Action: Creating Corridors to Influence Biodiversity

Key Messages:

- Studies that looked at untraditional corridors (roads, drainage, dams etc.) aimed to shed light on the ability for invasive populations to spread quickly in many environments, and that urban areas were not necessarily barriers for their dispersal. These studies highlighted that roads and highways are often pre-existing corridors for many species, and since invasive species thrive in unstable environments along the edges of habitat patches, they are typically going to be found at the entrances of conservation corridors as well as along roads. (supporting evidence 3,4,6,8,9,10)
- Studies that took into account "prey traps" were utilized to stress that the social structure of ecosystems are extremely important before constructing a corridor. Many invasive predators were able to utilize the corridors as a feeding hub, which decreased the native usage of the corridors. (supporting evidence 1,2)
- Two studies were done at the same location at Savannah River Site in South Carolina, and had conflicting results. Where one study found species richness lowered in the connected habitats and the corridors appeared to facilitate the spread of invasive fire ants, another found no increase of invasive species in the connected habitats. (supporting evidence 5,7)

Background Information

Conservation corridors have long been a leading solution to the vast abundance of fragmented landscapes around the world, most of which have anthropogenic origins. The concept gained modern attention in 1969 when Harvard ecologist Richard Levins coined the term metapopulation with his metapopulation model, which he described as a set of habitat patches linked together with what now became known as corridors (Doty, 2019). Levins believed that if a population was to become extinct in one habitat patch, the other members of the metapopulation could travel to the empty patch via corridors and set up a new population. In addition to fragmented landscapes, invasive alien species are a leading threat to biodiversity, both conservation issues stemming from anthropogenic origins. With travel becoming quicker and easier, invasive species are spread faster and oftentimes unintentionally across the world. Invasive alien species pose a huge threat to native ecosystems, from bringing disease to outcompeting the native species and decreasing biodiversity (Canada, 2007). Once the invasive plant or animal reaches a new habitat, it often spreads like wildfire, typically because it has no natural predators or obstacles for expansion. Fragmented ecosystems benefit from connectivity, but connectivity helps facilitate the spread of all wildlife, including invasive alien species. The supporting evidence highlights the detrimental ecosystem effects of invasive species and how corridors can contribute to this conservation issue, leading some researchers to question if conservation corridors have as much ecological value as previously thought, or if it's simply a stab in the dark at protecting our vulnerable ecosystems (Mann, 1995).

Supporting Evidence from Individual Studies

1. Melanie McGregor of Griffith University in Australia studied the success of the Compton Road fauna array in Brisbane, Queensland using a capture-release methodology for mammals and herpetofauna, cameratraps, and Echometer Touch bat call recorders for bats. Overall, the study found that the overpass was used much more often than the underpass by all categories of animals. Of the mammals detected using the overpass, 70% of them used the overpass, which was found to mimick the percent of invasive species that used the overpass at 71.4%. Less mammals used the underpass (45%), however, 30% of the total native mammals used the underpass and 71.4% of the total invasive mammals used the underpass. These results showed that although native mammals had a preference for corridors, invasive mammals did not. McGregor mentions that the presence of invasive prey could be driving native species away from the corridors, which is a potential roadblock for the success of the passages in the future.
2. Harris et al. surveyed the bandicoot usage of a 2005 series of underpasses (Roe Highway Stage 7) in Perth, Western Australia (*Isoodon obesulus fuscivente*r). The bandicoots were initially tracked using sand pads and reporting prints for a year, then bandicoots were trapped and fitted with PIT microchips for the remaining year of tracking. Fox were not fitted with PIT microchips, but their tracks were observed throughout the study indicating their use of the corridors. The bandicoots were found to use the underpasses often, immediately after construction of the highway, but a year after the underpasses were constructed, Harris saw a "dramatic decline" in the usage of the underpasses due to an increase in invasive alien fox (*Vulpes vulpes*) usage. The foxes and bandicoots were positively correlated in 2 of the series of underpasses, and it appeared there was little interaction between them. The underpass that was used the most accounted for 71% of bandicoot passes, although this pass specifically saw the largest decline in bandicoot usage after the invasive *Vulpes vulpes* was found to have

built a den at the entrance of the pass, something that Harris described as a "prey trap." Many bandicoots that were PIT tagged were not retrieved, and Harris believes this is due to fox predation.

3. Meek and Saunders tracked movement of the invasive aliens fox species *Vulpes vulpes* in Jervis Bay, New South Wales, a developed residential area. Eighteen foxes were tracked by radio collars. Once the radio signals were received while driving, Meek and Saunders tracked the animals on foot in order to more accurately measure their locations, while attempting to limit any disturbances that might change their behavior. Using 700 hours of data, and 2410 fixed location data for 14 foxes that survived throughout observations, Meek and Saunders found that 33% of the time *Vulpes vulpes* was found within 15m of a road. The study shows that the intruder predator is often found attempting to cross roads where there is a lack of corridor.
4. Hunt et al. studied the effectiveness of wildlife corridors versus "long-established drainage culverts," and how native versus non-native feral cats responded to both. The constructed tunnels are wider than the culverts and have much less vegetation due to the construction. Hunt used metal cage traps, scats, and footprints to identify species utilizing the corridors. The tunnels were surveyed multiple nights during multiple months. Mammals were found to regularly use the drainage culverts, and much fewer animals in total were found to use the wildlife corridors, which were often used by introduced feral animals such as domestic dogs, cats, and foxes. Harris believes that the tunnels did not attract native animals due to the fact that they were devoid of native plants, or plants at all, that would provide safety to native prey in the corridors. Much like Harris et. al, Hunt also mentions the fact that non-native feral animals such as dogs, cats, and foxes may use the corridors as a "prey trap," since the corridors essentially force native prey into the empty tunnels to be predated upon if they attempt to use them.
5. Resasco directly confronts his concert that landscape corridors "may facilitate the spread of invasive species." In his 2014 study, Resasco et al. studied the effectiveness of the landscape corridors at the Savannah River Site in South Carolina using a series of blocks of different shapes surrounded by patches that were connected to a center patch using a 15-dram plastic vial. Ants were surveyed using 12 pitfall traps per patch, and only over the course of 48 hours. They were subsequently collected and identified for whether they were native or nonnative and polygyne or monogyne. Resasco found negative net effects of corridors since

"species richness and evenness were both lower in connected patches than unconnected patches", specifically in polygyne dense blocks. This suggests that social behavior should be considered when interpreting whether or not a specific species takes advantage of conservation corridors. In all cases, polygyne or monogyne, invasive fire ants thrived when corriders were placed between their patches, and very much so facilitated their spread.

6. Danube Island in Vienna is an artificial island at the center of the city, and is surrounded by flood-controlling New Danube, which is separated from the main river. For four years, the Danube Monitoring Programme (DIMP) monitored the area for "relevant indicator groups" which included vegetation, dragonflies, amphibians, reptiles, and waterfowl, some of which colonized the area and thus should be treated as invasive species. Methods included hand nets and visual sightings. Colonized dragonflies were found the most in shallow fragmented areas with no connection to the Danube. Species richness was found to be highest in areas of with palaeopotamal characteristics.
7. Damschen et al. studied six 50-hectare areas at the Savannah River Site in South Carolina, each of the areas which contained connected and non-connected patches. The connected patches were linked with a man-made corridor 150 m x 25m. Damschen et al. surveyed the plant species in each patch for 5 years, after which they saw an increase in species richness in connected patches, by as much as 20%. Although the area of the unconnected patches to the connected patches were the same, connected patches still demonstated higher species richness. Contratry to Resasco et al., who's 2014 study took place in the same area, Damschen's results showed no increase in exotic species in connected habitats.
8. Cane toads are infamous invasive species that have taken over Australia's entire continent, the government of which even had a sizeable bounty on them at one point. Brown et al. surveyed the orientation of toads near roads that have served as dispersion corridors to them since they arrived in Australia, and found that there was a strong unimodal distribution centered around 0º (meaning parallel to the roads), indicating that toads often consciously or not, follow roads, and even were found to turn at intersections. In order to obtain this data, adult toads were fitted with radio transmitters with GPS that were found between the Adelaide River and the South Alligator River. These results suggest that manmade corridors are often utilized by invasive species, even if the corridors are not considered that way when they were built.

9. Like Brown et al., Kowarik et al. studied the effects of roads serving as corridors for non-native invasive species. *Ailanthus altissima* is native to northeast and central China and found along roads in southwest Berlin. Kowarik surveyed the seed shadow of an individual *Ailanthus altissima* for three days after a strong wind travelling parallel to the road that it was adjacent to. By categorizing the propagules as samaras and panicles, the researchers were able to quantify the impact of each propagule. Three consecutive days, Kowarik placed different painted groups of samaras at the same location of the tree and observed their transport for about 10 days. 58% of the seed shadow travelled 100 meters from the tree, with 34% up to 200 meters from the tree, and less than 2% were within 20 meters of the tree. These results are in stark contrast to other studies in closed canopy forests that found that within 27 days, all samaras were within 0.25 meters of the individual tree. The natural environment of the model species decreases the efficiency of secondary wind dispersal, and therefore the road serves as a habitat corridor for the invasive species, and undoubtedly, native species with similar dispersal methods as well.
10. Unlike other studies, Rahel focused on aquatic species, and how barriers such as dams and waterfalls are able to decrease the spread of invasive species. Preventing aquatic non-natives is easier than terrestrial non-natives, but both have their drawbacks. For aquatic non-natives, historically isolated waterways should never be connected, but that is many times unrealistic, and seawater ballasts and canals often serve as human-made connections to these aquatic habitats. Physical barriers preventing connectivity is only one way to stop the spread of non-native aquatic species, and the physical barrier only limits non-natives at a local level. The paper challenges the long-held belief that conservation corridors are successful in conservation, and, where most ecologists ignore aquatic species when speaking about conservation corridors, Rahel stresses the dangers of connected waterways and non-native dispersal, which include the spread of disease, hybridization, ecological traps, and novel competition.

Conclusions and Recommendations

Conservation corridors have many benefits, but the cost should not be ignored. The two leading threats to biodiversity are habitat fragmentation and invasive species, and their solutions are contradictory. Invasive species by nature reproduce and grow quickly, as well as thrive in a variety of environments, making it easy for their populations to spread. Knowing this, it is easy to understand that invasive species will typically spread over conservation corridors much faster than their native counterparts, meaning that the solution to habitat fragmentation is just the opposite for invasive species. Invasive predators have also been found to utilize conservation corridors to their advantage, by funneling (typically) native prey into their mouths. This does not mean that conservation corridors should not be implemented, but more thought should be given to them and they are not a band-aid to conservation issues, as many people treat them. The social behavior of species and the social structure of a habitat should be considered before building a conservation corridor. Vegetation should be installed throughout the corridor to give native prey shelter and security. Non-native invasive plant species should be removed from entrances to corridors, and this should be maintained. Non-native animal species should also be monitored in and around corridors and perhaps completely removed. When considering underpasses, corridors should be varying sizes in order for a variety of different fauna can cross effectively and comfortably. More research should be put into these considerations, as well as, what some articles mentioned, if the scent of a predator near a corridor could influence a prey's behavior towards the corridor.

Supporting Studies

1. McGregor, M.E. (2016). Fauna Passages as an Effective Way to Increase Habitat Connectivity for Diverse Non–Target Species.
2. Harris, Ian & Mills, Harriet & Bencini, Roberta. (2010). Multiple individual southern brown bandicoots (Isoodon obesulus fusciventer) and foxes (Vulpes vulpes) use underpasses installed at a new highway in Perth, Western Australia. CSIRO Wildlife Research. 37. 127-133. 10.1071/WR09040.
3. Meek Paul D. Saunders Glen (2000) Home range and movement of foxes (Vulpes vulpes) in coastal New South Wales, Australia. Wildlife Research 27, 663-668.
4. Hunt, A., H.J. Dickens, and R.J. Whelan. 1987. Movement of mammals through tunnels under railway lines. Australian Zoologist 24:89-93.
5. Resasco, J., Haddad, N.M., Orrock, J.L., Shoemaker, D., Brudvig, L.A., Damschen, E.I., Tewksbury, J.J. and Levey, D.J. (2014), Landscape corridors can increase invasion by an exotic species and reduce diversity of native species. Ecology, 95: 2033-2039. doi:10.1890/14-0169.
6. Chovanec, A., Schiemer, F., Cabela, A., Gressler, S., Grötzer, C., Pascher, K., Raab, R., Teufl, H. and Wimmer, R. (2000), Constructed inshore zones as river corridors through urban

areas—The Danube in Vienna: preliminary results. Regul. Rivers: Res. Mgmt., 16: 175-187. doi:10.1002/(SICI)1099-1646(200003/04)16:2<175::AID-RRR578>3.0.CO;2-C

7. Damschen, E., Haddad, N., Orrock, J., Tewksbury, J., & Levey, D. (2006). Corridors Increase Plant Species Richness at Large Scales. Science, 313(5791), 1284-1286. Retrieved April 28, 2020, from www.jstor.org/stable/3846865
8. Brown, Gregory P., Benjamin L. Phillips, Jonathan K. Webb, Richard Shine, Toad on the road: Use of roads as dispersal corridors by cane toads (Bufo marinus) at an invasion front in tropical Australia, Biological Conservation, Volume 133, Issue 1, 2006, Pages 88-94, ISSN 0006-3207, https://doi.org/10.1016/j.biocon.2006.05.020.
9. Kowarik, I., & Moritz von, d. L. (2011). Secondary wind dispersal enhances long-distance dispersal of an invasive species in urban road corridors. NeoBiota, 9, 49-70. doi:http://dx.doi.org/10.3897/neobiota.9.1469
10. Rahel, Frank J., Intentional Fragmentation as a Management Strategy in Aquatic Systems, BioScience, Volume 63, Issue 5, May 2013, Pages 362–372, https://doi.org/10.1525/bio.2013.63.5.9

References

1. Doty, L. (2019, January 9). Levins Model—Population Dynamics. Ecology Center. https://www.ecologycenter.us/population-dynamics-2/levins-model.html
2. Canada, E. and C. C. (2007, October 15). *Why invasive alien species are a problem* [Guidance]. Aem. https://www.canada.ca/en/environment-climate-change/services/biodiversity/why-invasive-alien-species-are-problem.html
3. Mann, C. C., & Plummer, M. L. (1995). Are wildlife corridors the right path? *Science, 270*(5241), 1428. Retrieved from https://login.proxy.lib.duke.edu/login?url=https://search.proquest.com/docview/213566253?accountid=10598