The Effects of Highways on Surrounding Environments

Ariana M. Sims, Dr. Kaplan (instructor), Urban Transport, 6 May. 2024

Introduction

Roads and highways present a serious problem to surrounding wildlife habitats. One of the most direct impacts is vehicle-wildlife collisions which lead to high wildlife mortality rates, human death and injury, and high costs in repair and damage. Highways also present indirect ecological impacts such as habitat fragmentation, migration disruption, and noise pollution. This essay will examine possible solutions to mitigate the negative environmental impacts that are caused by highways and how they can be improved. This paper will mainly focus on the western United States.

Current Issue

Roads have a direct influence on animal and plant communities by creating habitat fragmentation, providing a source of chemical and noise pollution, promoting the spread of invasive plant species, and influencing the gene flow among a population (Litvaitis & Tash, 2008). Roads impact a vast majority of the United States because there is so much road cover. An inventory conducted found that approximately 80% of all land areas were within only 1,000m of a road, and a small three percent were at least three kilometers away from a road (Litvaitis & Tash, 2008). The presence of roads is common in almost every US landscape.

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Wildlife Collisions

Although there are many environmental impacts from roads, the most direct is vehicle-wildlife collisions and the mortality rates that are a result of this issue. These vehicle wildlife collisions are a widespread problem in large portions of the United States. Wildlife collisions are dangerous, resulting in high death rates, and are very expensive in repair costs. The most common wildlife to be killed in these collisions are deer and elk (Washington *State Department of Transportation,* 2024). West Virginia, Montana, Iowa, Pennsylvania, and South Dakota have the highest rates of vehicle wildlife collisions (The Insurance Institute of Highway Safety estimates that about one and a half million deer collisions happen in the United States per year), which adds up to over one billion dollars in vehicle damage (*Perdue Forestry and Natural Resources,* 2018). The average claim for these collisions is about $3,995 (*Perdue Forestry and Natural Resources,* 2018). The peak time that drivers experience these collisions is between October and December (*Perdue Forestry and Natural Resources,* 2018). Not only are wildlife collisions dangerous to animals, but also contribute to human injury and fatalities. Annually there are around 59,000 human injuries and 440 human deaths attributed to wildlife collisions.

While not a proper solution on its own, many places in the United States have begun programs to help mitigate some of the issues that come with deer collisions. Notable among these issues is the issue of roadkill. When a buck or doe is struck on the road, the animal causes damage to both the vehicle and itself. However, damage may continue to occur if the animal in question is not properly taken care of. The deer may continue to do damage to other motor vehicles if it

remains in the roadway. Alongside this, the animal will continue to suffer until it is properly put down. When a deer is hit, law enforcement will be called out to the scene to put down the animal. Once this is done, the animal will then be dragged to the side of the road where it will remain out of the path of motor vehicles. To both prevent the meat from going to waste and scavengers like coyotes from becoming collateral damage in further roadkill incidents, law enforcement officers will make calls to a list of people from the local area who have volunteered to take and butcher the hit animals (*Cleveland 19 News*, 2004).

There are a couple of factors that contribute to a roadkill hotspot. The availability of food and water resources, suitable places for reproduction, forage, or cover plants, and proximity to wetlands are all considerations when determining the likelihood of a wildlife crossing (Litvaitis & Tash). Animals may also be attracted to road textures, for example, some reptiles will bask on warm asphalt to regulate body temperature (*Environmental Science.org*, 2024). The time of day that wildlife tends to cross can also impact how likely a collision is to occur. All these factors are things that could help determine the best place to put an animal crossing.

An example of this type of analysis in relation to wildlife collisions was done in Alaska. The aim of that study was to determine the highest risk factors for moose vehicle collisions in subarctic Alaska. Moose and human interactions are a frequent occurrence on Alaskan roads and may have serious complications for those involved. Multiple studies have identified important variables that would increase the likelihood of a moose vehicle collision. The population density of moose may vary depending on landscape features like elevation and land cover (Noordeloos,

2016). This particular study was conducted in Fairbanks North Star Borough, which can be characterized by a hill terrain that borders the Tanana River. The elevation is above sea level, and the climate is subarctic. The results of this study found that the spring months experience the lowest number of moose vehicle collisions (Noordeloos, 2016). An increase in collisions begins to rise after the month of June and is highest in the month of January (Noordeloos, 2016). Something else that was observed during the study was that these collisions tended to occur during the hours of twilight following a sunset (Noordeloose, 2016).

The study noted that the locations where moose vehicle collisions were occurring had speed limits that were 14.3 % higher in comparison to the sites of non-moose-related collisions (Noordeloose, 2016). Another factor that this study took into account was traffic volume. Moose vehicle collisions were found to more commonly occur on roads with high traffic volume, and a significant relationship was found between traffic and moose vehicle collisions (Noordeloos, 2016). Moose vehicle collisions were also noted to be less frequent in locations with high levels of urbanization. The areas in Fairbanks North Star Borough, Alaska that reported the greatest frequency of moose-vehicle collisions were described as “woody wetlands”, (Noordeloos, 2016).

Additionally, there was a strong correlation between the location of a moose-vehicle collision and its proximity to a recently burned (intentional or wildfire) area (Noordeloos, 2016). The majority of moose-vehicle collisions were noted to be five to fifteen kilometers from a recently burned area (Noordeloos, 2016). Fortunately, for Alaska moose, collisions have been on the

decline. This is mainly due to an increase in purposeful hunting to decrease their numbers (Noorsedeloos,2016).

In summary, this analysis found that there were five main factors (outside of the time of day/year) that were strong predictors of moose vehicle collisions. The most prominent was distance from a recently burned area, but the posted speed limit, traffic volume, and land cover also played an important role (Noordeloos, 2016). These types of analyses are not only critical in determining the extent of the problem but are crucial in developing wildlife collision mitigation strategies.

Habitat Fragmentation

Highways are not only harmful because of vehicle wildlife collisions; they can also lead to habitat fragmentation. Habitat fragmentation can be defined as large-scale development that involves both the loss and breaking apart of a habitat. Multiple studies have demonstrated that habitat loss has negative implications for biodiversity (Fahrig, 2003). Fragmentation occurs from the division of a habitat into smaller and more isolated fragments separated by human development (Wu, 2022). Many ecologists agree that habitat destruction is to the detriment of biodiversity, even though it is not the only contributing factor to biodiversity loss (Wu, 2022). Multiple analyses have revealed that a large percentage of the world's remaining forests are in close proximity to human development. (Wu, 2022). More than 70% of the remaining forests are within one kilometer of a forest edge (Wu, 2022). This close proximity, which almost always leads to habitat fragmentation, can have a number of negative effects on an ecosystem.

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Shrinking habitats can often lead to a lower survival rate, meaning that a smaller size of land possesses fewer resources. Some studies suggest that lower percentages of forest cover are associated with a lower rate of reproductive success, especially among birds (Wu, 2022). This makes sense for if animals have fewer resources they have less energy for reproduction. Another major consequence of habitat fragmentation is the edge effect. The edge effect increases the mortality of many species due to a lack of food, and higher chances of predation (Wu 2022).

Habitat Fragmentation can also be the culprit of a decline in genetic diversity. Genetic diversity is reduced significantly in small, isolated populations (Wu, 2022). A lack of genetic diversity can increase the rate of genetic abnormalities that are in a species (Wu, 2022). If species are not able to disperse, it is likely they will only breed among those that are close. Highways can significantly impact the natural flow of migration and dispersal. If animals are unable to cross major roads it greatly reduces their chances of dispersing into other parts of their habitat.

Impacts of Fragmentation on Elk in Western US

A study has been conducted analyzing the impacts of habitat fragmentation on elk populations. Elk are a good candidate for research because they are widespread and exist in all western states in the US and several midwestern states. Elk also happens to be one of the most studied animals in North America (Ruediger & Wall, 2005). This study is mainly concentrated on elk populations in western states such as Washington, Oregon, Montana, Colorado, Utah, California, and Nevada. Direct habitat loss for Elk often is a result of the paving

and fencing of highways (Ruediger & Wall, 2005). Parts of elk habitats that have highway development are permanently lost, as long as the highway is still active.

Based on some GIS assessments it was discovered that with just a two-lane highway (150ft in width) the number of elk habitat lost per mile is 18.18 acres (Ruediger & Wall, 2005). With a four-lane divided highway (300 ft in width) that number upticks to 36.6 acres lost per mile (Ruediger & Wall, 2005). In 2005 a GIS analysis indicated that approximately 387,000 acres of habitat had been lost in the Western United States. Oregon experienced the highest rate of elk habitat loss with over 65,000 acres impacted (Ruediger & Wall, 2005).

Habitat fragmentation from highway development has a significant impact on elk and other wildlife. The full extent of these impacts may not be fully understood such as noise pollution. However, it is clear that fragmentation has a large impact on the elk population. Habitat fragmentation has a greater impact on elk than other species because of their migratory nature (Ruediger & Wall, 2005). Elk require large home ranges which means they tend to disperse over a greater amount of land (Ruediger & Wall, 2005).

Highways can restrict elk's ability to move to and from winter habitats. This fragmentation may also separate cows from calves and affect breeding, and accessibility of food and water (Ruediger & Wall, 2005). The widening of highways from two to four lanes can increase fragmentation, making it even more difficult for elk to cross. Elk's responses to highways can be impacted by a number of factors such as topography, vegetation, traffic volumes, highway design, and hunting (Ruediger & Wall, 2005).

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From the study, it was found that elk's use of habitat typically decreases as the proximity to roads and highways increases (Ruediger & Wall, 2005). Elks' avoidance of habitat near highways further decreases the amount of habitat they are willing and able to use. Highways in the West (and other parts of the country) often provide ideal habitats for the spread of invasive plant species (Ruediger & Wall, 2005). The spread of plants such as noxious weeds has resulted in environmental degradation in many elk ranges.

Although not fully proven in the case of elk in the western US, highway development may increase the construction of infrastructure (Ruediger & Wall, 2005). This secondary development could lead to further habitat fragmentation. Any meaningful mitigation issues impacting wildlife due to highways must be addressed. Many highway projects do not factor in terrestrial migration as a priority. Terrestrial wildlife migration is often perceived as optional which means that many times it does not get addressed at all (Ruediger & Wall, 2005). It is vital that these considerations become important for highway projects. Mitigation solutions must address issues like habitat fragmentation, species mortality, and traffic safety issues.

The mitigation measures that address elk mortality, elk habitat fragmentation, and traffic safety measures need to be implemented. These mitigation efforts could include wildlife crossings and fencing. If a significant amount of habitat loss has taken place, then habitat acquisitions and enhancements should be implemented (Ruediger & Wall, 2005).

For habitat acquisition, there are three main options. One is to make up for lost elk habitat on public and private land, although this would not solve the issue of fragmentation where a

highway is already in place (Ruediger & Wall, 2005). Another solution is to replace Elk habitat affected only on public land. Lastly, for habitat acquisition a solution may be to replace elk habitat only in the most critical areas, which is typically in the winter ranges for Elk (Ruediger & Wall, 2005).

Mitigation for roadway deaths also needs to be taken into account. Wildlife crossings and fencing serve as mitigation for habitat fragmentation, mortality, and highway safety (Ruediger & Wall, 2005). Some take issue with the high cost of these mitigation measures, although the cost of such structures may be offset by reductions in human injuries, fatalities, deer and elk mortalities and vehicle damage costs (Ruediger & Wall, 2005).

Since elk are large animals, size must be taken into account when considering the appropriate crossings. There are several types of elk crossing designs that may be effective. These passes include open-span underpasses, wildlife overpasses, box culverts, or large elliptical culverts (Ruediger & Wall, 2005). Each of these passings have both advantages and disadvantages. The types of passings best suitable for elk are large (50m wide) wildlife overpasses (Ruediger & Wall, 2005). These have been utilized on a Trans-Canada highway in Banff National Park. Engineers have designed these overpasses to be wide at the top and narrow at the bottom (Ruediger& Wall, 2005). Box culverts for elk would have to be large, although culverts are typically used for smaller animals.

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Noise Pollution

Noise pollution is a common side effect of highways. It has an impact on habitats, animals, and people that are in close proximity. Noise pollution (> 85 decibels) may cause hearing loss and masking which is when animals are unable to hear important environmental signals (Arcangeli, Lulli, & Traversini, 2022). Animals near sound pollution may also experience increased heart rate, and abnormal behavioral side effects (Arcangeli, Lulli, Traversini, 2022). This may lead to the abandonment of certain locations, resulting in lower reproduction rates (Arcangeli, Lulli & Traversini, 2022).

Fortunately, there are ways to mitigate the impact of noise pollution. EPA scientists recommend roadside barriers to reduce traffic noise (*Environmental Protection Agency,* 2017). They can include vegetation made up of trees and bushes as well as physical wall barriers (*Environmental Protection Agency*, 2017). The combination of roadside vegetation and physical wall barriers may reduce downwind pollution at greater rates than one of those methods alone (*Environmental Protection Agency*, 2017).

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Conclusion

In summary, highways cause a lot of environmental degradation. Highway development in natural areas can cause wildlife collisions which are deadly to animals, often cause human injury, and can be very expensive in car damage. Highways also can lead to habitat fragmentation which may result in restricted migration, smaller habitats with fewer resources, and genetic deformities among a species in the affected area. Fortunately, there are ways to mitigate the effect of habitat fragmentation by building wildlife overpasses and restoring habitat that has been lost to highways. Even if animal mortality continues to be an issue there are still sustainable ways of dealing with roadkill, such as allowing it to be used as a food source for the surrounding community. Lastly, noise pollution is another detrimental complication of highways. Like habitat fragmentation and wildlife crossings, this issue has a mitigation strategy as well. With the use of barriers and roadside vegetation, sound pollution can be greatly reduced. These strategies for noise pollution may also help mitigate pollution for other forms of pollution produced by highways.

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