

Sustainable Infrastructure – A Matter of Mobility

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MOBILITY IS KEY

Mobility is fundamental – it is not only essential for economic development but an intrinsic property of life itself. Modern economies, markets and societies depend heavily on the mobility of people and goods. Mobility ensures access to resources, enables trade and the exchange of labor, knowledge, and capital. Likewise, wildlife populations and biodiversity per se strongly depend on the mobility of individuals and genes. Mobility allows access to food or mates and ensures the survival and propagation of both individuals and populations. Without mobility, trade stagnates, economies falter, and populations dwindle. Recognizing the significance of mobility is pivotal in understanding its far-reaching impact on the many aspects of life.

European transport policies¹ therefore aim at unifying transport arenas, developing corridors for fast intermodal transport, and de-mounting legal, technical, and physical barriers to ensure efficient mobility. In the same spirit, European environmental policies² seek to develop and restore green and blue infrastructures that connect important terrestrial and aquatic biodiversity areas. However, transport (grey) and ecological (green & blue) infrastructures do rarely go along well. Every so often, both networks intersect and compete for the same space. As a result, millions of animals are killed in traffic, migratory movements inhibited, ecosystem processes disrupted, and landscapes fragmented; all contributing to the ever-growing loss of biodiversity. According to IPBES [1], the intergovernmental science-policy platform for biodiversity and ecosystem services, transport infrastructure is indeed one of the most important drivers in the loss of biodiversity. Given the anticipated growth in transport demand, and infrastructure development, caused by growing populations and improved living standards, the prospects for 2050 are dark if business as



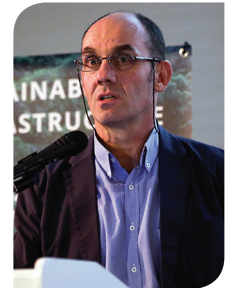
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usual prevails and the transport sector continues to be ecologically unsustainable [1]. Comprehensive actions to prevent social, economic, and ecological disasters are urgently needed – and the transport sector holds one of the keys in this development [2].

There is ample evidence from around the world on how roads or railways affect biodiversity [3, 4, 5]. They cut through important wildlife habitats, increase death rates in local populations, and prevent individuals to immigrate and repopulate vacant areas. Populations separated by busy infrastructure may diverge genetically, suffer from inbreeding, and eventually die out. In addition, natural habitats adjacent to infrastructure are disturbed by traffic noise, light, and pollution, which further reduces living conditions for many species. Some disturbance factors spread even farther into the surrounding landscape, affecting ecosystems (and people) at large scale. The combined ecological footprint of these disturbances, also called the “Road effect zone” [6], together with barrier effects, traffic mortality and habitat loss cause a fragmentation of the landscapes into smaller, isolated, and less suitable patches that support fewer wildlife and less biodiversity [7].

REMEDIES FOR FRAGMENTATION

The most effective way to minimize habitat fragmentation is to avoid it from the start. When planning new infrastructure, it is important to avoid sensitive and large contiguous natural areas, especially if they are still roadless [8]. Alternative solutions such as upgrading existing roads or rerouting traffic may prove to be sufficient or even more cost-effective. Where new infrastructure is to be built, the primary remedy for fragmentation is to maintain connectivity between separated habitats and ensure

¹ Trans European Transport Network: https://transport.ec.europa.eu/transport-themes/infrastructure-and-investment/trans-european-transport-network-ten-t/ten-t-revision_en

² European Biodiversity Strategy 2030: https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en

the ecological permeability of infrastructure barriers. Standards for design of ecologically sustainable infrastructure are being developed and should be implemented particularly in emerging economies experiencing a surge in new infrastructure investments [10, 12].

The second remedy involves enhancing the suitability of areas linked to and governed by transportation infrastructure to serve as additional habitats and movement corridors. This can bolster the resilience and survival of wildlife populations, even in the face of existing fragmentation challenges.

The third remedy is to reweave the fragmented landscape at large by restoring and protecting habitats and create ecological networks at a broad scale. This remedy extends beyond the sole responsibility of the transport sector, necessitating collaboration among a diverse array of stakeholders and specialists. This collaborative effort should involve infrastructure managers, landowners, engineers, and ecologists. By fostering collaboration, it becomes possible to develop practical and context-specific solutions for local challenges that align with broader landscape-level mitigation strategies. A successful implementation will require strong incentives for investing in mitigation measures and creating opportunities for enacting transformative changes. However, the urgency is palpable, particularly in Europe, a highly fragmented region, where the need for rapid, innovative, and sustainable solutions is of paramount importance (illustration 1).

Incentives are indeed provided at both practical, legal and political levels. For example, the «Global Biodiversity Framework»³ adopted at COP15 of the Convention on Biological Diversity (CBD) in Montreal, highlights the need to preserve the integrity of all ecosystems. This requires caring about the remaining «natural» ecosystems but also an increased concern for the integrity and connectivity of ecosystems that are already affected

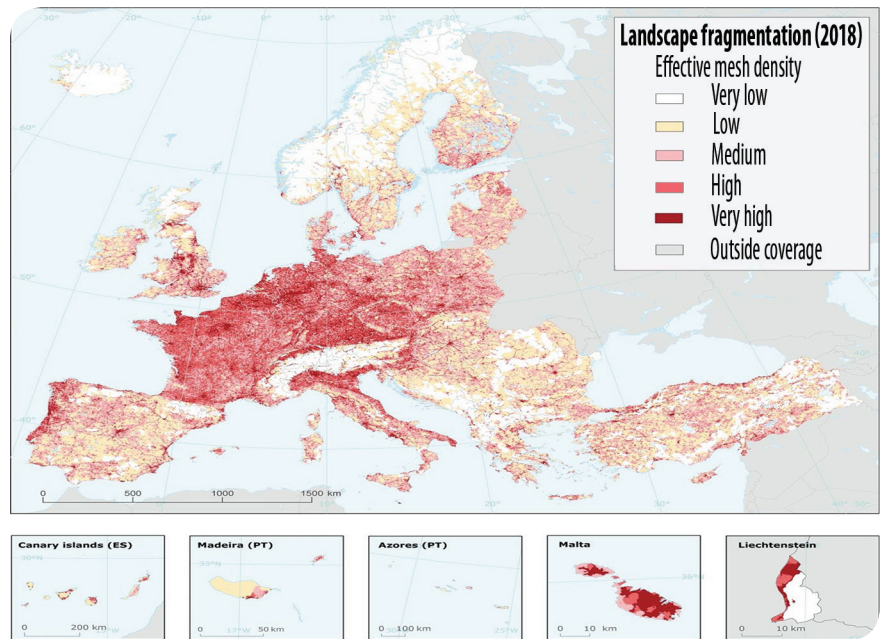


Illustration 1 - Landscape fragmentation in Europe – major and medium anthropogenic fragmenting elements [7] © Authors

by transport infrastructure, urbanization, and agriculture. The UN Decade on Ecosystem Restoration⁴ goes even further, it aims to prevent, halt and reverse the degradation of ecosystems – not only to prevent further loss of biodiversity but also to reduce poverty and combat climate change. In Europe, the recent «EU Biodiversity Strategy for 2030: bringing nature back into our lives»⁵ provides a comprehensive, ambitious and long-term plan with specific actions and commitments to protect nature and reverse the degradation of ecosystems. This is even more important with respect to global warming and its induced changes in ecosystems that trigger migrations of animals and plants. The strategy is a key pillar of the European Green Deal⁶ and aims at mobilizing €20 billion per year for biodiversity actions in Europe. Further juridical incentives are provided in the European Habitats Directive⁷ that was adopted already in 1992 and obliges all Member States to establish a strict protection regime for the already rare and endangered species listed in Annex IV, and to protect over a thousand species, including mammals, reptiles, amphibians, fish invertebrates, and plants, as well as 230 characteristic habitat types. The harmonized co-existence of a pan-European nature network (TEN-N) and a pan-European transport network (TEN-T) is a great challenge for the current decade of ecosystem restoration.

In addition, economic incentives to mitigate fragmentation include measures to prevent animal-vehicle collisions and increase traffic safety. Bird strikes on airports as well as vehicle collisions with larger ungulates such as moose, deer, or wild boar, have become common place in many European countries. For example, recent estimates suggest that over 70,000 accidents with ungulates occur on Swedish roads per year, producing a societal bill of about 1 billion

³ Kunming-Montreal Global Biodiversity Framework <https://www.cbd.int/gbf/>
⁴ The UN Decade on Ecosystem Restoration: <https://www.decadeonrestoration.org>
⁵ EU Biodiversity Strategy 2030: <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1590574123338&uri=CELEX%3A52020DC0380>
⁶ European Green Deal: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en
⁷ European habitats Directive: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A01992L0043-20130701>
⁸ European Commission (2019): Green infrastructure: https://environment.ec.europa.eu/topics/nature-and-biodiversity/green-infrastructure_en#reports

Euro, as well as many hundreds of injured people and several human fatalities. Accidents with ungulates stand for over 60% of all police registered traffic incidents and are also a major cause of train delays. Similar numbers are reported from other countries such as Germany or France and the trends point upwards, suggesting that the problem will continue to grow. Even though over 95% of these accidents only lead to property damage, the combined societal costs are significant and often large enough to justify the installation of mitigation measures. Accidents with smaller or rare species are less likely to produce direct economic impacts through vehicle damages but may counteract conservation efforts made in other sectors (e.g., agriculture, forestry) and may provoke compensatory fees.

IMPROVING ECOLOGICAL PERMEABILITY OF INFRASTRUCTURES

Securing infrastructure by creating and maintaining safe fauna passages combined with wildlife exclusion fences, is the most effective way to reduce accidents while maintaining animal mobility [9]. Thousands of passages have already been installed in Europe and many other countries worldwide [3]. Some are especially designed for single species or groups of species, such as amphibian culverts, crab bridges, tree-top passages, while others are adapted to a variety of species, often with

large mammals as target species. Large passages such as ecoducts provide even sufficient space to support entire habitats with a multitude of plant and animal species (illustration 2). Many wildlife crossing structures serve multiple purposes, i.e., they include passages for people, vehicles, or water. Even conventional bridges built only for local roads or trails may sometimes be used by wildlife, and small adjustments may often increase their usage. Adequate and inclusive planning of bridges will hence provide ample opportunities to support animal mobility at rather small extra costs. Further opportunities for wildlife adaptations derive from technical or safety requirements to repair, upgrade or replace aging structures.

In addition, culverts and bridges over rivers are increasingly subject to necessary climate change adaptations and will be replaced by larger and more robust constructions that withstand higher water levels and flooding events. All this provides significant opportunities to repay the debt of previous infrastructure developments and work actively towards reconnecting landscapes that long have been fragmented by infrastructure. This remedy is urgently needed because also wildlife needs to adapt to the effects of climate change on landscapes and habitats. A warming climate alters living conditions profoundly and will force many wildlife species to roam over larger areas or move to still suitable habitats. Their need for enhanced mobility must be met with coherent ecological corridors and with more and better crossing structures. As



*Illustration 2 - Ecoduct near Barnekow across the A20 in northern Germany
The bridge reconnects grassland and shrub habitats that have been recreated on both sides of the motorway
© DEGES, René Legrand, <https://www.deges.de/projekte/projekt/vde-10-a20/>*

stated above, we urgently need to reweave the ecological network that supports biodiversity in our landscapes⁸. And the transport sector, if any, is probably the one that is best suited to understand and integrate this need into its scope.

REPAIRING FRAGMENTED LANDSCAPES

As well as enabling species to adapt to climate change, infrastructure can also play a direct role in combating the decline in pollinators on which three quarters of the world's food crops, including fruit, vegetables, seeds, nuts, and oils, depend. The annual value of global crops directly affected by pollinators may exceed US\$235 billion. However, estimates indicate that the abundance

of pollinators, especially in lowland areas, has dropped by at least 70% to 80% in the past few decades. According to the first global assessment of pollinators by the IPBES in 2016⁹, this decline threatens millions of livelihoods and hundreds of billions of dollars' worth of food supplies.

There are more than 20,000 species of wild bees alone, plus many species of butterflies, flies, moths, wasps, and other animals that contribute to pollination. These species also provide a staple food for many larger species including birds and mammals. Declining pollinator abundances thus have cascading effects on many other species and ecosystems. Key measures to protect and recover pollinators are providing suitable habitats and safe movement corridors. Infrastructure can, here, play a significant if not decisive role. For example, road verges

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*Illustration 3 - Wildflowers along a country road in southern Sweden
These habitats provide valuable resources to pollinators and a refuge for rare grassland species
© Mats Lindquist, Swedish Transport Administration*

can serve as refuge for many grassland species while simultaneously meeting traffic safety and maintenance constraints [11] (illustration 3). They can supplement natural, nutrient poor and species rich grasslands that are becoming increasingly rare in modern landscapes and reconnect broken ecological corridors. These habitats offered by road verges can help to reweave the ecological network for species that depend on or utilize grasslands. Thus, as exemplified in the upcoming handbook on biodiversity and infrastructure [12], with the correct management, roadsides can turn into valuable assets that perform multiple technical and ecological services.

CONNECTING PEOPLE TO CONNECT WILDLIFE

It is not only possible but necessary to reconnect habitats by providing safe passages for wildlife, recreating habitat

corridors through appropriate verge management, and controlling the spread of noise, light, and pollutants through the utilization of nature-based solutions. These efforts not only enhance infrastructure resilience and safety but also result in reduced maintenance costs. The required know-how is available and has been developed over decades. Technical solutions and best-practice examples are shared among communities of practice such as the Infrastructure and Ecology Network in Europe¹⁰. Since 1996, IENE brings together planners, engineers and ecologists in biannual conferences, workshops and joint projects such as the 2003 handbook on wildlife and traffic¹¹. IENE is an independent, international and interdisciplinary arena for the exchange and development of expert knowledge from over 400 individual experts in more than 50 countries worldwide. It recently joined forces with PIARC and is maintaining and developing similar ventures with e.g., CEDR, FEHRL and UIC.

⁹ IPBES 2016. <https://www.ipbes.net/article/press-release-pollinators-vital-our-food-supply-under-threat>

¹⁰ Infrastructure and Ecology Network Europe - <https://www.iene.info>

¹¹ IENE projects: <https://www.iene.info/projects/>

¹² International Conference on ecology and transportation: <https://www.icoet.net>

¹³ Australasian Network on Ecology and Transportation : <https://www.eianz.org/events/event/ANET2023>

¹⁴ African Conference for Linear Infrastructure & Ecology: <https://aclie.org/>

¹⁵ IENE transport & ecology guidelines portal: https://handbookwildlifetraffic.info/transport-ecology-guidelines-portal/?fwp_category=publications

¹⁶ Biodiversity and Infrastructure Synergies and Opportunities for European Transport Networks (BISON): <https://bison-transport.eu>

Similar activities are growing around the globe, such as the ICOET¹² conferences in the US, the ANET¹³ conferences in Australasia, the ACLIE¹⁴ conferences in Africa, and other conferences in Canada, Brazil, or Asia. Practical handbooks and guidelines concerning wildlife and traffic are available in many languages¹⁵, and a new online and interactive handbook [12] developed in the BISON project¹⁶ will be published in 2023.

Thus, there is no excuse for repeating yesterday's mistakes and for not prioritizing current knowledge and best practices in planning, design, upgrading and construction of infrastructure. While Western Europe is currently grappling with the ecological and socio-economic repercussions of uncontrolled fragmentation in its natural areas, the challenges and potential solutions can serve as inspiration for global efforts to prevent the fragmentation of previously cohesive natural and semi-natural landscapes. Ensuring functional and ecological connectivity, alongside a resilient and efficient transportation system, is essential for a sustainable future, both in Europe and worldwide.

In simpler terms, road planners and engineers play a pivotal role in this undertaking, going beyond their traditional responsibilities of technical infrastructure design. A wide range of stakeholders from environmental and social sectors must collaborate to establish a shared vision of sustainable and ecologically responsible transport networks [13]. Transport infrastructure lies at the heart of future sustainable landscapes, where mobility for both people and wildlife is safeguarded.#