

Note: In relation to ecoducts and underpasses (fauna passages), the location has to be decided on the basis of sound knowledge regarding animal movements and the distribution of important habitats. Often topography and landscape structure can help to identify likely migration routes such as valley bottoms, streams, hedgerows, and continuous woodland and forest. Fauna passages should be well connected to the surroundings, either by way of habitat corridors leading towards passages for small animals or by way of guiding lines for larger ones. The required density of corridors depends on game abundance and population densities and on the behavioural characteristics of the animals living in the habitats affected. The placement of corridors should be defined together with ecologists and wildlife managers from the area.

Compensation

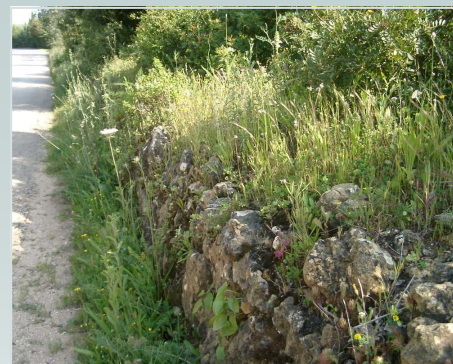
Where mitigation is insufficient or significant residual impacts remain, compensatory measures should be considered as a last resort. Compensation measures seek to compensate for loss and degradation of natural biotopes by re-creation of the lost areas elsewhere in the landscape, and by enhancement of the ecological infrastructure and quality of the surrounding landscape. Re-creation of new wildlife habitats must seek to resemble the destroyed ones in a qualitative and functional way. Full re-creation of habitat is largely not possible; however, the overall effect can be lowered if structures and features in the landscape can be adjusted to enhance the ecological continuity of the landscape.

Roads as ecological corridors

Areas adjacent to infrastructure are highly disturbed environments and such areas can often be hostile for some wildlife species. Yet, if properly designed and managed, they can still provide attractive resources such as shelter, food or nesting sites, and facilitate the spread of species along the direction of the road. In heavily exploited landscapes, roadsides can provide valuable refuges for species that otherwise could not survive.

Many plant and animal species in Europe that associate with traditional (and now rare) grassland and pasture habitats, may find a refuge in the grassy roadsides along motorways and railways, particularly if roadside management includes frequent mowing with hay removal. Bushes and trees that are planted along motorways as 'noise and visual screening' to reduce the effect of disturbance to people living nearby, can provide valuable nesting sites for birds and small mammals, and also offer food and shelter for larger species.

In addition, associated technical measures along infrastructure can provide attractive habitat elements for wildlife. For instance, stonewalls and drainage pipes under motorways in Catalonia, Northeast Spain, are often populated by lizards and wall geckos (*Tarentola mauritanica*). Cavities in the rocky embankments of railways may be used as shelter and breeding sites by lizards. Bats may find noisy but secure resting sites underneath bridges. However, it has to be emphasized that roadsides may provide important habitats or habitat elements for wildlife, but primarily for less demanding and generalist species that can cope with disturbance and pollution from the road and that are not sensitive to increased mortality due to traffic. These benefits do not therefore outweigh the damaging impacts of roads and other transport infrastructure in fragmenting habitat and disrupting the movement of wildlife.



ECOLOGICAL NETWORKS in TRANSPORT

Working together
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dam
road
link wa-
ter sea
nature fish
agriculture
walking path
forest bridge
river water bog
biodiversity buffer
zone tourism tree
ecological corridor
feeding ponds region
ecology policy dams sus-
tainable development resto-
ration area flower bat
ecosystems core area bird
transport law butterfly plants
connectivity highway urban frog-
tunnel spatial planning earth future



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Photographs: ECNC

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Why are ecological networks important?

Natural areas provide vital goods and services for people and make a significant contribution to human well-being. Finding a balance between maintaining biodiversity¹ and natural areas and providing space for human activities is one of the greatest challenges of the 21st Century.

There are large areas of land in Europe where many birds, mammals, insects and plants have vanished or are under threat of local disappearance or even extinction because the habitats that they rely on have become fragmented and broken into small, disconnected parts. The patches of habitat that are left are no longer large enough to sustain viable populations of many species. The causes of this problem include the intensification of agriculture, built development and transport and other infrastructure. Roads in particular have had a major impact in fragmenting habitats. To improve this situation, existing areas of habitat should not be allowed to become fragmented and patches of habitat should be reconnected by ecological networks (corridors, linkages).

Ecological networks connect areas of habitat and allow animals and plants to move through the countryside. This movement may be an important factor in assisting the survival of many species in relation to changes in land use patterns and climate. As well as being vital for the functioning of ecosystems, ecological networks and corridors, greenways and landscape linkages can also have aesthetic value and contribute to an attractive living and working environment. They have important recreational and tourism value and can provide further economic benefit by protecting property and businesses from environmental impacts or as a source of food, fuel and building materials.

Policy relevance

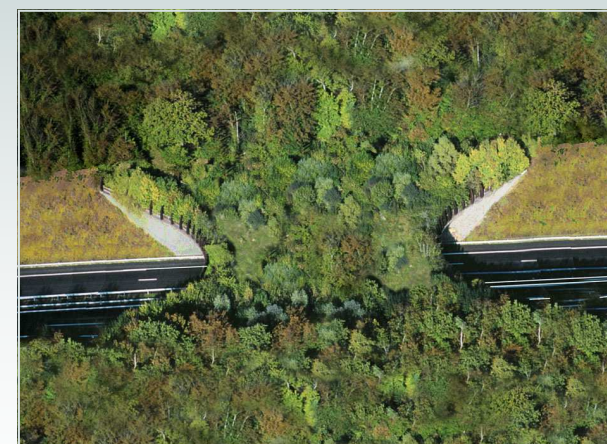
The development of ecological networks and corridors is recognized as an effective policy instrument for promoting nature conservation both at the European and global levels. The following policy instruments acknowledge the importance of enhancing connectivity at Pan-European level:

- The Pan-European Biological and Landscape Diversity Strategy (PEBLDS, 1995) calls for the conservation of biodiversity in Europe by promoting the establishment and the maintenance of a Pan-European Ecological Network (PEEN).
- The Habitats Directive (1992) and the Birds Directive (1979) acknowledge the importance of habitat connectivity.
- In 1997 the Infra Eco Network Europe (ENE) identified the need for co-operation and exchange of information in the field of fragmentation.
- The Intergovernmental framework for European Cooperation in the field of Scientific and Technical Research (COST) has the task to address the issues associated with habitat fragmentation due to transportation infrastructure; its actions include publications and organising international workshops as a means for collecting and disseminating knowledge.



Influence of road construction and transport

Motorways may consume more than 10 ha of land per kilometre of road. Narrow country roads occupy less area per kilometre, but as these roads are more frequent than motorways, their combined effect in the landscape can be considerably larger. If all associated features, such as roadsides, embankments and slope cuttings, parking places, gas stations and pedestrian's walkways are taken together the total area designated for transport is several times larger than the paved surface of the road.



¹ Biodiversity refers to the variety of life on Earth. It covers everything from polar bears to oak trees, green algae to grasslands. Once lost, species can never be replaced and fragile habitats may take decades to re-establish.

Infrastructure affects nature in both direct and indirect ways:

- The physical presence of roads and railroads in the landscape creates new habitat edges, alters hydrological dynamics – the movement of water above – and underground disrupts natural processes and impacts on habitats.
- Road maintenance and traffic contaminate the surrounding environment with a variety of chemical pollutants and noise, and roadside illumination provides 'light pollution' that can confuse many animals and disrupts their migration patterns.
- Infrastructure and traffic impose dispersal barriers to most non-flying terrestrial animals, and vehicle traffic causes the death of millions of individual animals per year.
- Collisions between vehicles and wildlife are a growing problem not only for species conservation and game management, but also for traffic safety, private and public economy.

Actions to minimise the impacts of roads on wildlife

To minimize the impacts of roads, the following priorities should be set: avoidance – mitigation – compensation.

Avoidance

The most favourable solution is to avoid having to cross valuable natural habitats when constructing new roads; when this is not possible the route that leaves the greatest unbroken area of habitat untouched is preferable. The basic philosophy is that avoidance is better than cure in avoiding the negative effects of habitat fragmentation.

Mitigation

Where avoidance is not possible or impractical, mitigation measures should be designed as an integral part of the road (or other infrastructure) construction scheme. Mitigation measures are usually restricted to the road corridor and seek to avoid or reduce immediate disturbance and barrier effects by means of technical and ecological improvements of road and its surroundings.

Mitigation measures are necessary where:

- a road, a waterway or railway line results in significant damage or loss of special habitats, communities or species;
- infrastructure affects species particularly sensitive to barriers and traffic mortality;
- connectivity between habitats in the wider countryside is significantly impaired by the infrastructure development;
- other, less costly measures are unlikely to be effective;
- the road and/or railway line is fenced along its length.



Types of measures to mitigate habitat fragmentation

Above the infrastructure:

- wildlife overpasses and landscape bridges—'ecoducts';
- viaducts and river crossings.

Below the infrastructure:

- underpasses for animals;
- modified and multifunctional underpasses;
- fish passages;
- amphibian tunnels;
- modified culverts.

Specific measures:

- fences;
- artificial deterrents;
- warning signs, warning systems with sensors.

Adaptation of habitats:

- clearing vegetation;
- planting vegetation.

Adaptation of infrastructure:

- noise barriers;
- adaptation of the kerb;
- escape ramps from drains;
- artificial lights;
- fauna exits in waterways.

