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#2 "Breaking down" global defragmentation concepts to a macro-region – the example of the Danube River Basin

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In a world shaped by human use, ecological connectivity is becoming increasingly important. Corridors facilitate biological processes such as dispersal, migration or the regular movement of animals and thus strengthen the spatial cohesion of the network of habitat patches, which is crucial for the survival of many species. We have investigated this question in several projects in the Danube River Basin (DRB).

The DRB comprises four main corridors, the Alps- Carpathian Corridor, the Alps-Dinaric Corridor, the Danube Corridor and the European Green Belt. The network of 12,395 protected areas is the backbone of the green infrastructure on land. The Danube itself and its main tributaries are considered key elements of green infrastructure in terms of water connectivity. Key elements for ecological connectivity in the air are the migratory routes of birds and the associated main resting spots for migratory birds, which are mostly wetlands. In addition, the Danube itself is also an important flyway for certain species. However, several anthropogenic barriers such as airports, highways, hydroelectric power plants, high-voltage power lines, dams, weirs and conurbations threaten this connectivity. With 19 countries, the DRB basin is the most international river basin, the Danube itself is the most international river flowing through 10 countries. Especially when it comes to ecological connectivity, management must also take place on a transboundary level. Joint activities, communication and exchange play a primary role.

On several occasions, we have assessed the activities in the DRB and looked at how to deal with this issue into such a large region. One of the results of our analysis was a map showing the degree of fragmentation and the spatial distribution of steppingstones. The analysis clearly shows where existing main corridors are located and gives a broad overview of areas with low general connectivity. Gaps can be seen in the Pannonian lowlands, in the lowlands between the Danube and the Carpathians in Romania and on the border to Slovakia and Austria where large areas are dominated by intensive agriculture or by conurbations.

Interreg as a funding programme that can include the stakeholders of an entire macro-region offers many transnational projects dealing with ecological connectivity. The main lessons learnt are among others that major problems can be solved by the simplest measures, such as the marking of high-power lines, which helps to greatly reduce the mortality of migratory birds and ensure continuity or WILDisland where wild islands along the Danube were identified, recognised as central elements of the green infrastructure and put under protection. The dangers of ecological connectivity have also become visible and it has become clear that, for example, if connectivity is to be promoted, defence mechanisms for invasive alien species must also be created at the same time. In the course of this analysis, guiding principles were extracted and processed into an overarching document.

KEYWORDS: Ecological corridor, Danube River Basin, Guiding principles, Transboundary projects

#3 Risks and opportunities for wildlife living in road dominated environments. What pieces are missing to complete the puzzle?

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A Living on the roadside involves serious risks including restrictions to movements, disturbance of resting and feeding places, and roadkill menace. However, when crossing highly human modified areas such as simplified intensive agricultural landscapes or highly grazed areas, remnant natural habitats associated to roads (verges, roundabouts, bypasses, etc.) may be the only leftover natural areas acting as a last refuge for rare plants and small fauna. In these circumstances, there may be a positive contribution of roads and associated vegetated areas for biodiversity conservation may be considered.

In Europe, remnants of natural habits on roadsidesmay be particularly relevant for the implementation of the "European Green Infrastructure" (EGI) , defined as "… an interconnected network of green spaces in urban and infrastructure dominated environments that preserves the natural value and functions of the ecosystems and provide humans with the benefits associated with them".However, to enhancethe role of road vegetated marginal areas in the EGI there is still a long way to go and many fundamental questions need to be more deeply addressed:i) are road verges refuges or ecological traps for fauna?; (ii) what species traits makes them more suited to persist in road natural habitats remnants?; (iii) what is the relevance of verges as corridors?; (v) what surrounding landscape features are key to define the ecological role of road natural habitats remnants? What are the effects of roads on demographicparameters of populations living on the roadside?

We have accessed the role of verges as providing foraging opportunities for bats, refuges and corridors for small mammals, and ecological traps for small mammal predators. We found that when roads cross lower suitable habitat, roads verges canbe an important last remnant feeding habitat for bats.In highly grazed areas we have shown that verges are a critical refuge for small mammals, as important as riparian galleries, considered one of the most relevant habitats for fauna in the Mediterranean landscape. Using graph-theory-based connectivity metrics we demonstrated that verges contributed significantly more to the overall landscape connectivity than surrounding areas. This shows the high importance of verges as small mammal corridors, even in well preserved landscapes. We also show a strong positive association between locations of snakes, owls and mammal carnivores road casualties and the abundance on verges of wood mice and rabbits, the two main prey in the studied area. These results support the hypothesis that prey abundance on road verges may be a major driver explaining predator roadkills.

In Portugal, road verges and other road remnants of natural habitats are estimated to cover more than 140 thousand hectares, an area larger than any terrestrial protected area in the country. Similar or larger areas of remnant habitats along roads occur

in many other countries. Thus, gathering further knowledge aiming to quantify and identify their role in biodiversity conservation is key to properly offset road impacts on wildlife.

KEYWORDS: Road verges, Verge habitats, Biodiversity refuges, Refuges, Ecological traps

#4 Developing mitigation strategies to reduce the impact of land transport infrastructures on Amphibian populations: the example of Denmark, Sweden, Poland, Lithuania and Estonia

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Land transport infrastructure (LTI) is the largest threat for Amphibians in Europe, thus by causing habitat fragmentation, habitat loss and degradation. More than half of the European Amphibians (59%) are in decline, 23% are threatened and listed under the European Red List.

In Europe, several mitigation strategies and actions to limit the impact of LTI on Amphibians have been undertaken. However, it remains a lack of homogenisation of actions and awareness of actors (e.g. local authorities, decision makers, road directorates, companies etc.) among European countries. There is a strong need to share know-how experience in order to develop a common best practice guidelines that will demonstrate the efficiency of our actions and enable us to replicate them.

Throughout five pilot projects in Europe, we present different mitigation strategies to limit the impact of LTI on Amphibian populations, where the first Amphibian tunnels have been built: Denmark in 1997, Sweden in 1998, Poland in 2000, Lithuania in 2013 and Estonia in 2015.

Several factors were affecting the design of the mitigation measures. At first, the interventions had to prioritise hot spot areas, i.e. where large-scale mortality was identified on existing roads, and where the different species were registered. The experience throughout these pilot projects has enabled us to provide recommendations and best practices, such as the optimal length of the tunnel to ensure a successful migration, the shape of the fences to guide the migrating species, and the choice of material to ensure a long lifespan of the different crossing devices.

In these five projects, pre- and post-monitoring of Amphibians have been performed to assess the efficiency of the implemented passages and other infrastructures. We present here the results of the projects and compare the adaptation of the measures, which are species-specific for large populations of *Bufo bufo*, *Rana temporaria*, *Rana arvalis*, *Pelobates fuscus* and *Ichthyosaura alpestris*. A minor occurrence of *Bombina bombina*, *Triturus cristatus*,*Pelophylax lessonae*, *Pelophylax kl. esculentus* and *Lissotriton vulgaris* also registered in some project sites, have been considered in the mitigation measures. Amphibian tunnels demonstrated to be especially effective for *Bufo bufo*, *Rana temporaria*, *Ichthyosaura alpestris* and *Pelobates fuscus*. Fences were effective in preventing all species crossing the road.

The comparison of the different actions and results among these five countries shows the possibilities to develop a common database and sharing experience between European countries.

KEYWORDS: Amphibians, Land Transport Infrastructure, Mitigation, Monitoring, Corridor