Is it Better to be a Moose or a Black Bear?*

An Analysis of Ontario Wildlife Harvest and Active Hunter Data From 2006 to 2023

Samantha Barfoot

April 23, 2024

This paper analyzes Ontario wildlife harvest counts, specifically moose and black bears, and the number of active hunters based on region. The analysis examines harvest counts from 2006 to 2023 across Northern, Southeastern, and Southwestern Ontario. It was found that moose harvests have decreased over the past 20 years whereas black bear hunting has stayed relatively consistent. The implications and causes of these trends are important for species population in Ontario as well as the Ontario hunting industry.

Table of contents

*Code and data are available at: https://github.com/SamanthaBarfoot/wildlife_hunting.git

1 Introduction

Every year the Ontario Ministry of Natural Resources and Forestry records data on the number of black bears and moose hunted per year and the number of active hunters per year. Ontario moose hunting season typically runs from early September to late October ("Moose | Ontario Hunting Regulations Summary | Ontario.ca" n.d.) and the black bear season runs from early May to mid-June and mid-August to late November depending on the region (Travel and Recreation 2023). To hunt either of these animals, hunters must have the proper license and are responsible for identifying their target and obtaining tags, which indicate how many harvests they can take. Moose tags also indicate what type of moose a hunter is allowed to harvest whether it be a cow, calf, or bull ("Moose | Ontario Hunting Regulations Summary | Ontario.ca" n.d.). Hunting is a significant contributor to the Ontario economy and tourism industry. It supports the employment of thousands of people and some years generates more money than the film and television industry in Ontario (Evaluation 2012). One year Canadian hunters spent around $1.2 billion on hunting trips with $70 million on the hunting licenses alone (Evaluation 2012). In 2000, the hunting industry represented $1.5 billion of the economy (Evaluation 2012). Despite being such a large industry, there is still a significant amount of poaching and other illegal hunting practices performed in Ontario (Fowler 2019). In 2016, there were 384 major offences related to these practices with people paying thousands of dollars in fines (Fowler 2019).

Therefore, it is important to properly regulate and monitor the wildlife populations as well as the hunting and harvest numbers so that species are not put at risk by overhunting. Additionally, it is important to analyze how these levels change over the years and what might cause these changes. Alongside overhunting, having too large a population of a certain species can also put a strain on the ecosystem, in which case hunting can be an important method of regulating population. The Ontario hunting industry is a significant economic contributor and, therefore, it is important to the province for hunting practices to continue. This paper examines these hunting activities in Ontario and how they have changed over the past few years. Specifically focusing on two majorly hunted species, moose and black bear, which are favoured by trophy hunters. Using data from the Ontario Data Catalogue active hunter and harvest numbers from 2006-2023 for moose and 2012-2023 for black bears are analyzed. From this analysis, it was found that moose harvests have drastically decreased since 2006 as has the number of active moose hunters. In comparison, black bear harvesting and hunting have stayed relatively consistent. While moose hunting has decreased, there is still a significant population of moose hunters, especially compared to black bear hunters.

The estimand of this paper is the correlation between the number of active hunters in Ontario and the number of annual moose and black bear harvests. Specifically, we examine how these numbers vary with regard to region and time.

Section 2 of this paper covers the broader context of the Ontario moose and black bear hunting activity and harvest data sets from the Ontario Data Catalogue. It examines the variables used in the data set using graphs to help explain them as well as discusses high-level aspects

of the data cleaning process. Section 3 further examines the relationship between the variables and the findings from the analysis of the two data sets. Section 4 of this paper explores what was learned from this analysis and the implications it has on Ontario's hunting industry and environment as well as weaknesses in the analysis.

The graphs and tables in this paper were made with using R studio (R Core Team 2022). The creation of these graphs and tables were made with `ggplot` (Wickham 2016), `tidyverse` (Wickham et al. 2019), `gridExtra` (Auguie 2017) packages. The analysis and cleaning of the data was conducted with `dyplr` (Wickham et al. 2023), `MASS` (Venables and Ripley 2002), `janitor` (Firke 2023), and `stringr` (Wickham 2023) packages.

2 Data

2.1 Data Source

The data sets used in this report, *Moose hunting activity and harvests* and *Black bear hunting activity and harvests*, were obtained from the Ontario Data Catalogue. Specifically, the data is provided by the Ministry of Natural Resources and Forestry and was last updated on February 16, 2024. The data sets provide the estimated hunter and harvest numbers by region across Ontario from 2006 for the moose data set and 2012 for the black bear data set. The numbers in these data sets are based on replies that the Ontario government received from a sample of hunters across Ontario. It is not specified exactly how these measurements were performed only that they received replies from these various hunters. The number of active hunters and harvests could have been measured by surveys or the government asking all hunters registered for moose and black bear hunting how many harvests they collected. To legally hunt moose and black bears, hunters must register and obtain licenses. Therefore, to measure how many active hunters are in Ontario, the Ministry of Resources and Forestry might have counted how many registered hunters they have for each species. The data collected are only estimations as it is composed of self-reported harvests. Hunters voluntarily submitted this data and thus might not entirely reflect the actual number of harvests. They can only estimate how many harvests were collected each year as it depends on hunters being honest about how many harvests they made and that all hunters possess the proper permits.

2.2 Variables of Interest

The original data set for moose hunting and harvests obtained from the Ontario Data Catalogue contained seven variables. The first variable, *WMU*, is the Wildlife Management Unit which indicates the specific region in Ontario. There are a total of 95 different WMUs, which are grouped into three larger regions, Northern (see Figure 1), Southeastern (see Figure 2), and Southwestern (see Figure 3) Ontario. However, the black bear data set only has data from WMUs 1 through 82 and the moose data set has data from WMUs 1 through 65. The second

variable, *Year*, indicates the harvest year. *Active Hunter* (see Figure 4) indicates how many hunters were active in that specific WMU and year. *Bull Harvest*, *Cow Harvest*, and *Calf Harvest* (see Figure 5) indicate the respective number of harvests for each type of moose for that specific WMU and year. *Total Harvest* (see Figure 6) is the sum of all bull, cow, and calf harvests for that specific WMU and year. The original data set for black bear hunting and harvests contain the same variables of WMU, year, and active hunters (see Figure 7). However, instead of bull, cow, calf, and total harvest, there is only one harvest variable called *Harvest* (see Figure 8) as all black bears are grouped as one.

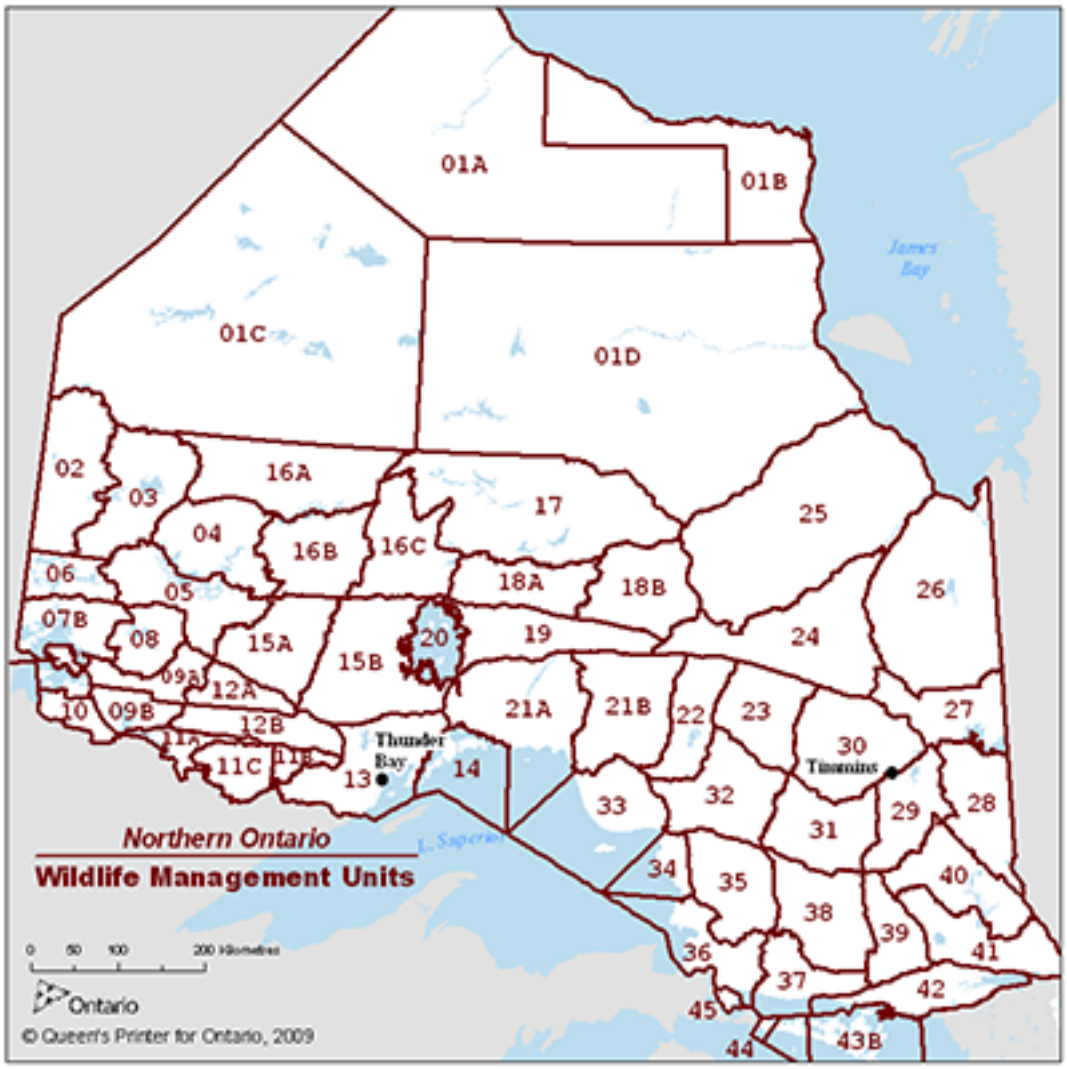

Figure 1: Map of Northern Ontario region and the included WMUs (image credit: ontario.ca)

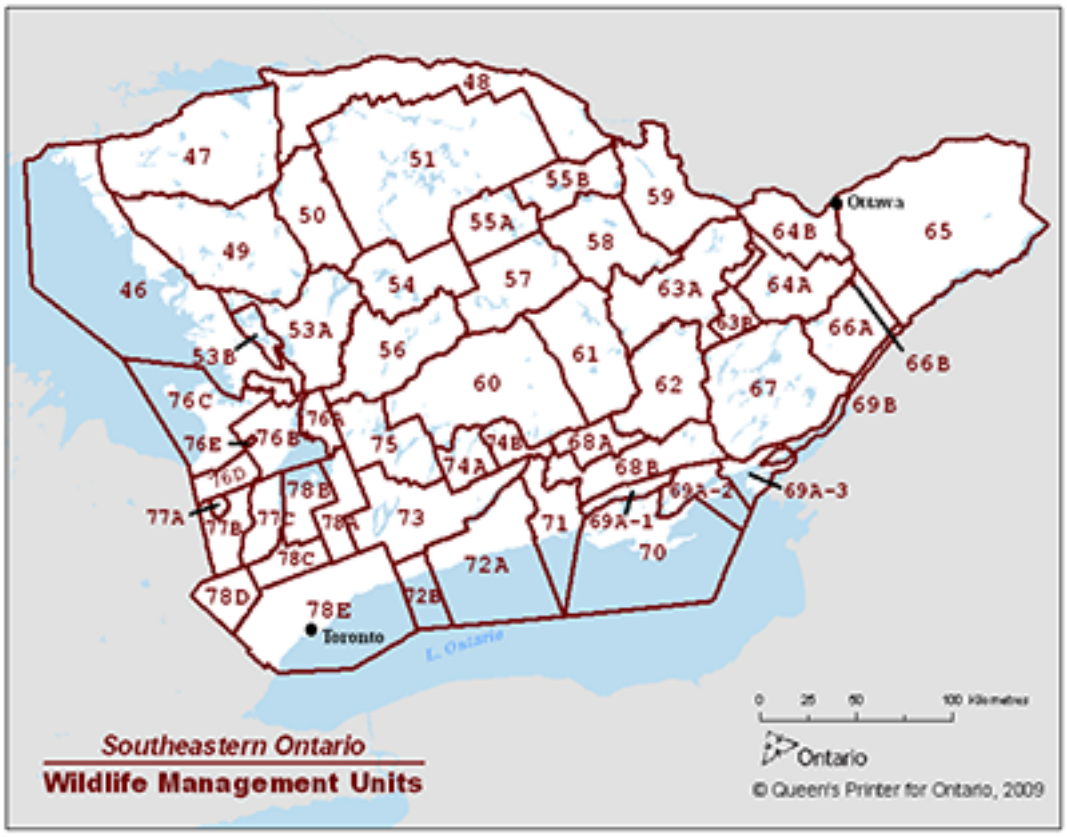

Figure 2: Map of southeast Ontario region and the included WMUs (image credit: ontario.ca

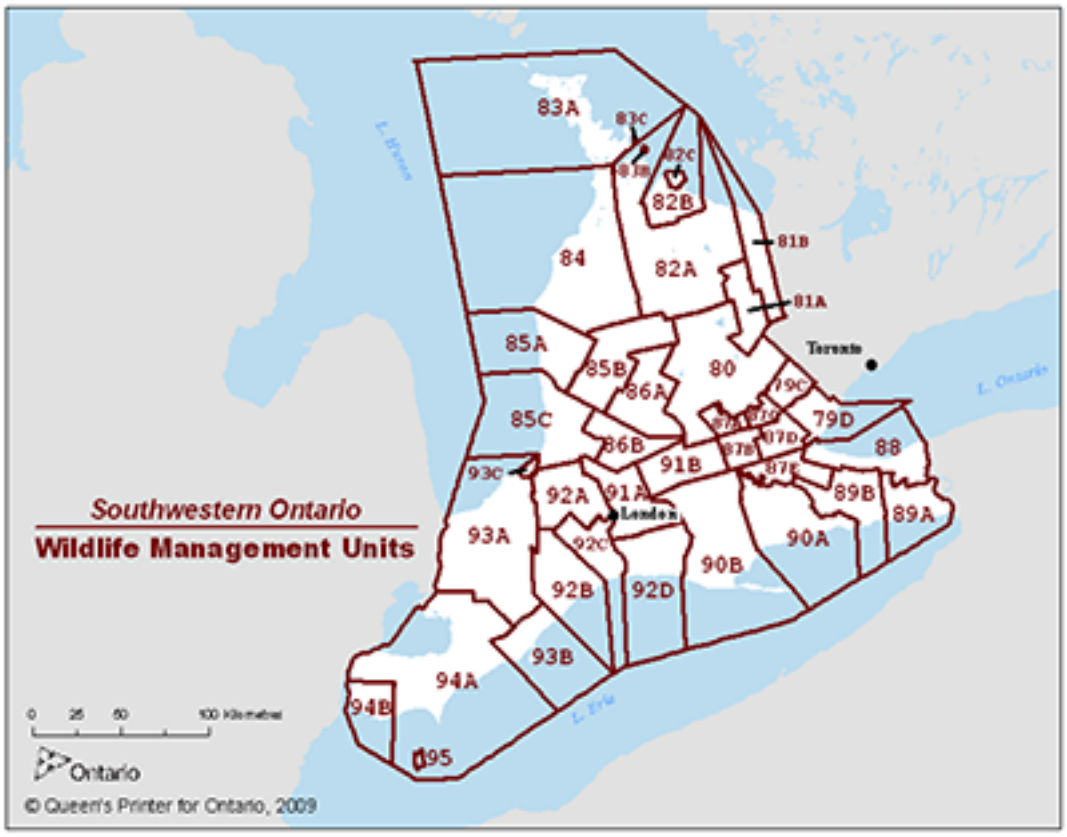

Figure 3: Map of southwest Ontario region and the included WMUs (image credit: ontario.ca)

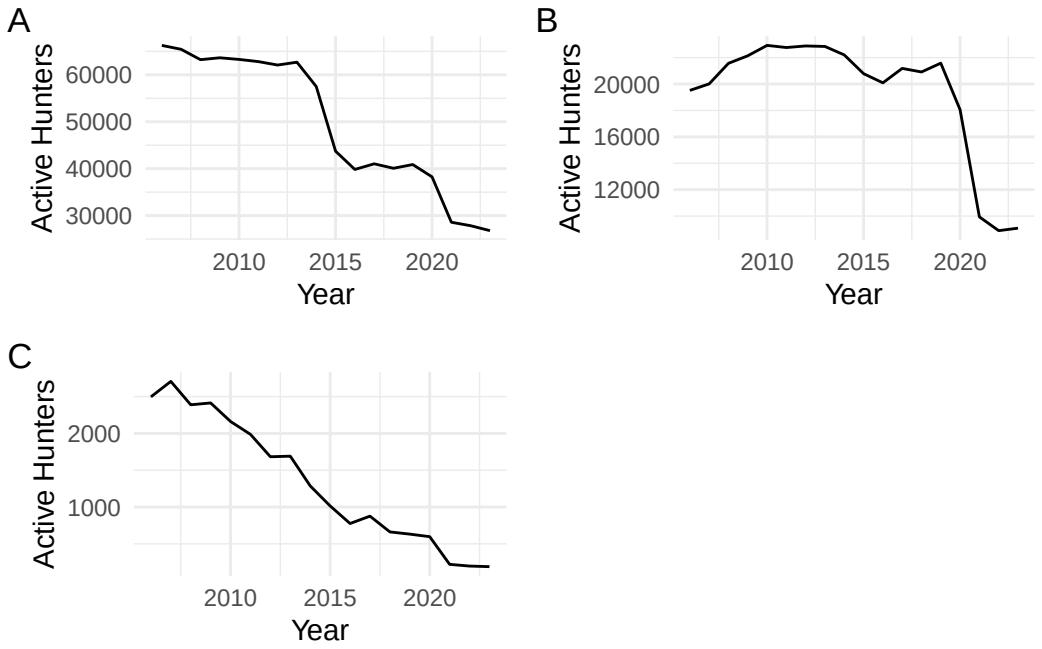

Figure 4: Number of active moose hunters between 2012 and 2023 in the Northern (A), Southeastern (B), and Southwestern (C) region

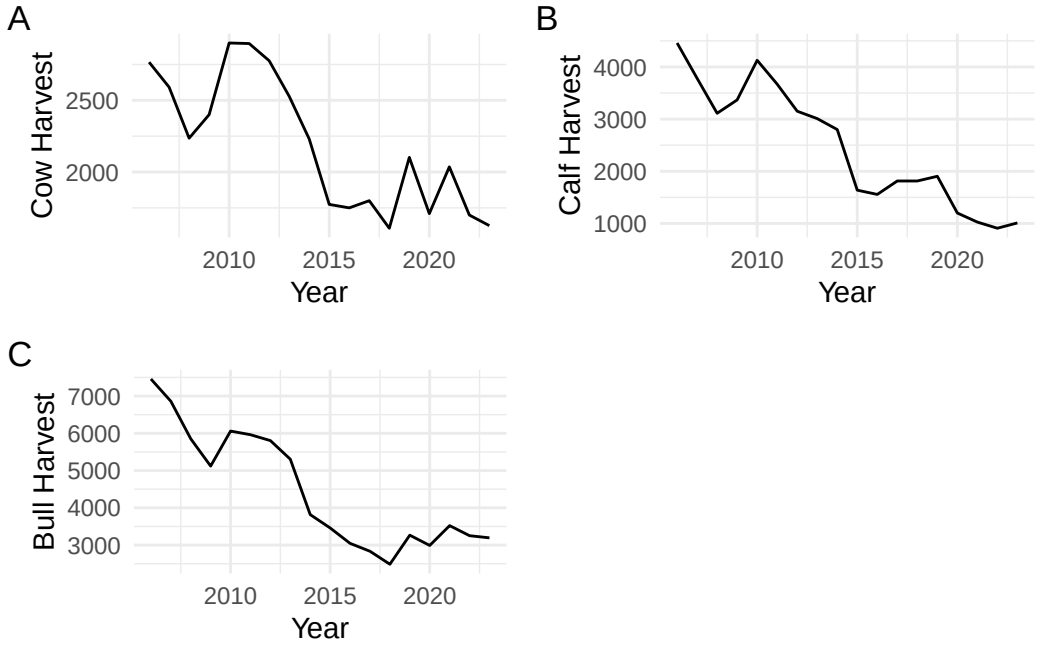

Figure 5: Total number of cow, bull, and calf moose types harvested between 2012 and 2023

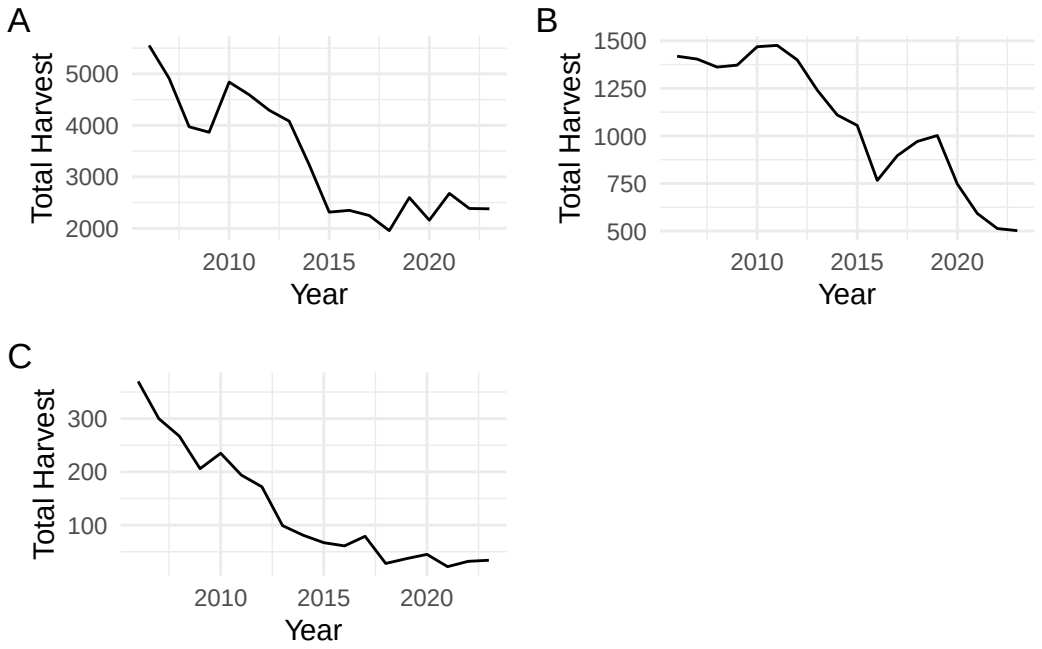

Figure 6: Number of moose harvested between 2012 and 2023 in the Northern (A), Southeastern (B), and Southwestern (C) region

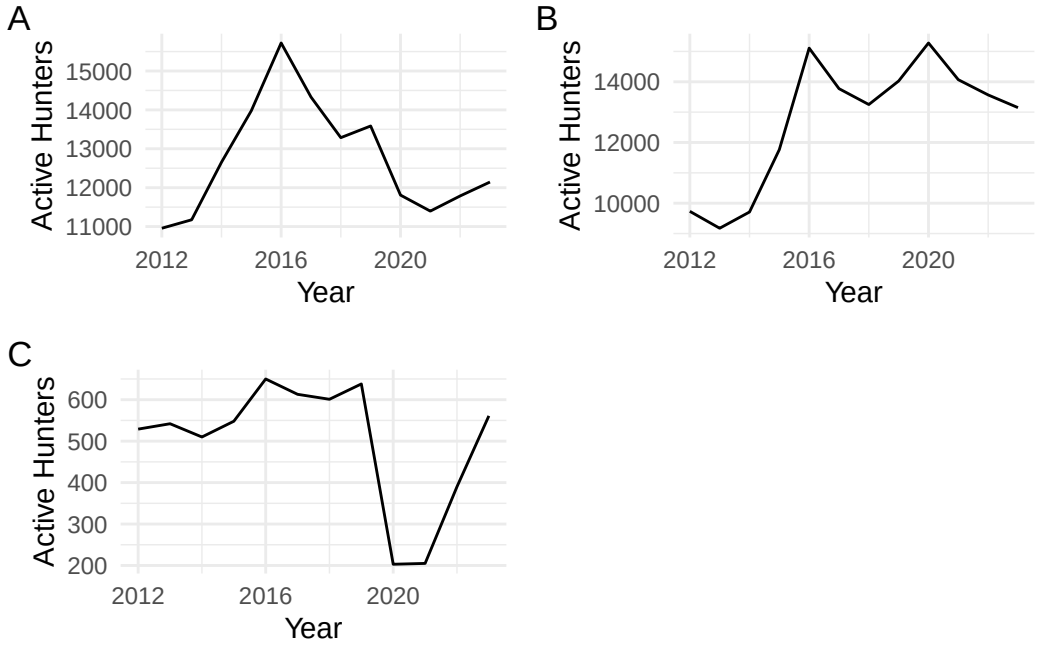

Figure 7: Number of active black bear hunters between 2012 and 2023 in the Northern (A), Southeastern (B), and Southwestern (C) region

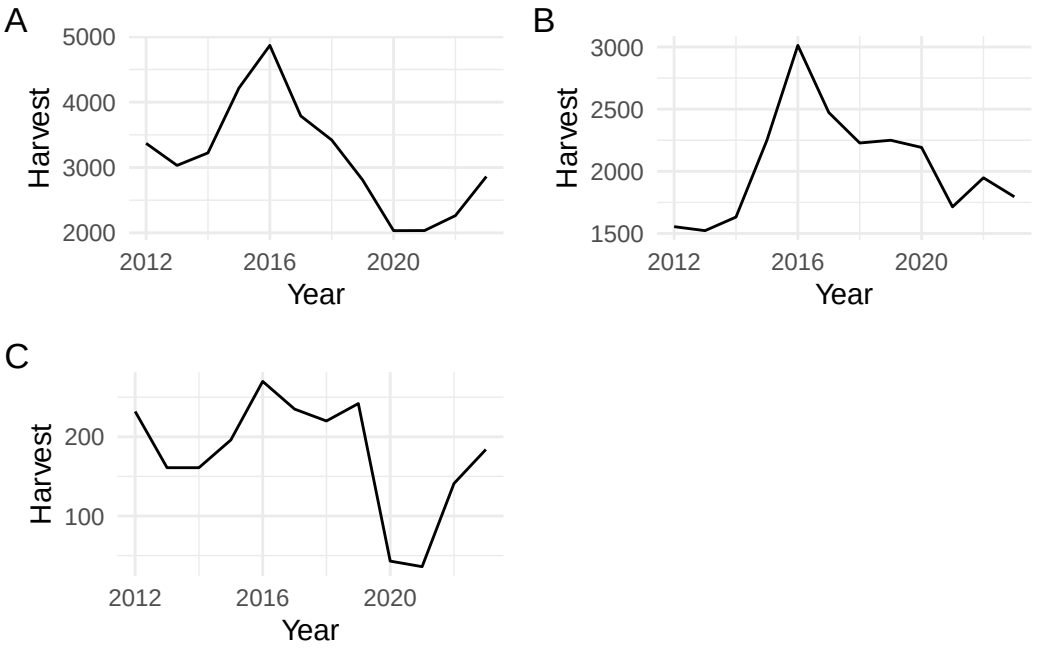

Figure 8: Number of bears harvested between 2012 and 2023 in the Northern (A), Southeastern (B), and Southwestern (C) region

To clean the data, each animal's data sets were split into three sets, one for WMUs in the Northern, Southeastern, and Southwestern regions. This way, different regions and their harvest and active hunter numbers could be plotted against each other. Each cleaned black bear data set contains 12 entries and each cleaned moose data set contains 18 entries. For each larger region, the active hunter and harvest numbers were totaled for each year. Each cleaned data set also contains the same variables as the original data sets. Some cleaning was also applied to the WMU values as many of them had extra zeros and letters joined to them.

3 Results

3.1 Total Harvest Trends

By analyzing each hunting region separately, we can examine how the total harvest rates of black bears and moose compare. Figure 9 shows that the harvest rates for moose generally decrease before 2018 whereas the amount of black bear harvests increases from 2012 to 2016 before decreasing and increasing again in 2021. The trend lines on Figure 9 cross three times between 2012 and 2023 with black bear harvest rates sometimes being higher than moose rates and vice versa. In comparison, they never cross in Figure 10 with the number of black bear harvests always being more than moose harvests. Interestingly, the peak for both Figure 9 and

Figure 10 for black bears are both in 2016 and have similar trends where they dramatically increase before 2016 and quickly fall after 2016. Whereas, in Figure 11 the black bear harvest peak stays relatively consistent between 2016 and 2019 before greatly decreasing after 2016. In Figure 11, similar to Figure 10, the number of black bear harvests is always higher than the number of moose harvests except in 2020 where they are equal. Interestingly, in all three graphs, the number of moose harvests tends to decrease overall between 2006 and 2023, most dramatically in the Northern and Southwestern regions. While all three of these graphs show that black bear harvest numbers are generally higher than moose, the number of harvests for each species is drastically different. In the Northern region, moose harvests reach around 5,500, and black bears around 5,000. Whereas, in the southeast region they reach 1,500 and 3,000, respectively, and in the Southwestern region, 350 and 275, respectively.

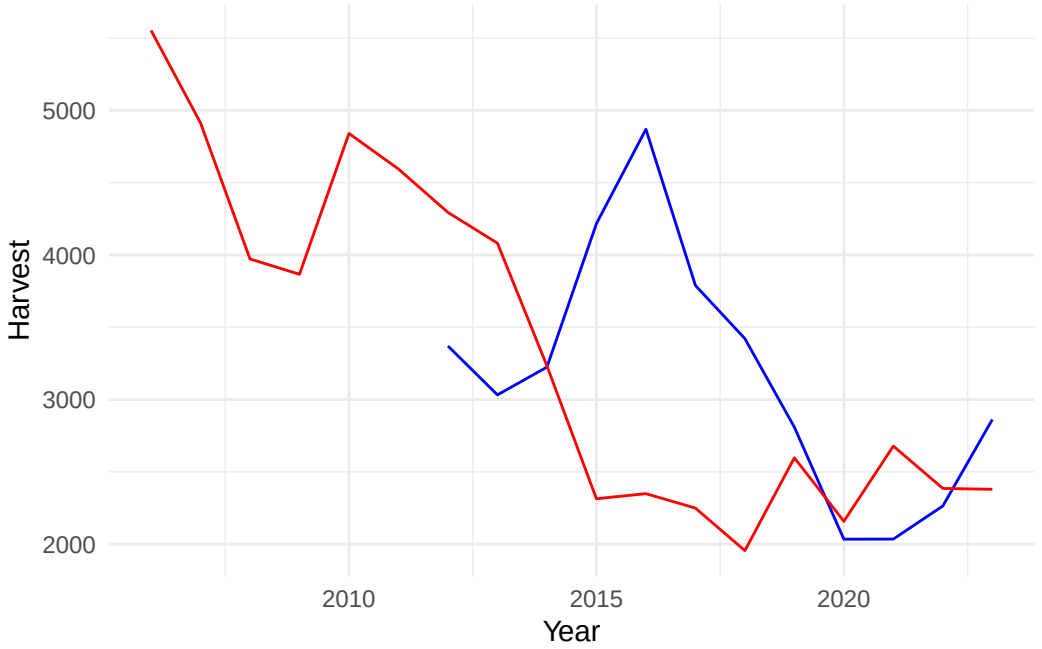

Figure 9: Northern harvest numbers for moose and bears between 2006 and 2023

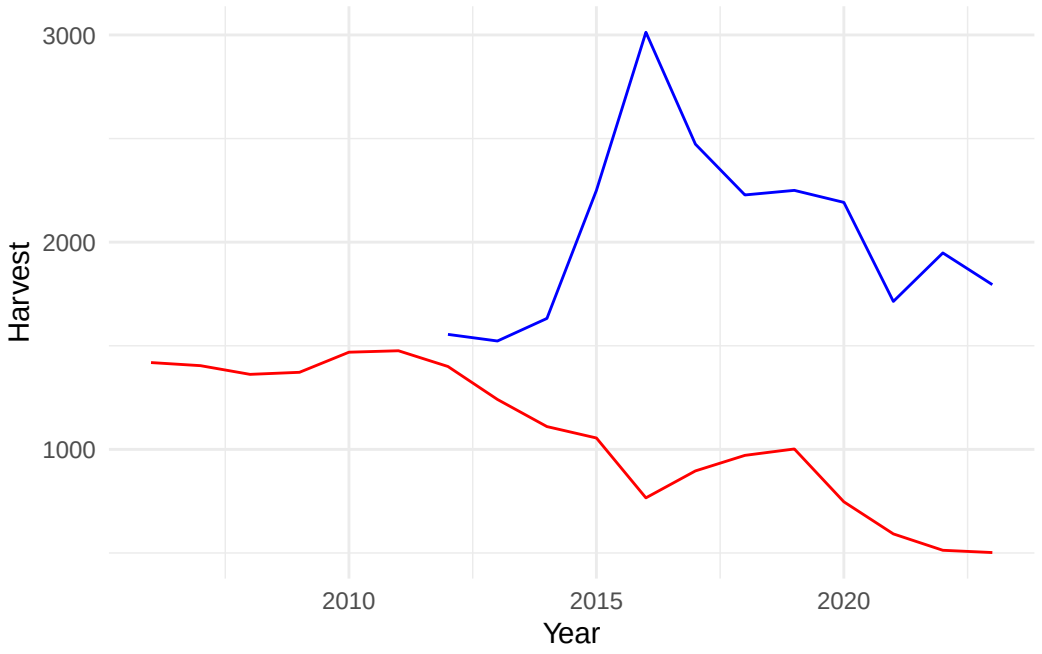

Figure 10: Southeastern harvest numbers for moose and bears between 2006 and 2023

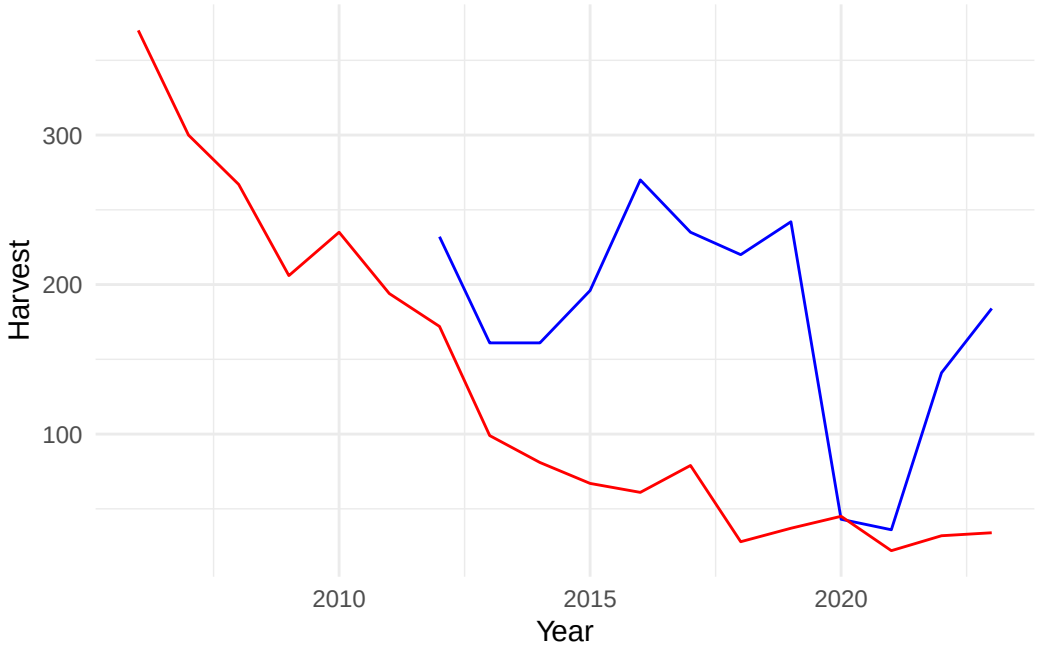

Figure 11: Southwestern harvest numbers for moose and bears between 2006 and 2023

We can also compare the harvest rates of each species separately for each region. In Figure 12 we can see more clearly what we observed previously where the amount of black bears harvested is very different between each region. The Northern region, on average, has the most harvests followed by the southeast and then the southwest region which is significantly lower than the other two regions. However, the Northern and Southeastern rates cross over at two points around 2020. Figure 13 shows a similar trend with the Northern region always having the most harvests followed by the Southeastern and then the Southwestern regions with no intersections. Both species likely experience this difference in harvest numbers because of the region's size as the Northern region is significantly larger than the southeast and southwest regions. However, it is interesting that the Northern and Southeastern harvest rates are so similar between 2018 and 2023 given that the areas are of drastically different sizes.

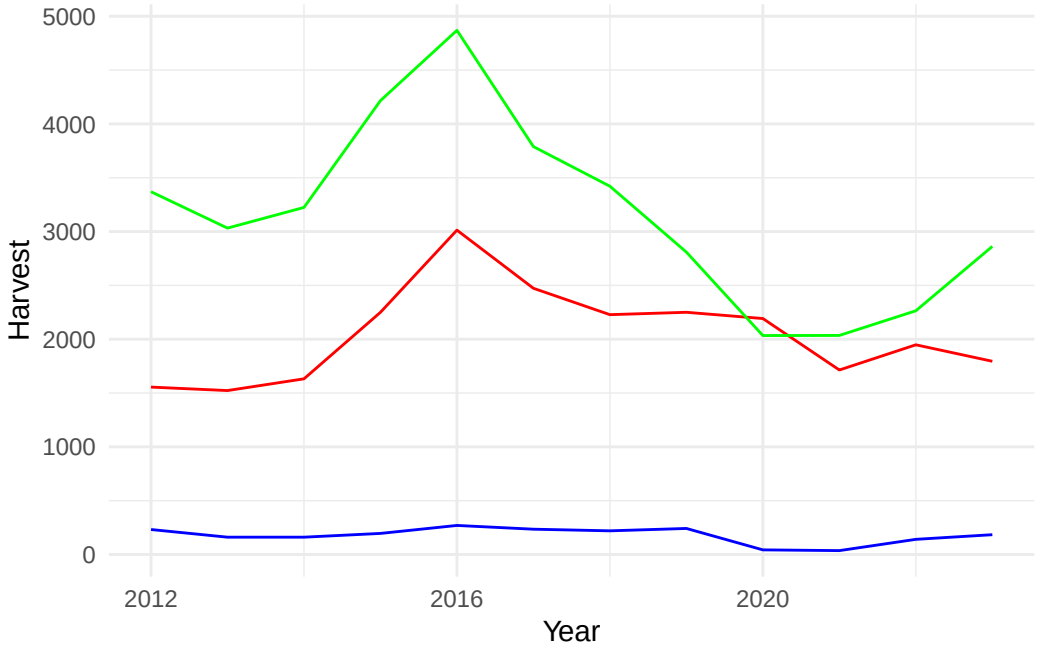

Figure 12: Bear harvest numbers for the Northern, Southeastern and Southwestern regions from 2012-2023

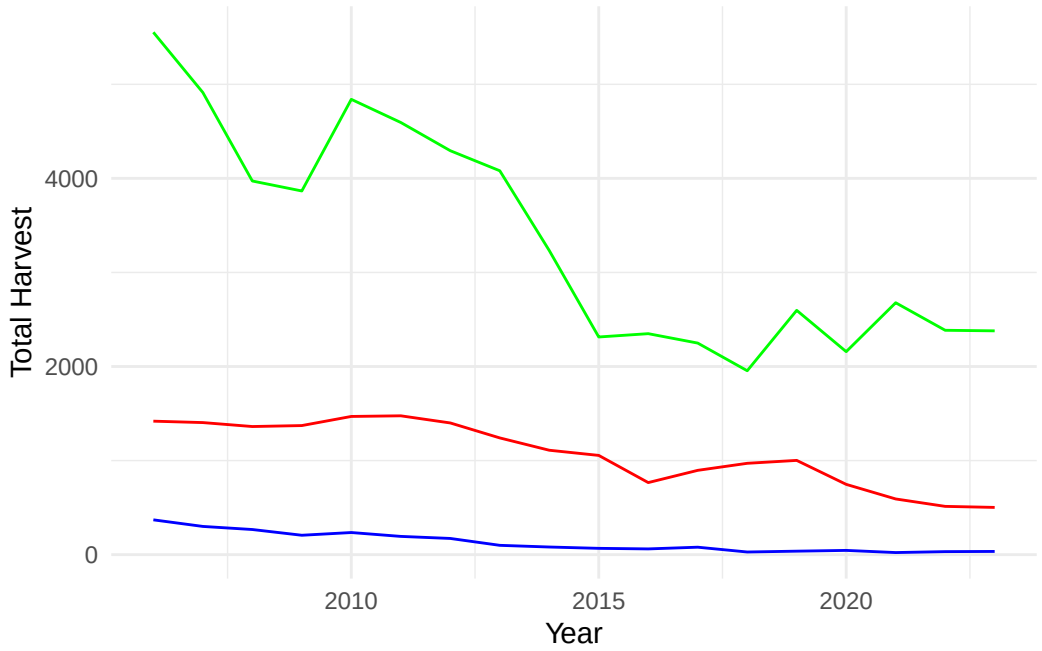

Figure 13: Moose harvest numbers for the Northern, Southeastern and Southwestern regions from 2006-2023

By examining the data sets we also learn that for black bears the average harvest between 2012 and 2023 is 3,160 in the Northern region, 2,046 in the Southeastern region, and 177 in the Southwestern region. In comparison, for moose between 2006 and 2023, it is 3,356 in the Northern region, 1,072 in the Southeastern region, and 129 in the Southwestern region. The maximum number of moose harvests was in 2006 with 7,342 total harvests. The minimum number of moose harvests was in 2023 with 2,915 total harvests. Whereas, for black bears, the maximum number of harvests was in 2016 with 8,152 harvests. The minimum was in 2021 with 3,785 harvests.

3.2 Active Hunter Trends

Additionally, we can compare the number of active moose and black bear hunters in all three regions. From Figure 16 we can see that there are significantly more moose hunters than black bear hunters every year. However, the number of moose hunters has significantly decreased since 2006. In 2006 there were over 65,000 moose hunters and in 2023 there were only around 25,000 moose hunters. In comparison, the number of black bear hunters has remained relatively consistent compared to moose hunters since 2012. The southwest region (see Figure 14) has a similar trend with the number of moose hunters greatly decreasing since 2006. Additionally, there have generally been fewer bear hunters in the region compared to moose hunters up until 2021 at which point the number of black bear hunters surpassed the number of moose hunters.

The southeast region (see Figure 15), however, has a different trend; the number of moose hunters in the region stayed relatively consistent from 2006 up to 2019 after which it greatly decreased. Around this time the number of black bear hunters also surpassed the number of moose hunters. Since 2012 the number of black bear hunters has increased. The discrepancy between the number of hunters by regain could, again, be because the Southwestern and Southeastern regions are much smaller than the Northern region.

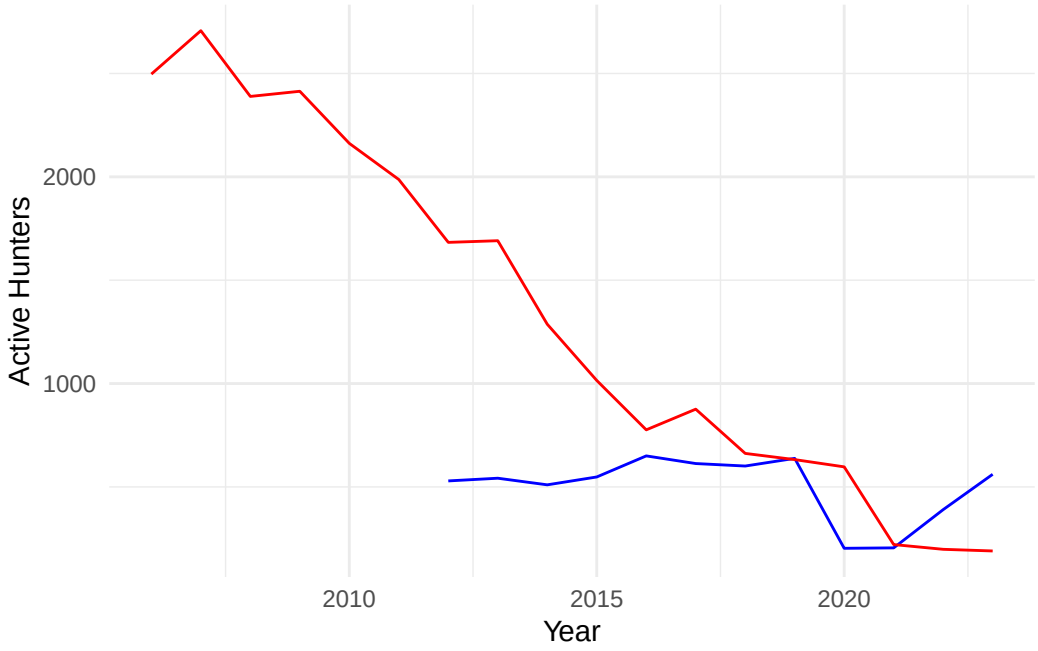

Figure 14: Number of active bear and moose hunters in the southwest region from 2006-2023

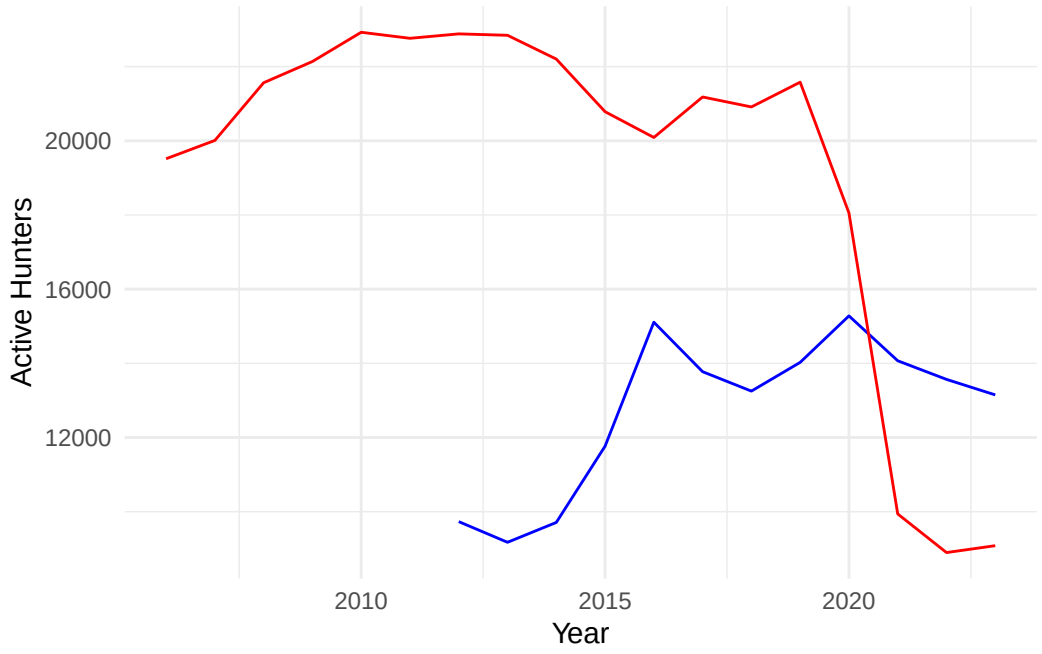

Figure 15: Number of active bear and moose hunters in the southeast region from 2006-2012

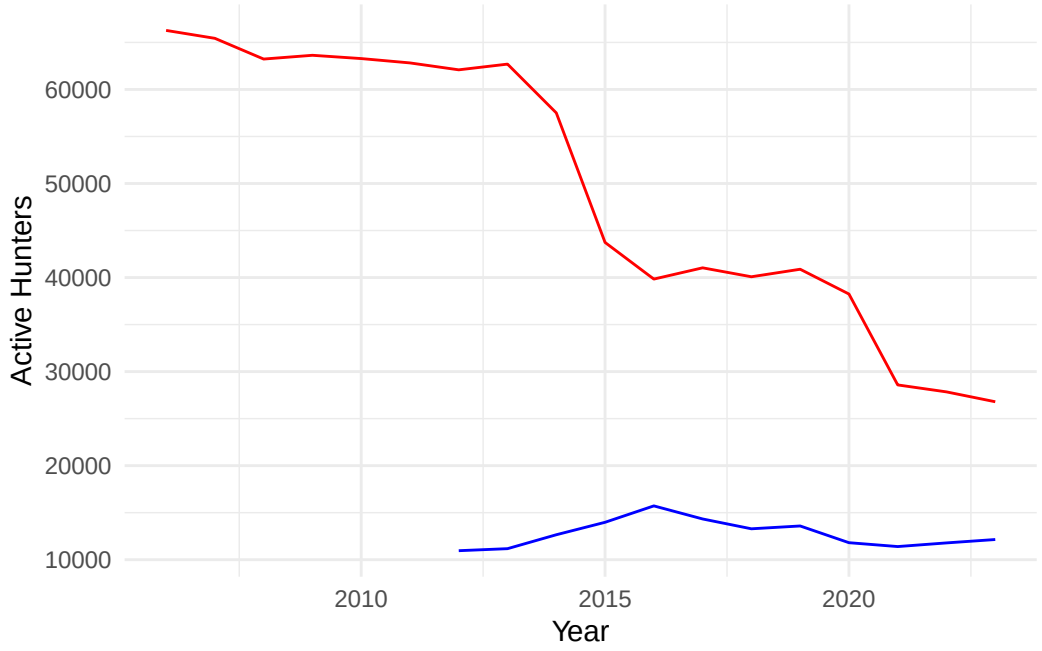

Figure 16: Number of active bear and moose hunters in the Northern region from 2006-2023

By examining the data sets, we also learn that for black bears the average number of active hunters between 2012 and 2023 is 12,736 in the Northern region, 12,717 in the Southeastern region, and 499 in the Southwestern region. In comparison, for moose between 2006 and 2023, it is 49,666 in the Northern region, 19,298 in the Southeastern region, and 1332 in the Southwestern region. The maximum number of active moose hunters was in 2010 with 88,369 total hunters. The minimum number of active hunters was in 2023 with 36,069 total hunters. Whereas, for black bears, the maximum number of hunters was in 2016 with 31,480 hunters. The minimum was in 2013 with 20,891 active hunters.

3.3 Active Hunters vs. Total Harvest

By examining the number of harvests against the number of hunters for both moose (Figure 17) and black bears (Figure 18) we notice a few trends. Overall, for both moose and black bears in all three regions, there is an almost linear relationship between the number of hunters and the number of harvests. From the graphs, we can see that as the number of hunters increases as does the total harvest. However, there are still many fluctuations in this trend, especially in the Southeastern region. For both moose and black bears there are numerous dips and peaks where, as the number of hunters increases, the total harvest is significantly less or more than the overall average.

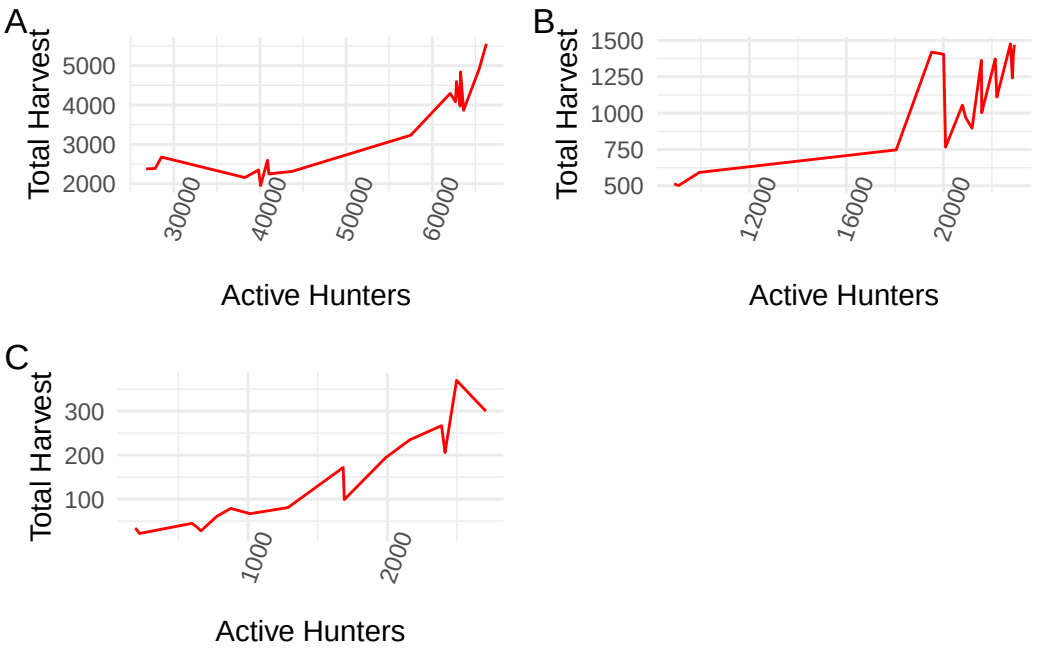

Figure 17: Number of active moose hunters plotted against total moose harvests from 2006-2023 in the Northern (A), Southeastern (B), and Southwestern (C) region

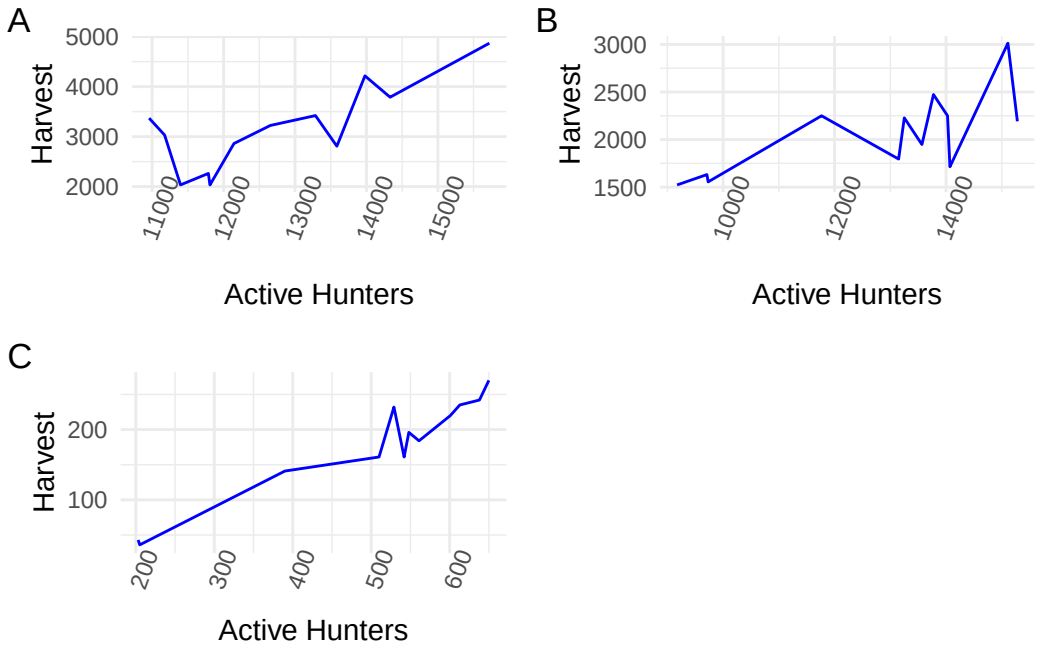

Figure 18: Number of active bear hunters plotted against total bear harvests from 2012-2023 in the Northern (A), Southeastern (B), and Southwestern (C) region

We can also compare the number of harvests against the number of hunters for both moose (Figure 19) and black bear (Figure 20) for each WMU. From both graphs, we can see that the more Northern WMUs tend to have higher harvest counts for lower hunter counts. Whereas, when the number of hunters is lower in the more southern regions, the fewer harvests there are. Overall, the more hunters the more harvests collected.

Overall, from all of these graphs, we can see that every year fewer and fewer people are actively hunting moose. The number of people hunting moose and the number of moose being harvested is decreasing. Whereas, hunting black bears peaked greatly in 2016 but has since gone back to its pre-2016 harvest levels and appears to be staying relatively consistent. Additionally, we can see that while there are often more moose hunters than black bear hunters, more black bears are harvested yearly than moose on average.

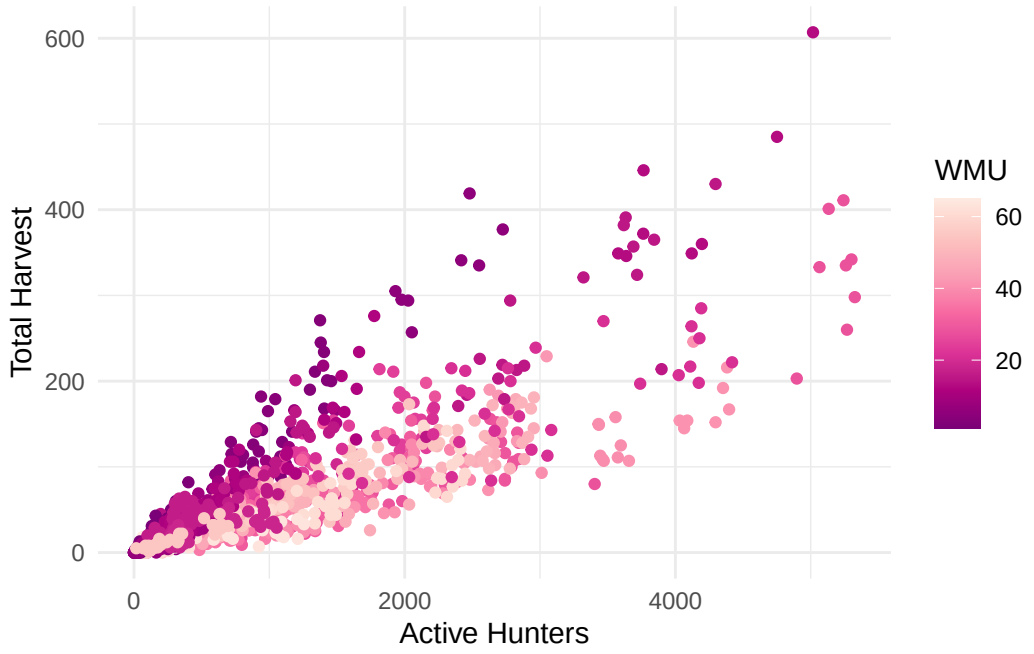

Figure 19: Number of moose harvested in each WMU from 2006-2023

Figure 20: Number of bear harvested in each WMU from 2012-2023

4 Discussion

This paper has analyzed the correlation between the number of active hunters and the number of moose and black bear harvests in Ontario and the impact of time and region on these numbers. Additionally, it examined the number of harvests against the number of active hunters. The analysis focused on three main regions, the Northern, Southeastern, and Southwestern areas of Ontario. This was done with the analysis of two data sets obtained from the Ontario Data Catalogue.

4.1 Ontario Moose Hunting is Declining

From Figure 4, we can see that in all three regions, the number of active hunters has been decreasing since 2006. Additionally, the number of moose being harvested has also been decreasing since 2006, which we can see in Figure 6. This clearly indicates that moose hunting as an activity is declining in all regions of Ontario. Although this is happening, we can see from the data that thousands of moose are still being harvested each year. However, from the data alone we cannot determine the cause for this decline.

The Ministry of Natural Resources and Forestry reports that moose populations have also been declining since 2004, although the exact reason is unknown (Sergio Arangio 2023). Some causes of this could be hunting, habitat destruction, disease, or other natural causes. Therefore, to protect these populations, the Ministry of Natural Resources and Forestry determines the number of moose hunting tags distributed based on the species population. This is likely the main reason for less active moose hunters and harvests over the past 20 years. However, despite this decline in moose population, there are still more moose hunters than moose in huntable areas. In Ontario, there are around 91,000 moose hunters whereas there are only 78,000 moose in these areas ("Factors That Affect Moose Survival | Ontario.ca" n.d.). Despite this decline in moose population and the imbalance between the number of hunters and prey, tags are still being issued. In 2023 alone, over 16,000 tags were issued ("Moose | Ontario Hunting Regulations Summary | Ontario.ca" n.d.). While it is likely not the sole cause of the declining moose population, hunting activity in Ontario appears to be contributing to this event.

4.2 Black Bears are Popular Hunting Targets in Ontario

In comparison to moose, hunting black bears is not a declining activity. However, it appears to have more fluctuation in harvest and active hunting numbers with its peak in 2016. On average, more bears are harvested than moose (see Figure 9, Figure 10, Figure 11) but there are fewer active black bear hunters than moose hunters (see Figure 14, Figure 15, Figure 16). Despite this imbalance between hunter and harvest rates, the Ontario black bear population remains high with Ontario having the second-largest black bear population in North America ("Black Bear in Ontario | Ontario.ca" n.d.). The Ontario black bear population is estimated to

be 85,000 to 105,000. More black bear sightings have also been reported in southern Ontario near cities and towns (White 2022). Black bear hunting in the spring had previously been banned in the 1990s but has reopened with hunters being allowed to hunt as early as May. Before the ban, and now that spring hunting has reopened, black bears were popular for trophy hunting (White 2022). With high populations and rising spotting of bears near towns and cities, hunting these animals appears to be a method of population regulation. Hunters are drawn to them as trophies and it in turn benefits Ontario's economy and helps maintain a healthy black bear population. While the data alone does not explain why there are fewer black bear hunters than moose and more black bear harvests than moose harvests, one possible reason could be because those hunting black bears are more successful than moose hunters. Additionally, the ratio of hunters to bears is larger than that of hunters to moose.

4.3 Weaknesses and Next Steps

The primary weakness of this analysis is its lack of depth. This is because it only focuses on and uses data with two main variables, number of active hunters and harvests. From the data alone, it is difficult to know the exact reasons for certain trends, such as the decrease in moose harvesting without external research. This analysis could have been made stronger if paired with moose and black bear population data. More types of data and variables would have added more depth to this analysis.

Another weakness is that the data does not cover a very large period. The black bear data is only from 2012 to 2023 whereas the moose data covers a larger time frame from 2006 to 2023. Analyzing a data set with a larger range would provide more depth. This would also be beneficial as trends related to populations provide more insight when analyzed over a large period. The moose data only shows decreasing harvest rates so it would be interesting to see when they began increasing or when their peak was.

Moving forward, it is clear that more insights and a deeper analysis could be made with the utilization of more types of data. This paper mostly focused on the trends observed in harvest and active hunter data but has created many questions with regard to the causes of these trends. These observations are important for Ontario's ecosystem and for maintaining healthy moose and black bear populations. Without proper monitoring, these species could be at risk of declining populations or populations that are too large and can in turn impact other species. Wildlife hunting is also a big contributor to Ontario's economy and thus healthy populations need to be maintained so that these practices can continue.

References

Auguie, Baptiste. 2017. *Stringr: Simple, Consistent Wrappers for Common String Operations*. https://cran.r-project.org/package=gridExtra.

"Black Bear in Ontario | Ontario.ca." n.d. Accessed April 23, 2024. http://www.ontario.ca/page/black-bear-ontario.

Evaluation, CTC Research &. 2012. "Sport Fishing and Game Hunting in Canada: An Assessment on the Potential International Tourism Opportunity." https://publications.gc.ca/collections/collection_2013/ic/Iu86-49-2012-eng.pdf.

"Factors That Affect Moose Survival | Ontario.ca." n.d. Accessed April 22, 2024. http://www.ontario.ca/page/factors-affect-moose-survival.

Firke, Sam. 2023. *Janitor: Simple Tools for Examining and Cleaning Dirty Data*. https://github.com/sfirke/janitor.

Fowler, Shane. 2019. "Numbers for Poaching and Other Major Hunting Offences Plunge in Province." *CBC News*, December. https://www.cbc.ca/news/canada/new-brunswick/provincial-stats-show-major-crimes-in-nb-forests-down-more-than-90-1.5395945.

"Moose | Ontario Hunting Regulations Summary | Ontario.ca." n.d. Accessed April 16, 2024. http://www.ontario.ca/document/ontario-hunting-regulations-summary/moose.

R Core Team. 2022. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.

Sergio Arangio, Darren MacDonald. 2023. "Annual Moose Count Underway in Northern Ontario." *Northern Ontario*. https://northernontario.ctvnews.ca/annual-moose-count-underway-in-northern-ont-1.6216552.

Travel, Ontario, and Recreation. 2023. "Ontario Black Bear Hunting Regulations." *Ontario Hunting Regulations| Black Bear*. https://www.ontario.ca/document/ontario-hunting-regulations-summary/black-bear#section-0.

Venables, W. N., and B. D. Ripley. 2002. *Modern Applied Statistics with s*. Fourth. New York: Springer. https://www.stats.ox.ac.uk/pub/MASS4/.

White, Erik. 2022. "Spring Bear Hunting Becoming More Popular in Southern Ontario, and Some Want It Expanded." *CBC News*, June. https://www.cbc.ca/news/canada/sudbury/spring-bear-hunting-southern-ontario-1.6487827.

Wickham, Hadley. 2016. *Ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New York. https://ggplot2.tidyverse.org.

———. 2023. *gridExtra: Miscellaneous Functions for "Grid" Graphics*. https://stringr.tidyverse.org.

Wickham, Hadley, Mara Averick, Jennifer Bryan, Winston Chang, Lucy D'Agostino McGowan, Romain François, Garrett Grolemund, et al. 2019. "Welcome to the tidyverse." *Journal of Open Source Software* 4 (43): 1686. https://doi.org/10.21105/joss.01686.

Wickham, Hadley, Romain François, Lionel Henry, Kirill Müller, and Davis Vaughan. 2023. *Dplyr: A Grammar of Data Manipulation*. https://dplyr.tidyverse.org.