Wildlife and Waste Interactions Project at the Assiniboine Park Zoo

Lynnae Martin

A Practicum Submitted to the Faculty of Graduate Studies of the University of Manitoba in Partial Fulfilment of the Requirements of the Degree of

Master of Natural Resources Management

Natural Resources Institute
Clayton H. Riddell Faculty of Environment, Earth, and Resources
University of Manitoba, Winnipeg MB,

Copyright © 2024 Lynnae Martin

Abstract

This report explores the interactions between wildlife and waste at the Assiniboine Park Zoo in Winnipeg, Manitoba, using a comprehensive project management plan. The introduction in Chapter 1 details the critical need for improved waste management to mitigate its effects on biodiversity loss and contributions to climate change. The following three chapters illustrate the deliverables produced by this project: the Integrated Project Plan (Chapter 2), Communication Outreach (Chapter 3), and the main component of this project, the Wildlife and Waste Interactions Project report (Chapter 4). The Integrated Project Plan covers the essential project management aspects, such as the project charter and scope, used to carry out the entire project. Chapter 3 details how communication outreach was implemented to raise awareness about the project going on at the zoo and engage a broader audience. Finally, Chapter 4 presents the final project report submitted to the Assiniboine Park Zoo. This report provides insights into wildlife and waste interactions at the zoo based on trail camera data and field observations. It offers practical recommendations based on the results from the study, aimed at improving waste management practices, reducing wildlife attraction to waste, and suggests future studies to enhance waste management efforts further. The last chapter critically reflects on the practicum, discussing learning outcomes and insights gained from the project's execution and completion. In summary, this document used a project management approach to implement a study highlighting the unique relationship between wildlife and waste.

Acknowledgements

First, I would like to thank my supervisor, Nikki. Joining your lab has been a transformative experience for me, and I am forever grateful for your guidance and mentorship. You are genuinely an inspiration to all the students you mentor.

I would also like to thank my committee members, Dr. Stephen Petersen and Sheldon McLeod. As well as Renata Machado with the Assiniboine Park Zoo. Your knowledge and expertise have been instrumental in this project, and I am very appreciative of your contributions.

Finally, thank you to the amazing group that makes up the NRI. This has been an incredible journey, and I feel fortunate to be part of such a supportive community of

Thank you all for making the experience so rewarding.

Dedication

To my partner, Matt, who helped me with every step of this process.

And to everyone who says when they think of garbage, they think of me – I am truly flattered.

List of Figures and Tables

Figures

Figure 1.1: Percentages of the kinds of waste produced in Canada.
Figure 1.2: Left: A gull found tangled in a plastic bag at Brady Landfill in Winnipeg. Right: A Canadian Goose nest made from garbage at Brady Landfill in Winnipeg.
Figure 1.3: Comparison of waste diversion rates from 2002 and 2018 across Canada
Figure 1.4: These signs posted around Assiniboine Park are meant to discourage people from feeding wildlife and explain the potential harm it does. However, even responsible visitors who put their waste in the appropriate bins may inadvertently feed wildlife.
Figure 3.1: Screenshot of the blog post published to the Assiniboine Park's website https://www.assiniboinepark.ca/stories/108/going-wild-about-waste and written by Sara Wolowich Brown, Communications Coordinator.
Figure 4.1: Map of Assiniboine Park Zoo and trail camera locations (Source: Google Earth)
Figure 4.2: Pie charts illustrating the distribution of wildlife species across the six study areas at the Assiniboine Park Zoo: Grasslands, Arctic, Aunt Sally's Farm, McFeetor's Centre, Asia, and Open Range. Each chart represents the proportion of different species, observed by trail cameras, that were interacting with waste.
Figure 4.3: A histogram showing the relative proportion of species observed each hour, excluding the regular admission hours from 9AM to 5PM.
Figure 4.4: Total time wildlife spent interacting with either the garbage bin, recycling bin, or both bins, across all the study areas.
Figure 4.5: The distribution of observed wildlife behaviours categorized into five main behaviours: Feeding, Foraging, Other, Running, and Territorial display. Only species observed interacting with waste and the bins were listed. The "Others" were incidental captures of wildlife which included Coyotes, Domestic Cats, Striped Skunk, and Cottontails.
Figure 4.6: A pie chart showing the proportion of contaminants observed in the top layer of the recycling bins. This included non-recyclables like coffee cups as well as food and compostable takeout containers.
Figure 4.7: Right: A Red Squirrel eating what looked like a muffin wrapper. Left: A Red Squirrel eating a tortilla chip. Both photos were taken in the Arctic Area.
Figure 4.8: A sequence of photos showing waste removed from the garbage bin by a Gray Squirrel (top two photos) which is later examined by a Richardson's Ground Squirrel (bottom left) and a Crow (bottom right).
Figure 4.9: A Crow with what appeared to be a cheese string snack, still in its wrapper, that was left behind on a picnic table at Aunt Sally's Farm (right). The Crow was seen pecking at it in a nearby tree (left) before flying out of the zoo boundaries with it.
Figure 4.10: Top left: two foxes in the Grasslands area. Top Right: Coyote walking through the Open Range area. Bottom left: A domestic cat in Aunt Sally's Farm. Bottom right: A Skunk in the Arctic area.
Figure 4.11: A crow with a takeout food container in the Open Range. This was left on top of the garbage bin and retrieved by the crow.
Figure 4.12: Two coyotes, possibly chasing one another in the Asia area.
Figure 4.13: Left: A Gray Squirrel removing an apple core from the garbage bin in McFeetor's Centre. Right: A Red Squirrel removing a rice crispy snack from the garbage bin in the Grasslands.

Figure 4.14: Left: A Common Raccoon eating something wrapped in tinfoil that was pulled out of the garbage bin in McFeetor's Centre. Right: Two Common Raccoon Kits wait while their mom is foraging inside the garbage bin in the Asia area.
Figure 4.15: Sequence of photos from Aunt Sally's Farm showing an adult raccoon with four kits. The adult got up onto the bins first while the kits took some time figuring out how to climb up. The adult quickly checked both bins and then started to walk away while the kits were still on the bins.
Figure 4.16: Left: A Crow picking at something a Red Squirrel had pulled out at McFeetor's Centre. Right: A group of Crows picking at something on or possibly in the garbage in at Aunt Sally's Farm.
Figure 4.17: Left: A Red Squirrel with a recyclable yogurt container. Right: A Gray Squirrel with a recyclable juice box.
Figure 4.18: Comparison photo of the contents of a recycling bin (left) and garbage bin (right) from Aunt Sally's Farm. The photos were changed to black and white to show how similar the contents were (the blue of the recycling bin showed through the clear bag).
Figure viii.1: Photos of each site with the location of where the trail cameras will be labelled with a star. Only one trail camera is assigned to each area, and it will rotate between the sites in these areas weekly.

Tables

Table 2.1: Stakeholder Information, including their name, role, and responsibilities.
Table 2.2: Risk Response Plan
Table 4.1: Ethogram of wildlife behaviours noted at the Assiniboine Park Zoo. The table represents observed behaviours of wildlife interacting with waste bins such as Foraging, Feeding, and Other, as well as other activities unrelated to waste such as Running and Territorial Display.
Table 4.2: Summary of activity counts recorded by the trail cameras. Counts were separated by events which were classified as sequential photos that were less than ten minutes apart. The table presents the total number of events and the waste interaction events observed in each area during the study period.
Table 4:3: Activity counts for the top three garbage foraging and feeding species: Common Raccoon, Gray Squirrel, and Red Squirrel. Species that did not directly access the garbage bins, like crows and ground squirrels, were excluded.
Table 4.3: Results of Tukey's HSD post-hoc test comparing the usage of garbage bins, recycling bins, and both bins by wildlife. Statistically significant differences ($p<0.05$) are indicated with an asterisk.
Table 4.4: The number of wildlife interactions observed in the morning (AM) and afternoon (PM) sessions.
Table 4.5: Chi-square test results analyzing the difference in wildlife observations between morning and afternoon sessions. The p-value of >0.05 indicates there is no significant difference between the two time periods.
Figure iii.1: Work Breakdown Structure with milestones identified by an Asterix (*).
Figure iii.2: Work Breakdown Structure-Activity List and Schedule Details
Table iv.1: Resource (Skills & Knowledge) Needs Assessment
Table iv.2: Skills & Knowledge Inventory of Team / Partner / Volunteers (U/K = unknown)
Table v.1: Internal interested party registry
Table v.2: External interested party registry
Table v.3: Planning elements for managing relationships
Table vi.1: Each risk is given an estimated "probability" and "impact assessment" of either low (0.2), medium (0.4), high (0.6) or very high (0.8). The probability and impact measurements are multiplied to calculate the "risk score."
Table vi.2: Risks identified in Table 1 are ordered from highest risk score to lowest. You can find details on where the response plan for each risk is located, who is responsible, and the status. The status may change as the project progresses and will be updated regularly. The Risk Response Plan can be found in section 6 above, and the Quality Management Plan can be found in section 7.
Table vii.1 Budget Details
Table viii.1: List of the six areas and their sites with a description of where those sites can be found.
Table ix.1: Original wildlife and visitor ethogram
Table ix.2: Updated wildlife ethogram
Table x.1: Change log

Table of Contents

Abstract 1
Acknowledgements 2
Dedication 3
List of Figures and Tables 4

Chapter 1: Introduction ***9***

Chapter 2: Integrated Project Plan ***17***

Executive Summary **19**

Project Charter **21**

Project Scope **25**

Project Schedule **27**

Resource Plan **27**

Managing Relationships **29**

Risk Management **30**

Quality Management Procedures **32**

Change Management **35**

Chapter 3: Communication Outreach ***37***

Chapter 4: Wildlife and Waste Interactions Project Report ***39***

Land Acknowledgement 41
Recommended Citation 41
Cover Photo Caption and Photo Credit 41

Summary **42**

Executive Summary 42
Sommaire Executif 43
Partners, Funders, and In-Kind Support 45

Wildlife and Waste Interactions Project at the Assiniboine Park Zoo **46**

Introduction 46
Methods 48
Results 54
Discussion 66
Recommendations 78
Conclusion 81
References 82
Outreach 83
Volunteer Form 83

Chapter 5: Critical Reflection ***91***

Appendices ***96***
i. Background Information 97
ii. Project Concept 118
iii. Schedule Details 121
iv. Resource Needs Assessments and Skills Inventory 124
v. Managing Relationships 127
vi. Risk Management 130
vii. Budget Details 132
viii. Bin Location Descriptions and Photos 132
ix. Ethogram template 137
x. Change Log 140

Chapter 1: Introduction

According to the United Nations Environment Programme (2024), global garbage production is estimated to increase from our current rates of 2.1 to 3.7 billion tons per year by 2050 if waste management practices remain unchanged. This could exacerbate environmental degradation and significantly amplify the adverse effects of biodiversity loss and climate change. Alarming projections like this highlight the pressing need to rethink our current relationship with waste. It is essential to prioritize both raising awareness and implementing practical solutions to address this challenge effectively to ensure a cleaner, more sustainable future.

Wealthier countries, like Canada, play a significant role in the global waste crisis. Higher living standards and our consumer culture contribute to an increase in waste production (Silpa et al, 2018). Canadians are one of the top producers of waste per capita, and despite making up less than 0.5% of the global population, we've produced 35.6 million tons of solid waste in one year (ECCC, 2021). We are generating garbage daily, yet with our efficient waste removal systems, there seems to be a tendency to disconnect from the magnitude of the problem. As a result, there may be less recognition and response to the urgent need for change as most of our garbage is taken out of sight and sent to landfills.

Most of the waste we produce in Canada is non-degradable items (like plastics) and food waste (Figure 1.1). "Non-degradable" means these products will not break down into more simple forms over time, at least not within our lifetime. The plastics in the form that we recognize today have only been around for about 100 years, which means there is some degree of uncertainty regarding their decomposition rates. Research on the decomposition of plastics indicates it could take anywhere from a few decades to several hundred years (or longer) depending on a variety of factors like the kind of plastic and the type of environment it's left in (Chamas, 2020). One study on microplastics in sediment layers found that they reflect their historical accumulation dating back to the 1950s, with notable fluctuations possibly related to policy and economic changes (Long et al, 2022).

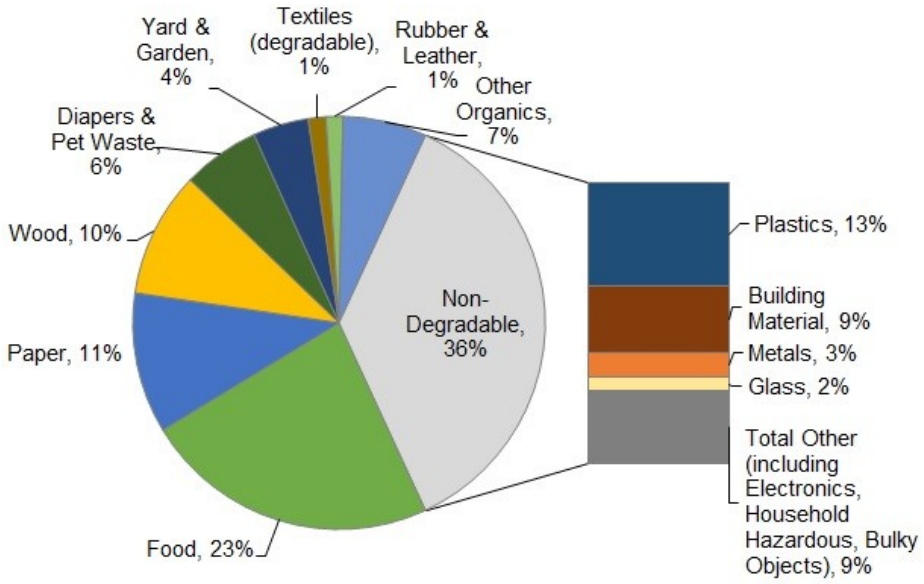


Figure 1.1: Percentages of the kinds of waste produced in Canada.

Source: National Waste Characterization Study, 2020 https://www.canada.ca/en/environment-climate-change/services/managing-reducing-waste/municipal-solid/statistics-trends.html

Food waste, however, is biodegradable, and as it decomposes, it can become a valuable, nutrient-rich compost. The problem is that food and non-degradable waste are often mixed before going to landfills. Once there, it's tightly packed into the earth, where the lack of oxygen leads to aerobic decomposition, producing methane, a potent greenhouse gas (Chickering et al. 2018). Not only are we throwing away valuable, nutrient-rich compost, thus contributing to the climate crisis, but it also makes our garbage highly attractive to wildlife. Wildlife is encouraged to come into direct contact with potentially harmful waste (Figure 1.2).



Figure 1.2: Left: A gull found tangled in a plastic bag at Brady Landfill in Winnipeg. Right: A Canadian Goose nest made from garbage at Brady Landfill in Winnipeg.

Photo credit: Lynnae Martin

Images of wildlife entangled in our garbage and reports of animals being poisoned by our garbage are unfortunately not uncommon in news feeds. Recent incidents like the eagles poisoned at a Minnesota landfill in the U.S and the landfill in Prince Rupert, British Columbia, highlight the ongoing threat to wildlife (CTV News, 2022; Vancouver Sun, 2024). Lesser-known ramifications of waste include impacts on the behaviours and ecology of various species (Newsome & Van Eeden, 2017). This can consist of altered migratory and foraging behaviours (Gilbert et al., 2016), disruptions in reproductive success (Gwynne & Rentz, 1983), modified group dynamics among social animals (PLoS Biol, 2004) and shifts in disease transmission rates (Flint et al, 2015). Furthermore, these effects can cascade through the trophic levels, impacting species without direct contact with our consolidated waste (Frixone et al. 2012, Maròn et al. 2015). Fortunately, efforts to address waste management and its environmental impacts are growing, offering potential solutions to mitigate the threats posed to wildlife.

As municipal composting programs become available, more Canadians can increase the amount of kitchen and yard waste they can compost, effectively diverting waste from landfills

(Statcan, 2022). However, the implementation of such programs varies across the country, with Manitoba having one of the lowest waste diversion rates, indicating a need for improved waste management and community engagement within the province (Figure 1.3). Given that most Manitobans live in the capital city of Winnipeg, establishing a composting program there would present a significant opportunity to engage a large portion of the province's population.

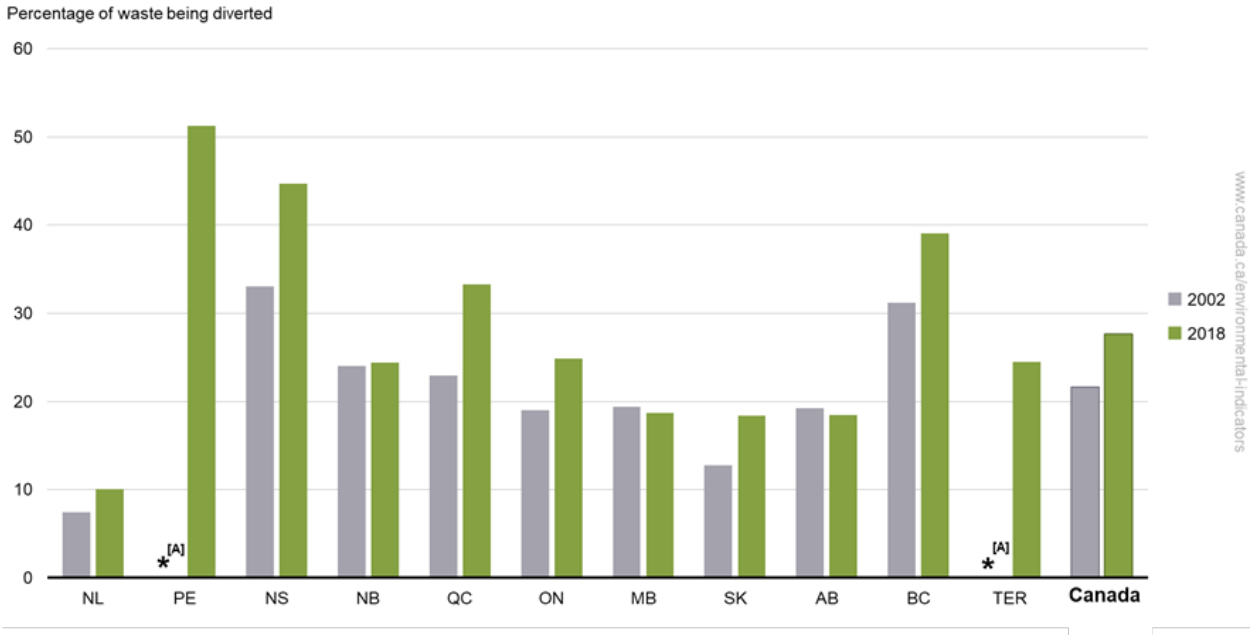


Figure 1.3: Comparison of waste diversion rates from 2002 and 2018 across Canada

Source: Waste diversion rates in Canada and prov stats Canada, 2022. https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/solid-waste-diversion-disposal.html

The results of a composting pilot project done by the City of Winnipeg (2023) in a few select neighbourhoods demonstrated the eagerness of the community to participate. However, for this to be available city-wide, infrastructure development that could manage more significant amounts of food waste would be required and likely unavailable until 2030. In the

meantime, places in Winnipeg like The Forks and The Assiniboine Park and Zoo have taken the initiative to compost their organic waste by installing a BIOvator. This is a composting system that is designed for rapid decomposition of organic waste, producing valuable compost. Having this kind of system can allow visitors to participate in composting efforts while on site.

This approach is an excellent way to engage visitors in better waste management and promote sustainability, but it does not fully address all related issues. Visitors may still fail to sort their garbage correctly or lack easy access to composting bins (such as composting bins not available in popular picnic areas), ultimately not diverting waste from landfills. Another related problem the Assiniboine Park and Zoo are actively trying to resolve is visitors who directly feed wildlife. Even properly disposing of waste in the provided trash bins can unintentionally provide a food source for wildlife, so more awareness and mitigation are required (Figure 1.4). Ultimately, that waste will continue to the landfill if it is not scavenged from the bins by local wildlife first.



Figure 1.4: These signs posted around Assiniboine Park are meant to discourage people from feeding wildlife and explain the potential harm it does. However, even responsible visitors who put their waste in the appropriate bins may inadvertently feed wildlife who scavenge the bins.

Photo credit: Lynnae Martin

Effective waste management begins with individuals, and increasing participation is crucial for improving our overall waste practices. Using wildlife as a motivator can be particularly impactful; one study found that signs featuring photos of wildlife affected by garbage led to better-sorting behaviours among people (Luo et al., 2022). Additionally, instances of wildlife being harmed by our waste triggered international support for policy changes regarding waste (BBC., 2024). Acknowledging the link between wildlife and waste and educating the public on the issues can lead to more people actively engaging in waste diversion and reduction efforts.

Zoos play a vital role in promoting conservation by connecting visitors with global conservation issues and encouraging behavioural changes (McNally et al., 2024). The Assiniboine Park Zoo in Winnipeg sets a leading example within the local community, exemplifying environmental sustainability through its commitment to waste management. In addition to using technology like the BIOvator, as previously mentioned, the zoo provides practical solutions such as compost bins in their restaurant, compostable take-out containers, and recycling bins. They also perform waste audits to identify areas for improvement. The Wildlife and Waste project aims to contribute to the zoo's sustainability goals by observing how free-roaming wildlife within the zoo is interacting with waste left by visitors.

The Assiniboine Park Zoo is not only home to the exotic animals visitors come to see but also to local free-roaming wildlife. Understanding how zoo operations influence local wildlife is essential for ensuring their well-being and the overall health of the surrounding ecosystem. Examining these interactions can provide insight for implementing effective conservation strategies and promoting coexistence between humans and wildlife in urban areas.

While the zoo provides compostable and recyclable products, visitors can also bring their own food and beverage items from outside sources. Disposing of these external items poses challenges as they may not always be easily discernible for proper sorting and disposal. This could lead to contamination and improper waste management. Visitors are responsible for

sorting their own waste, whether obtained from the zoo or not, which can be a problem for proper waste management.

Each waste receptacle area has at least one recycling and garbage bin. These bins are placed around the zoo in convenient locations for visitors. However, these bins are open and accessible to wildlife, which is attracted to discarded food. This food can range from unfinished sandwiches to residual food left inside disposable containers. This means that even though visitors may diligently dispose of their garbage in the appropriate bins, they may still unknowingly encourage scavenging from wildlife.

The goal of the Wildlife and Waste Interactions project is to contribute to the understanding of how waste influences wildlife. By installing cameras around the zoo's waste bins and performing in-person observations, the project documented which species are most attracted to waste and their related behaviours. This was developed and documented using an Integrated Project Plan (Chapter 2). These insights aim to encourage better waste management strategies by providing recommendations based on the results of this study and contribute to the Assiniboine Park Zoo's conservation efforts.

References

- BBC Future. (2024, April 2). The turtle video that sparked the plastic straw revolution. Retrieved from https://www.bbc.com/future/article/20240402-the-turtle-video-that-sparked-a-plastic-straw-revolution#
- City of Winnipeg. (2023, September 8). Residential food waste (RFW) pilot results and recommendations. Retrieved from https://clkapps.winnipeg.ca/dmis/ViewDoc.asp?DocId=23988&SectionId=&InitUrl=
- Chamas, A., Moon, G., Zheng, J., et al. (2020). Degradation rates of plastics in the environment. *ACS Sustainable Chemistry and Engineering, 8*(9), 3494-3511.
- Chickering, G. W., Krause, M. J., & Townsend, T. G. (2018). Determination of as-discarded methane potential in residential and commercial municipal solid waste. *Waste Management, 76*, 82-89.
- CTV News. (2022, December 11). 3 bald eagles die, 10 sick after eating animals dumped at U.S landfill. Retrieved from https://www.cbc.ca/news/canada/manitoba/winnipeg-compost-program-gets-green-thumbs-up-in-city-report-1.6955423

- Environment and Climate Change Canada (ECCC). (2021). Municipal solid waste and the environment. Retrieved from http://www.canada.ca/en/environment-climate-change/services/managing-reducing-waste/municipal-solid//environment.html
- Flint, B., Hawley, D., & Kathleen, A. (2015). Do not feed the wildlife: associations between garbage use, aggression, and disease in banded mongooses (*Mungos mungo*). *Ecology and Evolution, 6*(16), 5932-5939.
- Frixione, M., Casaux, R., Villanueva, C., & Alarcón, P. (2012). A recently established Kelp Gull colony in a freshwater environment supported by an inland refuse dump in Patagonia. *Emu - Austral Ornithology, 112*(2), 174-178.
- Gilbert, N., et al. (2016). Are white storks addicted to junk food? Impacts of landfill use on the movement and behaviour of resident white storks (*Ciconia ciconia*) from a partially migratory population. *Movement Ecology, 4*.
- Gwynne, D. T., & Rentz, D. C. F. (1983). Beetles on the bottle: Male buprestids mistake stubbies for females (Coleoptera). *Australian Journal of Entomology, 22*, 79–80.
- Kaza Silpa, Lisa Yao, Perinaz Bhada-Tata, and Frank Van Woerden. (2018). *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050*. Urban Development Series. Washington, DC: World Bank. doi:10.1596/978-1-4648-1329-0. License: Creative Commons Attribution CC BY 3.0 IGO
- Long, Z., Pan, Z., Jin, X., et al. (2022). Anthropocene microplastics stratigraphy of Xiamen Bay, China: A history of plastic production and waste management. *Water Research, 226*, 119215.
- Luo, Y., Douglas, J., Pahl, S., & Zhao, J. (2022). Reducing plastic waste by visualizing marine consequences. *Environment and Behavior, 54*(4), 809-832.
- Maròn, C., Beltramino, L., Martino, M., et al. (2015). Increased wounding of Southern Right Whales (*Eubalaena australis*) calves by Kelp Gulls (*Larus dominicanus*) at Península Valdés, Argentina. *PLOS ONE, 10*(10).
- McNally, X., Webb, T., Smith, C., Moss, A., & Gibson-Miller, J. (2024). A meta-analysis of the effect of visiting zoos and aquariums on visitors' conservation knowledge, beliefs, and behaviours. *Conservation Biology, 2024-02*.
- Newsome, T., & Eeden, L. (2017). The effects of food waste on wildlife and humans. *Sustainability Communications*.
- PLoS. (2004). Emergence of a peaceful culture in wild baboons. *PLoS Biol, 2*(4), e124. https://doi.org/10.1371/journal.pbio.0020124
- Statistics Canada. (2022). Dirt on composting. Retrieved from http://www.statcan.gc.ca/o1/en/plus/1326-dirt-composting
- United Nations Environment Programme. (2024). *Global Waste Management Outlook 2024: Beyond an age of waste – Turning rubbish into a resource*. Nairobi. Retrieved from https://www.unep.org/20.500.11822/44939
- Vancouver Sun. (2024, March 3). Eagles flock to Prince Rupert Dump for easy meals, but city wants to put a stop to it. Retrieved from https://vancouversun.com/news/local-news/prince-rupert-dump-eagles

Chapter 2: Integrated Project Plan

The Integrated Project Plan (IPP) functioned as both the initial project proposal and a dynamic living document. It includes information on the execution of this project from start to finish. It was updated and revised as changes were made and written in the past tense to reflect its completed status. Modifications to the original proposal were recorded in the Change Log. Additional information can be found in the Appendices at the end of this document.

Integrated Project Plan

Project name: Wildlife and Waste Interactions at the Assiniboine Park Zoo

Project Manager: Lynnae Martin

Project Supervisor: Dr. Nicola Koper

Project Partner: Dr. Stephen Petersen, Assiniboine Park Zoo

Copyright © 2024 by Lynnae Martin

Executive Summary

The Wildlife and Waste Interactions Project studied how free-living wildlife at the Assiniboine Park Zoo in Winnipeg, Manitoba, interacted with waste (garbage) produced by those visiting the zoo. While the zoo's volunteer and staff team are committed to keeping the zoo clean, wildlife is still attracted to garbage left in and around garbage bins and litter from the park's visitors. Wildlife using waste as a resource can potentially lead to negative consequences such as entanglements or ingestion of hazardous material and changes in their behaviour. The data collected through this research was used to evaluate those interactions and promote waste management practices that consider the effects on wildlife.

The project started in May 2022, with observational research taking place at selected waste receptacle locations and picnic areas from June to October 2022. Trail cameras were strategically placed around the bins and left operating while the zoo was closed. Additionally, daytime observations were conducted during the zoo's opening hours to complement the camera data. This data was later processed and used to provide insight into what kind of wildlife species interact with waste within the zoo boundaries and their behaviours.

Furthermore, a communication plan was implemented to engage with the Assiniboine Park's communication team for outreach purposes during the 2022 field season. This aimed to introduce the project and raise awareness to encourage visitors to adopt more sustainable practices while attending the zoo. A preliminary report featuring an overview of the collected data was presented on May 31, 2023, and the final report was delivered on May 22, 2024.

The objectives of this project are as follows:

1. Conduct a study on the interactions between wildlife and waste within the zoo and present those findings in a final report that includes actionable recommendations
2. Complete an outreach initiative to share the study insights and highlight the influences of waste on wildlife

Within this IPP, you will find information about what this project produced and detailed descriptions of how and when it met its goals. Below is a list of the sections in this IPP and a brief description of each component.

Project Charter: The foundational outline upon which the rest of the project's documents are based. This section contains an overview of the project, its justification, objectives and deliverables, requirements, and a preliminary budget. It also includes contact information for the key stakeholders and team members.

Project Scope: This section details the project boundaries, including the exclusions, assumptions, constraints, and acceptance criteria. It also describes the scope management plan and how to handle any changes made to the scope.

Project Schedule: This section provided details on the project schedule

Resource Plans: This section details the materials and equipment needed and the skills and knowledge required to achieve this project's objectives successfully.

Managing Relationships: This section describes the needs of each interested party and what the project needs from each of them. It highlights the communication method that will be used and how the relationships will be maintained.

Risk Management: This section considers all the project's known risks and evaluates each in the probability and impact matrix, risk registry, and risk response plan.

Quality Management: This section describes the steps to ensure quality is maintained throughout the project, detailed procedures to follow, and designates responsibility to team members.

Budget Summary: This section provides a more detailed budget account than the project charter.

Change Management: Explains how changes were managed and incorporated into the project.

Appendices: The appendices include the background report, which contains information on the study design. Other sections include details such as tables and charts pertaining to the abovementioned sections.

Project Charter

Project name: Wildlife and Waste Interactions at the Assiniboine Park Zoo

Charter Overview

The Assiniboine Park Zoo is one of Manitoba's leaders in promoting and educating on sustainability and conservation. One of their key sustainability goals is improving waste management. The APZ has implemented practices throughout its daily operations to reduce waste production, as well as programs to compost and recycle when possible and throughout the zoo. Additionally, the zoo conducts research to help conserve species and their habitats. The APZ Conservation Strategy includes a theme area that aligns with this research and is focused on Manitoba species conservation initiatives.

The Contributing Project and Subject of this Charter – Wildlife-Waste Interactions Project:

This project aims to build upon the APZ's efforts toward sustainable waste management and Manitoba species conservation in two ways: making the connection between wildlife and waste through research at the zoo and promoting waste reduction by visitors through outreach. By demonstrating how our waste influences free-living wildlife locally at the zoo and educating on how it impacts wildlife, we hope to encourage visitors to make positive changes towards reducing their own waste production.

Justification/Need:

During the summer months, the APZ experiences an influx of visitors who may bring their own disposable products. Additional throw-away items accumulating on-site from outside sources can potentially impact the zoo's mission of sustainable waste management, increase waste disposal costs, and influence the local wildlife. This project would help monitor areas of

concern in the park, allowing park management to maintain their high standards of sustainable waste management and monitor the impact on local wildlife.

Objectives and Deliverables:

The objectives of this project are as follows:

- Conduct a study on the interactions between wildlife and waste within the zoo and present those findings in a final report that includes actionable recommendations
- Complete an outreach initiative to share the study insights and highlight the influences of waste on wildlife

The following deliverables were produced:

- Wildlife and Waste Project Integrated Project Plan, May 12, 2022
- Communication Outreach, Summer 2022
- Final Wildlife-Waste Report, May 22, 2024

Requirements:

Deliverables:

- Wildlife and Waste Project Integrated Project Plan (IPP)
    - Consult with the Sustainability Coordinator to discuss areas the park has identified as concerns.
    - Discuss important aspects of producing a study design with supervisor Dr. Nicola Koper.
    - Contact the volunteer coordinator at APZ to help maintain trail cameras.
- Media Outreach
    - Discuss with Dr. Stephen Petersen and coordinate contact with the communications coordinator.
    - Participate in an interview discussing the project with communications coordinator

- Final Wildlife and Waste Report
    - Obtain necessary equipment by June 2022
    - Perform data collection from June to October 2022
    - Present preliminary findings May 31, 2023
    - Process and analyze data
    - Produce final report May 22, 2024

Resource and Cost Estimates:

This project required the following resources: trail cameras (x6), chain and locks (to secure cameras), SD cards, an SD reader, a smartphone to download photos from the SD cards, zoo membership, trail camera covers, and transportation to the zoo. It also required volunteers at the zoo to help cover the trail cameras to prevent photos from being taken during visitor admission hours.

The trail cameras and SD cards were provided at no cost to the project. The PM already had an SD card reader, zoo membership, and an iPhone to use for the project. Transportation costs were not included in the estimate. The project needed to acquire chains and locks, camera covers, and provide a small appreciation gift for the volunteers. The total estimated cost was 160$.

Roles and Responsibilities:

Table 2.1: Stakeholder Information, including their name, role, and responsibilities.

Interested party	Role	Responsibilities
Lynnae Martin	Project Manager (PM)	• Lead in implementing the objectives listed above • Manage volunteers • Ensure deadlines are met and completed to the satisfaction of APZ • Maintain communication with all interested parties • Produce all project deliverables
Dr. Nicola Koper	Project Supervisor (PS)	• Provide advice and expertise to the PM • Main contact for PM regarding all aspects of the project
Dr. Stephen Petersen (Conservation and research director at APZ)	Over sees all conservation research projects at the APZ & project committee member	• Authorizes funding through the APZ • Ensure project is meeting expectations of the APZ and will advise PM if needs are not being met
Renata Machado (Sustainability coordinator at APZ)	Day to day contact for the project	• Provide expertise on known waste problem areas • Point of contact for all things related to the APZ waste management
Sheldon McLeod	Committee member	• Provides project assistance and guidance as a committee member
Shaun Leonoff	Volunteer Coordinator at APZ	• Scheduling volunteers to remove/replace trail camera covers daily

Essential Contacts:

- Contact information for stakeholders
    - Stephen Petersen, ***@***ca
    - Renata Machado, ***@***ca
    - Nicola Koper, ***@***ca
    - Sheldon McLeod, ***@***ca
    - Shaun Leonoff, ...@ca
    - Lynnae Martin, ...@...ca

Project Scope

Scope Overview:

In this section, the Project Scope elaborates on what the project included or omitted. Exclusions from the project are identified to eliminate any potential misunderstanding about the project outcomes. It also consists of the assumptions made as the project proceeded and any known constraints. Acceptance criteria are laid out here to clarify when the project is considered successful. If any changes to the project scope are needed, an evaluation of the changes will be required, and the procedure to do so is described in the scope management section below.

This project began at the Assiniboine Park Zoo in May 2022, with the proposal submitted as the Integrated Project Plan. Data was collected at the zoo from June to October 2022. A communication outreach plan was also completed during that fieldwork. The data was then processed and analyzed, resulting in a preliminary report presented on May 31, 2023. The final report was submitted on May 22, 2024.

This project received funding and support from the Assiniboine Park Zoo, Project Learning Tree, and the Manitoba Wildlife Federation.

Exclusions from Scope:

The Wildlife-Waste Project aimed to encourage long-term waste reduction by park visitors; however, the following were noted as important exclusions from the project:

- It cannot guarantee a noticeable decrease in waste at the park
- It will not be able to evaluate its effectiveness in encouraging visitors to participate in waste reduction
- This project will only run for one season under the current agreement conditions

Assumptions:

The quality of this project is based on the critical assumptions listed below:

- The project supervisor will be able to provide guidance and expertise throughout the project
- Volunteers will be available to assist with camera maintenance
- The project will have access to the APZ's social media coordinator
- Due to the project mainly being outdoors, we assume any COVID-related issues shouldn't cause too many limitations. Similarly, meetings can be conducted virtually.

Constraints:

The constraints of this project that require careful consideration are as follows:

- The study portion of the project required continuous data collection from June to October 2022 for the successful completion of the report
- This project relies on volunteers to remain active throughout the duration; however, there is always the possibility that it may be challenging.

Acceptance Criteria:

The completion of this project will be considered successful based on the presentation of the following:

- Communications outreach is achieved
- Final Report is submitted

These two outcomes will need the following requirements to have been met:

- IPP completed in May 2022
- Discussion with the Communication Coordinator
- Fieldwork completed from June to October 2022
- Volunteers available to help with operating the trail cameras

Scope Management Plan:

This Project Scope should be considered the finalized outline of the project. Any changes to the project will be updated and included in the Change Log. Any changes were handled in the following ways.

- The Project Manager consulted with the Project Supervisor, committee members, and APZ partners to consider all aspects of the changes.
- Changes were implemented if they were conducive to the successful completion of the project.

Project Schedule

The schedule was initially created using a project management tool called ClickUp (http://clickup.com) before being converted into a Google Doc. This streamlined approach leveraged ClickUp's features to ensure organization for the project's timeline and incorporate reminders where necessary. A complete summary of the project's schedule is in the Appendices under Schedule Details (iii).

Resource Plan

Resource Plan Overview

The skills and knowledge needed to complete this project are identified based on the project deliverables described in the Project Scope section. The skills and knowledge the project team members possess are also highlighted. The combined knowledge of the Project Manager and other team members is sufficient to complete this project; however additional skills and knowledge acquisition needed to improve the project outcomes are represented (Table iv.1). Each team member and a description of their skills and education are found in Table iv.2 of the Resource Needs of the Appendices Lastly, the material resources needed, along with how to obtain them, are discussed. Tables describing each section's requirements, cost, and time are detailed in the appendix (iv. Resource Needs Assessment and Skills Inventory). Additional information on the budget can be found in Budget Details in the Appendices (vii).

Skills and Knowledge

Below is a description of the project's skills and knowledge needs. A summary can also be found in tables iv 1-3 in the Resource Needs Assessment and Skills Inventory of the Appendices (iv).

Deliverables:

1. Integrated Project Plan

This deliverable required knowledge of Project Management as well as study design. Additionally, it required knowledge of the study area (the Assiniboine Park Zoo) and an understanding of the key priority areas (i.e., which bins/sites are known as common areas for wildlife and waste interactions). The Sustainability Coordinator is familiar with these areas and provided insight as to which sites could be best to set up trail cameras. Knowledge of properly using and setting up trail cameras was also necessary.

The study design required a map detailing the locations of all the waste bins and picnic tables. It also required an understanding of quantitative design methods to ensure statistically appropriate data collection. The Project Manager completed courses in Project Management, study Design, and Quantitative Methods, which addressed any knowledge gaps. The project's committee members were also knowledgeable in these subjects and provided guidance and advice.

2. Communications Outreach

This deliverable requires the ability to articulate the project's goals effectively to convey the right message. The Project Manager must consult with the APZ communications coordinator to understand how the APZ specifically handles communication to meet their needs.

3. Final Report

This deliverable will require an understanding of conducting and interpreting statistical analyses. Additionally, RStudio will be used to analyze data and produce any figures or graphs needed for both reports (preliminary and final). The Project Manager completed the Study Design and Quantitative Methods course, demonstrating how to use R Studio.

Materials, supplies, equipment

The main equipment needed for the project included six trail cameras and SD cards, which were borrowed from the APZ. Additional supplies required for securing the trail cameras included chains, locks, and covers. The project manager will provide other necessary items such as a camera, laptop, pens, notebook, iPhone, and transportation. See Resource Needs and Skills Assessment and Budget Details in the Appendices (iv, vii) for more details.

Managing Relationships

Managing Relationships Overview

The relationships to be considered in the project are divided into two groups: internal interested parties and external interested parties. These can be found in more detail in tables v.1 and v.2, respectively, in the Managing Relationships section of the Appendices. Each party is identified, as well as their needs and what the project needs from them. Additionally, the plan for maintaining those relationships is outlined in Table v.3.

Risk Management

Risk Management Overview

Any possible risks to the project were identified by carefully considering the project deliverables, requirements, and relationships. A Probability and Impact Matrix was developed to identify risks based on a "risk score" (Table vi.1, appendices. The Risk Register lists all the risks from highest risk score to lowest (Table vi.2, appendices). Below, you'll find the Risk Response Plan that lists the main risks to the project and the plan for dealing with those risks. A comprehensive one-word response strategy for each risk is identified as one or more of the following options: avoid, mitigate, accept, and/or transfer. Details for each response are highlighted here, or you will be redirected to the Quality Management Plan for more information.

Table 2.2: Risk Response Plan

Risk Response Plan		
Risk	**Response Strategy**	**Response Details**
One or more trail cameras are stolen, or view is obstructed	Avoid	See quality management procedure for more details (1. a. i-iii)
	Mitigate	See quality management procedures for more details (1. a. iv)
Covid case number rise resulting in zoo closure + reduced non-essential work	Avoid	Practice covid protocols throughout project's entirety
	Accept	Elements of the pandemic and provincial health regulations are out of our control and to be respected
Additional bin types from Recycle Everywhere are unavailable	Accept	If bins are unavailable for the entire season or aren't available until late into the season, we will continue the project without including different bin types
	Transfer	See quality management procedures for more details (4. A, i-ii)
Data is collected poorly or lost	Avoid	See quality management procedures for more details (3. a. i-iv)
Funding is unavailable	Avoid	Maintain adequate communication with zoo partners and ensure there are no issues that could lead to funding retraction (i.e., Project is not up to their standards) and continue outreach for additional sources of funding
	Transfer	If there are problems in the project's progression that has led to concerns

		over funding, the PM and PA will address these concerns immediately.
Volunteer(s) are unavailable	Avoid	See quality management procedures for more details (2. a. i)
	Transfer	See quality management procedures for more details (2. a. ii)
Committee member(s) disagree with how the project should proceed	Mitigate	All disagreements will be carefully considered by project manager and changes will be made where needed
	Accept	The experience committee members have in conducting projects will be respected and any changes made based on their advice will be considered carefully
Additional bins from Recycle Everywhere are unavailable	Mitigate	See quality management procedures plan for more details (4. a. i-ii)
	Accept	See quality management procedures plan for more details (4. a. iii)

Quality Management Procedures

Quality Standards, Regulations and Commitments

This project required ethics approval for the research component and will adhere to those regulations. The Assiniboine Park Zoo does not have a Quality Policy; however, the project will follow the organization's standards of quality based on guidance provided by the project's APZ representatives.

Most Significant Risks to Quality

Here is a list of possible risks that can jeopardize the quality of the project

1. Trail cameras stolen or obstructed

2. Volunteers are unavailable
3. Discrepancies in recording observations and loss of data
4. Additional bin types from Recycle Everywhere are unavailable

Quality Management Procedures

1. Missing trail camera data and accidental photos taken of visitors
    a. There is always the possibility that the trail cameras could be stolen, or obstruction could be inadvertently placed in front of the camera. Additionally, there is a chance a camera or cameras may accidentally be left uncovered. To prevent this, the following will be implemented:
        i. The Project Manager (PM) will conduct a trial run to ensure cameras are capturing desired information
        ii. Trail cameras will be locked onto trees
        iii. Cameras will be locked up during the day, and covers will be removed/replaced by the zoo's volunteers daily. Weekly communication with the volunteer coordinator will be maintained to ensure cameras are appropriately covered.
        iv. Any photos containing pictures of visitors will be deleted immediately
        v. A portion of the budget will be set aside to replace cameras if needed
2. Volunteer commitment
    a. The APZ's volunteers will cover/uncover the trail cameras daily. Additionally, this project may include student volunteers not provided through the zoo to help with observational data collection and waste audits. To mitigate the potential loss of the volunteers, the following will be implemented:
        i. Incentives will be provided to ensure volunteers remain committed to the project and maintain interest
        ii. Clear instructions will be communicated regularly to ensure an understanding of expectations, which can be easily transferred to new volunteers. Additionally, regular contact will be maintained with the volunteer coordinator.
3. Data discrepancies
    a. Data needs to be collected daily in the same way for quality assurance. Similarly, there is a risk that data could be lost. To maintain appropriate data

collection among different collectors and ensure data is protected, the following will be implemented:

   i. Standardized instructions on how data is expected to be collected and recorded
   ii. Consistency among data collection days will be emphasized
   iii. The PM will perform regular check-ins to ensure any mistakes are addressed and corrected as soon as possible
   iv. Data will be backed up in One Drive daily

4. Additional bin types from Recycle Everywhere are unavailable
   a. Currently, there is a shortage of bins. However, they may be available later in the season.
      i. Maintain communication with Recycle Everywhere to advise we are still interested in the bins and to stay updated on future bin availability.
      ii. If we receive the additional bin types by June 30, 2022, we will add them to the project.
      iii. If we receive bins, the project will continue as planned with them.

<u>Roles and Responsibilities</u>

The PM will be responsible for all activities and quality assurance within the project. The PM is responsible for carrying out the following roles. The project supervisor is responsible for project oversight. Below is a summary of both people's responsibilities.

Project Manager

- Obtain required materials, such as trail cameras, and maintain them throughout the project.
- Understand and meet volunteer needs, recruit volunteers, and ensure the volunteers are meeting project expectations.
- Maintain adequate communication with APZ zoo representatives and committee members by providing regular updates.
- Identify and address quality issues and discuss solutions and changes with the Project Advisor.

- Monitor the effectiveness of any changes made for future learning opportunities.

Project Supervisor

- Provide guidance and advice throughout the project
- Offer suggestions on how to better project outcomes
- Approve any significant changes to the project that could affect the quality of the project outcomes

Change Management

Changes to the project are predicted to arise in one of the following possible ways:

- A risk already listed occurs, and the subsequent risk plan is initiated.
- A risk that was not planned for arises and, therefore, will need a mitigation plan.
- An addition to the project is requested either by the one or more of the stakeholders or as an afterthought of the Project Manager (PM)

The plan to address the possible changes listed above is as follows:

- A response plan is already listed in this document for this kind of change, either in the Risk Management or Quality Management sections. Should a change be necessary, the PM will discuss it with the Project Supervisor (PS) to ensure the response is still appropriate. If the PM and the PS decide the response is sufficient and no further actions are required, we will proceed as planned; however, if more thought on the subject is needed, the change will be discussed with the other stakeholders.
- The PM will discuss any new risks that arise and require change with the PS. The PM will then develop a plan to respond to the change and discuss it with all interested parties. The plan will be developed within an appropriate timeframe based on the significance of the change to the project.

- As this project is in the early development stages, some additions that could change the current project outline may be made. Should the change come from a stakeholder, all internal interested parties will first discuss the change, and the PM will write a plan. That plan will then be reviewed by all internal interested parties again, and an agreement will be reached. Should the addition come from the PM, the PM will write up a plan and present it to the PS for review. Once reviewed by the PS, it will be submitted for consideration to the other internal interested parties.

Any changes will be carefully documented and updated as the project continues. When necessary, considerations of how those changes or risks could be better handled in future projects will be noted. See the Change Log in the Appendices for details regarding the changes made to this project.

Chapter 3: Communication Outreach

This chapter outlines the communication and outreach efforts to promote the wildlife and waste project at the Assiniboine Park Zoo. The primary goals of these activities were to raise awareness about the project and the impacts of waste on wildlife, engage members of the public, and highlight the zoo's commitment to sustainability.

One of the project's deliverables was collaborating with the Assiniboine Park's Communication Coordinator. An initial meeting was held at the zoo to discuss details about the project in an interview format. This collaboration resulted in:

- A Feature in the Monthly Newsletter: the project was included in the park's monthly member newsletter.
- Blog Post: A blog post detailing the interview was published on the Assiniboine Park's website.

Going Wild About Waste

Aug 3, 2022



A conversation with Lynnae Martin, a master's student at the University of Manitoba with the Natural Resource Institute, who is completing her research project at the Assiniboine Park Zoo.

Figure 3.1: Screenshot of the blog post published to the Assiniboine Park's website https://www.assiniboinepark.ca/stories/108/going-wild-about-waste and written by Sara Wolowich Brown, Communications Coordinator.

Media Coverage

The outreach efforts caught the attention of the local media, allowing the project's details to reach a wider audience.

- CTV News Segment: The local CTV news station interviewed Dr. Stephen Petersen about the project. An article was also published on the CTV website. The new segment and article can be found here: https://winnipeg.ctvnews.ca/research-project-looking-at-how-wildlife-interacts-with-waste-at-assiniboine-park-zoo-1.6019903.
- Radio Canada Inquiry: Although an interview with Radio Canada was requested, it could not be conducted as it required French-speaking participants.

Additional Engagement

In October 2023, the project gained further outreach through educational engagement with youth. The organizer of Wild Outside with the Canadian Wildlife Federation contacted the Project Manager to arrange a discussion with their youth group at the zoo. The project manager conducted this session to provide insights into the project and other issues relating to wildlife and waste.

The communication and outreach activities helped enhance the visibility of the wildlife and waste project. These efforts helped inform the public and engage the media on the issue of waste. The positive reception demonstrated an interest in promoting environmental stewardship among the public.

Chapter 4: Wildlife and Waste Interactions Project Report

Below is the third deliverable presented to the zoo: the final Wildlife and Waste Interactions Project Report.

Wildlife and Waste Interactions Project at the Assiniboine Park Zoo



2024 Report

Zoo
Assiniboine Park

Land Acknowledgement

Assiniboine Park is located on Treaty 1 territory within the Province of Manitoba, the traditional lands of the Anishinaabe, Cree, Oji-Cree, Dene, and Dakota Peoples, and the national homeland of the Red River Métis. We recognize that land acknowledgements are not enough to rectify the violence, forcible displacement, and treaty violations on Indigenous peoples. However, we hope our acknowledgement will offer respect, create public awareness about the history of this area, promote decolonization of conservation biology, and serve as a call for more reconciliation action in our profession and our community.

Recommended Citation

L. Martin (2023). Wildlife and waste interactions project at the Assiniboine Park Zoo. Assiniboine Park Conservancy, Winnipeg, MB, pp. 40-83.

Cover Photo Caption and Photo Credit

A garbage and recycling bin next to each other with an adult raccoon on the recycling bin and two raccoon kits on the ground in the Asia area of the Assiniboine Park Zoo.

Photo credit: Lynnae Martin

For copies of this report, contact:
Conservation and Research Department
Assiniboine Park Zoo
2595 Roblin Blvd, Winnipeg, MB
conservationresearch@assiniboinepark.ca

Summary

Executive Summary

The Wildlife and Waste Interactions Project at the Assiniboine Park Zoo investigated how local wildlife interacts with visitor-generated waste across six areas of the zoo: Grasslands and Boreal Forests, Journey to Churchill, Aunt Sally's Farm, McFeetors Heavy Horse Centre, Asia, and Open Range. From June to October 2022, the study utilized trail cameras and in-person observations to document wildlife interacting with garbage and recycling bins during operational and closed hours. Additionally, photos were taken inside the garbage and recycling bins to record contamination rates. Trail cameras were placed near bins in the six areas mentioned above to monitor wildlife activity overnight. Daytime observations were carried out in person during regular admission hours at those same sites. Data analysis focused on species diversity, activity patterns, temporal trends, bin usage, behavioural interactions with the waste, and contamination rates within the bins.

The study observed various wildlife species interacting with waste, including Common Raccoons, Red Squirrels, Gray Squirrels, Crows, Richardson's Ground Squirrels, and Red Foxes. Additionally, species, such as Coyotes, Domestic Cats, and Skunks, were recorded after hours with the trail cameras but did not engage with waste. The Grasslands and Boreal Forests area showed the highest species diversity, with interactions primarily being Red Squirrels. The other five areas (Journey to Churchill, Aunt Sally's Farm, McFeetor's Heavy Horse Centre, Asia, and Open Range) had lower species variety, with 75-96% of their total observations being Common Raccoons.

Common Raccoons, Red Squirrels, and Gray Squirrels were the most frequent visitors to waste bins throughout the zoo. They exhibited distinct patterns in their active times, with squirrels active during daylight hours and raccoons primarily scavenging at night when the zoo was closed. There were also differences in how species accessed visitor-produced waste. Common Raccoons and Red and Gray Squirrels predominantly engaged in feeding and foraging behaviours within the waste bins. In contrast, other species, like Crows, opportunistically foraged on easily accessible waste, such as garbage on the ground around bins or picnic tables.

Of the wildlife recorded at the bins, most visits involved animals directly interacting with waste, as opposed to just perching on or running past the bins, with notable differences between areas. For instance, McFeetor's Heavy Horse Centre and the Grasslands and Boreal Forests areas saw the most frequent interactions with waste, while Journey to Churchill had very few recorded visits. Generally, wildlife seemed to use the garbage bins more frequently than the recycling bins. Although the recycling bins had high contamination rates, the contamination was mostly non-recyclables, such as coffee cups, rather than food waste.

However, wildlife was still incentivized to scavenge the recycling bins, as recyclables like yogurt containers often have leftover food residue.

Several recommendations are proposed to mitigate wildlife and waste interactions and enhance waste management practices. These include implementing wildlife-proof bins to prevent access to waste, increasing the availability of compost bins to manage food waste more effectively, offering clear and informative signage to educate visitors on waste disposal practices, establishing regular maintenance schedules for bins, providing staff and volunteer training on waste management, developing educational programs to raise awareness with visitors, and collaborating with local organizations for sustainable waste management incentives. These measures aim to support a safer environment for the local wildlife who live at the zoo while also serving as an example of environmental stewardship for visitors and the broader community.

Sommaire Executif

Le projet d'interactions entre la faune et les déchets du zoo du parc Assiniboine a étudié comment la faune locale interagit avec les déchets générés par les visiteurs dans six zones du zoo : Grasslands and Boreal Forests, Journey to Churchill, Aunt Sally's Farm, McFeetors Heavy Horse Centre, Asie et Open Range. De juin à octobre 2022, l'étude a utilisé des caméras de surveillance et des observations en personne pour documenter la faune interagir avec les poubelles et les bacs de recyclage pendant les heures de fonctionnement et de fermeture. De plus, des photos ont été prises à l'intérieur des poubelles et des bacs de recyclage pour enregistrer les taux de contamination. Des caméras de surveillance ont été stratégiquement placées près des poubelles dans les six zones mentionnées ci-dessus pour surveiller l'activité de la faune pendant la nuit. Les observations de jour ont été effectuées en personne pendant les heures d'admission habituelles sur ces mêmes sites. L'analyse des données s'est concentrée sur la diversité des espèces, les modèles d'activité, les tendances temporelles, l'utilisation des poubelles et les interactions comportementales avec les déchets.

L'étude a observé diverses espèces sauvages interagissant avec les déchets, notamment des ratons laveurs communs, des écureuils roux, des écureuils gris, des corneilles, des écureuils terrestres de Richardson et des renards roux. De plus, des espèces, telles que les coyotes, les chats domestiques et les mouffettes, ont été enregistrées pendant les heures de fermeture, avec les caméras de suivi, mais elles n'ont pas interagi avec les déchets. La région des Grasslands and Boreal Forests présentait la plus grande diversité d'espèces, avec les interactions principalement d'écureuils roux. Les autres cinq zones (Journey to Churchill, Aunt Sally's Farm, McFeetor's Heavy Horse Centre, Asia et Open Range) présentaient une variété

d'espèces plus faible, avec 75 à 96 % du total des observations étant des ratons laveurs communs.

Les ratons laveurs et les écureuils étaient les visiteurs les plus fréquents des poubelles du zoo. Ils présentaient des schémas distincts pendant leurs périodes d'activité, les écureuils étant actifs pendant la journée et les ratons laveurs fouillant principalement la nuit lorsque le zoo était fermé. Des différences comportementales distinctes ont également été observées entre les espèces. Les ratons laveurs communs et les écureuils roux et gris se livrant principalement à des comportements d'alimentation et de recherche de nourriture dans les poubelles. D'autres espèces, comme les corneilles, se nourrissaient de manière opportuniste dans des déchets facilement accessibles, tels que des déchets au sol autour des poubelles ou des tables de pique-nique.

La plupart des animaux sauvages enregistrés autour des poubelles, environ 66 %, étaient des animaux interagissant avec les déchets, avec des différences notables entre les zones. Par exemple, le McFeetor's Heavy Horse Centre et Grasslands and Boreal Forests ont connu les interactions les plus fréquentes, tandis que Journey to Churchill a enregistré très peu de visites. En générale, la faune semble utiliser davantage les bacs à déchets que les bacs de recyclage, malgré les taux de contamination élevés constatés dans les bacs de recyclage. Toutes les photos prises à l'intérieur des bacs de recyclage présentaient des contaminations, pour la plupart non recyclables (par example, des tasses à café jetables provenant de l'extérieur du zoo) mais aussi des éléments compostables.

Pour atténuer les interactions entre la faune et les déchets et améliorer les pratiques de gestion des déchets, plusieurs recommandations sont proposées. Il s'agit notamment de mettre en place des bacs à l'épreuve de la faune pour empêcher l'accès aux déchets, d'augmenter la disponibilité des bacs à compost pour gérer plus efficacement les déchets alimentaires, d'offrir une signalisation claire et informative aux visiteurs informés sur les pratiques d'élimination des déchets, d'établir des calendriers d'entretien réguliers pour les bacs, de fournir au personnel et aux bénévoles formation sur la gestion des déchets, développement de programmes éducatifs pour sensibiliser les visiteurs et collaboration avec des organisations locales pour des incitations à la gestion durable des déchets. Ces mesures visent à soutenir un environnement sûr pour la faune locale qui vit au zoo tout en servant également d'exemple de gestion environnementale pour les visiteurs et la communauté dans son ensemble.

Partners, Funders, and In-Kind Support

This project was made possible by the generous support and collaboration of several key partners and supporters.

Thank you to the Assiniboine Park Zoo for partnering and funding this project. A special thank you goes to the dedicated zoo volunteers who ensured the trail cameras operated daily when the zoo closed.

Project Learning Tree and the Manitoba Wildlife Federation also generously contributed to this project.

Thank you to my committee, Dr. Nicola Koper, Dr. Stephen Petersen, and Sheldon McLeod, for your expertise and guidance throughout this endeavour. Also, thank you to the members of the Koper Lab for your help and feedback.

Lastly, I want to acknowledge WildTrax for providing an essential, free platform for processing wildlife data, which was vital for this project.

Thank you all for your contributions and support!

Wildlife and Waste Interactions Project at the Assiniboine Park Zoo

Introduction

Visitors come to the Assiniboine Park Zoo to observe and learn about a diverse range of animals, from charismatic species native to Manitoba, like polar bears, to exotic animals from around the world. However, beyond the enclosures, visitors are inconspicuously linked to the more subtle and common local wildlife populations through their garbage. The Wildlife and Waste Interactions project aims to explore the relationship between this often-overlooked connection between humans and wildlife. In doing so, the goal is to highlight the local dimension of our global waste problem and encourage sustainable waste practices within the zoo.

Waste production is a growing global concern with significant implications for the environment and waste management systems. In Canada, the total amount of waste produced is increasing and as of 2020, has reached approximately 36.0 million tons (ECCC., 2023). We are one of the top countries with the highest waste generated per capita (Silpa et al., 2018). According to a report published by the Canadian government, Manitoba has some of the lowest diversion rates, meaning most of our waste ends up in landfills (ECCC., 2023).

Waste is generally sorted into two categories: biodegradable and non-biodegradable. Non-biodegradable materials, such as plastics, can persist within the environment for centuries, contributing to long-term environmental issues (Zhang & Peng, 2022). Even products marketed as “compostable” often fail to decompose efficiently, undermining efforts to reduce waste (Napper & Thompson, 2019). On the other hand, biodegradable waste, particularly food, could be diverted and used as compost more readily. However, instead, it often ends up in landfills, where it releases methane, a potent greenhouse gas, as it decomposes (Gabbatiss, 2023). Beyond its contribution to climate change, food waste attracts wildlife, increasing scavenging behaviours and disrupting ecosystems.

We are all familiar with the potentially harmful consequences of our garbage on animals, such as entanglements and ingesting toxic material. It can also influence the behaviour and ecology of many species (Newsome & Van Eeden., 2017). This manifests in the form of shifting migratory and foraging patterns (Gilbert et al., 2016), disruptions in reproductive successes (Gwynne & Rentz., 1983), and changes in disease transmission rates (Flint et al., 2015), among other effects. These influences can also cascade through the trophic levels, affecting species without direct contact with our consolidated waste (Frixone et al., 2012).

Efforts to decrease and divert waste from landfills are underway and gaining momentum across Canada (EREF., 2021). However, despite these efforts, Manitoba has much room for improvement when compared to other provinces (ECCC., 2023). Recycling and composting are well-known methods to mitigate the amount of waste. Yet, various factors, such as limited access, insufficient awareness and low motivation, contribute to the need for change. Reducing and separating food waste from our garbage is one way to coexist better with wildlife and the environment. This is a complicated, global problem; however, it is crucial to acknowledge the problem and address it at the community level, where waste production begins.

Accredited zoos and aquariums, like the Assiniboine Park Zoo, are known leaders in promoting conservation issues by positively influencing the education and actions of those who visit them (McNally et al., 2024). The Wildlife and Waste Interactions project aims to contribute to understanding how waste generated by visitors influences the local wildlife around the zoo. By installing cameras around the zoo's waste bins and performing in-person observations, the project documented which species are most attracted to waste and their behaviours. These insights aim to encourage better waste management strategies and further the Assiniboine Park Zoo's conservation efforts, ultimately contributing to broader environmental stewardship.

Methods

This project was conducted at the Assiniboine Park Zoo from June to October 2022. The zoo was divided into six main areas, each containing two to three individual sites (Figure 4.1; also see the volunteer form in the Appendices for more details). These areas are Grasslands and Boreal Forest, Journey to Churchill, Aunt Sally's Farm, McFeetors Heavy Horse Farm, Asia, and Open Range.



Figure 4.1: Map of Assiniboine Park Zoo and trail camera locations (Source: Google Earth)

Observations were primarily recorded using trail cameras, which operated while the zoo was closed, and photos were uploaded to WildTrax for processing. Any digital content accidentally capturing images of people, such as visitors or staff, was deleted. Observations were also recorded during the zoo's regular admission hours from 9 am to 5 pm using a notebook and camera. The methods for documenting wildlife and waste interactions were therefore divided into two periods: after-hours when the zoo was closed to visitors, and during opening hours when visitors were present.

1. After Hours Observations

A total of six trail cameras were operational from 5 pm until 9 am daily throughout the project. Each area had its own camera that rotated biweekly between the sites within that area (Figure 4.1). Trail cameras were secured to trees, positioned to face the selected garbage and recycling bins, and set up to capture bursts of photos triggered by motion. To avoid taking photos of guests during the day, a waterproof shower cap was used to cover the cameras. Every day, volunteers at the zoo removed the camera covers when the zoo closed (around 5 pm) and replaced the camera covers when the zoo opened (around 9 am) (Appendices).

Photos were uploaded from the SD cards twice weekly and processed using Wildtrax (wildtrax.ca). The species, behaviour, and which bin was used (when applicable) were documented. Any incidental photos of visitors and staff were removed, and no photos containing identifiable images of people were used in the data analysis. Trail camera footage rarely contained both a person and wildlife. During those instances when a human did appear, the wildlife would usually leave, so they were not counted.

After Hours Data Analysis

The trail camera data was downloaded from Wildtrax to an Excel file and then analyzed using R. The analysis focused on the following key aspects to help understand the interactions observed between wildlife and waste: species diversity, activity count, temporal trends, bin usage, and behavioural patterns.

- Species Diversity

To assess the diversity of wildlife interacting with waste documented by the trail cameras, only wildlife exhibiting behaviours related to the bins such as foraging, feeding, and other were analyzed (Table 4.1). Unrelated or incidental behaviours, such as running past the cameras (i.e., running or territorial display, see the ethogram in Table 4.1), were excluded. Using R, pie charts for each of the six areas were created to depict the relative proportion of each species observed (Figure 4.2).

- Activity Count

To capture the frequency of wildlife activity at each site, the number of visits or "events" was counted. Each photo's timestamp and date information was downloaded from WildTrax and processed using Excel and R. Photos in a continuous series separated by less than 10 minutes were classified as a single "event." This ensured that brief interruptions or an animal reappearing in the frame shortly after leaving (e.g., disappearing inside a bin and then re-triggering the camera's motion sensor as they leave) were counted as part of the same event to avoid overestimating the number of visits.

To focus specifically on interactions with waste, only observations classified as "feeding" and "foraging" were included while maintaining the 10-minute separation rule to identify distinct events. Additionally, events that contained a new species, regardless of the ten-minute rule, were counted as separate visits (e.g., a red squirrel was in the bin, and then two minutes later, a gray squirrel appeared).

Another analysis focused on the activity counts of the three primary scavengers: Common Raccoon, Gray Squirrel, and Red Squirrel. Species that did not directly scavenge or interact with waste from the bins, such as crows, were excluded. This approach provided a clearer understanding of the zoo's main contributors to waste interactions.

- Temporal Trends

Trends in the temporal activity of wildlife were analyzed during the evening, night, and early morning hours while the zoo was closed to visitors. Cameras were usually uncovered or covered slightly before 5 pm or after 9 am when volunteers were available. Therefore, for this analysis, only data collected by trail cameras from 5 pm to 9 am were used to focus on the activity levels when no visitors were present. Additionally, behaviours such as “running” and “territorial display” were excluded. The remaining data was aggregated by species and hour to count the number of wildlife photos captured during each hour. A stacked bar chart was then generated using R to represent the species present (Figure 4.2).

- Bin usage

Photos of wildlife engaging with either the garbage bin (G), recycling bin (R), or both (B) were noted in the tag comments. This was done as often an animal would engage with only one bin (garbage or recycling) or go back and forth between both bins during a single visit. Engaging with the bins included behaviours like feeding, foraging, or other (Table 4.1). Initial analysis summarized the total time spent at each bin across all sites (Figure 4.3).

A one-way ANOVA test was performed to assess the differences between the time spent in each category (G, R, or B), followed by a Leven’s test for homogeneity of variances. Post-hoc tests (Tukey HSD) were conducted if the ANOVA results were significant. Additionally, each of the six sites was analyzed separately, repeating the ANOVA and post-hoc tests to assess site-specific differences in bin usage.

- Behavioural Patterns

Behavioural observations were categorized using an ethogram (Table 4.1) to identify the activities of the observed wildlife. Each photo sequence was tagged using the predefined categories outlined below. Species less frequently observed and that had no interactions with the bins were classified into the “Others” category. This included Coyotes, Domestic Cats, Striped Skunks, Geese, and Cottontails. The frequency of each behaviour for every species group was summarized in Figure 4.4.

Ethogram of Wildlife Behaviours at the Assiniboine Park Zoo

BEHAVIOUR	DESCRIPTION
FORAGING	Wildlife observed investigating bins without taking or consuming anything
FEEDING	Wildlife observed taking or consuming items from the bins or surrounding litter
OTHER	Wildlife perched on or climbing bins without investigating their contents
RUNNING	Wildlife passing by the cameras without interacting with the bins
TERRITORIAL DISPLAY	Interactions between wildlife, such as chasing and fighting, seemingly unrelated to interacting with bins

Table 4.1: Ethogram of wildlife behaviours noted at the Assiniboine Park Zoo. The table represents observed behaviours of wildlife interacting with waste bins such as Foraging, Feeding, and Other, as well as other activities unrelated to waste such as Running and Territorial Display.

2. Opening Hours Observations

During regular operating hours from 9 AM to 5 PM, I visited the zoo two to three times a week on random days and random time blocks. These time blocks were divided into mornings (9 AM – 12 PM) and afternoons (12 PM – 5 PM). I followed the same general path as regular visitors to avoid disrupting wildlife that may interact with waste, and I visited each site twice per visit. Observations were recorded using a notebook and camera. Additionally, photos were taken inside the site's garbage and recycling bins, with the top layer recorded.

- Opening Hours Data Analysis

Given the limited number of wildlife observations during the day, this analysis was primarily qualitative. Notes and photos were taken during these visits to identify the species observed and describe their behaviour. This provided a general insight into the types of wildlife present during the day and their interactions with waste.

To quantitatively assess the occurrence of observations between morning (AM) and afternoon (PM) visits, a Chi-square test was performed. This test compared the observed occurrences of wildlife and waste interactions (Table 4.4) with the expected occurrences under the null hypothesis that there was no significant difference between the number of occurrences in the AM or PM visits. This analysis was done at a 0.05 significance level to determine if the time of day influenced the likelihood of observing wildlife interacting with waste (Table 4.5).

- Bin Contamination Rates

Photos of the bin contents were taken during daytime observations to assess contamination in the recycling bins and identify “missed opportunities” (recyclables in the garbage bin). This method provided a quick snapshot of the top layer of waste without disturbing the bins. The photographs were then visually analyzed to identify and categorize items as contaminants in the recycling bins or recyclables in the garbage bins.

Contaminants and missed opportunities were identified as single occurrences per bin. For instance, if food waste was found in a recycling bin, it was recorded as one occurrence without tallying the quantity of food items. Similarly, if that bin contained food waste and non-recyclable plastic, they would be recorded as separate but singular occurrences. The results from the recycling bins were compiled into a simple chart to provide a general overview of the types and frequencies of contaminants (Figure 4.6).

Results

1. After Hours Observations
   - Species Diversity

The species observed interacting with waste either by feeding, foraging, or other (Table 1) were examined across the six areas: Grasslands and Boreal Forests, Journey to Churchill, Aunt Sally's Farm, McFeetor's Heavy Horse Centre, Asia, and Open Range. The most observed wildlife among all the areas were Common Raccoons, Red Squirrels, and Gray Squirrels; however, the proportions of each species differed between all six areas (Figure 4.2).

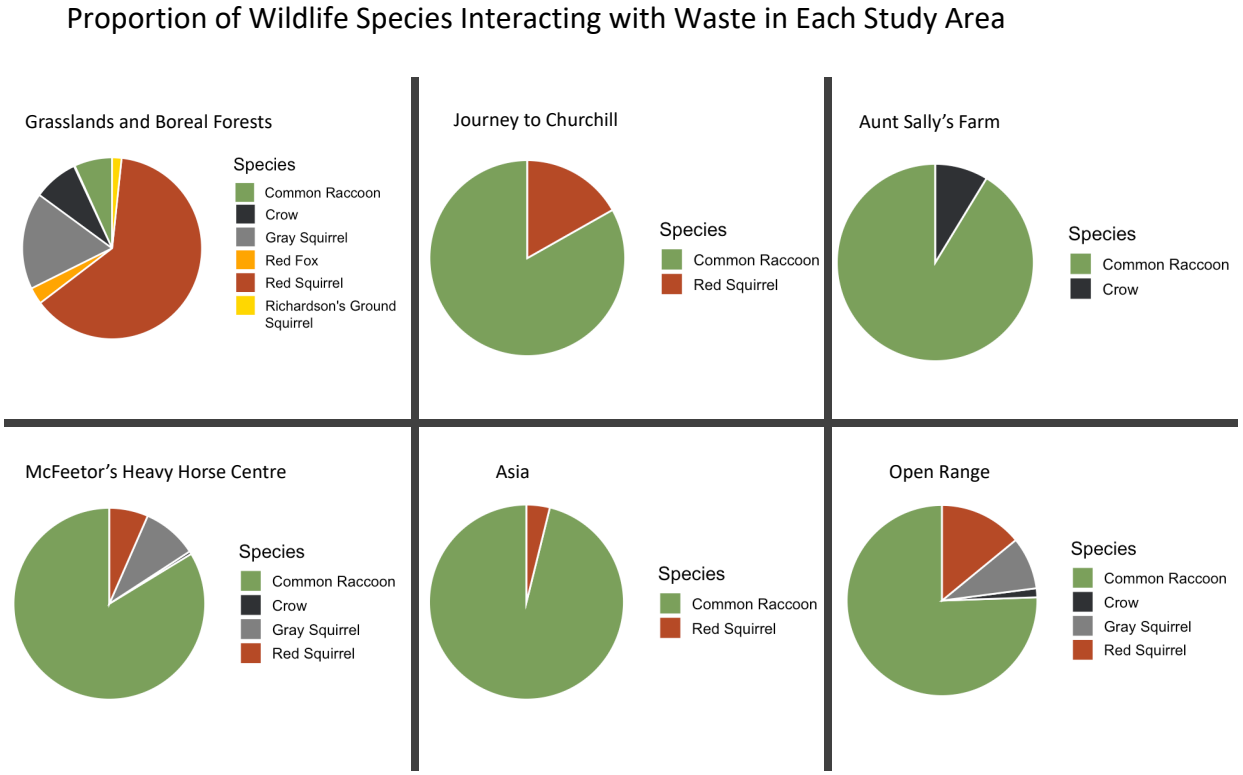


Figure 4.2: Pie charts illustrating the distribution of wildlife species across the six study areas at the Assiniboine Park Zoo: Grasslands and Boreal Forest, Journey to Churchill, Aunt Sally's Farm, McFeetor's Heavy Horse Centre, Asia, and Open Range. Each chart represents the proportion of different species observed by trail cameras within their respective areas interacting with waste bins.

In the Grasslands and Boreal Forests area, the Red Squirrel was the most dominant species, accounting for more than 60% of the observations. This site also had the highest species diversity compared to other areas, including species that were not seen interacting with garbage in other places, such as Red Fox and Richardson's Ground Squirrel. The Common Raccoon was the most observed species in the other five areas, making up between 75 - 96% of the observations. McFeetor's Centre and Open Range saw slightly more kinds of species, including both Red and Gray Squirrels, in addition to the occasional Crow. The only site that had no recorded instances of either squirrel species interacting with waste was Aunt Sally's Farm.

- Activity Counts

A total of 761 separate wildlife events were recorded by the trail cameras, where an event is defined as a sequence of photos taken within a 10-minute interval unless a different species was observed. Over 65% of these events involved wildlife interacting with the waste through foraging and feeding (Table 4.2). The Grasslands and Boreal Forests area exhibited the highest overall activity with 257 recorded events. Of these, 163 events (62.4%) involved waste interactions. McFeetor's Heavy Horse Centre also showed significant activity, recording 205 events with 175 (85.4%) related to waste interactions, showing the highest proportion of waste-related events across all the areas. Conversely, the Journey to Churchill area had the lowest overall activity, with 39 recorded events and, only 13 (33.3%) of which involved waste interactions.

Aunt Sally's Farm documented 27 events, of which 10 (37%) involved waste interactions. The Asia area recorded 101 events, with almost half (46.5%) relating to waste interactions. Finally, the Open Range had 132 events, with 96 (72.7%) involving waste interactions. Overall, out of the 761 recorded events, 504 (66.2%) were associated with wildlife interacting with waste. This indicates that most of the wildlife activity around the bins is related to feeding and foraging for garbage.

Table 4.3 provides a breakdown of the feeding and foraging activity of the three primary scavengers: Common Raccoon, Gray Squirrel, and Red Squirrel. Species that did not directly

access the bins, such as Crows, were excluded from this analysis. The Common Raccoon was the most frequently observed species interacting with garbage, with a total of 217 recorded events. The highest number of events for Common Raccoons occurred in McFeetor's Heavy Horse Centre (98 events) and the Open Range (58 events).

Red squirrels showed the second-highest number of activities, with a total of 144 recorded events. They were the most active in the Grasslands and Boreal Forests area, with 117 recorded events. Although Gray Squirrels were also present in the Grasslands and Boreal Forests area, they were less frequent than the Red Squirrels, with 32 recorded events in that area. In total, Gray Squirrels had 91 recorded events and were notably active in the McFeetor's Heavy Horse Centre area with an activity count of 53.

Wildlife Activity Counts

Area	Total Number of Events	Waste Interaction Events
Grasslands and Boreal Forests	257	163
Journey to Churchill	39	13
Aunt Sally's Farm	27	10
McFeetor's Heavy Horse Centre	205	175
Asia	101	47
Open Range	132	96
Total	761	504

Table 4.2: Summary of activity counts recorded by the trail cameras. Activity counts were separated by "events," classified as sequential photos of the same species less than ten minutes apart. This table presents the total number of events and the waste interaction events observed in each area during the study period.

Wildlife Activity Counts for Common Raccoon, Gray Squirrel, and Red Squirrel

Area	Common Raccoon	Gray Squirrel	Red Squirrel
Grasslands and Boreal Forests	7	32	117
Journey to Churchill	7	0	4
Aunt Sally's Farm	9	0	0
McFeetor's Heavy Horse Centre	98	53	20
Asia	38	0	8
Open Range	58	6	20
Total	217	91	144

Table 4.3: Activity counts for the top three garbage foraging and feeding species: Common Raccoon, Gray Squirrel, and Red Squirrel. Species that did not directly access the garbage bins, like crows and ground squirrels, were excluded.

- Temporal Trends

The temporal patterns of wildlife activity around the bins were analyzed for the six species observed interacting with waste (Common Raccoon, Red Squirrel, Gray Squirrel, Red Fox, Richardson's Ground Squirrel, and Crow) during the hours from 5 PM to 9 AM (Figure 4.3).

The most observed species, Common Raccoon, Red Squirrel, and Gray Squirrel, appear to have different patterns of temporal activities. The activity of Common Raccoons was observed well outside the zoo's operating hours, with noticeable peaks during the evening from around 8 PM till 11 PM and in the early morning from around 1 AM till 5 AM. In contrast, Red and Gray Squirrels activity appears absent during peak raccoon hours. The other observed species, such as Crows and Richardson's Ground Squirrel, were observed during daylight hours, whereas the Red Fox was also observed during crepuscular periods.

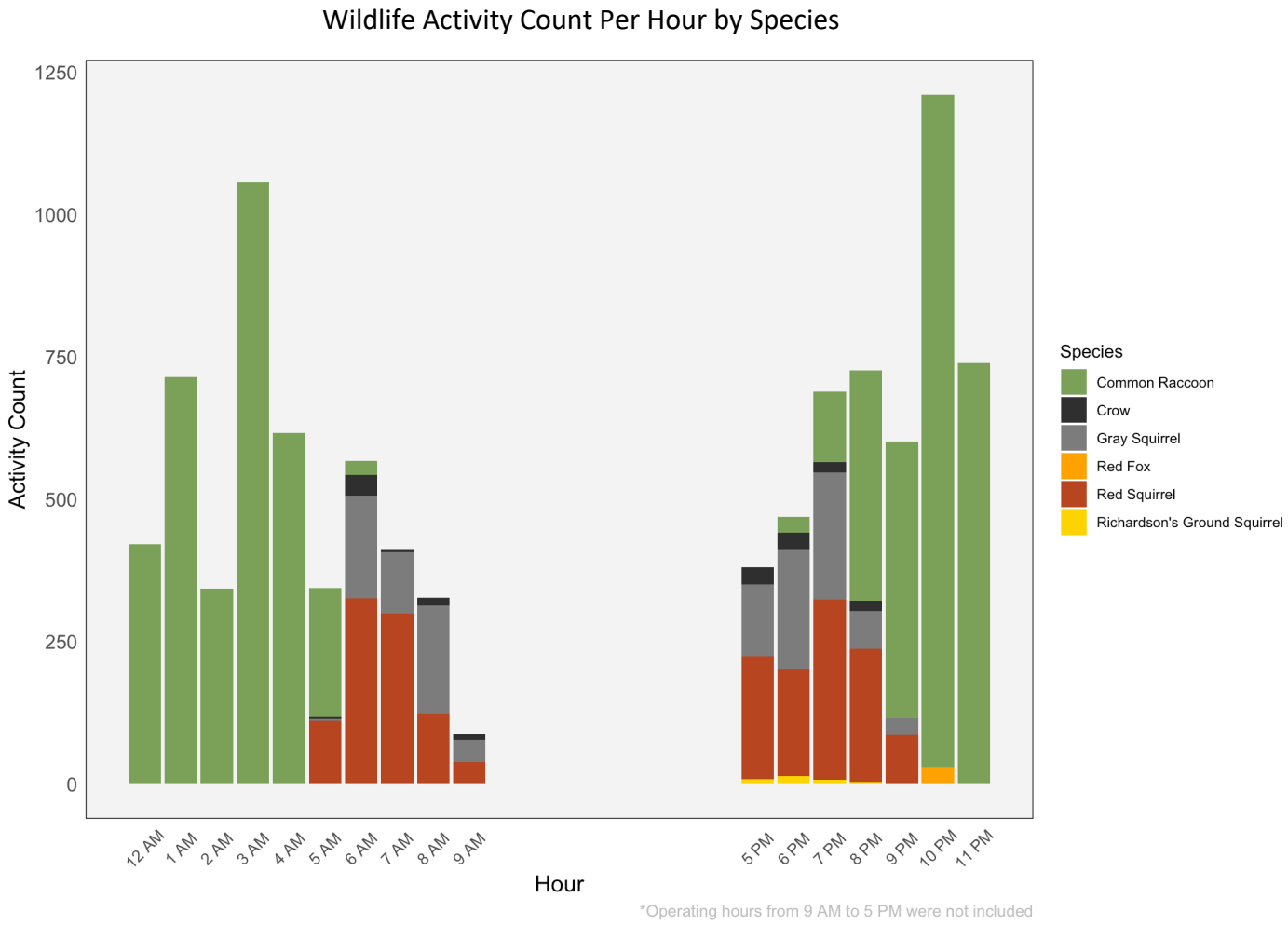


Figure 4.3: A histogram showing the relative proportion of species observed each hour, excluding the regular admission hours from 9 AM to 5 PM.

- Bin usage

The total number of photos taken during a visit was summarized and tagged as either interacting with the garbage bin (G), recycling bin (R), or both (B) captured the proportionate value of time spent interacting with the bins across all six areas (Figure 4.4). If an animal engaged with both bins within the same visit (e.g., moving back and forth between the bins), it counted as an interaction between both bins.

The ANOVA test performed for all the areas combined revealed a significant difference in the total time spent among the garage bin (G), recycling bin (R), and both (B) categories (F(2,

9616) = 3.522, p = 0.0296). Despite the violation of the homogeneity of variances assumption as per the Levene's test (F(2, 9616) = 3.5216, p = 0.02959), the ANOVA results were still used due to the large sample size (n = 9619) and the robustness of ANOVA to moderate violation of assumptions. Post-hoc Tukey tests showed significant differences (*) between the recycling (R) and garbage (G) bins and between recycling (R) and both (B) bins (Table 4.4).

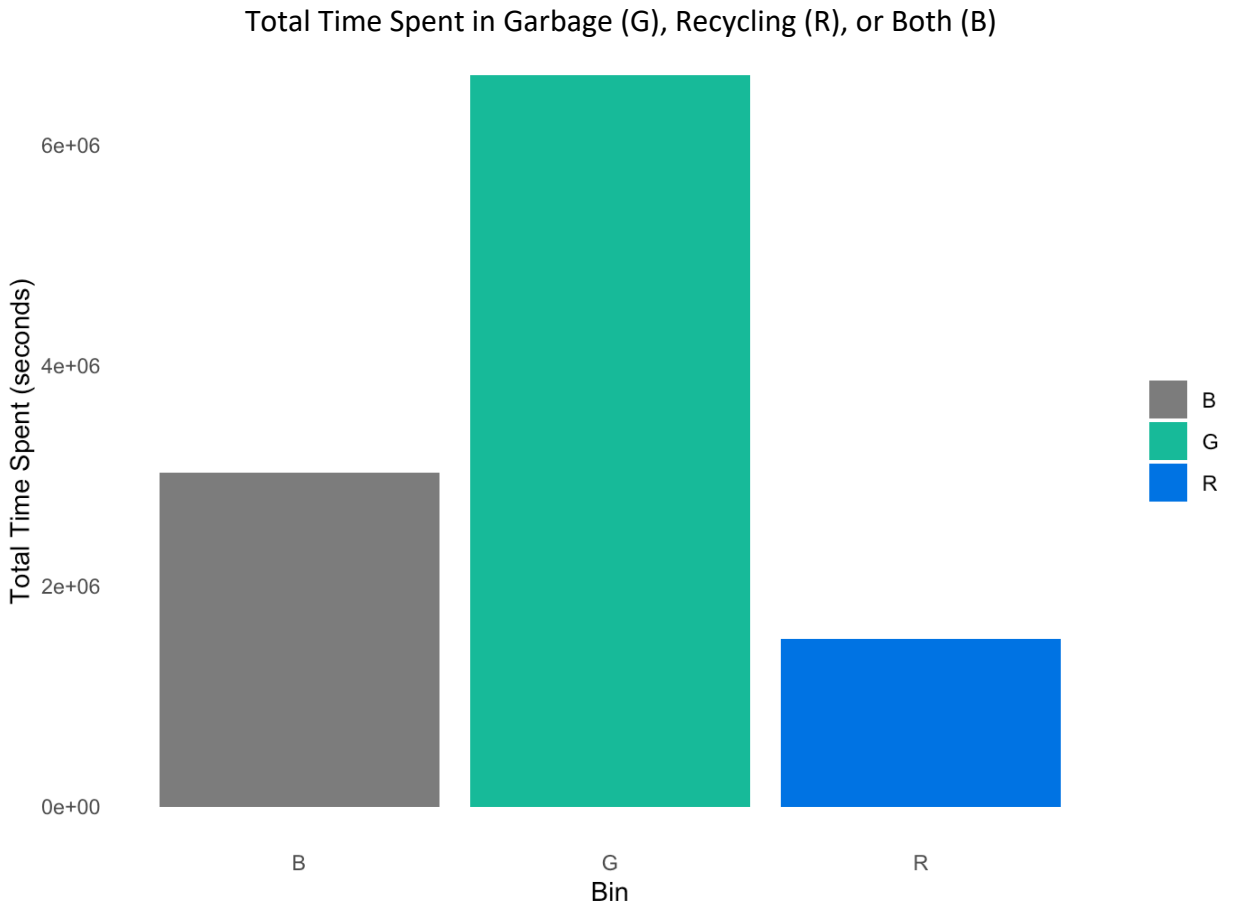


Figure 4.4: Total time wildlife spent interacting with just the garbage bin or recycling bin during one visit. If they engaged with both bins during a single visit (e.g., going back and forth between the bins) that was counted as interacting with both bins.

Tukey's HSD Post-Hoc Test Results for Wildlife Usage of Garbage Bins (G), Recycling Bins (R), and Both (B).

Comparison	Difference	Lower	Upper	Adjusted P-value
G-B	17.248	-764.418	798.914	0.9985
R-B	1743.228	123.176	3363.28	*0.03134
R-G	1725.98	176.43	3275.531	*0.02453

Table 4.4: Results of Tukey's HSD post-hoc test comparing the usage of garbage bins, recycling bins, and both bins by wildlife. Statistically significant differences ($p<0.05$) are indicated with an asterisk.

The same tests were done again but to analyze the differences between each area. Area 1 (Grasslands and Boreal Forests) ANOVA results indicated a significant difference among the categories of bins ($F(2,1650) = 10.71$, $p<0.001$), showing similar results as shown for all the areas together (Table 4.3). Despite the violation of the homogeneity of variances assumption as per the Levene's test ($F(2,1650) = 10.713$, $p <0.001$, the ANOVA results were still used due to the large sample size ($n = 1653$) and post-hoc Tukey tests were performed. This revealed significant differences between the recycling (R) and garbage (G) bins ($p<0.001$), and between recycling (R) and both (B) bins ($p<0.001$).

Areas 2-6: ANOVA results showed no significant differences between the three categories, so no further tests were performed.

- Behavioural Patterns

The behavioural observations of wildlife recorded by the trail cameras were categorized into five main behaviours: Feeding, Foraging, Other, Running, and Territorial Display (Table 4.1). The species with observed less frequently such as Coyotes, Domestic Cats, Striped Skunks, and Cottontails were categorized as "Others".

Figure 4.5 illustrates the distribution of the observed behaviours across the different species. The Common Raccoon showed the highest proportion of observations either Feeding or Foraging. Red and Gray Squirrels also showed high engagement levels with the bins primarily

through Feeding and Foraging, with Red Squirrels having a slightly higher frequency compared to Gray Squirrels.

Crows were primarily observed Foraging waste with a relatively moderate frequency. Photo sequences capture on trail cameras as well as in person observations suggest Crows will opportunistically forage and/or feed on waste when it is more easily accessible (i.e. left on the ground, picnic table, of edge of the bins).

Species such as Red Fox and Richardson's Ground Squirrel were also observed on trail cameras interacting with waste but with much less frequency and only in the Grasslands and Boreal Forests area. They were observed foraging garbage taken out of the bins by squirrels and left where it was more accessible. Wildlife categorized as "Others" (Coyote, Domestic Cat, Striped Skunk, Cottontails) were mostly captured incidentally by the trail cameras as they went past.

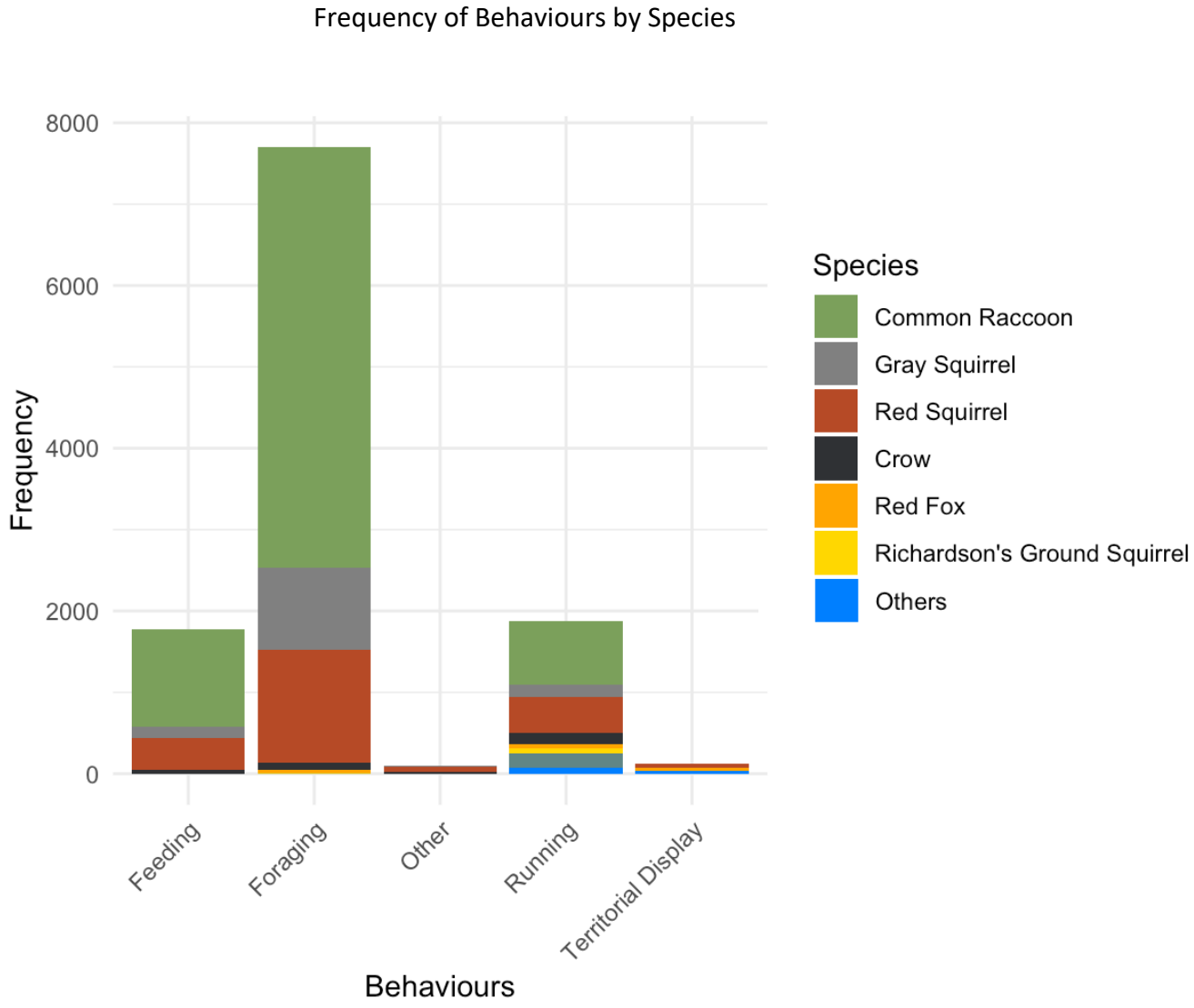


Figure 4.5: The distribution of observed wildlife behaviours categorized into five main behaviours: Feeding, Foraging, Other, Running, and Territorial display. Only species observed interacting with waste and/or the bins were listed. The "Others" were incidental captures of wildlife which included Coyotes, Domestic Cats, Striped Skunk, and Cottontails.

- Opening Hours Data Analysis

Day time observations reported Red Squirrels and Gray Squirrels to be the most frequently observed species at the bins. Crows were observed interacting with waste but more so from the availability of litter either left by visitors at picnic tables or possibly removed from bins by

squirrels. There was one instance of a Richardson's Ground Squirrel foraging litter around one of the bins. Otherwise, no other species were seen interacting with waste during regular zoo hours.

Of the 53 visits made during regular admission hours, 23 occurred in the morning (AM), and 30 occurred in the afternoon (PM). Wildlife interactions with waste were observed eight times in the morning, comprising approximately 34.8% of the AM observations, and 17 times in the afternoon, comprising approximately 56.7% of PM observations. Table 4.5 summarizes these findings, indicating the proportion of wildlife and waste interactions with waste in the morning, afternoon, and in total for all the visits.

Observations of Wildlife and Waste Interactions During Regular Admission Hours

Time of Day	# of Observations	Total Visits	% of Observations
Morning (AM)	8	23	34.8%
Afternoon (PM)	17	30	56.7%
Total	25	53	47.2%

Table 4.5: Table summary of the number of wildlife and waste interactions observed in the morning (AM) and afternoon (PM), along with the percentage of observations for the total number of visits.

The species that were noted during the day were mainly Red Squirrels and Crows, with the occasional Gray Squirrel and Ground Squirrel. Crows were often seen going around the picnic tables in the Open Range and Aunt Sally's Farm. They were seen in groups or alone, going from one table to the next during periods when there were fewer visitors in those seating areas. They also accessed garbage that was easily reachable, such as items left on the lip of bins or on top of overfilled bins. They were seen scavenging items such as Timbits, cheese strings, and takeout food containers.

Red Squirrels and Gray Squirrels were also observed around the picnic table areas in Open Range, Aunt Sally's Farm and McFeetor's Centre, in addition to entering both garbage and recycling bins throughout the zoo. However, Red Squirrels were seen more often than Gray Squirrels. There was only one recorded instance of a Richardson Ground Squirrels foraging through garbage that had fallen beside the bins on Aunt Sally's Farm.

- Bin Contamination Rates

Almost all of the photos taken inside the bins had some contamination or missed opportunity visible at the top. A total of 621 occurrences labelled as contaminants were observed in the recycling bin. These were classified into three main categories: Compostable Takeout Containers, Food, and Non-Recyclables (Figure 4.6). While Food comprised a relatively small proportion of the overall contaminants, notably lemons from beverages served at the lemonade stand constituted over 70% of the observed food items. Compostable Takeout Containers were relatively infrequent and primarily consisted of containers and cutlery likely originating from Tundra Grill.

Non-recyclables represented the most substantial proportion of contaminants. Straws accounted for approximately one-fourth of the total non-recyclable items observed. Both paper and plastic straws were present; however, both were considered non-recyclables as small items are screened out at recycling facilities to avoid jamming up their machines. Additionally, disposable coffee and drinks cups brought into the zoo (e.g., from Tim Hortons, Starbucks, McDonald's, etc.) and to-go cups sourced from within the zoo *each* constituted approximately 17% of the non-recyclable items. Other non-recyclables were snow cone cups, disposable plates, and snack wrappers.

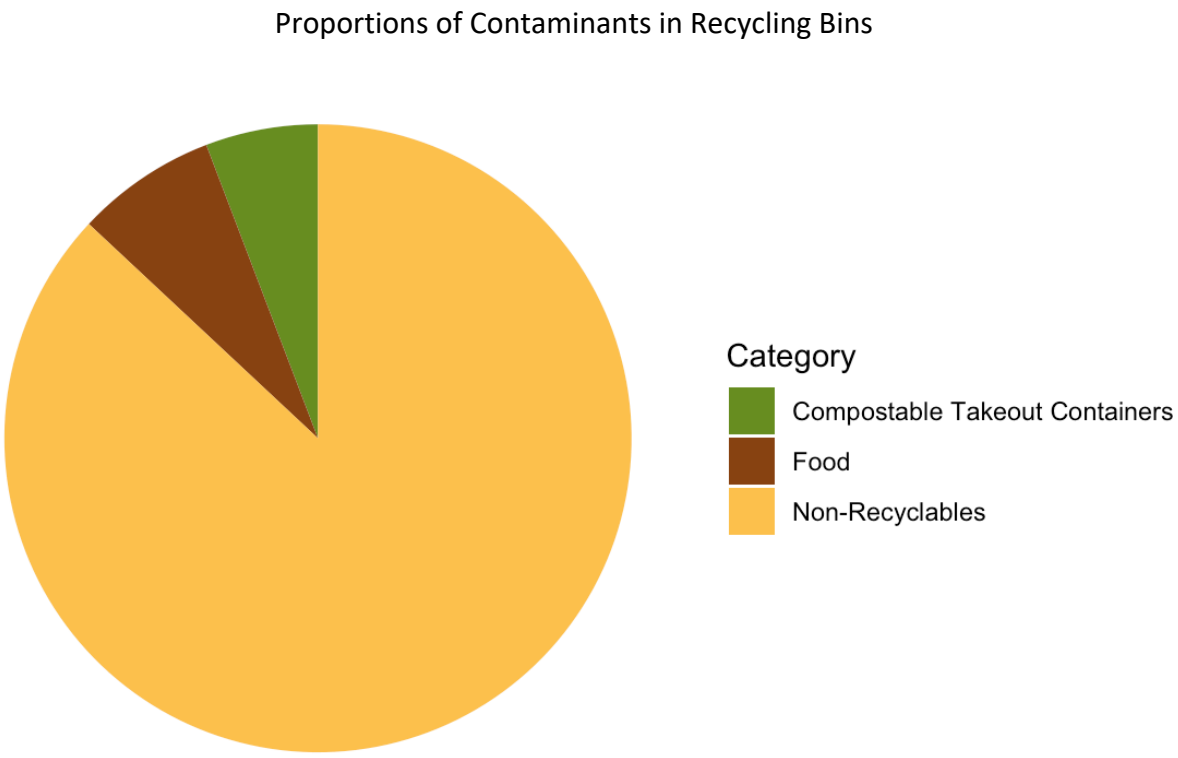


Figure 4.6: A pie chart showing the proportion of contaminants observed in the top layer of the recycling bins. This included non-recyclables like coffee cups as well as food and compostable takeout containers.

Missed recycling opportunities were observed in 28% of the recorded garbage bins. These included plastic water bottles, aluminum drink cans, juice boxes, large paper bags, recyclable plastic food containers (like yogurt containers, Lunchables, Pringles, etc.), and cardboard boxes. Among the items observed, paper coffee sleeves were the most common, making up 31% of the missed opportunities.

Discussion

The differences in species diversity and activity levels across the six areas provided insights into what kind of wildlife interacts with waste at the zoo. While Common Raccoons, Red Squirrels, and Gray Squirrels were the most frequently observed, the proportions of each species varied between the sites. In the Grasslands area, Red Squirrels were the dominant species, making up more than 60% of the observations. This site also had the highest species diversity, with additional animals such as Red Fox and Richardson's Ground Squirrel recorded interacting with waste.

Squirrels, particularly Red Squirrels and the occasional Gray Squirrel, were often seen pulling items out of the bins on trail camera photos and during in-person observations (Figure 4.7). The additional species recorded in the Grasslands and Boreal Forests could only interact with waste made available by the squirrels (Figure 4.8). In contrast, the Common Raccoon was the predominant species in the remaining five areas, with a small proportion in the Grasslands and Boreal Forests area. Other small rodents, such as mice, voles, and rats, were not detected; however, it is possible they were also present but not captured by the trail cameras due to their position higher off the ground.



Figure 4.7: Right: A Red Squirrel eating what looks like a muffin wrapper. Left: A Red Squirrel eating a tortilla chip. Both photos were taken in the Arctic Area.



Figure 4.8: A sequence of photos showing waste removed from the garbage bin by a Gray Squirrel (top two photos), which is later examined by a Richardson's Ground Squirrel (bottom left) and a Crow (bottom right).

The variations in species composition could be attributed to several factors. First, trail camera efficacy may have influenced the detection of smaller animals, like squirrels, which tend to move quickly in and out of bins, potentially leading to underrepresented recorded data. Also, smaller rodents like mice, voles, and rats may have gone undetected for this reason. Additionally, the differences in human presence at each site may have impacted wildlife behaviour. For instance, Aunt Sally's Farm, which serves as an entrance point for staff, volunteers, and after-hours events (i.e. a wedding), may deter wildlife from scavenging bins due to the higher presence of people.

Sites frequented by visitors for breaks and lunch, such as the Open Range and Aunt Sally's farm, appear to benefit from volunteers' extra cleaning efforts. While these areas may generate more waste, proactive cleaning measures likely mitigate the impact on wildlife waste interactions, resulting in fewer observations. The Grasslands and Boreal Forests area was also the furthest away from the river, which may be where the raccoons originate from, explaining why they were seen there in lower proportions. Even while cleaning measures were in place around the zoo, the wildlife activity data indicates that these bins remain a target for scavenging.

Based on the wildlife activity counts, wildlife is frequenting the bins primarily to feed, with over 65% of the recorded events involving feeding and foraging behaviours (Table 4.2). Common Raccoons, Red Squirrels and Gray Squirrels were the three main scavengers, directly utilizing the bin's contents. Their prevalence can likely be attributed to their adaptability and opportunistic nature. Raccoons are well known for their intelligence and dexterity, enabling them to exploit a wide range of food sources, including garbage. Their nocturnal habits also allow them to scavenge with less disturbance (i.e. when visitors are gone) and access garbage in areas like McFeetor's Heavy Horse Centre, Open Range, and Asia, where their activity counts were highest (Table 4.3).

Similarly, both Red and Gray Squirrels are also highly adaptable and thrive in environments where lots of humans are present. Red Squirrels showed high activity levels in the Grasslands and Boreal Forests area, likely due to the availability of both natural and visitors-

waste food sources. Their smaller size and diurnal habits make them well suited for scavenging during the day, generally going unnoticed by people and capitalizing on food left behind by visitors.

Regarding temporal patterns, Red Squirrels were the most frequently encountered species during daytime observations, followed by Gray Squirrels and Crows. While both squirrel species directly scavenged food from the bins, Crows exhibited more opportunistic scavenging behaviours, particularly around the picnic table areas, accessing readily available garbage outside the bins (Figure 4.9).

The proportion of wildlife interactions with waste varied between morning and afternoon visits. In the morning, these interactions were observed 34.8% of the time out of 23 visits, whereas during the afternoon visits, they occurred 56.7% of the 30 visits (Table 4.5). The increased frequency of interactions during the afternoon can be attributed to higher visitor presence and accumulation of post-lunch garbage, which often becomes more abundant as the day progresses.



Figure 4.9: A Crow with what appeared to be a cheese string snack, still in its wrapper, that was left behind on a picnic table at Aunt Sally's Farm (right). The Crow was seen pecking at it in a nearby tree (left) before flying out of the zoo boundaries with it.

Trail camera observations revealed more distinct temporal activity patterns among the species while the zoo was closed. Common Raccoons were more active well outside the zoo's operating hours, with noticeable peaks in the late evening and early morning. Red and Gray Squirrels were observed during opening hours as well as before and after closing, but not during the night. Again, this could be due to discrepancies with the trail camera's ability to detect small animals, especially with lower light levels. In addition to raccoons, other species were active during the night and were incidentally captured on cameras. These included Coyote, Domestic Cats, Skunks, and Red Fox (Figure 4.10).



Figure 4.10: Top left: two foxes in the Grasslands and Boreal Forests area. Top Right: Coyote walking through the Open Range area. Bottom left: A domestic cat in Aunt Sally's Farm. Bottom right: A Skunk in the Journey to Churchill area.

Daytime observations revealed that Red Squirrels and Crows were the most frequently observed species interacting with waste at the zoo. These species were often seen foraging around picnic tables and waste bins, taking advantage of litter left by visitors or other waste that was easily accessible. The presence of Crows at picnic tables in the Open Range and Aunt Sally's Farm highlights their opportunistic behaviour, as they moved from one table to another during periods of low visitor activity to scavenge items such as Timbits, cheese strings, and takeout food containers (Figure 4.11).



Figure 4.11: A crow with a takeout food container in the Open Range. This was left on top of the garbage bin and retrieved by the crow.

All the trail camera images of wildlife were grouped into behaviour categories described by the ethogram (Table 4.1). Species like the Skunk, Domestic Cat, Cottontails and Coyote were never observed interacting with waste, so they were classified as “Others” for simplicity. The presence of predators, however, may deter some wildlife from the bins in the area (Figure 4.12). Coyotes, in particular, were noticed around the zoo at night.



Figure 4.12: Two coyotes, possibly chasing one another in the Asia area.

Common raccoons exhibited the highest frequency of feeding and foraging behaviours, suggesting a reliance or preference for bin contents, which aligns with their known scavenging behaviour. Similarly, Red and Gray Squirrels frequently engaged with waste by feeding and foraging. It is possible that the same individual made repeat visits, either at the same bin or at other bins around the zoo. However, distinguishing between individual animals is difficult based on camera footage alone. It was evident that there were different groups of raccoons scavenging, for example, as there were females with different amounts of kits (up to five) and lone raccoons of different sizes. Despite this limitation, the focus remains on understanding the overall pattern rather than individual behaviours.

Red Squirrels were observed slightly more often than Gray Squirrels, and both were seen pulling items out of bins (Figure 4.13). Raccoons, on the other hand, seemed to prefer to eat at or in the bins instead of taking food away with them (Figure 4.14). Even while their kits waited on the ground, seemingly unable to climb into the bins, the adults were not seen removing items from the bins. They would, however, occasionally leave garbage on the bin's edge. Despite their smaller size, the young raccoons quickly learned how to climb up into the bins, overcoming the initial challenge of accessing them and following their mother's example of eating at or in the bins (Figure 4.15)



Figure 4.13: Left: A Gray Squirrel removing an apple core from the garbage bin in McFeetor's Heavy Horse Centre. Right: A Red Squirrel removing a rice crispy snack from the garbage bin in the Grasslands and Boreal Forests area.



Figure 4.14: Left: A Common Raccoon eating something wrapped in tinfoil while remaining on the garbage bin in McFeetor's Heavy Horse Centre. Right: Two Common Raccoon Kits wait while their mom is foraging inside the garbage bin in the Asia area.



Figure 4.15: Sequence of photos from Aunt Sally's Farm showing an adult raccoon with four kits. The adult got up onto the bins first while the kits took some time figuring out how to climb up. The adult quickly checked both bins (less than one minute) and then walked away while the kits were still on the bins.

Crows were observed foraging waste left on the lip of the bins or on the ground around bins and, during the day, around picnic tables (Figure 4.16). Similarly, less frequently observed species, such as Red Fox and Richardson's Ground Squirrel, had interactions with waste through foraging leftover garbage extracted often by squirrels. These are examples of more indirect ways wildlife may interact with waste from the bins.



Figure 4.16: Left: A Crow picking at something a Red Squirrel had pulled out at McFeetor's Heavy Horse Centre. Right: A group of Crows picking at something on or possibly in the garbage at Aunt Sally's Farm.

With the idea that wildlife might be interacting with both recycling and garbage bins if contamination rates were high (i.e. if there was food available in both bins), photos of inside both bins were taken during daytime visits. In addition, an analysis to determine whether wildlife spent more time in the garbage bin, recycling bin or interacted with both bins during a single visit revealed a statistically significant difference in bin usage (Figure 3, Table 3). However, when the same test was run for each site separately, only the Grasslands and Boreal Forests had a significant difference, meaning this area is likely influencing the overall results due to its larger sample size. In total, there were more interactions with the garbage bin alone; therefore, there was more activity in the garbage bin rather than the recycling bin. Similarly, wildlife was viewed interacting with both bins during a single visit more often than just the recycling bin alone.

Another analysis demonstrated that most of the recycling bin contamination was from non-recyclable (i.e. not food), thereby reducing the incentive for wildlife to enter the recycling bins. Nonetheless, there were high contamination rates in the recycling bins, and often, the contents of garbage and recycling bins looked identical (Figure 4.17). However, some recyclable items like yogurt containers and juice boxes may have enough residual food to entice wildlife

(Figure 4.18). While recycling bins can offer a food source, it would seem more advantageous for wildlife to check the garbage bin or both bins during a visit as opposed to only the recycling bin while scavenging waste. This aligns with the higher frequency of wildlife interacting with garbage bins, attributed to the increased food availability compared to recycling bins, where negligible food contamination was observed.



Figure 4.17: Comparison photo of the contents of a recycling bin (left) and garbage bin (right) from Aunt Sally's Farm. The photos were changed to black and white to show how similar the contents were (the blue of the recycling bin showed through the clear bag).

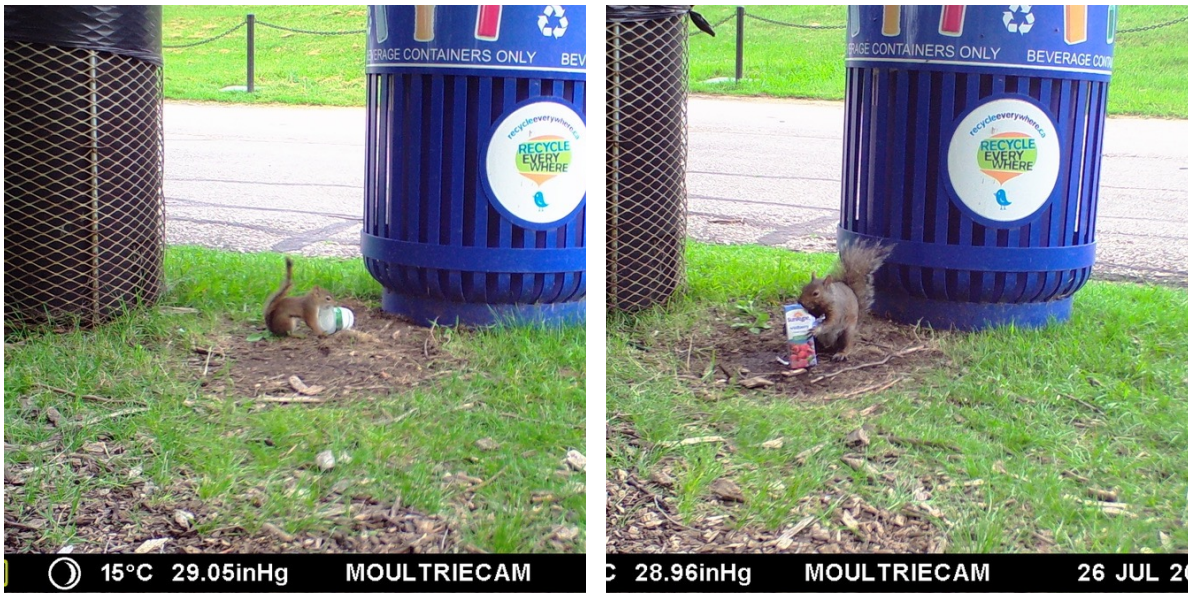


Figure 4.18: Left: A Red Squirrel with a recyclable yogurt container. Right: A Gray Squirrel with a recyclable juice box. Each item may have residue food left inside, making it desirable for wildlife to scavenge from the recycling bin.

Recommendations

To enhance waste management at the zoo while protecting local wildlife and improving overall cleanliness and environmental stewardship, the following recommendations are proposed:

1. **Wildlife-Proof Bins:** Implement a plan to replace current bins with wildlife-proof bins. These bins should be designed to prevent animals from accessing the waste while remaining user-friendly and accessible for zoo visitors. Wildlife-proof bins could help mitigate the risks associated with wildlife scavenging, such as disease transmission, stress to zoo animals, and disruption to wildlife's natural behaviours.
    - *Future Study*: A pilot program could be conducted to test the effectiveness of different types of bins as well as collect feedback from zoo visitors and staff on usage. Additionally, waste audits can be performed to see how the bins are working. This cost-effective approach would help evaluate the bins' effectiveness before full-scale implementation, ensuring the best use of

resources. It is important to consider each possible bin type and how it could meet the needs of keeping wildlife out while remaining accessible to everyone, including children.

2. **Increase Availability of Compost Bins:** Introduce more compost bins to separate food waste from regular garbage. This would reduce wildlife's desire to forage in garbage and recycling bins while promoting composting. Compost bins should be available in common lunch sites such as Aunt Sally's Farm, Open Range, and McFeetor's Heavy Horse Farm. Compost bins should also be wildlife-proof, and their contents should be removed at the end of the day to avoid leaving them out for wildlife to try scavenging while the zoo is closed.
3. **Clear and Informative Signage:** Improve signage at all waste disposal sites, particularly for what can and cannot be recycled. Additionally, should compost bins be added, include guidelines on what can go into them. While contamination rates in recycling bins were notably high, they did not appear to influence wildlife behaviour. Contamination in recycling bins reduces the efficiency of waste diversion from landfills as recycling facilities do not process loads with high contamination rates. However, effective signage can influence human behaviour by encouraging proper waste disposal and raising awareness about our waste problem, which could have an indirect but positive effect on wildlife in general.
    - *Future Study:* Investigate how different signage influences visitors' waste sorting behaviour. For example, it could explore how images of wildlife, garbage, and the use of keywords guide decision-making when throwing something away. The paper "Reducing Plastic Waste by Visualizing Marine Consequence" by Yu Luo et al. l (2022) presents a similar study and could provide valuable insights for this research.
4. **Regular Maintenance:** Establish a routine schedule for monitoring and maintaining bins to ensure they remain functional and clean. At the end of the day, garbage and recycling should be removed from all bin locations. This would mean removing bags even when not full, which could increase cost and plastic bag usage. However, this

is a strategy that could be applied more readily when compared to replacing bins, as mentioned in the first recommendation. Additionally, if compost bins were introduced and removed, as mentioned in recommendation number two, there would be less food available in the garbage bins for scavengers to get into.

5. **Staff and Volunteer training:** Provide additional training and resources for staff and volunteers on proper waste management practices. Ensuring they understand the importance of reducing waste and contamination rates could help them also educate visitors.
6. **Enhances Visitor Education:** Develop educational programs and interactive displays to inform visitors about the impact of waste on wildlife and the environment and how they can contribute to conservation efforts. Educating the public on the issues surrounding waste would not only help the zoo's waste management goals but could potentially lead to positive impacts that reach outside the zoo as visitors can implement better changes at home.
    - *Future Study:* Explore the impact of educational programs on waste management at the zoo. A study could evaluate the effectiveness of various educational tools (pamphlets, interactive displays, workshops, guided tours, etc.) in improving waste management behaviours at the zoo. These educational tools could be made available at the front as guests arrive or throughout the zoo, providing visitors with the option to participate. Subsequent waste audits could then be performed to measure the success of each program.
7. **Collaborations, partnerships, and incentive programs:** Partner with local environmental organizations and waste management companies (ex., Recycle Everywhere, Green Action Centre, Compost Winnipeg, etc.) to implement and promote best practices for waste management and wildlife protection. Encourage visitors to consider their actions by offering incentives for practicing waste reduction (i.e. Bringing your own reusable water bottles or coffee cups could earn visitors a prize). Partnering with other local organizations that could sponsor and

provide support for such programs could help engage more members of the community.

Conclusion

The Wildlife and Waste Interactions project at the Assiniboine Park Zoo was initiated to explore the subtle but significant impact of visitor-generated waste on local wildlife. By understanding how waste influences wildlife, this project aims to highlight the importance of sustainable waste management practices and its role in wildlife conservation.

The study's findings indicate that visitor-generated waste does influence wildlife, with distinct differences in species activity between regular operating hours and after the zoo closes. Red Squirrels, Gray Squirrels, and Crows were most frequently observed during the day, often scavenging around picnic tables and waste bins. Common Raccoons were notably active at night, peaking during the evening and early morning hours. Species like Crows, Ground Squirrels, and Red Foxes were also seen interacting with waste, but more often when that waste was outside the bins. These interactions would occur when garbage was pulled out by the main scavengers like squirrels and raccoons. Other local species, like Coyotes, Domestic Cats, and Skunks, were photographed near the bins, although they did not interact with the waste. This study also revealed significant contamination in recycling bins and missed opportunities for recycling in the garbage bins, highlighting the need for improved waste management.

Implementing wildlife-proof bins, increasing compost bin availability, and enhancing visitor education are crucial steps toward reducing wildlife interactions with waste. Encouraging visitors to adopt better waste management behaviours can also play a vital role in minimizing the impact on wildlife. These efforts not only contribute to the zoo's conservation goals by protecting local wildlife and maintaining a cleaner environment on site but also serve as a model for sustainable practices, inspiring positive change within the community and beyond.

References

Environment and Climate Change Canada. (2023). *Canadian Environmental Sustainability Indicators: Solid waste diversion and disposal*. Retrieved from https://www.canada.ca/content/dam/eccc/documents/pdf/cesindicators/solid-waste/2024/solid-waste-diversion-disposal-en.pdf

Environment Research and Education Foundation of Canada. (2021). *State of the Practice of Organic Waste Management and Collection in Canada*. Retrieved from www.eref-canada-.ca/projects

Frixione, M., Casaux, R., Villanueva, C., & Alarcón, P. (2012). A recently established Kelp Gull colony in a freshwater environment supported by an inland refuse dump in Patagonia. *Emu - Austral Ornithology, 112*(2), 174-178.

Gabbatiss, J. (2023). Food waste makes up half of global food system emissions. *Carbon Brief*. Retrieved from https://www.carbonbrief.org/food-waste-makes-up-half-of-global-food-system-emissions/

Gwynne, D. T., & Rentz, D. C. F. (1983). Beetles on the bottle: Male buprestids mistake stubbies for females (Coleoptera). *Australian Journal of Entomology, 22*, 79–80.

McNally, X., Webb, T., Smith, C., Moss, A., & Gibson-Miller, J. (2024). A meta-analysis of the effect of visiting zoos and aquariums on visitors' conservation knowledge, beliefs, and behaviours. *Conservation Biology*.

Napper, I., & Thompson, R. (2019). Environmental deterioration of biodegradable, oxo-biodegradable, compostable, and conventional plastic carrier bags in the sea, soil, and open air over a 3 year period. *Environmental Science and Technology, 53*(9), 4775-4783.

Newsome, T., & Eeden, L. (2017). The effects of food waste on wildlife and humans. *Sustainability Communications*.

Silpa, K., Yao, L., Bhada-Tata, P., & Van Woerden, F. (2018). *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050*. Urban Development Series. Washington, DC: World Bank. doi:10.1596/978-1-4648-1329-0. License: Creative Commons Attribution CC BY 3.0 IGO

Zhang, X., & Peng, X. (2022). How long for plastics to decompose in the deep sea? *Geochemical Perspectives Letters, 22*, 20-25.

Appendices

Outreach

This project was featured in the following outreach initiatives:

- CTV News in Winnipeg featured it in August 2022 during a new segment and in an online article

https://winnipeg.ctvnews.ca/research-project-looking-at-how-wildlife-interacts-with-waste-at-assiniboine-park-zoo-1.6019903

- It was published included in the Assiniboine Park's monthly newsletter and published in a blog post on their website in August 2022.

https://www.assiniboinepark.ca/stories/108/going-wild-about-waste

- Radio-Canada reached out for an interview around the project in August 2022.

- Additionally, I also did a "fire side chat" with Wild Outside, a youth program with the Canadian Wildlife Federation in October 2023.

Volunteer Form

The following form was provided to zoo's volunteers at the beginning of the project explaining their role in helping with the trail cameras and showing them where the trail cameras were located. Note the names of the areas were different at the beginning of the project and were changed in the report to reflect the actual names used by the zoo.

Wildlife-Waste Interactions Project at the Assiniboine Park Zoo



Contacts

Lynnae Martin, MSc student

Renata Machado, Sustainability Coordinator

Dr. Stephen Petersen, Director of Conservation and Research

Project Summary

The Wildlife-Waste Interactions Project is a University of Manitoba master's project done in partnership with the Assiniboine Park Zoo's conservation and research department. Throughout the summer season of 2022, trail cameras and in-person observations will be used to study how free-living wildlife at the zoo interacts with waste found on site. Wild animals that use garbage as a resource may be at risk of entanglements or toxicity, and it can also lead to changes in their behaviour. These effects can potentially ripple through the ecosystem in ways we may not fully be aware of. The amount and type of waste humans produce is one of the biggest environmental challenges we face today. This research will help build upon our understanding of the relationship between wildlife and waste. By demonstrating this connection, we hope to encourage a reduction in the amount of waste produced at the individual level.

Fifteen sites from six different areas around the zoo have been selected for monitoring (Figure 1, Table 1). One trail camera is assigned to each of the six areas, for a total of six trail cameras, and will be secured to trees near garbage bins (Figure 2). The trail cameras will collect data only while the zoo is closed and must be covered during opening hours. During the day, only in-person observations will be conducted to stay compliant with the human ethics guidelines. No photos containing humans may be used for this project.

A waterproof, opaque cover with an adjustable drawstring will be provided at each trail camera. Volunteers are asked to place the cover back on all six cameras when the zoo opens (as soon as possible to avoid accidentally taking pictures of visitors) and remove the cover once the zoo is closed. When the cover is removed, it can be tucked into the chain that is securing the camera to the tree with the drawstring. The cameras will rotate between the sites within each of the six areas every week. A notice will be emailed to the volunteer coordinator to advise where the cameras will be located that week. If there are any issues (i.e., the cover is lost or broken), please contact Lynnae.

Figure 1: Map of trail camera site locations in Assiniboine Park Zoo.



Table 1: Description of trail camera locations

Area	Site	Description
Grasslands	1a	Picnic tables between the bisons and red fox near the entrance of the zoo
	1b	Picnic tables near Bison Snack Shack
Arctic	2a	Bins near snowy owl enclosure
	2b	Bins near arctic foxes and washrooms
Aunt Sally's Farm	3a	Tree near Shaved Iced shack
	3b	Bins on the path between the two picnic areas in Aunt Sally's farm
	3c	Bins in picnic area closer to special events entrance
McFeetor's Centre	4a	Bins in picnic area
	4b	Bins beside benches near cougars/snowy leopards
Asia	5a	Bins near play area by camels
	5b	Bins by gibbons
Open Range	6a	Intersection of trails near mini donuts in open range
	6b	Middle of picnic area, closer to pronghorn enclosure
	6c	Near Winston's ice cream stand

Figure 2: Photos of area with the location of where the trail cameras will be labelled with a star. Only one trail camera is assigned to each area, and it will rotate between the sites in these areas bi-weekly.

Grasslands: 1a, 1b





Arctic: 2a, 2b, 2c





Aunt Sally's Farm: 3a, 3b, 3c







McFeetor's Centre: 4a, 4b





Asia: 5a, 5b





Open Range: 6a, 6b, 6c







Chapter 5: Critical Reflection

Introduction

Working at landfills profoundly changed my perspective on garbage. Being confronted with the issue of waste every day and observing its impact on wildlife sparked my interest in the global waste crisis, ultimately leading me to pursue a related project. When I decided to pursue a master's degree, I was working with birds, and because of this, I was advised to contact Dr. Nicola Koper at the Natural Resources Institute (NRI). After sharing my thoughts on studying wildlife and waste, they connected me with Dr. Stephen Petersen at the Assiniboine Park Zoo. As a long time member and enthusiast of the zoo, I was thrilled to have the opportunity to collaborate with them. This connection was the first of many networking opportunities I encountered at the NRI, which I believe has been the most valuable outcome of the program.

Additionally, the interdisciplinary nature of the NRI master's degree allowed me to learn practical skills that have significantly increased my confidence in this field. In this critical reflection, I will discuss the challenges I have overcome, the technical skills and knowledge I have gained, the problems I have solved and adapted to, and my experience with communication and collaboration. Finally, I will discuss the lessons learned and future project recommendations.

Overcoming Challenges

One of the unique aspects of the NRI program is the interdisciplinary approach to the environmental field, which allowed me to take courses I probably would not have. Truthfully, I found the Project Management course challenging. Having never encountered Project Management, I found all the terminology and processes completely new. I am grateful for Professor Sheldon McLeod's reassurance and guidance throughout the course and later as a

committee member for my project. Through this experience, I developed new planning, organizing, and time management skills. Creating an Integrated Project Plan (IPP) helped me clearly outline my project's tasks and requirements and consider aspects of the project I might not have otherwise, such as risk management. This gave me experience implementing a project using Project Management skills, which are sought after in the environmental field.

My passion for the outdoors and wildlife led me to this field, not statistics. However, I admire and appreciate the importance of statistical analysis in research, communication, and policy advising. Initially, I needed more confidence and experience in statistical analysis and coding. When I had to take Dr. Nicola Koper's course in Study Design and Quantitative Methods, I was intimidated. This was the course I spent the most time on, diligently taking notes and rewatching lecture recordings. My previous attempts to learn R before joining the NRI had not been successful. The dedication and patience of the course instructors, including Dr. Steffi LaZerte, who met with me one-on-one multiple times, made the learning process possible for me. What I learned during this course helped me with my project, boosted my confidence, and proved invaluable in a new job I was fortunate to start during my last year with the NRI.

Technical Skills and Knowledge

Throughout this project, I honed my technical skills and knowledge using various tools and software. As mentioned, learning to use R for statistical analysis was a significant achievement. Another significant learning curve was data processing. In total, I collected around 40,000 trail camera photos, which I manually organized based on the site they were taken in and deleted irrelevant photos. By the end of the data collection, I still had around 12,000 photos that required the identification of species, behavior, and bin type, along with including data and time stamps for analysis. Luckily, I learned how to use WildTrax with the help of another member of the Koper Lab (Zach Moore). This is another example of the benefits of networking within the NRI because I was still determining how I would accomplish this. Learning to use WildTrax was paramount in the completion of this project.

Problem Solving and Adaptability

During the development of the IPP, I wanted to include an analysis of the effectiveness of different types of waste bins on wildlife interactions and visitor usage. However, due to supply availability, we were unable to get the different bins. This was disappointing as I thought it would enhance the project's outcomes, and I worried about how I could make up for this deficit.

Additionally, I had anticipated seeing more wildlife and waste interactions during the day, but in reality, there were fewer than I had thought. I felt like I was not collecting enough data despite having visited the zoo 53 times. To compensate, I integrated an additional analysis by taking photos of bin contents. Although I could not include the planned analysis of different waste bins, I remained optimistic by adding an alternative analysis to enhance my project and continuing the daytime observations as planned. These experiences taught me the importance of flexibility and problem-solving in project management.

Communication and Collaboration

The communication and collaboration opportunities were integral aspects of my project. I have always enjoyed going to the zoo and actively followed the Assiniboine Park research initiatives. The prospect of collaborating with Dr. Stephen Petersen was exciting as I admire the work he and the conservation team do. Working with the zoo also allowed me to engage with the Assiniboine Park's Communication Coordinator to share my project, resulting in a blog post that garnered attention from our local news stations. It was a privilege to see my project discussed in the media. I was also given the opportunity to engage with youth from the Wild Outside program with the Canadian Wildlife Federation during their visit to the zoo. Collaborating with the park's communication team and other organizations offered a platform to discuss an issue that is important to me, which fostered a sense of purpose and enthusiasm.

I also started this program during the pandemic, which meant all lectures and meetings were conducted remotely through Zoom. I doubted my ability to foster meaningful

relationships through virtual platforms or to feel comfortable reaching out to individuals I had yet to meet in person. Contrary to my expectations, I had the opportunity to interact with many like-minded people who were equally eager to collaborate and support one another. Throughout the process, I've been able to learn from individuals with diverse backgrounds and perspectives, which enriched my experience with this program.

Key Lessons Learned

Reflecting on the Wildlife and Waste Project, a two key lessons helped to shape my understanding of project management and environmental research. First, the initial challenge of acquiring different types of waste bins highlighted the importance of contingency planning and flexibility in project management. While the project continued without this component, it demonstrated the value in preparing for and mitigating unforeseen challenges. Second, the discrepancy between the anticipated and actual wildlife interactions during daylight hours provided a valuable lesson in data collection strategies. Planning for such changes and limitations is critical in future projects where more substantial challenges could arise.

If I were to do this project again, I would implement a trial period or pilot study before starting the full study. A preliminary study phase would have provided better insight into what to expect while collecting data in the field and could be included as a deliverable. In this case, conducting a pilot study might have provided me with a clearer understanding of actual wildlife activity patterns, allowing me to adjust my study design. Additionally, I could have used this time to add extra data collection methods, such as photographing the bin contents, which I only decided to include once the study was underway. Implementing these adjustments prior to starting the main study might have made for a smoother process and potentially enhanced the overall quality and depth of this project.

Conclusion

During my master’s practicum, I gained invaluable experience applying project management skills to the design and execution of a study. This hands-on approach allowed me

to understand the intricacies of planning, coordinating, and managing a research project from start to finish. Specifically, I learned how to develop a study design, allocate resources, set timelines, and troubleshoot unexpected challenges. One of the most significant takeaways from this program was building my confidence in completing project management tasks. By engaging in each step of the process, I learned how to anticipate potential issues and consider strategies to address them. This practical exposure has reinforced my theoretical knowledge, making me feel more prepared for future project management roles.

Reflecting on my time with the NRI program, I am grateful for the skills, knowledge, and connections I gained. The program's accessibility and flexibility allowed me to balance my responsibilities as an older student and continue my master's while starting a new job. The interdisciplinary approach and the supportive environment fostered by the NRI have been essential in my professional and personal growth. I look forward to applying these experiences to future projects and continuing to make meaningful contributions to the field of environmental studies.

Appendices

The following ten sections are found in the Appendices.

i. Background Information Report
ii. Project Concept
iii. Schedule Details
iv. Resource Needs Assessment and Skill Inventory
v. Managing Relationships
vi. Risk Management
vii. Budget Details
viii. Bin location descriptions and photos
ix. Ethogram template
x. Change Log

i. Background Information

This background information report was the initial report submitted as part of the proposal. It also includes details on the study design however, elements such as the different bin types, ethograms, and site locations have change. See Change Log for more details. For complete study design details see the Chapter 2: Wildlife and Waste Interactions Project Report "Methods" section.

Wildlife-Waste Interaction Project at the Assiniboine Park Zoo: Background report and study methods

Introduction

As urbanization and human population growth continue to increase, so does the amount of waste we generate every day. Our population has risen from less than one billion in the early 1800s to almost eight billion today (populationmatters.org, 2022), and each one of us is contributing to the waste problem. We produce so much waste, much of which is non-biodegradable plastic, that it is now found all over the globe, from the most remote regions of the earth, such as the deep sea (Woodall et al., 2014), to inside the tissues of fish (Hou et al., 2021). It is so widely distributed that we have left a clear mark on the planet's geological record (Zalasiewicz et al. et al., 2016), and we are only continuing to produce more. Urbanization, wealthier economies, and higher living standards are associated with increased waste generation, meaning developed countries contribute significantly to our current problem (Silpa et al., 2018). In Canada, we are one of the top three countries that produce the highest amount of waste per capita (Silpa et al., 2018).

Canadians generate about 35.6 million tons of solid waste per year, but less than one-third is diverted from waste management facilities (Figure i.1). Most developed nations, including Canada, live in what many have labelled a “throwaway society” made up of cheap, disposable items continually discarded and replaced (Hellmann & Luedicke, 2018). Over half of the solid waste we produce falls into two categories: non-degradable (primarily plastic) and food waste (figure 2). In Canada, 97% of our waste is sent to landfills; the other 3% is incinerated (ECCC, 2021). Even if garbage is properly disposed of and makes it to the landfill, it does not guarantee it will stay there. We are just beginning to understand how smaller, broken-down pieces of garbage can make its way out of the landfill and into the surrounding environment (Pinjing, et al., 2019). Additionally, it can be lost as litter from garbage trucks or blown away from uncovered landfills in strong winds. It can also be carried by wild animals, particularly birds, and discarded in residential areas (Gutman, 2019). Our food waste, mixed with non-degradable and other waste products, is highly attractive to wildlife.

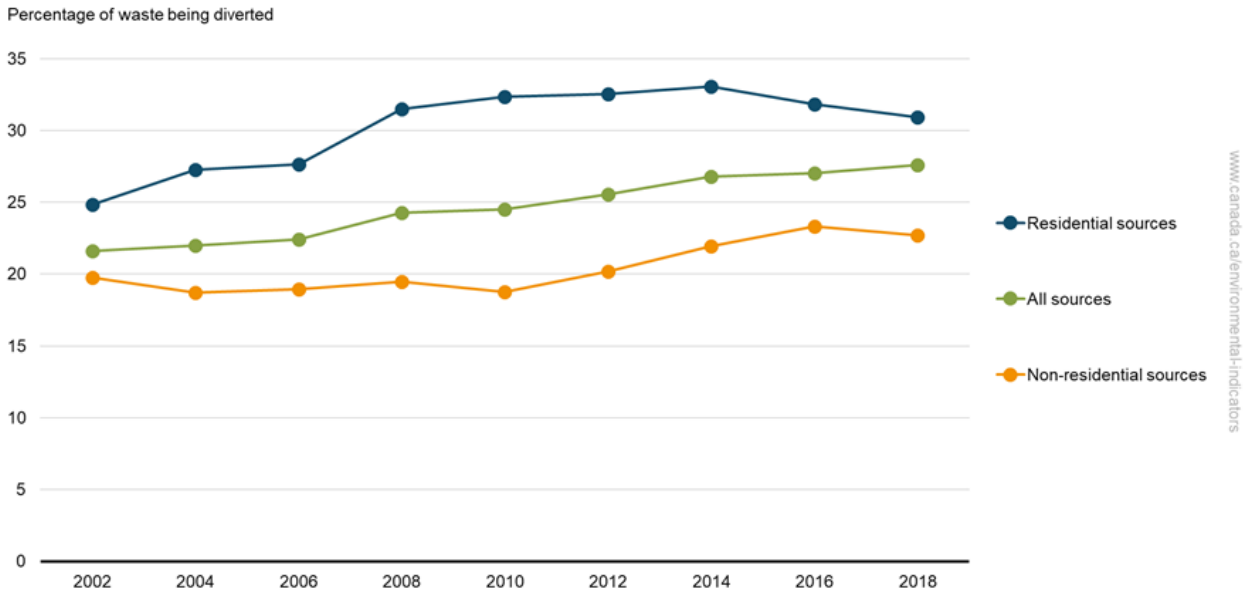


Figure i.1: Average diversion rates for Canada from 2002-to 2018

Source: Waste diversion rates in Canada and prov stats Canada, 2022. https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/solid-waste-diversion-disposal.html

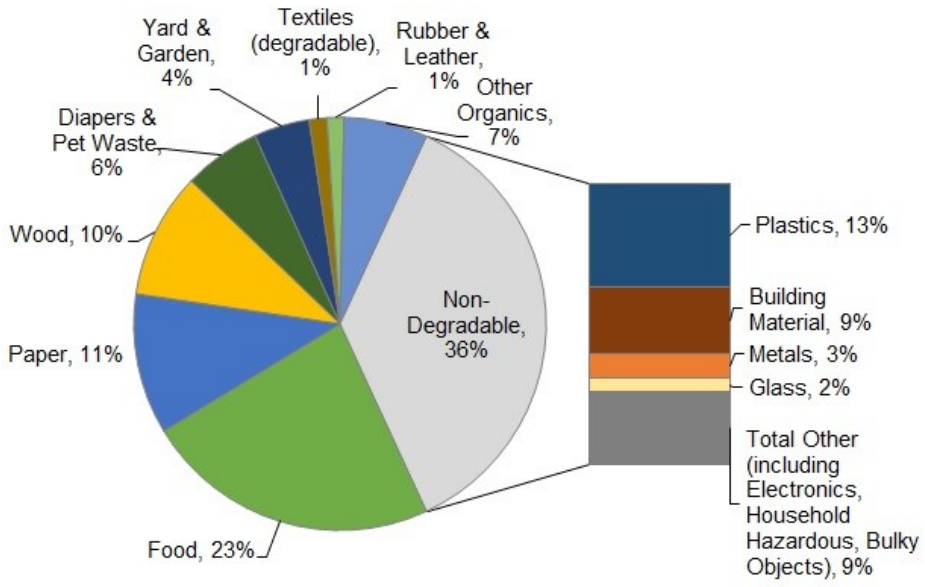


Figure i.2: Percentages of the kinds of waste produced in Canada

Source: National Waste Characterization Study, 2020 https://www.canada.ca/en/environment-climate-change/services/managing-reducing-waste/municipal-solid/statistics-trends.html

Two of the most notable consequences of wildlife interacting with our waste are animal entanglement in and ingesting of plastics. It is not uncommon for photos of animals tangled in

our trash to make the news or circulate on social media. One study that examined the naturally regurgitated pellets of non-digestible material from albatross chicks noted that each one contained bits of plastic (Young et al., 2009). Ingestion of plastic, however, varies among species. Some consume more depending on their scavenging strategies, such as “gulpers,” which indiscriminately scoop up food and plastics, or animals that can separate food from inedible garbage (Katlam et al. 2018). Others may be more likely to swallow plastics of certain colours (Lopez-Martinez et al., 2020) or mistake garbage for their natural prey (Schuyler, 2014). These effects may be more prevalent in certain age groups, such as younger, inexperienced juvenile Bald Eagles scavenging lower quality and potentially hazardous but reliable food found at landfills (Turrin et al., 2015). There are, however, less apparent effects our garbage may have on the behaviour and ecology of various species (Newsome & Van Eeden, 2017).

Our waste can lead to unintended consequences, such as changing migratory and foraging patterns (Gilbert et al., 2016) and disrupting reproductive success (Gwynne & Rentz, 1983). It can also change the behaviour seen in some groups; for example, the dominant, resource guarding males of one baboon troop were observed scavenging contaminated, discarded food waste which subsequently led to their deaths. In the absence of these notoriously aggressive individuals, the following generation demonstrated a cultural shift towards seemingly more docile males with a notably lower presence of stress hormones than their aggressive predecessors (PLoS Biol, 2004). On the other hand, a consolidated presence of waste could potentially increase aggression through direct competition, causing higher rates of injuries and disease transmission (Flint et al., 2015).

The changes in a species’ ecology due to waste can also ripple through to different trophic levels within a community (Newsome & van Eeden, 2017). For example, Kelp gulls’ populations in Argentina have been increasing, and access to supplementary food found at landfills could be one reason why (Frixone et al., 2012). Consequentially, instances of gull

parasitism on Southern right whales have also increased. Adult whales have responded by assuming a posture that could help avoid this attack while coming up for air; however, calves remain vulnerable as they may not be physically capable or have yet to learn the posture performed by their experienced mothers, possibly hurting their health (Maròn et al., 2015). Additionally, gulls feeding at landfills or other contaminated sites may pick up diseases and transmit them to whales while pecking at their skin (Fazio et al., 2012).

Despite the potentially harmful consequence of gull wound inflictions on whales, the public appears to be more interested in addressing the human-waste component related to this problem than management strategies that include culling gulls (Stefanski & Villasante, 2015). This potentially accentuates how education about wildlife and waste interactions could be used to encourage waste reduction or improve waste management by people. We will also need to consider how removing this supplemental food source could decrease the survival rates of dependent animals due to starvation (Delgado et al., 2021) and how this could negatively affect other species in non-direct ways (Fazio et al., 2012). Food waste presents a complicated threat to wildlife due to the inadvertent consequence of these interconnected ecological systems. There is a need for more research, particularly with those involving less “charismatic” but equally important wildlife (Newsome & Eeden, 2006).

Wildlife commonly found within municipalities, like squirrels and crows, may be simply considered a nuisance by some and receive less attention to how our human habits affect them. Urban areas with higher human populations typically have higher food resources and lower predator abundance, causing greater population density of smaller prey animals (Uchida et al., 2020). Similarly, the abundant food availability in urban centres may decrease the normal range of some species as they do not need to go as far in search of food (Harmon et al., 2005). Separating food waste from non-edible disposable waste could help discourage wildlife from scavenging our garbage (Katlam et al., 2018). Nevertheless, plastic packaging has been essential

in prolonging the shelf life of many kinds of food, reducing food waste (White & Lockyer, 2020). Curbside composting programs have been on the rise in Canada and would help minimize wildlife-waste contact and reduce the amount of greenhouse gas emissions from decomposing organics in landfills (EREF, 2021).

Access to food in urbanized areas can increase interactions between wild and domestic animals, risking the spread and transmission of disease, increasing hybridization, and could lead to habituation of humans, causing more human-wildlife conflicts, which can potentially end poorly for both humans and the animals (Newsome & Eeden, 2017). Long-term solutions involving education and enforcement of better waste management habits can help mitigate the problem (Baruch-Mordo et al., 2011). For example, black bear populations often increase within the vicinity of human-inhabited areas; however, education in conjunction with bear-proof bins was found to have been successful in redistributing bears back to their historical range (Beckmann & Lackey, 2018).

By 2030, it is estimated that our oceans will contain 35 million tonnes of plastic which is predicted to cost almost one trillion Canadian dollars if we were to attempt a clean-up (Cordier & Uehara, 2019). Even if we could clean it up, we would still have to find a place to put it all and ensure it did not go back into the environment. Humans are responsible for all this waste, and it starts at the individual level. In Canada, residential waste (i.e., households) contributes to most of the garbage generated (Figure 1). Recycling, composting, and switching to reusable items help divert waste from going to the landfill or ending the environment. While diversion rates have increased nationally across Canada, Manitoba is one of the worst offenders and has not seen a significant increase compared to other provinces (Figure 3).

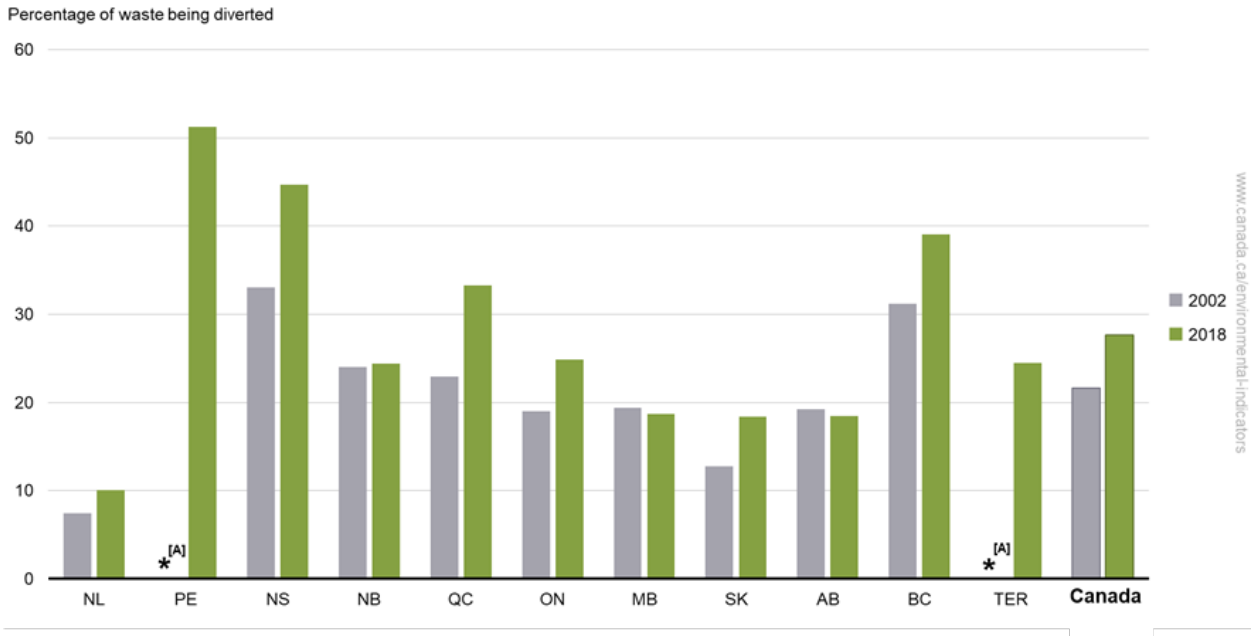


Figure i.3: Comparison of waste diversion rates from 2002 and 2018 across Canada

Source: Waste diversion rates in Canada and prov stats Canada, 2022. https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/solid-waste-diversion-disposal.html

The Assiniboine Park Zoo (APZ) is a popular attraction for local people and tourists in Winnipeg, Manitoba. It is one of 26 accredited zoos in Canada and the only one in Manitoba (CAZA, 2022). The APZ is recognized as a leader in conservation, research, and education within their industry and community. This location presents an interesting opportunity to study how wildlife interacts with waste for several reasons; it is located within an urban city, next to an urban forest (the Assiniboine Forest) which is home to a variety of urban wildlife, it is fenced in making it a controllable and defined area, and they have a following of people interested in wildlife and conservation. Wildlife in this area also has easy access to waste as a resource in garbage bins and as litter. While the APZ has made waste disposable sites available around the park, including recycling and composting options, littering and high contamination rates of bins

due to improper disposable is a concern for the park's management. This project will help identify what kind of wildlife uses this resource and how. Additionally, a communications plan using social media will be developed with the APZ to encourage waste reduction on site by visitors.

Study Design

This study will occur at the Assiniboine Park Zoo (APZ) from May to November 2022. Fifteen sites within the zoo will be monitored using trail cameras and in-person observations (Figure 4). Sites were chosen based on the locations of existing bins near main zoo attractions, food locations, and picnic areas. The trail cameras and in-person observations will collect data on wildlife-waste interactions during closed and open hours. In-person observations of visitor use of bins will be collected anonymously during the day. Human ethics approval was not necessary if no visitors were caught on camera and persons being observed remained anonymous. Only an abbreviated animal ethics approval was required, which will allow us to monitor wildlife using trail cameras and in-person observations.



Figure i.4: Map of 15 bin locations for monitoring at Assiniboine Park Zoo.

Source: Google Earth

Each of the six areas will have one trail camera rotating weekly between the bins sites found in that group (appendix viii, table 1 & figure 1). Trail cameras will be left up but covered during opening hours. The zoo's volunteers will remove the covers when the zoo is closed and re-cover the cameras when the zoo opens. This is done to avoid accidentally recording visitors, although employees/volunteers may be captured on camera. A document will be sent to the volunteer coordinator providing details of the trail camera locations. The 15 sites have been placed into six categories: Asia, Open Range, Arctic, Aunt Sally's Farm, Grasslands, and McFeetor's Centre. The camera used in areas with only two bin sites (Asia, Grasslands, and

McFeetor's Centre) may also be used to observe treed areas. The treed areas might offer some insight into where animals go with any garbage they have scavenged; however, these locations will be decided later. Trail camera footage will collect information on species type and activity level around waste bins while no visitors are present. See Appendix vii, table 1 for descriptions of trail camera locations and Figure 1 for photos of where the trail cameras will be set up.

Table i.1: Trail camera rotation schedule

Trail cam	Group	Site	Week 1	Week 2	Week 3
A	Grassland	1.a	A		A
		1.b		A	
B	Arctic	2.a	B		
		2.b		B	
		2.c			B
C	Aunt Sally's Farm	3.a	C		
		3.b		C	
		3.c			C
D	McFeetor's Centre	4.a	D		D
		4.b		D	
E	Asia	5.a	E		E
		5.b		E	
F	Open Range and Toucan Ridge	6.a	F		
		6.b		F	
		6.c			F

In-person wildlife and visitor observations will be conducted during the zoo's open hours and will be done on four randomly selected days each week. If there are poor weather conditions, observations will be done another day. Data will be collected using an ethogram, one for wildlife and one for human interactions. These observations will be made using the "focal-animal sampling" method, as Altmann (1974) described. Depending on the interaction, one individual or a small group (less than five) will be observed for a specified amount of time. Each site will be visited three times a day, between 0900-1100hrs, 1100-1300hrs, and 1300-1500hrs. Every behaviour will be classified as an "event" (occurrence of behaviour over a short period, such as taking a piece of garbage then flying away) or a "state" (occurrence of behaviour over a longer, measurable amount of time, such as rummaging in a bin for several minutes). It will be chosen from a predetermined list of behaviours (Altmann, 1974).

Observations will be recorded using the "Behayve" app:https://www.behayve.com/app. This app allows for easy, quick, and discreet recording of animal behaviours using a smartphone that can later be uploaded to a computer for further analysis. A notebook will also be used when necessary. Each behaviour will be identified as an event or a state, and a list of anticipated behaviours and a description of each can be found in Table 2. The list has been entered in "Behayve" and will be modified throughout the season. The ethogram template can be found in the Appendix.

Table i.2: List of wildlife and human behaviours with their description

	Behaviour	Description
Wildlife	Scavenging	Looking through garbage/bins, sniffing but not eating or taking it away from site yet
	Eating	Picking items out of garbage and consuming it, could include organic or nonorganic material
	Collecting	May occur after scavenging, animal takes item away from site
	Fighting	Interspecific or intraspecific interaction, includes biting, scratching, wrestling
	Taking	Grabbing, swopping, or chasing individuals(s) away, taking or “stealing” material from another individual
	Vocalizing	Making noise around the resource, includes calling when another individual approach’s site, calling from bin or while interacting with garbage
	Nesting	Nest building taking place within view of site, gathering

		material about bin and/or using garbage for nest
Visitor	Littering	Waste is intentionally discarded on the ground away from bin or person notices waste got away on them, but made no attempt to retrieve
	Dropped	Unintentional litter, such as blown away from picnic table or dropped from bag, attempt may be made to retrieve but not successful
	Placed IN bin	Waste is placed directly into bin
	Placed AT bin	Waste is not placed into bin, rather on top, be side, or behind (within contact of bin)

In addition to monitoring activity around the bins, different types of bins will be included in the analysis. Currently, there are two types of bins at the APZ, and we are looking at adding three new types for this project, pending Recycle Everywhere's approval (see Figure 5). All bins have unique characteristics that may make them more or less likely to be used by wildlife and visitors. Each bin includes a set of one garbage and one recycling receptacle. Bins A and B are already found on-site at the APZ; bin A contains a smooth, slightly rounded top with a top-facing opening, whereas bin B has more potential perching and climbing options with a metal rim surrounding the top-facing opening and a rain cap.

The proposed new bins are bins C, D, and. E (figure 5). Bin C is similar to bin B with the same top-facing opening and perching options, but both recycling and garbage are attached. Bin D has front-facing openings that may be more difficult for certain species to access, and it can include the optional baffle, used to prevent insects such as wasps, which discourage visitor use. Bin E is a wildlife-proof recycling bin made of metal with a heavy lid that can control access. It will be accompanied by a standard, single garbage bin. The different kinds of bins might help determine which ones are more likely to be used by wildlife and visitors.

A wildlife-proof bin like bin E would prevent wildlife from accessing its contents; however, it is also not accessible for every kind of visitor (i.e. children or persons with disabilities) or may not be as easy to use as the other kinds of receptacles like bins A, B, C, or D (having to lift the lid versus just tossing waste in a bin). To see how visitors use each bin type, we will examine contamination rates (non-recyclables placed in recycling bins or recyclables placed in the waste bins) by performing waste audits and documenting rates of littering (leaving garbage on, beside, on top, or around bins). The misuse of bins can attract wildlife scavengers even if they are not as easily accessible to wildlife. The containers will be rotated every two weeks to account for any bias related to location (Table 3). The rotation cycles will be ten weeks long, allowing all sites to have each bin type at least twice throughout the study period. A waste audit will be completed once a month and will be done at different cycle periods; for example, if a waste audit was done during the week 1-2 cycle, the next one will be done during the week 3-4 cycle and so on. This will help separate whether the location of the bin or the bin type is associated with contamination rates.

The additional bins would be provided by Recycle Everywhere. Currently, there is a supply shortage, and they may not be able to offer the extra bins. The project will begin without the different types of bins; however, if we are able to get them before June 30, 2022,

they will be added to the project. Should we be unable to include the bins, the project will continue without them and will only use the bins that are available at the zoo. Other factors, such as contamination rates and location, will also be considered for the potential effects on wildlife and waste interactions.

Figure i.5: Bin types. Bins A & B are the existing bins at APZ, and bins C, D, and E are the proposed new bins to be added to the project.



Source: Renata Machado (bin A), Lynnae Martin (Bin B), and recycleeverywhere.ca (bin C, D, E)

Table i.3: Bin (A, B, C, D, E) rotation schedule

Area	Site	Week 1-2	Week 3-4	Week 4-6	Week 6-8	Week 8-10
Asia	12	A	B	C	D	E
	13	B	C	D	E	A
Free Range	10	C	D	E	A	B
	11	D	E	A	B	C
	9	E	A	B	C	D
Churchill	4	A	B	C	D	E
	5	B	C	D	E	A
	6	C	D	E	A	B
Aunt Sally's	7	D	E	A	B	C
	8	E	A	B	C	D
Grasslands + Boreal	3	A	B	C	D	E
	15	B	C	D	E	A
Toucan Ridge	14	C	D	E	A	B
Parking lot	1	D	E	A	B	C
	2	E	A	B	C	D

Lastly, a communications plan will be developed with the Sustainability Coordinator and the Communications Coordinator at the APZ. The purpose of this plan will be to help promote waste reduction on-site by encouraging the use of reusable, recyclable, or compostable items and a "pack in, pack out" mentality for those visiting the zoo through social media. Food and drink items purchased at the zoo are either recyclable or compostable; however, visitors can also bring in their own food and drink items that may not be. Coffee cups, for example, are not

recyclable but are often found in recycling bins at the zoo, leading to increased contamination rates and, subsequently, increased waste management costs. Similarly, excess garbage and food waste that is not composted may be found in the zoo's garbage and recycling bins, attracting free-living wildlife. When waste items are not correctly sorted into the correct bins or are left behind as litter, it creates an artificial resource for wildlife. Additionally, it could make an unsightly landscape, decreasing the visitor experience at the zoo. By connecting how our waste influences wildlife, we hope to promote a change in habit that will benefit wildlife and benefit the zoo's sustainable waste management goal.

Conclusion

Humans produce a lot of garbage, most of which is non-biodegradable plastic and food waste. This is a massive problem as we are finding it more often in the environment, affecting the ecology, behaviour, and well-being of wildlife. In Canada, Manitoba has one of the lowest rates of waste divergence and has seen little to no improvement over the years. More research is needed on how waste influences urban wildlife as urbanization is associated with increased garbage production, and it may also encourage change in the waste-producing habits of individuals. A zoo setting offers a unique place to conduct such research due to its urban location, controllable settings, and reputation for education and attracting those passionate about wildlife conservation. This project at the Assiniboine Park Zoo in Winnipeg, Manitoba, will help fill that knowledge gap while educating the public on this matter.

References

1. Altmann, J. (1974). Observational study of behaviour: sampling methods. *Behaviour*, 49(3/4): 227-267.
2. Baruch-Mordo, S., Breck, S., Wilson, K., & Broderick, J. (2011). The carrot or the stick? Evaluation of education and enforcement as management tools for human-wildlife conflicts. *PLoS ONE* 6(1).
3. Beckmann, J., & Lackey, C. (2018). Lessons learned from a 20-year collaborative study on American black bears. *Human-Wildlife Interactions*, 12(3): 396-404.
4. *CAZA - Canada's Accredited Zoos and Aquariums* (February 2022). https://caza.ca
5. Cordier, M., & Uehara, T. (2019). How much innovation is needed to protect the ocean from plastic contamination? Science of the total environment, 670(20): 789-799.
6. Delgado, S., Alfredo, H., Aitor, G., et al. (2021). Demographic impact of landfill closure on a resident opportunistic gull. *Population ecology*, 63(3): 238-246.
7. ECCC, (2021). *Municipal solid waste and the environment* - Canada.ca. https://www.canada.ca/en/environment-climate-change/services/managing-reducing-waste/municipal-solid/environment.html
8. EREF - The Environmental Research & Education Foundation of Canada (2021). State of the Practice of Organic Waste Management and Collection in Canada. Retrieved from www.eref-canada.ca/projects/
9. Fazio, A, Bertellotti, M., & Villanueva, C. (2012). Kelp gulls attack southern right whales: a conservation concern? *Marine Biology*, 159: 1981-1990
10. Flint, B., Hawley, D., & Kathleen, A. (2015). Do not feed the wildlife: associations between garbage use, aggression, and disease in banded mongooses (Mungos mungo). *Ecology and Evolution* 6(16): 5932-5939.
11. Frixione, M., Casaux, R., Villanueva, C., & Alarcón, P. (2012) A recently established Kelp Gull colony in a freshwater environment supported by an inland refuse dump in Patagonia, Emu - *Austral Ornithology*,112:2, 174-178

12. Gilbert, N., et al. (2016). Are white storks addicted to junk food? Impacts of landfill use of the movement and behaviour of resident white storks (Ciconia Ciconia) from a partially migratory population. *Movement Ecology*, 4.
13. Gutman, D. (2019, April 2). *King County Council wants plan to keep Eagles out of dump*. The Seattle Times. https://www.seattletimes.com/seattle-news/environment/king-county-council-wants-plan-to-keep-eagles-out-of-dump/
14. Gwynne, D. T., & Rentz, D. C. F. (1983). Beetles on the bottle: Male buprestids mistake stubbies for females (Coleoptera). *Australian Journal of Entomology*, **22**, 79–80.
15. Harmon, L., Bauman, K., McCloud, M., Parks, J., Howell, S., & Losos, J. (2005). What free-ranging animals do at the zoo: A study of the behavior and habitat use of opossums (Didelphis virginiana) on the grounds of the St. Louis Zoo. *Zoo Biology*, 24: 197-213.
16. Hellmann, K., & Luedicke, M., (2018). The throwaway society: A look in the back mirror. *Journal of Consumer Policy*, 41(1), 83-97.
17. Hou, L., McMahan, C., McNeish, R., Munno, K., Rochman, C., & Hoellein, T. (2021). A fish tale: a century of museum specimens reveals increasing microplastic concentration in freshwater fish. *Ecological Applications*, 31(5): 02320.
18. Katlam, G., Prasad, S., Aggarwal, M., & Kumar, R. (2018). Trash on the menu: patterns of animal visitation and foraging behaviour at garbage dumps. *Research Communications*, 115(12): 2322-2326.
19. Kaza Silpa, Lisa Yao, Perinaz Bhada-Tata, and Frank Van Woerden. 2018. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. Urban Development Series. Washington, DC: World Bank. doi:10.1596/978-1-4648 -1329-0. License: Creative Commons Attribution CC BY 3.0 IGO
20. Lopez-Martinez, S., Morales-Caselles, C., Kadar, J., & Rivas, M. (2020). Overview of global status of plastic presence in marine vertebrates. *Global change biology*, 27(4):728-737.
21. Maròn, C., Beltramino, L., Martino, M., et al. (2015). Increased wounding of Southern Right Whales (*Eubalaena australis*) calves by Kelp Gulls (Larus dominicanus) at Península Valdés, Argentina. *PLOS ONE*, 10(10).

22. Newsome, T., & Eeden, L. (2006). Food waste is still an underappreciated threat to wildlife. *Animal Conservation.*
23. Newsome, T., & Eeden, L. (2017). The effects of food waste on wildlife and humans. *Sustainability communications*.
24. Pinjing, H., Chen, L., Shao, L., Zhang, H., et Lü, F. (2019). Municipal solid waste (MSW) landfill: A source of microplastics? – Evidence of microplastics in landfill leachate. *Water Research*, 159: 38-45.
25. PLoS, (2004) Emergence of a Peaceful Culture in Wild Baboons. *PLoS Biol* 2(4): e124. https://doi.org/10.1371/journal.pbio.0020124
26. *Population: The numbers*. Population Matters. (2022, January 19). Retrieved February 25, 2022, from https://populationmatters.org/population-numbers?gclid=CjwKCAiA9tyQBhAIEiwA6tdCrPmImCrO9rmhldEisxsLWAP6iMsL2s0d8Ncn4UfTPJVs7IgcnFLE9xoCxmcQAvD_BwE
27. Schuyler, Q., Wilcox, C., Townsend, K., Hardesty, B., & Marshall, J. (2014). Mistaken identity? Visual similarities of marine debris to natural prey items of sea turtles. *BMC Ecology*, 14(1).
28. Stefanski, S., & Villasante, S. (2015). Whales vs. gulls: assessing trade-offs in wildlife and waste management in Patagonia, Argentia. Ecosystem Services, 16: 294-305.
29. Turrin, C., Watts, B., & Mojica, E. (2015). Landfill use by bald eagles in Chesapeake Bay region. *Journal of Raptor Research*, 49(3): 239-249.
30. Uchida, K., Shimamoto, T., Yanagawa, H., & Koizumi, I. (2020). Comparison of multiple behavioral traits between urban and rural squirrels. *Urban Ecosystem*, 23: 745-754.
31. White, A., & Lockyer, S. (2020). Removing plastic packaging from fresh produce – what's the impact? *Nutrition Bulletin,* 45(1): 35-50.
32. Woodall, L. C., Sanchez-Vidal, A., Canals, M., et al. (2014). The deep sea is a major sink for microplastic debris. *Royal Society Open Science*, 1(4): 140317.
33. Young, L., Vanderlip, C., Duffy, D., Afanasyev, V., & Shaffer, S. (2009). Bringing home the trash: Do colony-based differences in foraging distribution lead to increased plastic ingestion in Laysan Albatrosses? *PLoS ONE* 4(10): e7623

34. Zalasiewicz, J., Waters, C., Ivar do Sul., et al. (2016). The geological cycle of plastics and their use as a stratigraphic indicator of the Anthropocene. *Anthropocene*, 13: 4-17.

ii. Project Concept

**The following text is the original Project Concept from which the Project Charter and Scope were developed. The concept was completed and submitted to the Project Supervisor and the Project Management course instructors (Iain Davidson-Hunt and Sheldon Mcleod) for review on September 29, 2021.

Justification/Need:

The need for waste reduction is becoming increasingly apparent as our population grows. We produce more and more garbage every year, yet that garbage remains, for the most part, "out of sight out of mind." While photos or videos containing images of vast amounts of waste in landfills, rivers, oceans etc., might evoke feelings of needing to do something, they are also overwhelming. It's difficult to imagine that we, as individuals, could make a difference and because we don't need to look at it every day, we can forget about it. On the other hand, people want to help, especially in scenarios where we are inadvertently causing harm to wildlife. Consider the viral video of a turtle with a straw up its nose; one turtle, with one misplaced straw, was enough to lead to international bans on plastic straws and open the conversation on banning other single-use plastics.

Accredited zoos and aquariums are recognized as leaders in protecting wildlife, including the free-living wild animals that inhabit these facilities. The Assiniboine Park Zoo conducted a waste audit of the park and found that visitors brought in most of the garbage being left behind. In addition to the accumulation of waste that the park must manage, this waste attracts free-living wild animals, potentially influencing their behaviour. As leaders in sustainable practices, the zoo could support this project by studying how free-living wild animals of the park are being affected and propose solutions to mitigate any negative impacts. Demonstrating the relationship between wildlife and waste might encourage people to adopt habits that lead to waste reduction.

Project Description:

This project would study wildlife interactions with waste bins at the zoo and where garbage is more likely to be accessible, such as in picnic areas. Project team members would observe interactions during the day when visitors are present and set up trail cameras to evaluate interactions after the park is closed. We would also create content using ambassador animals from the zoo to educate zoo visitors about sustainable waste management. This would be done via social media and physical posters at the zoo. At the end of the study, a report would be made for the zoo containing the findings and possible recommendations.

Resource and Cost Estimates:

1. Stipend for the student Project Manager – negotiable
2. Undergraduate volunteers (3-5) – TBD
3. Trail cameras - ~500$ for four cameras
4. Educational material - ~100$ (simple posters)

Timeframe:

This project would begin in the spring of 2022, when wildlife and zoo visitor activities increase and would continue into fall.

<u>Planning Estimates:</u>

- Discuss with zoo representatives - fall 2021
- Look for additional funding opportunities - Winter 2022
- Find and train volunteers – winter/spring 2022

How are your organization's other activities impacted?

This project would be done independently of other zoo operations however, it would require funding which may take away from other planned activities.

iii. Schedule Details

Figure iii.1: Work Breakdown Structure with milestones identified by an Asterix (*).

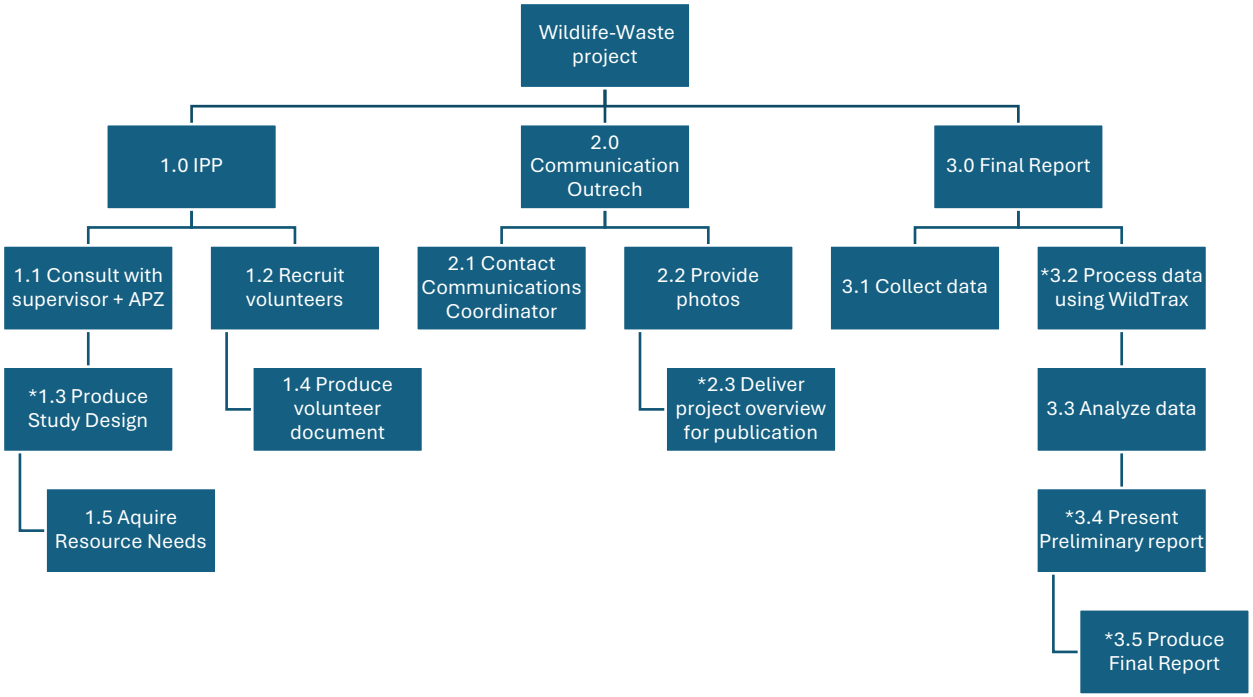


Figure iii.2: Work Breakdown Structure-Activity List and Schedule Details

WBS no.	*Deliverable*	*Work Package*	*Duration*	*Date initiated*	*Date Complete*	*Comments*
1.1	IPP	Consult advisor + APC	1 day	01/31/22	05/12/2022	Required to begin project
1.2	IPP	Recruit volunteers	1 day	02/07/22	06/01/2022	PM met with volunteer coordinator in person to show where trail cameras are located
1.3	IPP	Produce Study Design	30 days	02/07/22	05/12/2022	Completed prior to the commencement of the data collection process
1.4	IPP	Produce volunteer document	1 day	05/31/2022	06/02/2022	PM produce a document detailing the location of the cameras with photos
1.5	IPP	Acquire resource needs	3 days	05/15/2022	05/31/2022	Trail cameras were picked up from the APZ, other items such as chains, locks, camera covers were also acquired
2.1	Communications Outreach	Contact communi-cations coordinator	1 day	05/31/2022	07/19/2022	Contact with communications coordinator facilitated by Dr. Stephen Petersen
2.2	Communications Outreach	Provide photos	1 day	05/31/2022	07/29/2022 & 08/10/2022	Attended the zoo for photos, once with APZ communications coordinators and once for CTV news https://winnipeg.ctvnews.ca/research-project-looking-at-how-wildlife-interacts-with-waste-at-assiniboine-park-zoo-1.6019903
2.3	Communications Outreach	Deliver project overview for publica-tion	1 day	05/31/2022	07/25/2022	Met with communications coordinator in person for project interview which was published here https://www.assiniboinepark.ca/stories/108/going-wild-about-waste

3.1	Final Report	Collect data	17 weeks	06/04/2022	10/07/2022	Go over results with PS
3.2	Final Report	Process data using WildTrax		11/01/2022	03/30/2023	Photos sorted and deleted as required. Then were tagged and processed using WildTrax
3.3	Final Report	Analyze data		03/01/2024	03/31/2024	Data was downloaded from WildTrax and reorganized in excel. Then analyzed using RStudio
3.4	Final Report	Present prelimi-nary report		04/01/2023	05/31/2023	Preliminary results were gathered from and presented in May 2023
3.5	Final Report	Produce final report		04/01/2024	05/22/2024	Data, graphs, and photos were compiled to produce the final report

iv. Resource Needs Assessments and Skills Inventory

Resource (Skills & Knowledge) Needs Acquisition Plan:

Table iv.1: Resource (Skills & Knowledge) Needs Assessment

Deliverable	Activity / Task	Skill / Knowledge Requirement	Team Member (Name)	Contract (Name/ Organization)	Approximate Cost ($/Time)
Integrated Project Plan	Collect information on study site	Understand problem/priority areas in the park	Renata Machado	APZ	No add. cost, 1 day
	Create study design	Study design techniques	Lynnae Martin & Dr. Nicola Koper	NRI	No add. cost, 4 weeks
	Set up trail cameras	Working trail cameras	Lynnae Martin + volunteers	NRI	No add. cost, 1 day
Communication Outreach	Communication plan	Knowledge of APZ communication regulations	Lynnae Martin + Dr. Stephen Petersen	NRI/APZ	No add. Cost, time as needed
	Photos	Downloading photos from SD cards	Lynnae Martin	NRI	No add. Cost, time as needed
Final report	Process data	WildTrax	Lynnae Martin	NRI	No add. Cost, 12 weeks
	Preliminary report	WildTrax, PowerPoint, Excel	Lynnae Martin	NRI	No add. Cost, 4 weeks
	Data processing	R studio, statistics, Excel	Lynnae Martin	NRI	No add. Cost, 4 weeks
	Compile file report	Scientific writing, R Studio, data interpretation	Lynnae Martin	NRI	No add. Cost, 8 weeks

Table iv.2: Skills & Knowledge Inventory of Team / Partner / Volunteers (U/K = unknown)

Person	Job Title	Skills/Training	Years	Education
Lynnae Martin	Student/Project manager	-Project management -Trail camera usage -Scientific writing and statistics	3	Final year master's student
Dr. Nicola Koper	Professor at University of Winnipeg	-study design and statistics -research and conservation	>10 years	PhD
Dr. Stephen Petersen	Director of conservation and research at Assiniboine park zoo	-research and conservation	>10 years	PhD
Renata Machado	Sustainability specialist at Assiniboine park zoo	-sustainability and waste management at APC	U/K	U/K

Resource Needs (Materials, Supplies & Equipment) and Procurement Plan:

Table iv.3: Resource Needs (Materials, Supplies & Equipment) Assessment

Activity / Task	Quantity	Materials/Supplies/Equipment	Available/Procure	Approximate Cost ($/Time)
Set up trail cameras	6	Trail cameras	Trail cameras were provided by APZ	Couple hours on one day
Secure trail cameras	12 locks, 6 chains, 6 covers	12 locks, one to lock the SD card and 1 to lock the camera to tree and six chains	Purchase	60$
Study Design	N/A	Course material	NRI course	16 weeks
Data collection	N/V	Trail cameras, iPhone, SD card reader, laptop, transportation	Available by APZ and PM	17 weeks
Data analysis	N/A	Course material, R studio, laptop	NRI course	16 weeks + 8 weeks
Provide photos for media	As needed	Trail cameras, SD cards, SD card reader, iPhone	Available by APZ and PM	As needed, no cost
Present preliminary report	1	Trail cameras, SD cards, SD card reader, iPhone, laptop	Available by APZ and PM	8 weeks
Compile Final Report	1	Trail cameras, SD cards, SD card reader, iPhone, laptop,	Available by APZ and PM	8 weeks

v. Managing Relationships

A summary of the project's relationships is provided in the tables below.

Table v.1: Internal interested party registry

Name or Office	Nature of Interest	Type of Engagement Needed
Dr. Nicola Koper	As the supervisor of the project, she is investing her time and guidance into the project. Her expertise is an invaluable resource needed for the successful completion of this project.	Regular meetings to discuss progress and direction of the project
Renata Machado	As the Sustainability Coordinator at the APZ, she is interested in maintaining high standards of sustainable waste management at the zoo. She has the knowledge and connections needed pursue the project and will be the main contact person on site.	Engagements made mostly via email and meetings in person when necessary.
Dr. Stephen Petersen	As the Director of Conservation and Research at the APZ, he is interested in wildlife research being conducted appropriately on site at the zoo. He is responsible for allocating funding for research, which includes this project.	Emails and updates through virtual meetings
Shaun Leonoff	Volunteer coordinator for the APZ. She is responsible for the zoo's volunteers and has agreed to include the covering/uncovering of the trail cameras into the daily tasks.	Initial email to start the process and follow up emails as needed
Lindsey Hughes	Communications Coordinator for the Assiniboine Park. She is responsible for posting the zoo's media content.	In-person and email correspondence

Table v.2: External interested party registry

Interested Party	Why they Care	What they Seek from Us	What we Seek from Them	Implications for Managing the Relationships
APZ attendees, members + supporters (including donors, board of directors, etc.)	Visitors and those who support the zoo are interested in how the zoo is leading sustainability within the community	Engagement through social media with regular updates and information what they can do to help	Willingness to support sustainable initiatives and be part of the solution	Due to the diversity of visitors and supporters, the PM will discuss with APZ representative (as mentioned in Table 1) the different kinds of visitors (ex. adults, kids, locals, international) and supporters (ex. academics, board of directors) and how best to address their needs.

Table v.3: Planning elements for managing relationships

Interested Party with whom you need to Engage	Purposes	Mechanism and Fitness	Timing	Responsibility
Dr. Nicola Koper	Receive expert advice, ensure project is being completed on time while meeting satisfactory results	• Email update; in-person/virtual meeting. • Email to keep record and maintain contact • In person/virtual for more in-depth project discussions	Monthly/as needed	Project Manager
Renata Machado	Ensure she stays up to date with project progress	• Email update • Email to keep record and maintain contact	As needed following introduction	Project Manager
Dr. Stephen Petersen	Ensure he is up to date with project progress	• Email update • Email to keep record and maintain contact	As needed	Project Manager
APZ attendees, members + supporters (including donors, board of directors, etc.)	Made aware of project and how visitors can support it	• Communication outreach • Share project details	Once throughout the project	Project Manager
Volunteers	Ensure zoo volunteers have access to clear description of role	• Provide volunteer document • Maintain email correspondence with volunteer coordinator	As needed	Project Manager

vi. Risk Management

Table vi.1: Each risk is given an estimated "probability" and "impact assessment" of either low (0.2), medium (0.4), high (0.6) or very high (0.8). The probability and impact measurements are multiplied to calculate the "risk score."

Probability and Impact Matrix			
Risk Description	**Probability**	**Impact**	**Risk Score**
One or more trail cameras are stolen, or view is obstructed	Med – 0.4	Very High – 0.8	0.32
Additional bin types are unavailable	Med – 0.4	High – 0.60	0.12
Volunteer(s) are unavailable	Low – 0.2	High – 0.60	0.12
Funding is retracked	Low – 0.2	Very High – 0.8	0.16
Covid case numbers rise resulting in zoo closure + reduced non-essential work	Med – 0.4	Very High – 0.8	0.32
Committee member(s) disagree with how the project should proceed	Med – 0.4	Med – 0.4	0.16
Data is collected poorly or lost	Low – 0.2	Very High – 0.8	0.16
Cannot complete communication outreach deliverable	Low – 0.2	Low – 0.2	0.04

Table vi.2: Risks identified in table 1 are ordered from highest risk score to lowest. You can find details on where the response plan for each risk is located, who is responsible, and the status. The status may change as the project progresses and will be updated regularly. The Risk Response Plan can be found in section 6 above, and the Quality Management Plan can be found in section 7.

Risk Registry				
Risk *(from highest "risk score" to lowest*	**Response Plan Created?** *Y = yes N = no*	**Location of Response Plan**	**Risk Owner**	**Status**
One or more trail cameras are stolen, or view is obstructed	Y	Quality Management Plan/ Risk Response Plan	Project Manager (PM)	Complete
Covid case numbers rise resulting in zoo closure + reduced non-essential work	Y	Risk Response Plan	PM	Complete
Additional bin types are unavailable	Y	Risk Response Plan	PM	Unavailable
Data is collected poorly or lost	Y	Quality Management Plan/ Risk Response Plan	PM	Complete
Funding is retracked	Y	Risk Response Plan	PM + Project Advisor (PA)	Complete
Volunteer(s) are unavailable	Y	Quality Management Plan/ Risk Response Plan	PM	Complete
Committee member(s) disagree with how the project should proceed	Y	Risk Response Plan	PM	Complete

vii. Budget Details

Figure vii.1 Budget Details

Item(quantity)	Estimated price	Actual price	Store	Date purchased	Purpose
Trail cams (6)	800$	0$ (Borrowed from APZ)	N/A	05/14/2022	Monitor wildlife
Volunteer appreciation	100$	100$	Oh Doughnuts	09/30/2022	To thank the volunteers
Chains + locks	50$	41.54$	Canadian tire	05/14/2022	Camera security
Covers	20$	33.58$	Amazon	05/23/2022	Cover trail cameras during the day
Total	**970$**	**175.12**			

viii. Bin Location Descriptions and Photos

Table viii.1: List of the six areas and their sites with a description of where those sites can be found

Area	Site	Description
Grasslands	1a	Picnic tables between bisons and red fox near the entrance of the zoo
	1b	Picnic tables near Bison Snack Shack
Arctic	2a	Bins near snowy owl enclosure
	2b	Bins near arctic foxes and washrooms
Aunt Sally's Farm	3a	Tree near Shaved Iced shack

	3b	Bins on the path between the two picnic areas in Aunt Sally's farm
	3c	Bins in picnic area closer to special events entrance
McFeetor's Centre	4a	Bins in picnic area
	4b	Bins beside benches near cougars/snowy leopards
Asia	5a	Bins near play area by camels
	5b	Bins by gibbons
Open Range	6a	Intersection of trails near mini donuts in open range
	6b	Middle of picnic area, closer to pronghorn enclosure
	6c	Near Winston's ice cream stand

Figure viii.1: Photos of each site with the location of where the trail cameras will be labelled with a star. Only one trail camera is assigned to each area, and it will rotate between the sites in these areas weekly.

Grasslands: 1a, 1b





Arctic: 2a, 2b





Aunt Sally's Farm: 3a, 3b, 3c







McFeetor's Centre: 4a, 4b





Asia: 5a, 5b





Open Range: 6a, 6b, 6c







ix. Ethogram template

Below represents the original ethogram templates followed by the updated version. The human ethogram was ultimately excluded from the project. See Change Log for details.

Original Ethograms

Table ix.1: Original wildlife and visitor ethogram

	Behaviour	**Description**
Wildlife	Scavenging	Looking through garbage/bins, sniffing but not eating or taking it away from site yet
	Eating	Picking items out of garbage and consuming it, could include organic or nonorganic material
	Collecting	May occur after scavenging, animal takes item away from site
	Fighting	Interspecific or intraspecific interaction, includes biting, scratching, wrestling
	Taking	Grabbing, swopping, or chasing individuals(s) away, taking or “stealing” material from another individual
	Vocalizing	Making noise around the resource, includes calling when another individual approach’s site, calling from

		bin or while interacting with garbage
	Nesting	Nest building taking place within view of site, gathering material about bin and/or using garbage for nest
Visitor	Littering	Waste is intentionally discarded on the ground away from bin or person notices waste got away on them, but made no attempt to retrieve
	Dropped	Unintentional litter, such as blown away from picnic table or dropped from bag, attempt may be made to retrieve but not successful
	Placed IN bin	Waste is placed directly into bin
	Placed AT bin	Waste is not placed into bin, rather on top, be side, or behind (within contact of bin)

Table ix.2: Updated wildlife ethogram

Behaviour	Description
Foraging	Wildlife observed investigating bins without taking or consuming anything
Feeding	Wildlife observed taking or consuming items from the bins or surrounding litter
Other	Wildlife perched on or climbing bins without investigating their contents
Running	Wildlife passing by the cameras without interacting with the bins
Territorial Display	Interactions between wildlife, such as chasing and fighting, seemingly unrelated to interacting with bins

x. Change Log

Below is the list of changes that occurred throughout the project, including a description of each change and why it was made.

Table x.1: Change log

Date submitted	Approved/Rejected	Change
June 2, 2022	Approved	Deliverable #4, "educational material" was replaced with Deliverable #2 "Communication Outreach". Instead of creating a poster and Instagram post for this project, a discussion will be had with the zoo's social media coordinator to post about the project at least once throughout the season. Changes were made in the Project Charter, Scope, and Schedule to reflect this.
June 2, 2022	Approved	Instead of removing the trail cameras during the day, cameras will remain up and will be covered during the day. PM has met with the volunteer coordinator and volunteers will replace/remove coverings during their rounds when the zoo opens/closes. This change has been included in the Risk Management, Quality Management Procedures section and Managing Relationships section (Also Appendices iv and vi).
June 2, 2022	Approved	Photos and description of the locations of where the trail cameras will be has been included in Appendix viii.
June 2, 2022	Approved	We were unable to procure access to additional bin types as Recycle Everywhere due to a shortage of bins. Changes to Risk Management section (including appendix vi), Quality Management section (4, a) and background report (appendix i) were made to reflect this. This will no longer be included in the data analysis.
June 2, 2022	Approved	Editorial changes were made to the IPP as advised by committee members.
June 4, 2022	Approved	One of the trail camera sites were removed from the Arctic (2.b) as it faced the women's bathroom. The PM decided to remove for concern over guest comfort.
June 30, 2022	Approved	The visitor ethogram (study design section in the Background Information Report) was removed as it

		was too difficult to determine, and not enough data was being collected.
March 30, 2024	Approved	The Wildlife Ethogram was updated from its original proposal in the Background Information Report to the one found in the Methods section of the Final Report (Chapter 2) to accurately reflect the types of behaviours seen and perform the data analysis
May 26, 2024	Pending	Editorial changes and updates were made to the IPP (Chapter 1) to reflect the above changes. Pending approval from first draft review.
August 6, 2024	Approved	Editorial changes and updates approved. Finalized report sent to the Assiniboine Park Zoo.