

From Fragmentation to Connectivity: The Role of Ecological Corridors

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Introduction: why connectivity matters in a fragmented world

Evidence of fragmented habitats and climate change shows the importance of maintaining connectivity. Connectivity refers to the ability to connect distinct areas together, allowing organisms to move freely among them. This is essential to maintain ecosystems and diversity of species. Due to land-use change and habitat loss, species' natural habitat becomes fragmented and isolated. These fragmented habitats prevent organisms from migrating freely and reproducing. Ecological corridors are a way of connecting fragmented habitats. This creates pathways for the species to move safely between their habitats. Land with limited movement, dispersal ability and habitat restrictions makes species vulnerable (Merenlender et al., 2022). This paper discusses how ecological corridors maintain connectivity between fragmented habitats to promote biodiversity and ecosystem services.

Understanding habitat fragmentation

When habitats become fragmented, they are divided into smaller and more isolated new habitat patches, separated by either direct human activity or anthropogenic landscapes. This reduces not only the total habitat area, but also influences the functioning of the ecosystem.

One key consequence is the so-called edge effect, which refers to the changes in species richness and composition at the boundaries between a habitat and its surrounding areas. It states that within a habitat the species richness increases if you go from its border towards the center. Habitat fragmentation and therefore smaller patches of habitats lead to a higher share of such edges, and reduces the area in which a high species richness occurs even more. If the fragments become too small, there is also risk of local extinctions when the species' conditions for survival are no longer met (Laurance et al., 2002).

An overview study conducted in 2015 investigated how different fragmentation treatments influence ecological measures. They concluded that the reduction of total habitat area leads to a decrease in community composition, species richness and species persistence. Additionally, an increase in distance between the patches reduces the capacity of pollination and nutrient retention the most. Enlarging the edge area, while keeping the original size of a patch, leads to a change in community composition. Despite this, the other measures remain unaffected in this case (Haddad et al., 2015).

Restoring connectivity through ecological corridors

Ecological corridors, also referred to as wildlife or green corridors, are structural connections between distinct and sometimes isolated habitat patches. They are found across natural, rural and urban areas. And they occur in different forms depending on their structural configuration or spatial context. Common types include stepping stones (separate patches), linear (single continuous path) and landscape corridors (wide network). Other examples are riparian corridors that function along rivers and streams, urban

corridors that connect habitats within cities, and mountain/alpine corridors that support migration across high-elevation areas (Bennett, 2003).

The corridor's main function is to facilitate the movement of both plants and animals (Beier and Noss, 1998). It is essentially a nature based solution made to reconnect landscapes, while continuing to support broader ecological systems and maintaining biodiversity. This connectivity is essential for preventing local extinctions, since isolated populations are more vulnerable to random disturbances and environmental changes. Beyond facilitating movement, ecological corridors significantly contribute to ecosystem services (Samways et al., 2010). For example, vegetation within the corridors play a role in carbon sequestration. It captures atmospheric carbon dioxide and stores it in biomass and soils. On top of that, riparian corridors are particularly valuable for water management. They regulate water flow, reduce soil erosion, filter pollutants, and help buffer the impacts of floods. In the context of climate change, corridors are increasingly important for species adaptation and migration. As temperatures rise and environmental conditions shift, many species must move to remain within suitable habitats. Corridors provide safer and more accessible pathways for these migrations. This function is critical for maintaining species distributions and ecosystem stability over a longer time frame. Ecological corridors can also reduce human-wildlife conflict. When habitats are fragmented, animals are more likely to enter urban or agricultural areas. This could lead to among other things traffic accidents, crop damage, and safety risks. Corridors thus help guide wildlife along designated routes that avoid high risk areas such as roads and settlements, protecting both animals and people. Lastly, ecological corridors are a key strategy for biodiversity conservation. By reconnecting landscapes, supporting ecosystem services, and enabling better adaptation to environmental change, they help ensure that ecosystems remain functional and resilient in an increasingly human-dominated world (Hilty et al., 2020).

Challenges

Although corridors provide many benefits, the development of these systems faces many challenges. The importance of ecological networks and habitat connectivity is often misunderstood. The information is not always well communicated or clear to both the general public and governments, making it difficult for scientists to take further action in conservation efforts. Another issue arises due to the flaws in currently available evaluations. Most research focuses on the short-term or instant effects of corridors (successful species migration, population connectivity, etc.), rather than the long-term outcomes (e.g. sustained impact on ecosystems and their services over the course of time). There is thus a lack of information on how the corridors work within different landscapes and environments as well. Differences in habitats, climate, and local-land-use practices have a great impact on the success of a corridor (Le Hoang Nam et al., 2024). With these knowledge gaps present, it is hard to prove the need for ecological corridors to investors or the government and nearly impossible to gain their financial support.

Policies

Several policies focus on biodiversity recovery and ecological connectivity. The European Union's "Biodiversity Strategy for 2030" aims to recover Europe's biodiversity by legally protecting at least 30% of

its land, including ecological corridors within a Trans-European Nature Network (EU, 2020). EUs overall goal, and ecological corridors support several of the same UN Sustainable Development Goals, specifically the targets of SDG15: Life on land. This includes targets 15.1: conserve and restore terrestrial and freshwater ecosystems, 15.4: conservation of mountain ecosystems, 15.5: protect biodiversity and natural habitats, and 15.9: integrate ecosystem considerations in governmental planning (UN, 2026).

Conclusion

Habitat fragmentation is becoming a more prominent issue in today's society. The rapid expansion of urban areas result in more isolation between habitat patches, which in turn constricts migration routes and disrupts ecosystems. Ecological corridors allow for better ecosystem services, increase biodiversity, and improve species' mobility. This supports UNs goal 15: Life on land and its targets 15.1, 15.4, 15.5 and 15.9. By reconnecting these natural areas, the negative effects of habitat fragmentation are limited.

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