Preventing roadkill incidents: comparison of methods, what we know, what needs improvement

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Abstract

The wildlife-vehicle collisions (WVCs) have led to significant roadkill incidents, causing a great threat to the animal population and biodiversity. This paper compares various WVC prevention methods, focusing on their effectiveness in wildlife fatalities. The study reviews both the physical (fencing, crossing structure, and sign signal) and olfactory methods (using odor to prevent WVCs). Data from multiple studies are compiled and visualized as graphs. This study suggests that fencing is the most effective method, especially when it is used with crossing structures. The study emphasizes the importance of combining methods for optimal results and calls for further research to address gaps in the research.

Keywords: roadkill, wildlife-vehicle collision (WVCs), prevention, methods, physical, chemical, biological, olfactory

Introduction

Ongoing development is blurring the boundaries between human and animal life. For instance, deforestation has led to habitat loss and habitat fragmentation and has reduced the food available. Consequently, animals are forced to move closer to people. This has put wildlife in even greater danger of collisions (Pagany et al. [1]) “Roadkill”, the unintentional phenomenon of cars colliding with wildlife animals, is a significant issue. Every year, millions of animals (Trina et al. [2], Chyn et al. [3]) like reptiles, mammals, and amphibians are killed on the road worldwide. These collisions pose a threat not only to individual lives but also to the existence of entire species. For instance, the Leopard Panthera pardus of North India (*Panthera pardus*), the maned wolf of Brazil (*Chrysocyon btachyurus*), the little spotted cat of Brazil (*Leopardus tigrinus*), and the Brown hyena of Southern Africa (*Hyaena brunnea*) have increased risk of extinction because of roadkill respectively 83%, 34% and both of 75% (Grilo et al. [4]).

Various strategies can be proposed, such as making a fence, using chemical repellents, and building a crossing structure (over-passing and under-passing) for animals. The effectiveness of each method can be different depending on location, duration, season, etc. In addition to effectiveness, feasibility must be considered, such as the cost of implementing the method. Moreover, the environmental/conservational and ethical impacts must be considered. For example, fences are often considered the simplest solution but can limit gene inflow as it causes geographic isolation (Latch et al [5]), and chemical repellents, such as capsaicin, can be one of the most effective solutions, but it requires careful ethical consideration due to their potential threat to animals. Furthermore, we
need to consider environmental factors like time, weather, and season to make the solution most effective.

To address the pressing issue of roadkill and mitigate the risk of species extinction, this study focuses on how to protect animals from this threat while weighing in these other factors. This study compiles and analyzes results from published literature to determine the efficacy of each method under different environmental conditions and times of day or season. Also, this study focused on revealing the effectiveness of various means on mammals. Furthermore, the Graphical representations and charts are

used to compare the effectiveness of these prevention strategies, providing insights into their impact on reducing wildlife road mortality.

The physical approach

The physical approach involves installing fences, crossing structures, and wildlife crossing signals to prevent animals from crossing the road or to make drivers aware of animal crossing. However, this method is not effective for small animals like reptiles that they can pass through under the fence and can lead to species isolation by limiting animal movement.

The olfactory approach

This approach uses various olfactory means, which are beneficial for the environment but difficult to collect regularly. It involves substances like capsaicin, Big Game Repellent, and predator's urine. While this method is effective, it has a relatively short duration and raises ethical concerns.

Overview of methods used in this study

The main strategy used in this research was quantifying, calculating, and visualizing values as charts and graphs. First, I explored two methods: physical and olfactory. Then, I specified each method. For the physical method, I collected data for fences, animal crossing road sign signals, and crossing structures. The use of the chemical deterrents was measured using the olfactory method. Then I collected the data on effectiveness by using the effectiveness values reported in each study for the various methods. After, I showed it as a chart to compare and determine the best way to prevent wildlife collision. Finally, I compared the duration, cost, and variety of mammal species each method is effective at protecting.

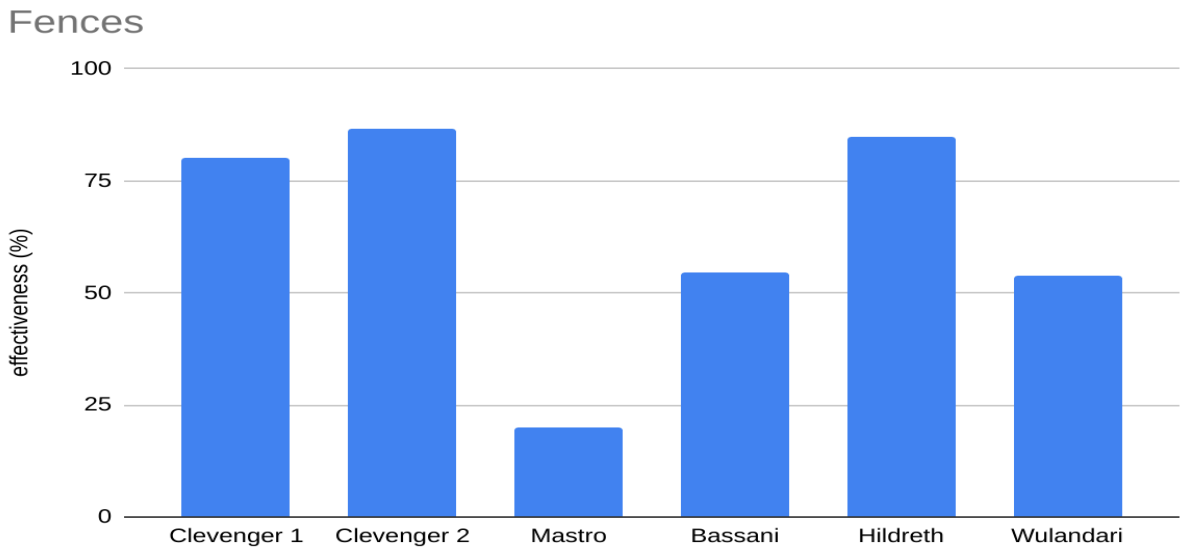
Strategies for Use

I utilized Google Scholar to gather data on roadkill prevention. I used search terms such as 'fence effectiveness roadkill', 'chemical deterrent effectiveness roadkill', 'crossing structure effectiveness roadkill', 'WVCs effectiveness', and more. The research papers varied in testing sites, season, time of the day, and species. I focused on mammal species. Firstly, I collected data on physical methods including fences, sign signals, and crossing structures. For the fences, I considered the different sizes used in the experiments and selected the most effective value. I excluded values that differed significantly from others in terms of the size of the fences used in the research.

Results

Physical methods

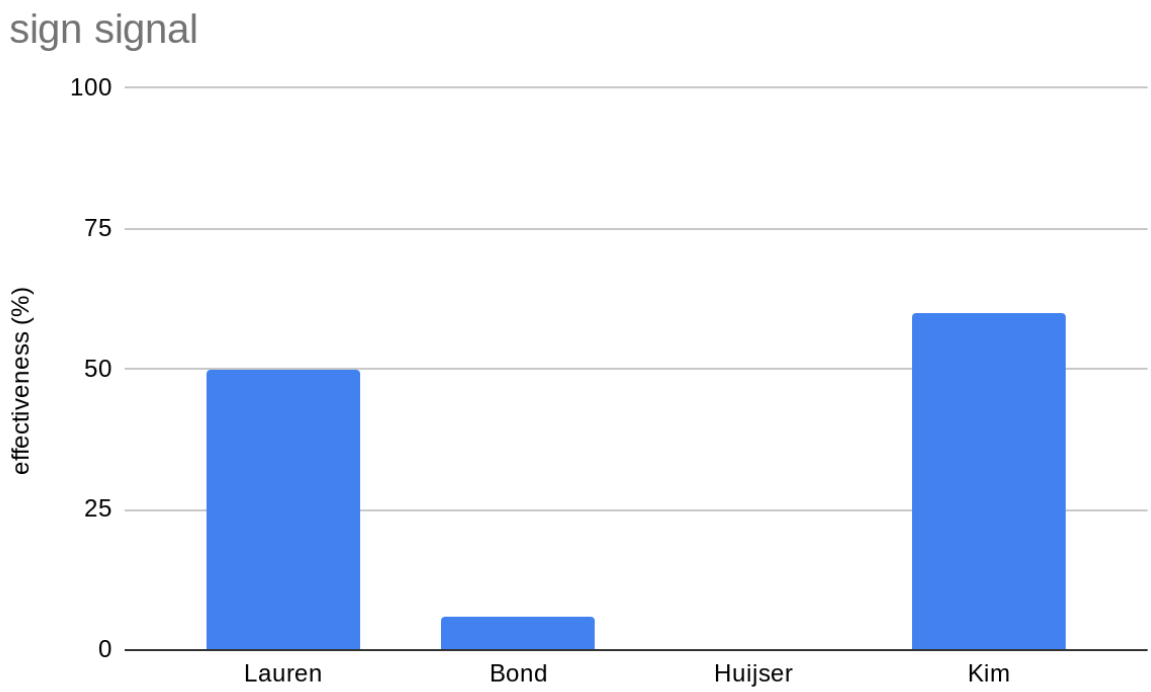
The values of the effectiveness of fences as WVC prevention methods were first collected. The result of the collected data is shown in **Figure 1**.



^ *Figure 1. This graph shows the effectiveness of fences as a WVC prevention method observed in each research paper ([6] - [11]).*

The animal crossing sign signal was analyzed next. The Wildlife Sign Signal Prevention is constructing the animal crossing sign signal to show the drivers implementing the speed limit. Therefore, this method itself does not directly affect wildlife animals. The collected effectiveness values for the Sign Signal are shown in **Figure 2**.

Sign signals



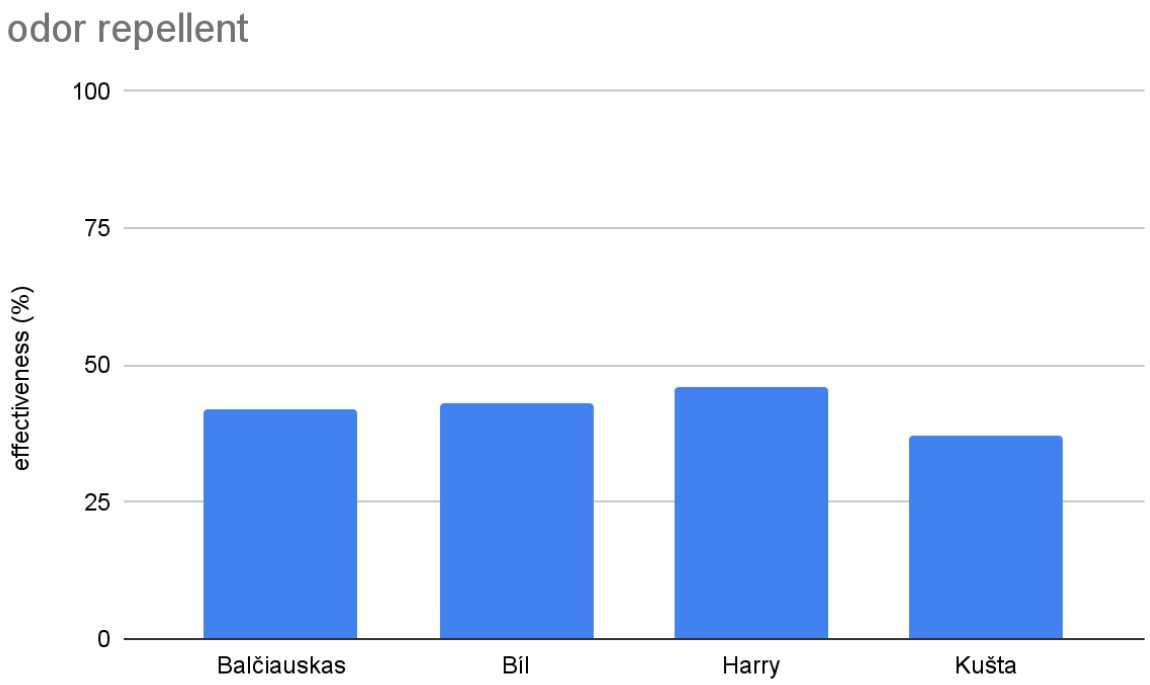
^ *figure2. A graph showing the effectiveness of the animal crossing sign signal as the prevention method, shown in research ([12] - [15])*

In **Figure 2**, the studies using this method demonstrated varying effectiveness percentages, ranging from 0 percent to 60 percent. This indicates that there is no clear correlation between the reduction of WVCs and the display of a sign signal. Some research also questioned the effectiveness of sign signals (Meyer [16]). Furthermore, certain studies highlighted the importance of specific location, timing, and reliability for these signals to be effective (Huijser et al. [17]).

Next, the effectiveness of the crossing structures was collected. I couldn't find the research paper that solely used the crossing structure or stated the exact effectiveness percentage. However, many studies showed that many animals used the crossing structure after installation ([18] - [20]), which means it is likely to be effective in preventing WVCs.

Odor Repellents

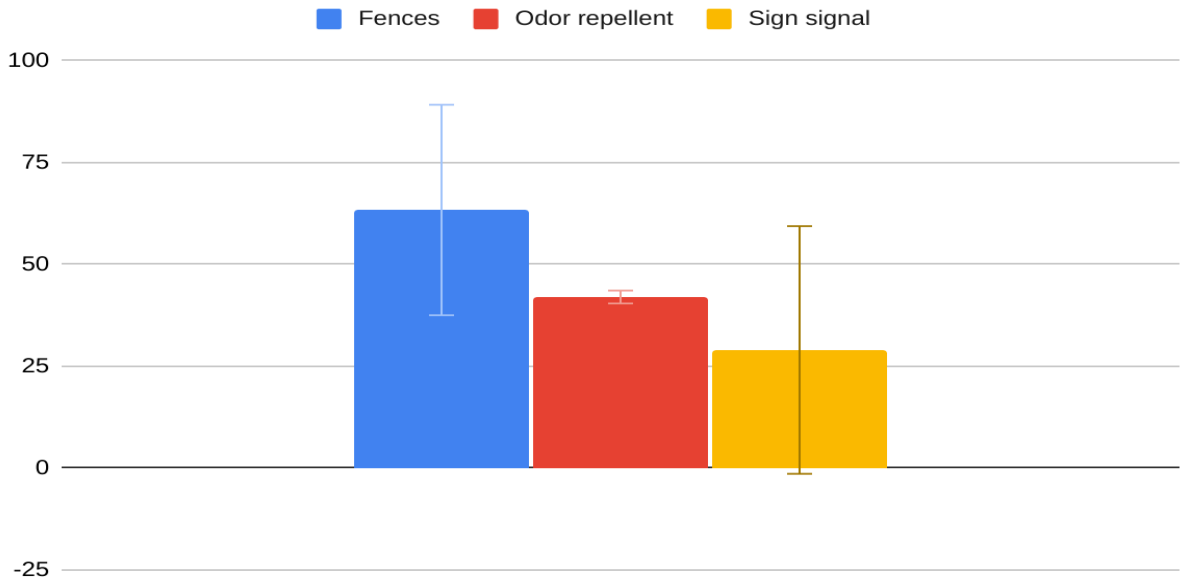
Odor repellents are a technical solution to managing WVCs with a chemical concentrate that mimics the odors of large carnivores (bear, wolf, lynx) and humans (Zdeněk et al. [26]). The collected values for the effectiveness of odor repellents are shown in **Figure 3**.



^ *Figure 5. This graph shows the effectiveness of the odor repellents as the WVCs prevention method.*

In several studies, different types of chemical deterrents were tested. These included Wam Porocol (Balčiauskas et al. [21]), Pacholek (Bíl et al. [22]), remedy (Harry et al. [23]), and a combination of scents from Hagopur (smelling like predators and humans), Hukinol (smelling like human sweat), and Kornitol (a natural mixture of fats and oils) (Kušta et al. [24]). One study did not yield any effectiveness (Elmeros et al. [25]), but it was conducted in winter, and chemical deterrents are known to be ineffective during that season (Kušta et al. [24]). Therefore, I did not include it in the data.

Average data



^ *Figure 4. This graph shows the average effectiveness values and STDEV for each prevention method: Fence, odor repellent, and sign signal*

Figure 4 shows that the values collected for odor repellents were the most accurate and the sign signal was the least accurate. Therefore, the value for the odor repellents is the most reliable.

Discussion

Factors Influencing the Frequency of Roadkill

Landscape and season can be two of the factors that determine the frequency of WVCs. The WVCs tend to happen mostly in the rural areas rather than the city, especially if it is near the natural resources essential to the wildlife animals such as lakes (water) and forests (habitat/food source). Also, the roadkill frequency tends to increase in particular seasons: Autumn and spring. Fall is the mating season for many animals and they travel longer distances to search for mates, which increases the WVCs frequency (Raymond et al. [27]). Also, migration and the shorter daylight cause the increased tendency of roadkill. Similar to Fall, spring has more frequency of roadkill than any other season because it is the breeding season and many animals emerge from hibernation they move a long distance in order to search the food resources.

Knowledge Gaps in the Literature

There was a knowledge gap in WVCs. There were many studies done to find out the WVC hot spots, the reason the WVCs are happening, and their impact on the environment and the vehicle, but there was not sufficient research about roadkill prevention methods, especially using olfactory.

Challenges faced by roadkill prevention studies

Collecting enough data for each method was the hardest part of this research. Not all of the methods were tested enough to be analyzed. Especially for the means using chemical repellents, the ethical problem needed to be considered in the research about that method was not frequently used. Also,

building the crossing structure costs a lot of money, which makes it hard for individual researchers to conduct research about it without fundraising. Moreover, the olfactory method like using a predator's scent and chemical deterrents as a means to prevent is not a great means to use in the long-term because it is hard to utilize it. Furthermore, the length and width of the fences differed between the researchers, which might have caused the different results.

Future Directions

This study suggests more study on the various prevention methods of WVCs. Also, standardization would be helpful in determining the best method for the WVCs, such as the size of the fences and the use of chemical deterrents.

Conclusion

The use of the fence is most effective on WVCs. The average of using fences as the prevention method was 63.4%. Even though the fence itself can provide the distinctive effect of WVC prevention, using mixed prevention methods can be more effective. The effectiveness of the use of both fencing and crossing structures was 83% (Rytwinski et al. [28]). Also, the effectiveness of using an electrical fence was 77% (Mastro et al. [12]). Using the crossing structure can also be effective, but it is more costly than the fence. Also, using odor as the mean of WVC prevention had a mean value of 42% with a low standard deviation of 3.7, but it was shown that it is not effective during winter (Elmeros et al. [25]). The mean for the sign signal was 29% and the standard deviation was about 30.4, which makes the values unreliable (has no effect).

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