Determining the Significance of Various Variables on Wildlife Poison Exposure in Canada using GIS Spatial Analysis Tools

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Introduction

Ecosystem health, which is dependant on high levels of biodiversity[1], is threatened by wildlife poisoning[2]. Many human activities, such as agriculture, resource extraction, and technological advancement, expose wildlife to poisons[2]. However, there has been little research into the spatial relationship of poisoning events.

Purpose

The purpose of this research is to develop and utilize a GIS-model to determine what variables affect poison exposure of birds and mammals in Canada, as well as the strength of these relationships.

Study Area

Canada is a biodiverse country with 1,449 native vertebrate species[3]. These species are at risk of poisoning. Figure 1 shows wildlife mortality across Canada. Canada is a growing country, with 2,233,140 road networks, 277 agricultural areas, 14,000 PRFs, and 9,007 protected areas[4].

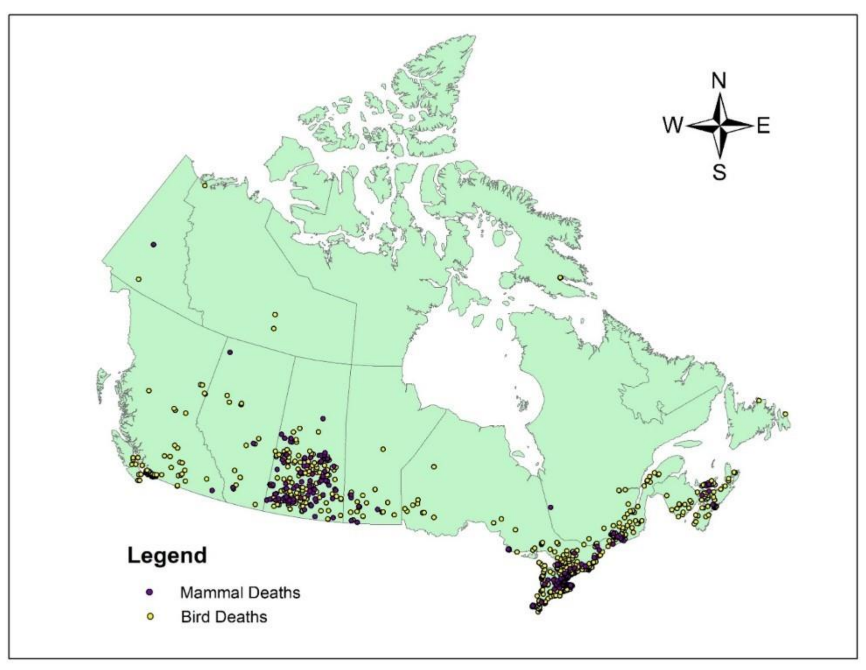


Figure 1: Map displaying CWHC wildlife mortality points due to poisoning across Canada.

Objective 1

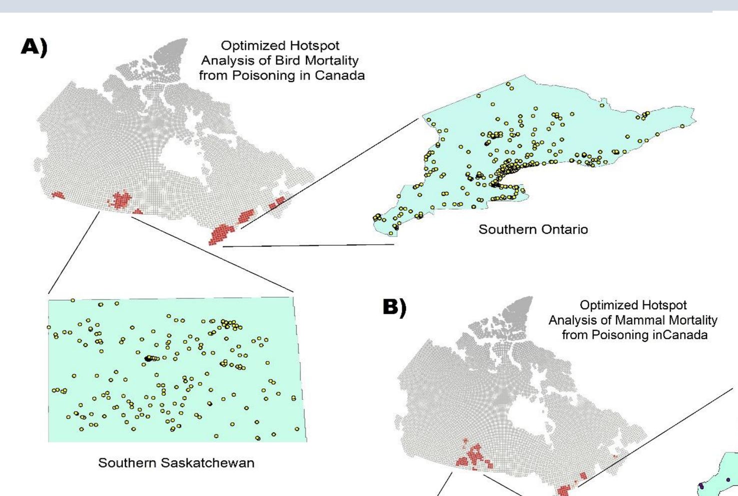
Identify variables that could explain the spatial distribution of wildlife mortality in Canada.

We performed a literature review to accomplish this objective. The variables are road networks, agricultural areas, pollutant-release facilities (manufacturing, chemical, metal, wood producing, electrical, and waste removal sites), and protected areas.

Objective 2

Identify areas of focus with the greatest proportion of bird and mammal mortalities due to poisoning in Canada.

To accomplish this objective, we divided the wildlife data into bird and mammal point data. Then, we performed an optimized hotspot map on both datasets. This identified two areas of focus: southern Ontario and southern Saskatchewan. We then isolated variables and wildlife data to these extents (Figure 2).



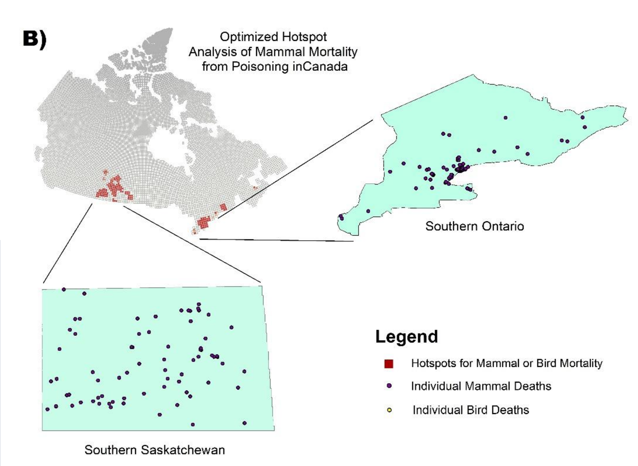


Figure 2: Output maps from the optimized hotspot analysis conducted on bird mortality locations (A) and mammal mortality locations (B) across Canada

Objective 3 & 4

Develop a GIS-based model and perform statistical analysis to assess the spatial relationship of wildlife mortality with the selected variables and their significance on wildlife poisoning.

We developed a GIS-model in model builder. This involved multiple steps, summarized in Figure 3, including creating a random distribution of points. The output of this model produced the amount of wildlife found within a buffer area of each variable (Figure 4). This value was used to calculate a Chi-square statistic and a p-value.

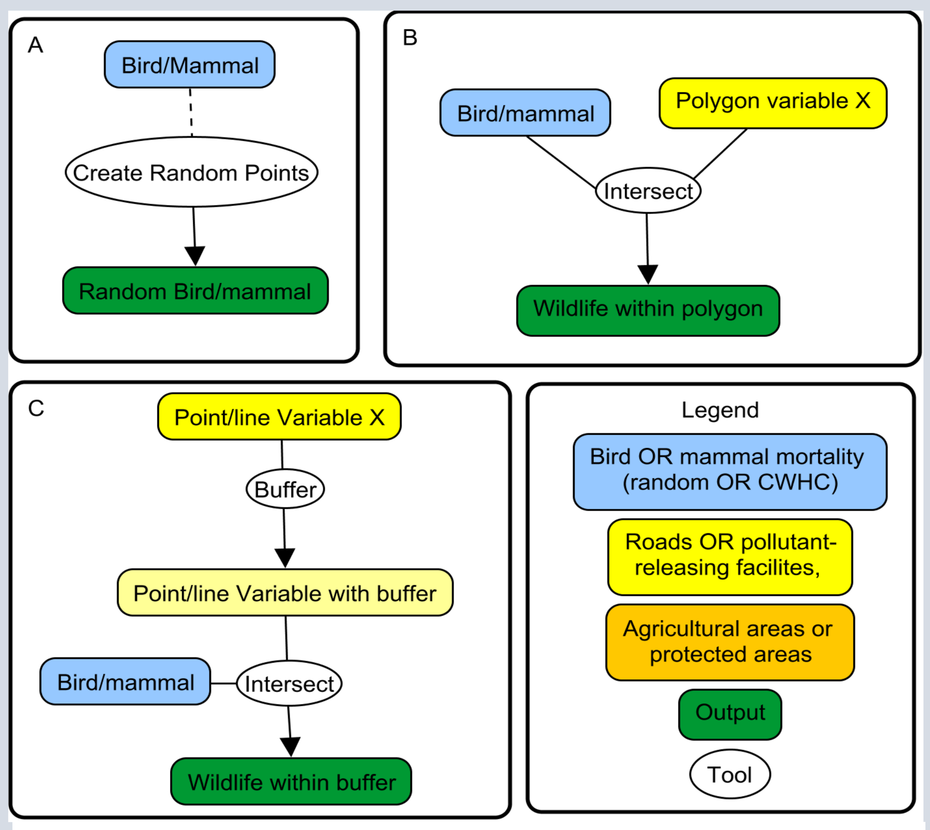


Figure 3: Flowcharts demonstrating steps of the GIS-model; (A) refers to the process for making a random distribution of points using the raw CWHC data as a parameter, (B) refers to the process for polygons data, and (C) refers to the process for point or line data.

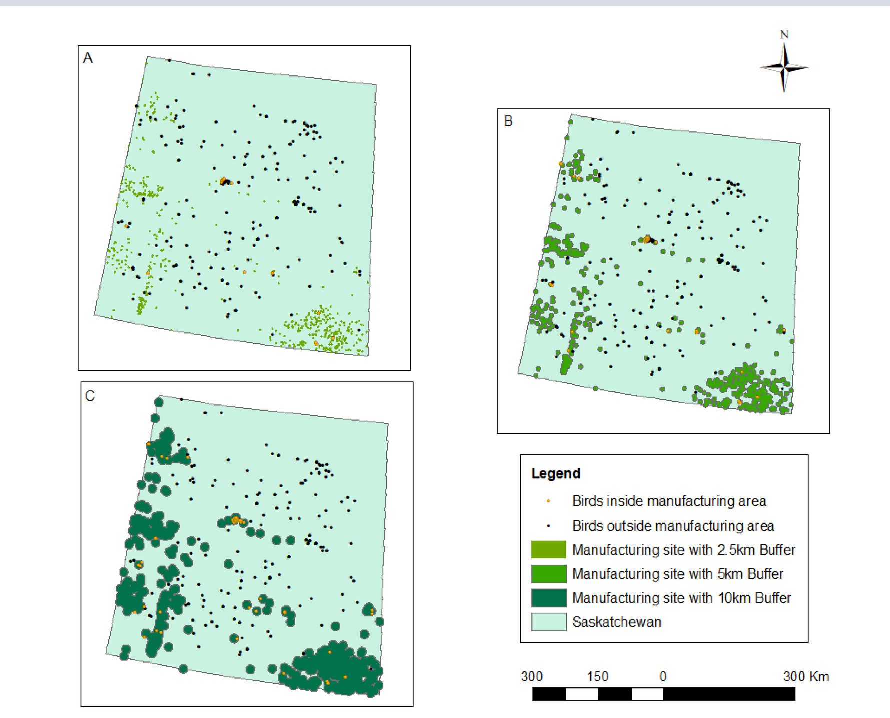


Figure 4: Example output maps of the three buffer sizes demonstrating birds and manufacturing sites in southern Saskatchewan: (A) 2.5km buffer, (B) 5km buffer, (C) 10km buffer.

Strengths / weaknesses

There was bias and inconsistencies in this research through the data collection. The data was collected by laypeople, using different techniques from accurate GPS coordinates to generalized landmarks. This means that the points were not necessarily accurate. Additionally, public lands and populated areas were more likely to have points, since these are areas the laypeople had access to.

Despite this weakness, this research provides a strong foundation for understanding the spatial relationships involved in wildlife poisoning.

Future Research

Future research should develop a deeper understanding of the spatial patterns explored in this study. Future research could also expand into other areas of Canada, as well as to aquatic and marine species, amphibians and reptiles. Finally, future research could actively sample wildlife mortality events in order to minimize the reporting bias of passively collected data.

Research Findings

The following research results demonstrate strength of correlation (displayed as chi-square value) between variables and: birds in southern Ontario (Figure 5); mammals in southern Ontario (Figure 6); birds in southern Saskatchewan (Figure 7); and mammals in southern Saskatchewan (Figure 8). Orange indicates a direct correlation with wildlife mortality and blue indicates an indirect correlation.

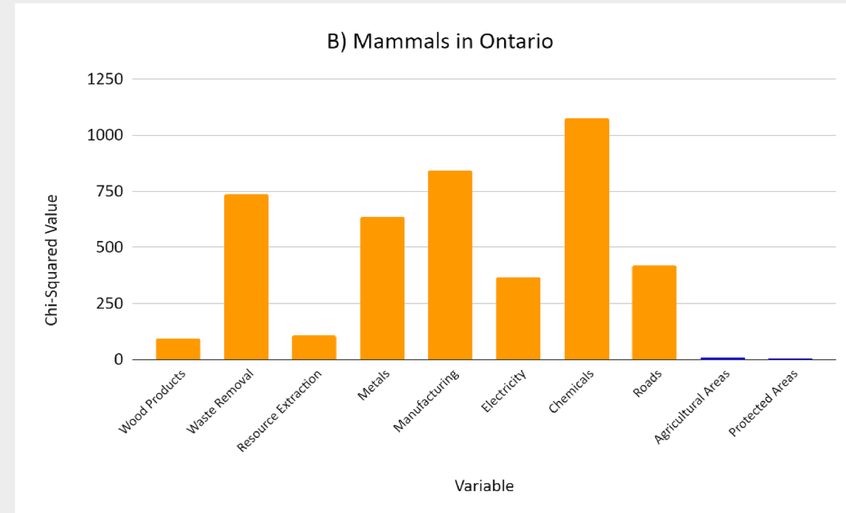


Figure 5. bird mortality in southern Ontario.

All variables had a significant effect on bird mortality in southern Ontario ($p<0.05$). Variables with the greatest influence were waste removal sites, metal sites, and road networks.

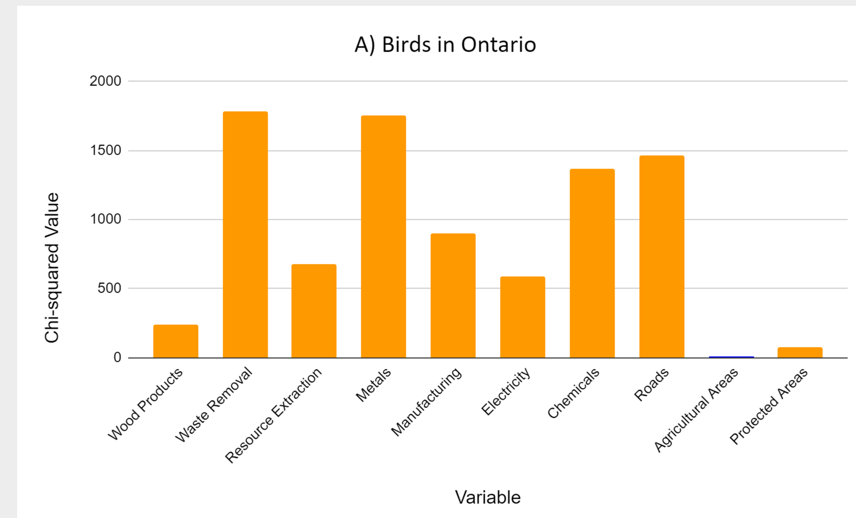


Figure 6. mammal mortality in southern Ontario.

All variables except for resource extraction sites had a significant effect on wildlife mortality in southern Ontario ($p<0.05$). Variables with the greatest influence were waste removal sites, manufacturing sites, and chemical sites sites.

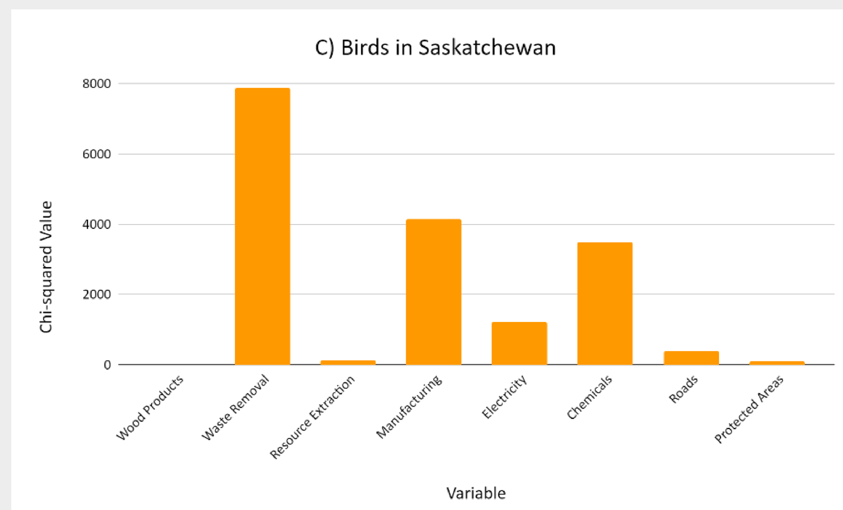


Figure 7. bird mortality in southern Saskatchewan.

All variables except for wood product and electrical sites had a significant effect on wildlife mortality in southern Saskatchewan ($p<0.05$). Variables with the greatest influence were waste removal sites, manufacturing sites, and chemical sites.

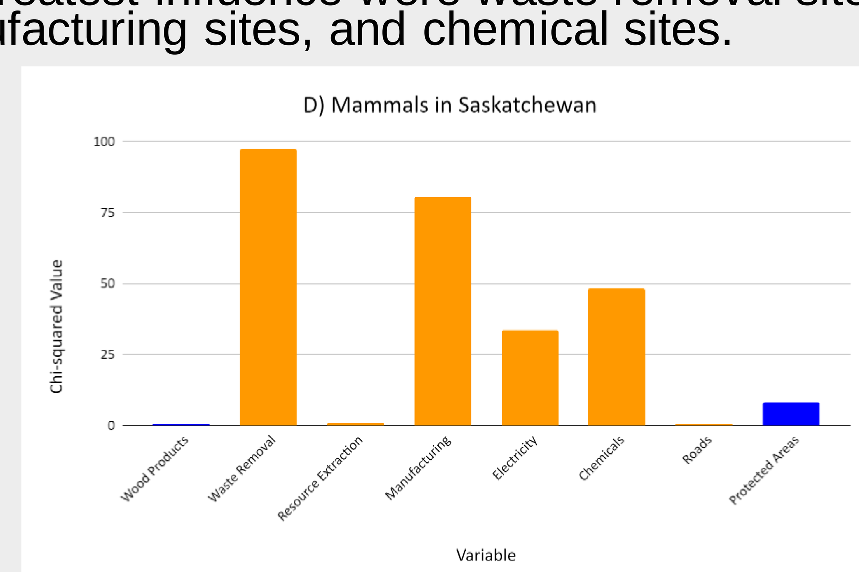


Figure 8. mammal mortality in southern Saskatchewan.

Only waste removal sites, manufacturing sites, chemical sites, and protected areas had a significant effect on wildlife mortality in southern Saskatchewan ($p<0.05$). Variables with the greatest influence were waste removal sites, manufacturing sites, and chemical sites.

Conclusion

The variables with the greatest effect across both species and study areas are waste removal sites, manufacturing sites, and chemical sites.

Acknowledgements

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References

1. Thompson, I. Mackey, B. McNulty, S. Mosseler, A. (2009). Forest Resilience, Biodiversity, and Climate Change: a synthesis of the biodiversity/resilience/stability relationship in forest ecosystems. Secretariat of the Convention on Biological Diversity, Technical Series no. 43. 1-67.
2. Ryser-Degiorgis, M. (2013). Wildlife health investigations: needs, challenges and recommendations. BMC Veterinary Research, 9(1). https://doi.org/10.1186/1746-6148-9-223
3. WWF (World Wildlife Foundation). (2017). Living Planet Report Canada: A National Look at Wildlife Loss. WWF Canada. Toronto, Ontario.
4. Statistics Canada. (2016). Snapshot of Canadian agriculture. Retrieved March 10, 2020, from https://www150.statcan.gc.ca/n1/ca-ra2006/articles/snapshot-portrait-eng.htm.