

**Action:** Creating corridors to influence ecosystem services

**Key Messages:**

- Carbon markets can be great sources of not only money to help fight deforestation, climate change, and more, but also provide important services in more resilient landscapes, more valuable forests, and job creation in both reforestation efforts and consequent stewardship.
- Corridors are especially attractive carbon market options because of their low cost to impact ratio compared to more expensive or less efficient programs.
- Corridors can impact the spread of intended and unintended organisms and ecological disturbances. In one case, fires can be spread easier due to both more understory vegetation and connected larger forest fragments.
- In some cases, however, fires can be beneficial to the ecosystem rather than detrimental, such as in longleaf pine or shrubland fragments.
- Concerns of invasive species spreading easier are also unfounded because they would already be able to proliferate while rarer, less dispersive species are helped much more, preventing native lands from being overrun.
- Pollinators being able to move easier through corridors is a fantastic ecosystem service that these projects improve because it allows seeds to be dispersed more widely and also allows more genetic diversity within the plant species.
- Riparian buffers are fantastic corridor options because they prevent erosion and runoff, absorb fertilizers and pesticides, and provide aesthetic beauty in monotonous agricultural land.
- Planning of these wildlife corridors must take into account the regional impact of their construction in order to have the largest net positive impact.
- With respect to monetary services, landscape corridors in urban areas can provide massive amounts of value for undeveloped land, which must be considered when creating urban plans.

**Background Information**

Wildlife corridors are a very popular form of conservation intervention due to their wide range of beneficial effects to ecosystems, as well as their typically low cost of implementation. While there exists a wide body of literature discussing and confirming corridors' positive effects on biodiversity, species richness, edge effects, and much more, there is a certain lack of information on their effects on ecosystem services that these fragmented habitats provide. Thus, it is important to discuss existing studies, as well as potential for future insights.

There exist large review articles about both the positive and negative effects of wildlife corridors on the ecosystems they are created in. For example, Haddad, et al. (2004) found that wildlife corridors have very limited negative effects from a list of potential harms, and found that

of only one potential harm, increased fire intensity, even this one was beneficial in the many ecosystems that rely on fire (Brudvig, et al. 2014). Several other studies have shown that wildlife corridors have a net positive effect, with potential negatives being very limited.

Studies by both Poffenberger (2015) and Paiva, et al. (2014) have shown that wildlife corridors in both India and Brazil are very attractive investments due to their lower cost and high amount of benefits. Because of this, they have been very popular as destinations for carbon offsets. Further, wildlife corridors, by their very nature, must be created. This creation leads to many benefits in and of itself because of the capital that is required for creating them.

Overall, the benefits to ecosystem services seem quite apparent, as wildlife corridors provide such a large amount of benefits to the ecosystems they connect, it is safe to say that the benefits these ecosystems will provide to people will be impacted positively as well. Stronger ecosystems means their services will be protected for a longer amount of time while benefits to species themselves can allow them to perform more services. The rest of this summary will look into specific studies on interventions and some of their benefits, as well as recommendations for future projects.

### **Supporting Evidence From Individual Studies**

1. In a study by Paiva, et al. (2014), it was found by analyzing the Monte Pascoal-Pau Ecological Corridor Project in Brazil, that wildlife corridors contribute significantly to both the ecosystems themselves, as well as surrounding communities. The paper found that corridors are attractive voluntary carbon offset projects because they provide a wide array of co-benefits as well as sustainable development to communities in which they are built. Corridors provide jobs in both building them through infrastructure and reforestation, as well as in stewardship once the corridor has been completed. Further, the corridors allow for more protection from and control over water, as well as increased protection for the natural resources that adjacent communities rely on. (80%)
2. Poffenberger (2015) found similar results to those of Paiva, but in studying the Khasi Hills Community REDD+ program in India. The carbon market in this region was somewhat of a success, but many are mismanaged. Money flows into these projects because they are fairly efficient, but it is important to involve local communities and provide them with a good amount of freedom. In this case, the Khasi faced several roadblocks from governments, carbon markets, and others in creating the most efficient program. Similarly still, this study found that corridor projects generated many jobs, as well as increased the amount and resilience of forests and their natural resources including timber, medicines, and cultural value to the between 0.4 and 1.6 billion people around the world that rely directly on forests. (80%)
3. Some studies, such as Brudvig, et al (2012) have looked at the negative effects of corridors such as fire connectivity. This study looked at wildlife corridors' effects on fire through temperature, intensity, and other measures at the Savannah River Site in South Carolina, an experimentally fragmented test site used in many studies. They used forested

regions with some corridors to measure the fires. The paper found that corridors did create a certain connectivity effect, allowing fires to spread. Further, because corridors allow for more richness, the increased vegetation created hotter fires. This meant less soil, and less vegetation for the habitat to provide ecosystem services such as cleaning air or water, and other benefits related to the wildlife present. Still, these results are not detrimental across the board, as many ecosystems in which corridors exist actually benefit from fire, so a corridor would allow these burns to affect a larger area with more ease. (50%)

4. In a review article of several potentially harmful effects of corridors, Haddad, et al. (2004) found a general lack of research, but did identify fire connectivity as the only consistent effect that might be misconstrued as harmful. As was said above, fire connectivity is actually beneficial in many ecosystems. The article also found that invasive species spreading was not much of a concern as they would spread either way, but less dispersive species would benefit much more from corridors. (30%)
5. Tewksbury, et al (2002) found that seed dispersal and pollination at the Savannah River Site in South Carolina was significantly increased by corridors. They selected eight 50-hectare landscapes with pine forests and created several forest fragments, some connected and others isolated. Pollinators such as bees and butterflies, which provide an immeasurable ecosystem service by helping to fertilize crops, were found to be healthier and able to disperse more in areas with corridors. This leads to increased diversity and resilience in plants, something that could be very beneficial to agriculture. Further, animals that disperse the seeds themselves are able to deposit them over a much larger area, further increasing diversity. (100%)
6. Fischer, et al (2000) took a look at riparian buffers, their benefits, and potential ways to improve them in a review article. They found that riparian buffers, which are strips of habitat flanking rivers and streams, provide a wide array of benefits. These include reductions in erosion and runoff which directly impact agriculture. They also protect water quality, making more water safe to drink. Apart from this, they allow for animals to cross more habitats. While they account for only 1% of land in their respective areas, their benefits are far more. The study also found that riparian buffers are most effective when they constitute of forested land that is at least 15m wide on either side of a river. (100%)
7. Dosskey, et al (1997) found (through reviews as well) that riparian buffers are extremely effective wildlife corridors with many benefits for humans, specifically in agriculture. In addition to the above benefits, they found that buffers protect best when used in environments with sandy or silty soil, smaller, less powerful rivers, and microbes as opposed to clays or liquid fertilizers. Buffers also protect fisheries by providing shade for spawning fish and other species. Furthermore, the paper discussed the cultural importance of these buffers as they provide a nice interruption from the unending fields seen in many agricultural regions where people can go to recreate. (100%)

8. Durham (2004) also discussed the benefits of riparian buffer restoration. This study took place in a restored riparian wetland buffer in Tifton, Georgia. They monitored water entering through channels into riparian buffer zones, and then took samples from the streams runoff was leaving from. It found that when fertilizers were applied to adjacent fields, regions with buffers could remove at least 60% of nitrogen and 65% of phosphorus. This study was the first to confirm buffers' ability to remove phosphorus from runoff at such a high level. Grassy wetland edges on fields were found to be particularly effective at removing excess nutrients from runoff because of their ability to quickly absorb water. (100%)
9. Hoctor et al (2008) reviewed several conservation projects across the Southeast for their effectiveness at promoting biodiversity as well as ecosystem services. They found that there was a wide range of effectiveness based off of planning strategies as well as the spatial nature of projects. Large scale, regional projects that could connect very large fragments overall had the highest positive impact. However, they do pose issues of logistics due to the large spaces, amount of stakeholders, and resources required to complete these projects. The paper recommends the incorporation of GIS units as well as planning in conjunction with development. The vast amount of new roads in developments, particularly in Florida, is likely to result in even more fragmentation and complication for future conservation projects. (50%)
10. Lee, et al (2014) also looked at corridors through the lense of planning around development, in this case in urban environments. The study looked at open spaces, classified by type of environment and its potential uses, and what value could be attributed to it through a connectivity project in Gwacheon, South Korea, a small city. While it did find that land open to development had some of the highest value because of this investment, several ecosystems did have very high values for the ecosystem services they provided. In particular, riparian buffers, rice paddies, and forests provided the highest amount of services, in particular due to the agricultural benefits they could provide to people. The article concluded that although not a definitive plan, these types of results and analyses should be considered in future urban development projects in order to create good urban ecological environments, as well as fully benefit from the economic potential of different types of land. (100%)

## **Conclusions and Recommendations**

Wildlife corridors seem to have a very positive benefit on ecosystem services in many cases. However, it has been shown that some types of corridors offer more, or higher value benefits to humans than other types. While certain projects such as riparian buffers and wetland restoration increase the value of land, save land from erosion, and create more agriculture, others benefit species themselves more directly. Still, it is important to consider that corridors play a vital role in helping to keep ecosystems from disappearing regardless, meaning they protect the cultural, spiritual, and medicinal values of all types of ecosystems.

While corridors are generally thought of as being positive, they do have some potentially negative effects, namely on fire or pest connectivity. While pest connectivity is unavoidable typically because of the ease by which many spread, fire connectivity due to increased vegetation and corridors by which to spread is not necessarily an evil. Many ecosystems such as longleaf pine rely heavily on fires and isolated forest patches might not burn enough, leading to catastrophic large scale fires, or might burn out completely due to edge effects. Thus, it is important to consider fire depending on the type of ecosystem one is working with.

Finally, all of these factors must be taken into consideration for planning purposes. Wildlife corridors are one of the most effective conservation practices and thus receive much funding, but that funding must be managed well in order to protect the ecosystems and provide truly sustainable development for adjacent communities. Plans must be able to work on a regional scale and be cost effective, particularly when applied to land or urban planning. A wider body of literature into the actual economic and monetary effects of corridors should be done, considering the value of benefits such as agricultural land protection, cleaner water, and carbon offsets, among others. This can help create better plans to incorporate corridors into existing ecosystems and account for them in future development plans.

### **Supporting Studies**

1. Paiva, D. S., Guinevere Alvarez Machado De Melo Gomes, Fernández, L., & Andrade, J. C. S. (2014). Voluntary carbon market and its contributions to sustainable development: analysis of the Monte Pascoal-Pau Brazil ecological corridor. *International Journal of Innovation and Sustainable Development*, 8(1), 1. doi: 10.1504/ijisd.2014.059219
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