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4.27.20

ACTION: Creating Corridors to Influence Plant Dispersal

KEY MESSAGES:

- In most cases, the creation of corridors helps facilitate the dispersal of plants, creating benefits above and beyond that which would be experienced by simply adding the same amount of land.
- In certain scenarios, building connected corridors did not benefit plant dispersal, suggesting that plant dispersal benefits can be site and species specific, depending on both plant and mutualistic animal (i.e. birds) that spread seeds.
- In cases where benefits of a corridor were not found, the creation of a "step ladder" was found to be more effective.

Background Information:

The loss of habitat and fragmentation of forests across the globe are among the leading causes for species loss. The creation of wildlife corridors has been touted as a potential solution for mitigating the impacts of forest fragmentation by reconnecting isolated patches of forests. The goal of a corridor is not merely to add habitat acreage, but rather, to provide value to species that is above and beyond . A meta-analysis on corridor effectiveness (Gilbert-Norton et *al 2009)* found that corridors lead to an increase in movement between previously isolated habitat patches by approximately 50%. However, some argue that the creation of habitat corridors can have unforeseen negative consequences, such as the spread of invasive species, that the relative higher cost of corridors do not always justify their benefits (Breier 2015). Thus, a critical question emerges: do wildlife corridors provide benefits to plant dispersal that are well above that of simply added land value? A review of several studies suggests that, although in certain scenarios the benefits of corridors can be minimal, on the whole, habitat corridors benefit species dispersal in a manner that is above and beyond simply the value created by added land area.

While more attention has been payed towards the movement of larger mammalian species, the impact of such projects on endemic plants are of critical importance. Plants come in numerous forms and their means of dispersing are numerous. Some plants disperse through wind. Other plants rely on birds and mutualistic relationships. Thus, plant dispersal is both site and species dependent.

Supporting Evidence from Individual Studies:

1. *A controlled site comparison study of American Black Nightshade at the Savanah River Site in South Carolina (Evans et al., 2013), found that corridors increased long-distance seed dispersal during winter, but not during summer. Summer and winter experiments in which American Black Nightshade plants were transplanted evenly across the six replicated landscape blocks with seed traps (mesh bottomed circular baskets fitted around 3-meter high poles on which birds perch and defecate) such that at the end of the season, trapped seeds could be counted. It was found that 22 times more seeds were trapped in winter than summer, due to the fact that in winter birds were not busy defending territories, nesting, and raising young, allowing more time to perch in an open sunny location. Winter seed dispersal was significantly greater in connected patches (15.2%) than in unconnected patches (3.7%). However, in summer, almost* *all of the seeds dispersed were in unconnected patches, showing that the forest is permeable and that territories may be large enough to span the central patch containing the plants and at least one unconnected patch. These results show that seasonality is key driver of corridor effectiveness and that the synergy of plant production and animal movement must be considered.*

2. HABITAT PATCH SHAPE, NOT CORRIDORS, DETERMINES HERBIVORY AND FRUIT PRODUCTION

A controlled site comparison study of Solanum Americanum in South Carolina (Evans et al., 2012) found that the creation of corridors did not lead to increased herbivory. Rather, patches with the least edge habitat and greatest core area were more vulnerable, showing the greatest numbers of grasshoppers, most severe leaf destruction and least fruit production. Eight landscape blocks (savannah habitat) were replicated within mature pine forest, each containing three patch shapes: connected, winged and rectangular. The connected and winged patches had large ratios of edge to core, while the rectangular patch had a small edge to core ratio. Solanum Americanum was planted in all patches, with control plants encased in mesh. Patches were monitored during the summers of 2008 and 2009, with number of grasshoppers, extent of leaf damage, and fruit production recorded. While patch shape did not influence the proportion of plants that experienced herbivory, it did influence severity, with rectangular patches showing more severe leaf damage than plants in connected patches. Likewise, fruit production was significantly lower in rectangular patches with each 0.1 increase in proportion of damage leaves corresponding to a 13-22% decrease in fruit showing that patch shape was a more important determinant of herbivory than the presence of a corridor.

3**. How Fragmentation and Corridors Affect Wind Dynamics and Seed Dispersal in Open Habitats**

A controlled site comparison study and accompanying computer modeling of the release of artificial seeds in Southern Carolina (Damschen et al., 2014) found that habitat corridors are beneficial for plants that are dependent upon wind dispersal. The study found that corridor patches had 15% more wind-dispersed seeds than non-corridor patches. The computer modeling program predicts that corridors that are aligned with the winds have much greater potential to benefit wind-driven dispersal than corridors that are constructed perpendicular to prevailing wind patterns. The study released artificial neon dyed seeds every 30 to 40 seconds, five at at time. In the experiment, the corridors were patches open grassland that were “cut out” of surrounding forested areas. For wind-dispersed species that live within forested areas, wind dynamics may differ.

4. An Experimental Test of Whether Habitat Corridors Affect Pollen Transfer

A controlled site comparison study of *lantana camara* (pollinated by butterflies) and Rudbeckia hirta (pollinated by bees) (Townsend et. al, 2005) found that wildlife corridors benefit pollinators. In patches with a corridor, 59% of L. Camera flowers received pollen, compared to only 25% in rectangular patches. Likewise, in patches of R. hirta, an average of 30% of connected corridor patches received received pollen bees, compared to only 14.5% in rectangular / winged patches. The experiment was conducted at the Southern Carolina facility and matched the design of study three.

5. Do Corridors Promote Connectivity for Bird-dispersed trees? The case of Persea Lingue in Chilean Fragmented Landscapes

A study of the lingo (Persea Lingue), which is dispersed by the austral thrush (Turdus Falcklandit) in Chile (Pérez-Hernández et al, 2015) found that construction of a corridor did not benefit the dispersal of seeds and that, rather, the creation of stepping stones provided greater benefit to Persia lingue. The study combined both a dispersal model with empirical evidence gathered through observation of the thrush behavior in order to predict the relative success of a corridor compared to a stepping stones approach.

6. The Effects of Vegetational Corridor on the Abundance and Dispersal of Insect Biodiversity Within A Northern California Organic Vineyard (Nicholls et al, 2001)

Two organic vineyard blocks in Northern California, one cut by a vegetatal corridor connected to a riparian forest, and the other with no plant corridor were monitored for two years to assess the abundance of Western Grape Leafhopper, its parasitoid Girault, and Western Flower thrips and generalist predators. All of these insects were more abundant in the central portion of the block with the corridor, and less abundant in the rows near the forest corridor, where predators were more abundant. In the block without a corridor, the insects were evenly distributed. Insects were collected weekly on both sites using blue and yellow sticky traps, a D-Vac insect suction machine, and by counting leafhopper nymphs on 10 randomly selected grape leaves/row. The total number of generalist predators was found to be greater in the block with the corridor, and most were found near the intersection of the vineyard and corridor and vineyard and riparian habitat. resulting in the lowest number of leafhoppers in these locations. The diverse sources of pollen offered by the riparian habitats enhanced predator colonization, and was in turn further amplified by the presence of the corridor. Because corridors provide alternative food sources, they allow natural enemies to disperse over otherwise monoculture systems, linking various crop fields and riparian systems and enabling beneficial insects to disperse across whole agricultural regions.

7. Effects of Landscape Corridors on Seed Dispersal by Birds

A controlled site comparison analysis of at a testing site in South Carolina (Levey et al, 2005) found that habitat corridors were effective in promoting the spread of seeds that are dispersed by birds. Seeds in traps were 37% more likely to be found in connected patches than in unconnected or winged patches. The study suggests that connected corridors provide benefits for plants through their mutualistic relationship with bird species that act as dispersers.

8. Restoring a rainforest Habitat linkage in North Queensland Donaghy's Corridor

A before and after study of a constructed corridor in northern Queensland (Tucker et al. 2009) found that seedlings were successfully dispersed into the corridor area. In the three years of the study, scientists found that 119 species of flora existed within the corridor, 35 of which had not been planted suggesting that they had dispersed from either end of the forest linkage. The corridor was 1.2 km long and 100 meters wide. Species endemic to the local rainforest were planted.

9. Corridors Affect Plants, animals, and their interactions in fragmented landscapes

Tewksbury et al, studied the impacts of constructed corridors on plant and animal dispersal. Patches with connected corridors had 69% more species than those without corridors. The goal of the study was to control for the area differences in land patches, in order to show to what extent constructed corridors provide benefits "above and beyond" land patches with the same area/shape that do not connect landscapes. The study also found that corridors lead to a significant increase in seed movement by birds, with twice as many *I vomitoria* seeds found in corridor patches than in non-corridor patches. The study highlighted the link between animals/plants as it relates to plant dispersal and suggested that corridors do, in fact, provide benefits above and beyond those that would be experienced by simply increasing land area.

10. CONSTRUCTED INSHORE ZONES AS RIVER CORRIDORS THROUGH URBAN AREAS: THE DANUBE IN VIENNA: PRELIMINARY RESULTS:

In Chovanec et al, a four year study took place after the restructuring of a series of land strips that border the Danube River in Vienna, Austria. In the wake of the construction of the Vienna hydroelectric power plant (Freudenau), the riverbanks on the previously existing man made island, "Danube Island" were reconstructed. Previously, the river banks were steep enbankments. They were reconstructed in order to create a more diverse series of habitat offerings, including "shallow water areas, gravel banks, small side challenge and temporary waters." These reconstructed embankments connected previously isolated patches of riverfront habitat. After the construction of the corridor, 107 plant species were recorded in the newly constructed corridor. The results were preliminary.

Conclusion and Recommendations.

The creation of habitat corridors has been largely effective in promoting the dispersal of native plants. That being said, conservation is locally dependent, and critical adjustments to corridor design must be made depending on targeted species and forest type. When designing corridors with plants that live in open landscapes, it is beneficial to attempt to align corridors with prevailing wind patterns in order to facilitate wind-dispersal. When designing corridors that are meant to benefit plants, whose seeds are dispersed by birds, it is critical to remain cognizant of edge effects. The dispersal of plants is dependent on the health of butterflies, bees, and birds and, as such, cannot be studied or pursued in isolation.

Supporting Studies

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