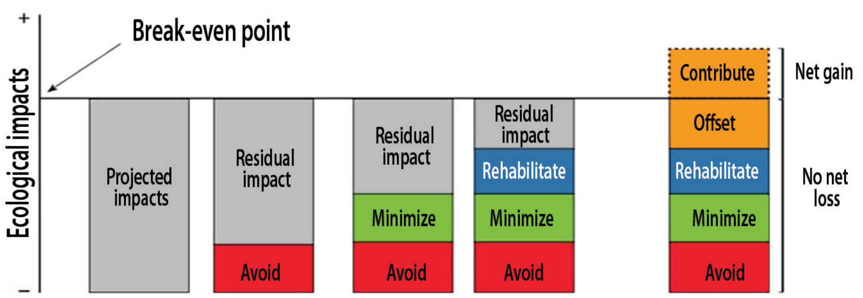


*Illustration 3 – Mitigation Hierarchy ([2] adapted from [3 and 4])*

- **Wildlife deterrents**: signals or cues intended to cause fear or discomfort in animals in order to trigger an increased alertness or flight response.
- **Clearing vegetation**: removal of road verge to improve visibility of animals at verges to drivers, which may reduce the number of AVC.
- **Choosing and planting vegetation**: selection of plants along the road verges that are unattractive to

animals (while avoiding or limiting the introduction of invasive alien plant species), which may help reduce the risk of AVC.

- **Noise screens**: barriers constructed along roads close to human dwellings to reduce the traffic noise for the human residents though there are some built to protect avian breeding colonies.
- **Earthen mounds**: raised structures on the road verges to simulate a "buried road" in order to create a flight corridor above the traffic to reduce the mortality risk of flying vertebrates.
- **Adaptation of kerbs and drains**: modifications to road infrastructure components that can help small animals escape these structures where they often become trapped and die.
- **Adaptation of road lighting**: modifications to road infrastructure lighting to limit its contribution to habitat fragmentation and its effects on biodiversity (i.e., nocturnal species).
- **Carcass removal**: the removal of roadkill so that it does not attract scavengers to roadsides putting them at risk of AVC.

## Providing links

While the measures described below also aim to reduce wildlife roadkills, they likewise support efforts in biodiversity conservation, namely, restoring some ecological connectivity interrupted by a road infrastructure. **Ecological connectivity** is the "*unimpeded movement of species and the flow of natural processes that sustain life on Earth*" *[6]*.

The magnitude of the impact of roads on biodiversity is highly dependent on road characteristics. (e.g., traffic density and infrastructure type) and the species in the affected area (e.g., mobility and behaviour towards traffic and modified habitats). Restoring ecological connectivity across roads involves providing crossing structures that wildlife can use to get from one core natural area to another (i.e., (re)connect fragmented landscapes).

Wildlife passages fall into two categories: those that cross over the transport infrastructure (overpasses) and those that cross under the transport infrastructure (underpasses). Choosing an overpass versus an underpass depends on many factors such as local topography, landscape, the requirements of the target species, the habitats being connected and budget.

**Overpasses** are generally large structures over the road infrastructure (e.g. motorway), connecting to separated habitats on each side of the infrastructure:

- **Landscape overpasses (ecoducts, green bridges)** are structures over transport infrastructure that connect habitats on both sides of said infrastructure enhancing ecological connectivity at the ecosystem level.
- **Wildlife overpasses (fauna overpasses)** are structures over transport infrastructure that connect habitats on both sides of said infrastructure specifically providing a safe crossing point for wildlife at the population/ metapopulation level.
- **Multiuse overpasses** are structures built over roadways that combine human and wildlife use.

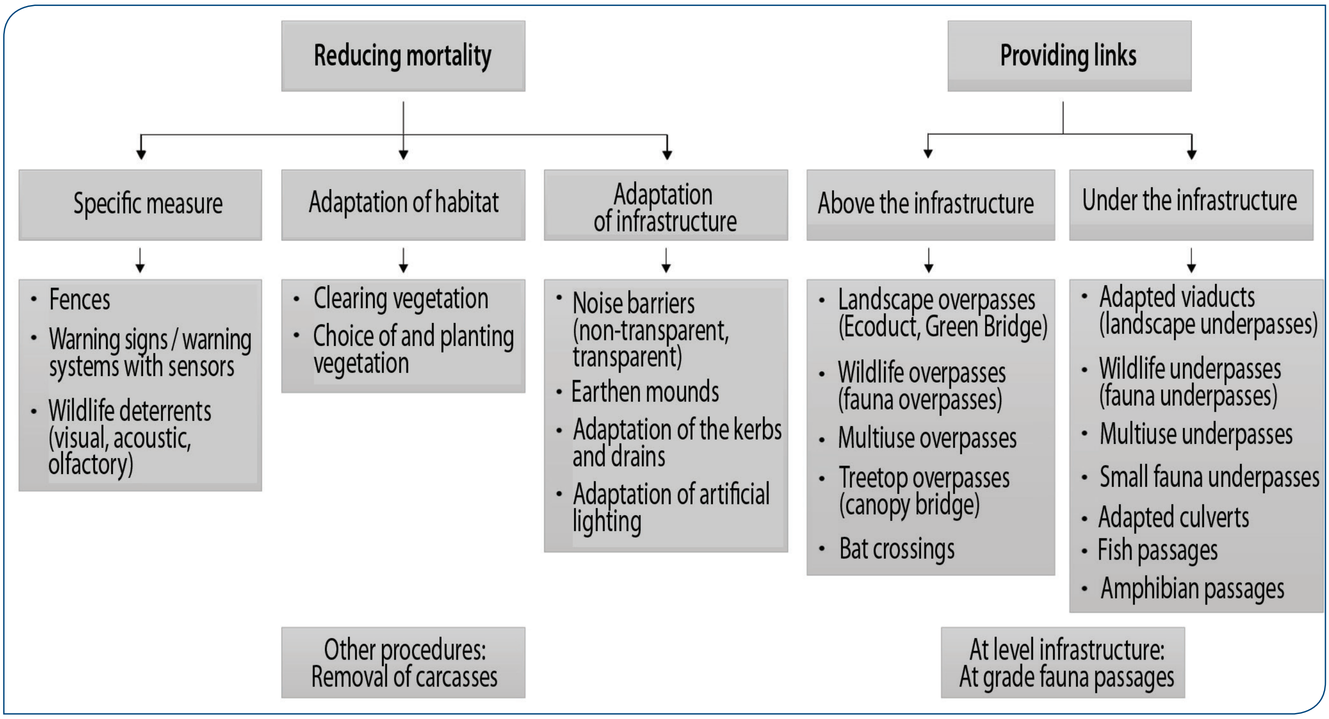


*Illustration 4 – Measures to mitigate habitat impacts on wildlife (adapted from [5 and 6])*

*Illustration 5 – Banff National Park's Wildlife Crossings Project: Wildlife Overpass*
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- **Treetop overpasses (canopy bridges)** are designed either by trees, rope-like ladders or walkways for climbing and/or arboreal species to allow them to cross the transport infrastructure above the traffic.
- **Bat crossings** are apparatuses designed to facilitate safe passage over transport infrastructure for bats who particularly follow landscape elements such as trees.

**Underpasses** are generally structures under the transport infrastructure, which are built mainly for drainage or human use. However, they can be adapted to connect separated habitats (e.g., aquatic ecosystems) on each side of the infrastructure:

- **Adapted viaducts (landscape underpasses)** are large transport infrastructures supported by pillars or arches that enable the preservation of ecological corridors or ecosystems associated with floodplains and river valleys below the structure.
- **Wildlife underpasses (fauna underpasses)** are structures constructed under transport infrastructure with lower traffic volumes than viaducts that provide safe crossing points for wildlife such as ungulates or large carnivores.
- **Multiuse underpasses** are structures constructed under road infrastructure that combine human and wildlife use.
- **Small fauna underpasses** are structures built under transport infrastructure and are designed specifically for small animals, included bats.
- **Adapted culverts** are culverts that allow water streams and/or drainage to flow under transport infrastructure but also have modifications to enable aquatic and terrestrial wildlife crossings.
- **Fish passages** are structures that are specifically designed (or adapted from viaducts or culverts) to preserve the connectivity of aquatic ecosystems and allow the free movement of aquatic species both upstream and downstream.
- **Amphibian passages** are small structures designed and constructed in close proximity to each other to allow the movement of amphibians across roads.

**At grade fauna passages (level crossings)** are at level infrastructures in areas where overpasses (or underpasses) cannot be constructed to facilitate ungulate crossings.

## MITIGATION MEASURES IN PRACTICE: A SUCCESS STORY

The Trans-Canada Highway runs through the Rocky Mountains in Banff National Park. It was built without the expectation that it would be a major road artery. As traffic increased over time, so too did highway-related wildlife mortality.

In the 1990s a solution was proposed by the Parks Canada Agency – the construction of wildlife crossings to mitigate AVC and restore critical habitat and migration routes that had been fragmented by the highway *(illustration 5)*. These now iconic structures, combined with fencing to keep animals off the road, have reduced AVC by more than 80% *[8]*. They have also helped maintain genetic diversity in wildlife populations by reconnecting fragmented habitats.

Since 1996, the Parks Canada Agency has been monitoring wildlife movement at these crossings making it longest ongoing wildlife crossing research and monitoring program in the world. This program has been able to demonstrate that different species have different crossing preferences, for instance, ungulates prefer overpasses while large carnivores and some omnivores prefer underpasses. The information gathered from this program can help identify future wildlife crossing structure locations.

Banff National Park's Wildlife Crossings Project is one of Canada's biggest conservation success stories as it is the largest road transportation infrastructure mitigation complex in the world. The project has expanded to include 6 overpasses and 38 underpasses *[8]*. The success of the project and its research and monitoring program has positioned the Parks Canada Agency as "best practice" in road ecology.

## CONCLUSION

Road networks and traffic generate many positive benefits, such as economic growth and connecting peoples; however, they also have significant negative impacts especially on biodiversity and ecosystems. While roads are undoubtedly necessary in most cases, there is a need to mitigate their adverse effects. Road ecology provides a useful lens to describe the scope and nature of road infrastructure impacts; to model, design, and test strategies and solutions to mitigate impacts; and to provide information for decision-making. Soon before a road construction, it is critical to have open discussions between environmental experts and road planners and designers to determine what will be the most effective and appropriate measures to mitigate as much of the impacts of the road as possible.#

## REFERENCES


[1] Coffin, A W., Ouren, D.S., Bettez, N.D., Borda-de-Água, L., Daniels, A.E., Grilo, C., Jaeger, J.A.G., Navarro, L.M., Preisler, H.K., and Rauschert, E.S.J. 2021. The Ecology of Rural Roads: Effects, Management, and Research. Issues in Ecology (23). Washington DC, US: Ecological Society of America.

[2] Quintero, J. D. 2016. A Guide to Good Practices for Environmentally Friendly Roads. Arlington, Virginia, US: The Nature Conservancy–Latin America Conservation Council.

[3] Business and Biodiversity Offsets Programme (BBOP). 2009. Biodiversity Offset Design Handbook. Washington, DC: Forest Trends.

[4] PricewaterhouseCoopers LLP. 2010. Biodiversity Offsets and the Mitigation Hierarchy: A Review of Current Application in the Banking Sector. On behalf of the Business and Biodiversity Offsets Programme and the UNEP Finance Initiative. London.

[5] Luell, B., Bekker, G. J., Cuperus, R., Dufek, J., Fry, G., Hicks, C., Hlaváč, V., Keller, V., B., Rosell, C., Sangwine, T, Tørsløv, N., Wandall, B. le Maire, (Eds.) 2003. COST 341—Habitat Fragmentation due to Transportation Infrastructure. Wildlife and Traffic: A European Handbook for Identifying Conflicts and Designing Solutions. Brussels: European Co-operation in the Field of Scientific and Technical Research.

[6] Infrastructure and Ecology Network Europe (IENE). 2022. '7 Solutions to reduce transport infrastructure impacts on wildlife.' Wildlife & Traffic A European Handbook for Identifying Conflicts and Designing Solutions. Paris, France: IENE. https://handbookwildlifetraffic.info/ch-7-solutions-to-reduce-transport-infrastructure-impacts-on-wildlife

[7] Convention on Migratory Species (CMS) (2020). Ecological Connectivity. Convention on the Conservation of Migratory Species of Wild Animals. https://www.cms.int/en/topics/ecological-connectivity.

[8] Parks Canada Agency. 2022. Wildlife crossing structures and research: Banff National Park. *https://parks.canada.ca/pn-np/ab/banff/nature/conservation/transport/tch-rtc/passages-crossings*