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Action: Underpasses and Overpasses for Animal Dispersal

Key Messages:

- Five studies looked at underpasses use by a variety of animal species. Overall, most species used the underpass, but some species like bobcats, coyotes, and deer were seen to use them most often.
- The impact on wildlife usage of underpasses, overpasses and culverts in areas with high human population depends on the animal.
- One study showed deer to more successfully cross overpasses.
- Arboreal and land-bridge overpasses were studied in two articles and are successful in connecting arboreal species to fragmented pieces of land while also protecting them from predators.

Background Information

Since the rise of urbanization, development has expanded into land traditionally inhabited by wildlife species. As roads are built, land is fragmented decreasing the habitat size for these species. Concurrently, the number of animals killed by vehicles has increased. Large mammals like carnivores tend to be the most threatened population because they travel long distances. There are several ways to protect these species and mitigate the influx of roadkill. This includes drainage culverts, land-bridges, underpasses, and overpasses (Ng, Dole, Sauvajot, Riley, & Valone, 2004). The studies included in the literature reviews below look at all three of these solutions.

Arboreal mammals are a unique set of species that are impacted by land fragmentation. Several studies looked at the impacts of installing glide poles as a replacement for trees to help restore habitat connectivity (Taylor & Goldingay, 2011). Several studies also consider the effectiveness of wildlife fencing in combination with crossing structures like underpasses or overpasses. When combined, large mammal-vehicle collisions can be reduced by 80 – 97%. This study also says white-tailed deer, Florida panthers and black bears have been most severely impacted by road mortalities (Clevenger, Chruszcz, & Gunson, 2001). The purpose of the following studies are to determine the effectiveness of the land-connectors on different types of species.

Supporting Evidence from Individual Studies

1. (Ng, Dole, Sauvajot, Riley, & Valone, 2004)

This study was conducted along three highways near Ventura County, California. The three highways studied are US Highway 101, State Route 23, and US Highway 118. Both US 101 and 118 are barriers to animal movements to and from surrounding regions within the Santa Susana Mountains and Santa Monica Mountains. There are 15 potential wildlife underpasses, drainage culverts, and livestock tunnels there were studied. The square culverts are on average 97 m long, 4.2 m wide, and 3.7 m high, the pipe culverts are 176 m long, 2.6 m wide, and 2.9 m high, and the underpasses are 44 m long, 42 m wide, and 5.2 m high. The passages were monitored for four consecutive days each month for one year. Remotely triggered cameras and gypsum powder track stations were used to monitor. Throughout the study, 2723 pieces of data were collected including deer mice, woodrats, ground squirrels, cottontail rabbits, opossums, striped skunks, spotted skunks, raccoons, coyotes, bobcats, mountain lions, and mule deer. Raccoons used all the passages except one. Coyotes, bobcats, and domestic dogs and cats used approximately half of the 15 sites. Deer and mountain lions were only seen in a few sites. The study concludes that underpasses, culverts, and other cross-highway structures are important for regional conservation strategies. To further reduce the number of animals kills on roadways, it is recommended that animal proof fencing is installed to funnel animals away from road surfaces.

2. (Taylor & Goldingay, 2011)

This is a land-bridge study that looks at the use of glide poles by gliding mammals, a group vulnerable to road fragmentation. The study site is at Compton Road and Hamilton Road in Brisbane, Queensland, Australia. This is a busy arterial road that was converted from 2-lanes to 4-laes in 2004. Each land-bridge has soil on it to promote vegetation growth. The land-bridge on Hamilton Road is 36 m x 15 m. There are six 6.5 m high hardwood poles with a wooden crossbar located 5 m apart across the bridge. Single ropes were attached at the top of each pole to provide a canopy connection for the non-gliding animals. The Compton Road land-bridge has 8 wooden glide poles along with exclusion fencing. The bridge is 70 m long and 10 m wide. Hair traps were used to determine pole use. Each hair trap is made of 100 mm long x 40 mm diameter lengths poly vinyl chloride pipe with peanut butter, honey, and oat bait inside. And double-sided tape on each end. This method does not allow differentiation of species using the sites. In total, data from 34.4 months at Compton Road and 25.4 months at Hamilton road were collected. Camera monitoring was also used at each site and radio-tracking was used near the Compton Road land-bridge. The results of the study support the hypothesis that glide poles promote gap-crossing by the squirrel glider. When comparing the poles versus the shrubs, the poles facilitated more crossing than the shrubs. It is not certain if the gliding mammals prefer rope canopy or glide poles.

3. (Huijser, et al., 2016)

Along with a literature review, this study examines highways in western Montana, USA to see if the length of wildlife fencing near wildlife underpasses impacts the use of these underpasses by large mammals. The first study looked use of sections with no or very short fences in comparison to underpasses with longer sections of fencing. The second study looked at longer fence sections and their association to wildlife using that underpass more and reduced crossing at the end of the fence. The first study looked at 23 underpasses on US Hwy 93 using wildlife cameras. The cameras recorded data for one full year. The second study looked specifically at white-tailed deer at 10 large mammal underpasses each with four fence ends. There were minimum five cameras placed at each site. For the results of the first study, white-tailed deer were the species that used the 23 crossings the most. Other species that used the crossings were mule deer, American black bear, mountain lion, unidentified deer species, grizzly bear, elk, and an unknown bear species. The second study saw 997 large mammals either in the underpass on at the fence ends. 727 of these resulted in animals actually crossing the highway corridor. 82% of these crossings were at the underpass and 18% were at the fence ends. Based on the literature review, short fences are less effective at reducing collisions with large mammals. The effectiveness of the short fences was also much more variable. The first study results show that wildlife fencing, and longer fences do not guarantee higher wildlife use suggesting there are other factors influences large mammal use. The second study showed that 82% of large animal highway crossings occurred at the underpass. The longer fence length did not impact the use of underpasses.

4. (Simpson, et al., 2016)

This study looked at two sites along US 93 in northeastern Nevada, USA between Wells and Contact. Crossing structures were built where radio-collar data pointed to high volume of deer crossing during migration. The first site included one overpass and two underpasses each separated by 2 km. The second site had one underpass and one overpass separated by 1.5 km. The overpasses were both made of concrete and covered with soil and seeded with vegetation. The three underpasses were all cylinder in shape. Native soil was also placed at the base of each cylinder. Most of the deer using these structures were migrating, not residents. Data was collected during these migration periods using cameras with infrared technology. The results showed 35,369 mule deer successfully crossing more than one of the structures during eight migratory periods. Three elk were documented, but only one crossed successfully. Three elk did cross the overpass. The overpass was crossed most successfully in terms of number of deer. Passage rates were greater at overpasses regardless of location.

5. (Green, Davidson, Kaaria, & Doncaster, 2018)

Data for this study were collected within the 14 km long Mount Kenya Elephant Corridor. There is a concrete underpass located on the corridor that allows elephants so pass through. For the study, 25 Bushnell HD camera traps were set out from February 22 until May 6, 2016. The results of the study showed 43,400 photos analyzed with 2,070 trapping events. Within this were 22 mammal species. At sites with presence of cattle, the elephant crossings occurred more often at night. All camera traps saw elephants. It appears elephants were using this corridor within a week of it opening. 60 different elephants used the corridor and 52% traveled the entire corridor length. During the day, elephants used sites with lower human or livestock disturbance. Recommendations based on the study results include protecting corridor width and managing human activity within the corridor.

6. (Tigas, Van Vuren, & Sauvajot, 2002)

This study took place in the Simi Hills and Conejo Valley in western Los Angeles and eastern Ventura. Animals were trapped with padded leg-holds, bobcats restrained with ketamine hydrochloride/xylaxine mixture, and coyotes were physically restrained. The animals were then tagged. Data were collected from the tagged animals using GPS. Animal movements were determined using focal-animal telemetry. The results of the study showed less activity during the day in fragmented areas than unfragmented areas. Bobcats were seen to be less tolerant of human activity than coyotes. Coyotes are more willing to cross roads than bobcats. When a culvert was available, 63% of crossings still occurred over the road. Both bobcats and coyotes were often seen in the five corridors within the study area, but they did not use the corridors often.

7. (Teixeira, Printes, Fagundes, Alonso, & Kindel, 2013)

This study was completed in Lami district in Porto Alegre in southern Brazil. There are six rope bridges, similar to a horizontal ship ladder, monitored. The bridges were installed over hot spots identified through common road-kill spots. These bridges were designed for the brown howler monkey. The bridges were monitored using camera trap data over 15 months. The results of the study recorded three native mammal species using the rope bridges. This includes the brown howler monkey, white-eared opossum, and porcupine. It was determined that the overpasses are used as a linear corridor that restores the connectivity of these forests. This study did not address the survivorship of the species crossing the bridges.

8. (Goosem, Weston, & Bushnell, 2005)

This study took place in the tropical rainforest of northeast Queensland, Australia. This study area was identified because it is a hot sport for road mortality of tree-kangaroos. When upgraded, the road included four underpasses and allowed the animals a direct line of sight to the rainforest. On another section there were three faunal underpasses that included escape poles situated vertically and the base was covered with ground cover of soil, leaf, and branch litter. These underpasses were designed to help multiple species safely escape predators. Two species were focused on including the Lumholtz tree-kangaroo and the Southern Cassowary. There were several methods for data collection including road kill monitoring and camera trapping. The second part of the study included a rope tunnel arboreal overpass in a highland rainforest 30 km southwest of Cairns. The tunnel design is specifically to protect animals using it from predators. The main species this overpass targeted was the rainforest ringtail opossum, Lemuroid ringtail opossum, Herbert River ringtail opossum and the Green ringtail opossum. This canopy connection is the only way this species can move over the road. Data was collected for this part of the study through scat collection, hair analysis, and remote photography. Based on the study results, it is clear natural connections rather than artificial structures are preferred by rainforest species. Not all wildlife species used the faunal underpasses and it is thought that several years of habituation may be required before using the crossing structures. The arboreal overpasses are thought to be successful and have thus be installed elsewhere in Australia. Overall, use of the overpass and underpass does not prove that these populations have been sufficiently re-connected. In order to determine that, a population study must be conducted.

9. (Jensen, 2018)

This study was conducted along U.S. highway 101 in San Luis Obispo County, California. This area has been identified as a movement corridor for mountain lion, mule deer and black bear. The California Department of Transportation made a 4 km wildlife exclusion fence in hotspot areas. There are also dozens of underpasses along Hwy 101. Wildlife activity was tracked using wildlife cameras. Researchers found significant variation between the four species usage of the underpasses. Deer were seen to use the underpasses more than culverts. Deer tend to avoid small confined culverts. Bear were the least discriminating and used the underpasses at regular frequency. A mountain lion was detected only once over a one-year period but were seen using a variety of underpasses. Bobcats were the only species to use every underpass. Activity was higher at underpasses that were less open and longer. However, they prefer culverts because they are less confined.

10. (Braden, Lopez, Roberts, Silvy, & Owen, 2008)

This study looks at impacts of US 1 highway on Big Pine Key (BPK) on Key deer movements. Between 1998 and 2000 the deer were radiomarked. There are two underpasses, one on the north and one to the south. Camera data was also used for this study. The sample size of this study was limited meaning the results should be considered lightly. They did find a decrease in deer-vehicle collisions following the completion of the underpasses. The south underpass was used more than the north underpass by deer. The lack of alternative crossings in the southern region is contributed to this observation. The camera suggests the deer might become acclimated to the underpass after six months.

Conclusions and Recommendations

The implantation of underpasses, overpasses, culverts, and glide poles do not treat all species equally and these are not overnight solutions. When continuing to study these methods of connection, it is important to work enough time into the study to allow for the wildlife to warm up to the new crossing structures.

Wildlife fencing is most effective at reducing collisions when it extends over 5 km of road. The effectiveness becomes very unpredictable if under this length. Underpasses with no to short fences had irregular use by large mammals. The overall takeaway is that longer fences do not guarantee wildlife use of the underpasses, but instead the location of the crossing structure is extremely important (Huijser, et al., 2016).

The study that looked at glide poles concluded that vegetation on the land-bridge should be installed along with the glide poles, but a clear path must be ensured. Moving forward, it is recommended to look at other species of gliding mammals besides small petaurid marsupial gliders (Taylor & Goldingay, 2011).

When considering culverts, it is important to understand the animals that will be using the connector to ensure the dimensions are large enough to accommodate the targeted species. These dimensions were seen to significantly impact the use by deer. It is also recommended to install animal proof fencing to encourage passage of these wildlife species (Ng, Dole, Sauvajot, Riley, & Valone, 2004).

Overall, these structures have been proven to be successful in facilitating wildlife attempting to cross roads and are important in regional conservation strategies. A recommendation moving forward is to consider alternate designs of these crossing structures to see if they are more effective than the existing designs.

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