Using predictors of public reporting and reducing attractant accessibility can support proactive management of human conflict with urban coyotes

by

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ABSTRACT

Human-wildlife conflicts are increasing globally, prompting a need for efficient, proactive management strategies. Management can be supported by collecting information about human-wildlife conflicts from citizen-provided reports and by mitigating drivers of conflict, like wildlife access to anthropogenic sources of food. Coyotes (*Canis latrans*) commonly come into conflict with humans in urban areas across North America. In Edmonton (hereafter City), citizen-provided reports about coyotes often describe benign behaviours, reducing the efficiency with which City rangers can address reports that describe conflict-prone coyotes. Human-coyote conflicts are frequently driven by coyotes accessing anthropogenic foods, such as birdseed and compost, which negatively impact coyote health and promote food conditioning that leads to conflict. Birdseed is especially ubiquitous and appears to attract both coyotes and rodents, creating opportunities for the transmission of the zoonotic tapeworm *Echinococcus multilocularis*, an emerging infectious disease for people in Alberta. In this thesis, we (a) explored the tendencies of the public to report benign vs. conflict-prone interactions with coyotes to the City (Chapter 2) and (b) investigated the presence in residential yards of coyotes and their prey beneath bird feeders that were (treatment) or not (control) fitted with seed hoops that were intended to reduce seed spillage below feeders (Chapter 3).

In Chapter 2, we used questionnaire data collected by the City to build a path model exploring how a survey respondent's anticipation of reporting a benign vs. a conflict-prone observation of a coyote varied with demographic, situational, experiential, and cognitive factors. We gathered this information to support an ongoing education campaign to increase the prevalence of actionable reports about human-coyote conflicts while reducing reports of benign coyote behaviour. Reporting conflict-prone coyotes was associated with lower risk perceptions

about coyotes and more knowledge of the consequences of food conditioning in coyotes. Higher risk perceptions about coyotes were associated with more knowledge of the consequences of food conditioning, more severe interactions with coyotes, and less education. Those who had more severe interactions with coyotes were more likely to live on greenspaces. Our results suggest that educational messaging should increase knowledge of food conditioning in coyotes and reduce risk perceptions. Such messaging should be targeted where and when interactions with coyotes are more likely to occur, such as in neighbourhoods adjacent to natural areas, or be provided by 311 operators upon receipt of reports.

In Chapter 3, we investigated the occurrence of coyotes and small rodent prey at spilled birdseed beneath bird feeders in 44 residential yards in Edmonton where we also characterized yard features and adjacent greenspaces. In each yard, we monitored coyote and rodent activity for three months using a trail camera and rodent track and hair tube placed near the feeder. We used a before-after control-impact (BACI) study design to test whether seed hoops effectively reduce coyote and prey attraction to bird feeders by adding hoops at half the sites halfway through the monitoring period. Coyotes, small rodents, and other wildlife visited bird feeders at most of our sites, but seed hoops did not significantly affect the detection of coyotes and rodents at feeders. Coyotes more often visited feeders that were located closer to greenspace edges and provided sunflower seeds. Our findings suggest that individuals who feed birds can deter coyotes by placing feeders as far as possible from greenspace edges or similar cover and offering foods that are less palatable to mammals.

Taken together, the findings of this research help inform ways to improve the monitoring and management of human-coyote conflict through public education, leveraging data contained in citizen-provided reports, and reducing the potential for conflict by mitigating access to anthropogenic foods that may promote food conditioning and poor health in coyotes and the transmission of zoonotic diseases from coyotes and their prey.

PREFACE

This thesis is an original work by Abby Linh Keller. The questionnaire data used in Chapter 2 was collected through a survey created in collaboration with and administered by the City of Edmonton. Coyote image and small mammal track and hair data used in Chapter 3 were collected by Abby Keller from July through December 2023. Coyote image tagging, hair sample preparation, and hair identification were performed by Abby Keller at the University of Alberta. Track identification was performed by Abby Keller and Sage Raymond at the University of Alberta.

The data collected with camera traps and small mammal track and hair tubes for Chapter 3 received animal ethics approval from the University of Alberta Animal Care and Use Committee ("Attraction of rodents and coyotes to birdseed"; No. AUP00004431, 2023) and a Research Permit and Collection Licence through the Government of Alberta (Research Permit #23-451). Homeowners who volunteered to participate in the project provided permission to access and collect data on their properties.

Chapter 2 has been submitted for publication in *PLOS ONE* and is currently in review as "Knowledge of risks associated with food-conditioned coyotes increases likelihood of reporting", with Colleen Cassady St. Clair, Carly Sponarski, and Chrystal Coleman as co-authors. Chapter 3 will be submitted for publication in *The Journal of Urban Ecology* as "Attraction to birdseed by non-target taxa and implications for management of urban coyotes", with Colleen Cassady St. Clair as co-author.

DEDICATION

Liv av kvar ein død,

død av kvart eit liv

Hjulet syng om ringar,

ikkje linjar.

Ivar Bjørnson & Einar Selvik, "Kvervandi"

Hold on, don't fade away;

don't be afraid to bleed, afraid to dream.

Enslaved, "Ethica Odini"

Stay curious, stay weird, stay kind, and don't let anyone ever tell you you aren't smart or brave or worthy enough.

Stanford Pines in Journal 3

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First and foremost, I want to thank my supervisors, Drs. Colleen Cassady St. Clair and Carly Sponarski for their mentorship, support, and kindness. I have learned so much from working with them, and I appreciate all the creative ways they have pushed me to think outside the box and challenge myself. I greatly appreciate all the thoughtful feedback and support Colleen and Carly have provided. Colleen and Carly have helped me grow immensely both personally and professionally, and being their student has been a wonderful experience. I also thank Dr. Erin Bayne for taking the time to be a part of my examining committee and for the support and feedback he provided.

The coyote survey data used in Chapter 2 was made possible thanks to the effort of countless employees of the City of Edmonton who organized and implemented the survey and subsequent education campaign. I am grateful for the opportunity to have worked closely with these City employees and to see firsthand how science can be applied to real-world management for the good of people and wildlife. I also want to thank the nearly 6,000 Edmonton residents who took the time to respond to the survey, providing us with a wealth of valuable data. I am grateful to the many Edmonton residents who kindly allowed me to access their properties to collect the data used in Chapter 3. In addition, I appreciate the many fascinating insights about the animals that visited each yard that many of these volunteers shared.

I thank the other past and present members of the St. Clair lab, Sage Raymond, Kate Rutherford, Peter Thompson, Gabrielle Lajeunesse, Claire Edwards, Carrie Ann Adams, Cassondra Stevenson, and Leif Hvenegaard, as well as many others from the University of Alberta. Learning from and with so many wonderful people has been incredible, and I've appreciated all the inspiration and camaraderie they shared with me.

I want to thank all my wonderful family and friends. I especially want to acknowledge my late grandmother, ShirleyAnn Larson. I am here today in no small part because she encouraged my curiosity and interest in science throughout my early life. I cherish the formative moments she fostered by sending me outside armed with a magnifying glass, scratch paper, and an old knife-sharpened pencil. In addition to my grandmother, I am grateful to my siblings, especially Nick and Katie, aunts Debbie and Linda, uncles Bob, Duane, Doug, and Tim, cousins Nicole, Joe, and Eleanor, my husband, and my dear friends – my chosen family – for their support over the years. Their character, love, encouragement, and brilliance have consistently inspired and strengthened me. My husband, Cameron, has been an incredible partner, providing me with endless support, kindness, love, and laughter for over a decade. I must also note that his tech-savvy helped me *immensely* with the daunting task of learning to code in R.

This project was made possible by a William Wishart Post-Graduate Award and an Alberta Graduate Excellence Award awarded to Abby Keller, and a Natural Science and Engineering Research Council of Canada Grant to Colleen Cassady St. Clair (RGPIN-2023-04892).

Finally, I'd like to thank the coyotes roaming North America for teaching me to be adaptable, reminding me not to take myself too seriously, and to laugh and sing often. Woo-yip, woo-yip, woo!

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Chapter 1

Introduction

Conflicts between humans and wildlife are a growing issue globally as humans and wildlife increasingly share space (Soulsbury and White 2015, Schell et al. 2021). Human-wildlife conflicts are diverse and encompass: the depredation of livestock (McInturff et al. 2021, Støen et al. 2022), pets (Alexander and Quinn 2011, Nation and St. Clair 2019), crops (Negi et al. 2023), and residential yards (Schell et al. 2020); physical conflict such as aggression towards and attacks on humans (Baker and Timm 2017, Scharhag et al. 2021); and the transmission of zoonotic diseases (Somily et al. 2005, Hegglin et al. 2015, Roe et al. 2020). These conflicts can pose significant risks to the health and safety of humans who may be negatively impacted by economic losses due to crop and livestock depredation and property damage (Lamichhane et al. 2018), emotional and psychological stress from conflicts (Yeshey et al. 2022, Blackie 2023), and physical harm by attacks or diseases transmitted by wildlife (Yeshey et al. 2022). In turn, these interactions can negatively affect wildlife by changing human perceptions of and reducing tolerance for wildlife (Basak et al. 2023), and even lessening support for conservation (Jonker et al. 2006, Lamichhane et al. 2018). Wildlife that come into conflict with humans are often subject to lethal management, which has become increasingly contentious in urban areas (Martínez-Espiñeira 2006, Jackman and Rutberg 2015).

Effective mitigation of human-wildlife conflict requires robust, accurate information about conflicts and their contributing factors. Many municipalities collect citizen-provided reports about human-wildlife interactions to support monitoring efforts and inform management decisions (Hayman et al. 2014, Quinn et al. 2016, Wilbur et al. 2018). The information in these reports is valuable to wildlife managers, allowing them to make better-informed decisions and develop proactive management strategies (Heathcote et al. 2019). Further, reporting by the public can provide information about public perceptions and levels of tolerance for wildlife species (Jonker et al. 2006, Puri et al. 2024), which help managers to identify effective and publicly acceptable actions. Understanding the factors that influence whether someone reports an animal and the types of interactions they are inclined to report can inform education promoting human-wildlife coexistence (Sponarski et al. 2016, 2019, Puri et al. 2024). When this education equips the public to identify potential or ongoing conflicts and guides them to report these situations, it can support more efficient reporting by reducing the number of reports that describe benign wildlife behaviours and encouraging reporting of potential or ongoing conflicts.

Another important component of mitigating human-wildlife conflict is managing the drivers of conflict (Hopkins III et al. 2012). Wildlife access to anthropogenic sources of food is a common contributor to conflicts (Nowak et al. 2021, Smith et al. 2023). Access to these foods can lead to food conditioning, a learning process by which an animal comes to associate humans with food (McCullough 1982). In turn, this can lead to animals behaving boldly and even aggressively towards humans (McNay 2002, Nowak et al. 2021, Smith et al. 2023). Compounding this issue, anthropogenic sources of food can have negative impacts on the health of wildlife (Murray et al. 2015*b*, Lawson et al. 2018, Stimmelmayr et al. 2023) and can drive the transmission of communicable diseases by increasing contact rates between animals that visit the food source (Blanco et al. 2011, Murray et al. 2016*a*). Animals that are in poor health are often more prone to physical conflict with humans (Murray and St. Clair 2017) and present the risk of zoonotic disease transmission to people and pets (Jiménez-Ruiz et al. 2024, Raymond et al. 2024). Identifying foods that may attract wildlife and minimizing animal access to these items can help prevent conflicts from arising.

Coyotes (*Canis latrans*) are a carnivore species that commonly comes into conflict with humans (Poessel et al. 2013, Farr et al. 2023*a*). Coyotes are adaptable, generalist canids that range across North America and are now found in all major cities within their range (Hody and Kays 2018). In Edmonton, Alberta, Canada, there is growing public concern about physical conflicts with coyotes (Farr et al. 2023) and the risk of zoonotic diseases, such as the tapeworm *Echinococcus multilocularis* (Catalano et al. 2012, Houston et al. 2021). People can report conflicts with coyotes to the City of Edmonton through 311, a phone line and app that connects residents with various municipal services. These reports are then made available to City of Edmonton rangers, who use them to monitor and respond to human-coyote conflicts; however, many of the reports received by 311 describe benign coyote behaviours that do not require management intervention. Rangers report that the high volume of reports describing benign behaviour reduces the efficiency with which they can find and address reports that describe conflict-prone behaviour or ongoing conflicts that require prompt management action.

Conflict-prone behaviour in urban coyotes is often driven in part by coyotes accessing anthropogenic sources of food. (White and Gehrt 2009). Access to these foods leads to conflict through food conditioning (White and Gehrt 2009), and negative impacts on the health of coyotes (Murray et al. 2015*b*). Coyotes that consume more anthropogenic food sources and assimilate less protein in their diets are more likely to be in poor health and access residential yards (Murray et al. 2015*a*), where they may come into physical conflict with humans and pets or put humans at risk of exposure to zoonotic pathogens (Murray et al. 2015*b*, Luong et al. 2020). Birdseed is an abundant anthropogenic source of food across North America (Government of Canada 2015, Orros and Fellowes 2015) that may be underappreciated for its impact on non-target taxa (Orros and Fellowes 2012, Reed and Bonter 2018), including its role as an attractant to coyotes. In Edmonton, birdseed scattered on the ground or spilled beneath feeders is commonly found in greenspaces and natural areas used by coyotes and in residential areas along greenspaces (Raymond and St. Clair 2023) where coyotes can consume the birdseed or the rodents attracted to it, such as squirrels, mice, and voles. As a result, birdseed may play an under-recognized role in promoting human-coyote conflict through food conditioning, negative impacts on the health of coyotes, facilitating the transmission of diseases, and increasing the risk of exposure by humans.

This research investigated the factors that influence the reporting of coyotes to the City of Edmonton 311 service and the role and management of birdseed as a potential attractant to coyotes and their rodent prey. In Chapter 2, I used data collected from a survey of approximately 6,000 Edmonton residents to build a path model exploring how various demographic, situational, experiential, and cognitive factors, directly and indirectly, influence whether an individual anticipated reporting a scenario describing a conflict-prone coyote to 311 relative to a scenario with a benign sighting of a coyote. With this path model, we aimed to inform an ongoing City education campaign that promotes coexistence between humans and coyotes and supports City goals of reducing the volume of reports that describe benign coyote behaviour and encouraging reporting of conflict-prone coyotes to 311. In Chapter 3, I used motion-triggered infrared trail cameras and rodent track and hair tubes to monitor coyote and rodent attraction to bird feeders in residential yards near greenspaces in Edmonton. I employed a before-after control-impact (BACI) study design to test the efficacy of seed hoops, which are simple mesh hoops designed to prevent birdseed from falling to the ground where it is more easily accessed by mammals, thus reducing attraction to bird feeders by coyotes and their rodent prey. Further, I investigated the features of bird feeders and yards that influence attraction to bird feeders by coyotes and mouse-sized rodents that may carry the tapeworm *Echinococcus multilocularis*. Lastly, in Chapter 4, I synthesize the findings of Chapters 2 and 3 and discuss the broader implications for proactive management of coyotes and other wildlife that commonly come into conflict with humans.

Chapter 2

Knowledge of risks associated with food-conditioned coyotes increases the likelihood of informative reporting by the public

2.1 ABSTRACT

Many municipalities use information about human-wildlife interactions collected in citizen-provided reports to monitor conflicts and guide management actions. However, high volumes of reports that describe benign wildlife behaviour can reduce the efficiency with which officials address reports that require management interventions, a situation that has occurred in Edmonton, Canada. We used data from a survey of Edmonton residents (n = 5,926) that asked respondents to anticipate whether they would alert officials if they witnessed (a) a coyote exhibiting benign behaviour in a natural area and (b) conflict-prone behaviour near human dwellings. To create a response variable for informative reporting, we subtracted each respondent's benign agreement score from their conflict score. We then built a path model to explore how this difference was affected by demographic, situational, cognitive, and experiential factors measured in the survey. A greater tendency to report a conflict-prone coyote was associated with lower risk perceptions and greater knowledge of the consequences of food conditioning in coyotes. Individuals with higher risk perceptions were more likely to have experienced more severe interactions, and more severe interactions were associated with living on a greenspace. Our results suggest that education should help people identify and mitigate potential conflicts with coyotes and occur as part of report receipt by city staff and outreach that targets areas where coyote interactions are more likely, such as in residential areas along greenspaces.

2.2 INTRODUCTION

Human-wildlife interactions have increased globally, driven by rapid urbanization, encroachment of humans on wildlife habitat, and wildlife adaptation to human-modified environments (Ditchkoff et al. 2006, Soulsbury and White 2015, Parsons et al. 2019). Many municipalities collect citizen-provided reports about human-wildlife interactions to monitor conflict and inform wildlife management actions (Quinn et al. 2016, Flamm 2019). Reporting of wildlife may also reflect public perceptions of a given species (Organ and Ellingwood 2000, Jonker et al. 2006), which can further inform education campaigns and management strategies. However, large volumes of reports describing benign wildlife behaviour can strain limited resources and make it difficult for officials to prioritize reports that describe conflict-prone behaviour and require management intervention. Understanding the factors that influence the types of human-wildlife interactions people report can help officials target education and refine reporting systems, ideally increasing the number of informative reports, decreasing uninformative reports that describe benign behaviours, and promoting human-wildlife coexistence. Only a few studies to date have explored the drivers of actual reporting behaviour to guide education and management. For example, individuals who reported nuisance alligators (*Alligator mississippiensis*) in Florida were more likely to live near alligator habitat, have children or pets in the home, and have greater risk perceptions of and lower tolerance for alligators (Hayman et al. 2014). In Colorado, individuals who reported black bears (*Ursus americanus*) were more likely to be dissatisfied with black bear management and have experienced more encounters with black bears (Wilbur et al. 2018).

Public reporting of coyotes (*Canis latrans*) is increasingly prevalent in urban areas where both sightings of and conflicts with coyotes have risen in recent years (Lawrence and Krausman

2011, Quinn et al. 2016, Wilkinson et al. 2023). As with reporting of alligators, situational factors that increase the odds of an individual encountering a coyote, such as living near coyote habitat, may also increase the likelihood that an individual makes a report. Conflicts with coyotes are often reported in and near urban greenspaces (e.g., powerline rights-of-way, natural areas) and parks (Lukasik and Alexander 2011, Wilkinson et al. 2023) and open areas (Farr et al. 2023). The time of year may also influence the likelihood of conflicts and reporting of coyote encounters. For example, conflicts occur more often during the summer pup-rearing season, though people may see coyotes more frequently during autumn when young coyotes disperse (Farr et al. 2023). Conflicts are also more likely when coyotes are food-conditioned (i.e., associate people with food) (Murray et al. 2015*a*, Soulsbury and White 2015), in poor health (Murray et al. 2015*b*), or when pets are present (Lawrence and Krausman 2011, Poessel et al. 2013). One's perception of the risk of conflict with or injury from coyotes may also influence whether one believes it is necessary to report an encounter with a coyote (Sponarski et al. 2018). In Edmonton, Alberta, Canada (hereafter the City), the City government maintains records of coyote sightings and interactions reported to 311, a free phone service and app that connects residents to various municipal services. City rangers use these reports to monitor and guide management actions ranging from signage placement to hazing of bold animals and lethal removal of aggressive coyotes. Reports of coyotes in Edmonton have increased in the last decade (Farr et al. 2023), and large volumes of reports describing benign coyote behaviour have made it difficult for City officials to prioritize reports that describe conflict-prone coyotes or other situations that require management intervention.

In this study, we use data from a public survey of Edmonton residents to explore how demographic, situational, cognitive, and experiential factors predict whether someone anticipates reporting a conflict-prone coyote relative to a benign sighting of a coyote to 311. Our goal was to use information about these relationships to support an ongoing education campaign and encourage reporting of encounters with coyotes that require management action while reducing the volume of reports describing benign sightings. We expected that the tendency to emphasize reporting conflict-prone coyotes would be influenced by demographic factors that may affect whether someone lives near coyote habitat (Schell et al. 2021), situational factors that increase the likelihood of encountering a coyote (Hayman et al. 2014), experiential factors such as the severity of past interactions with coyotes (Wilbur et al. 2018) and previous experience reporting a coyote to 311, and cognitive factors such as knowledge of food conditioning in coyotes and perceptions of risks posed by coyotes (Sponarski et al. 2018, Wilbur et al. 2018).

2.3 METHODS

In spring 2022, we assisted the City of Edmonton in designing a questionnaire based on discussion with City rangers and a review of relevant literature focused on public perceptions of coyotes and other predators. The questionnaire consisted of 78 items that targeted experiences with coyotes (3 items), observations of coyote attractants (2 items), knowledge of the consequences of coyotes accessing anthropogenic food resources (7 items), beliefs about coyotes (7 items), risk perceptions (16 items), personal reactions to coyote scenarios (8 items per scenario in two scenarios), opinions concerning coyote management (6 items in each of two scenarios), awareness of and comfort with hazing bold coyotes (2 items), past reporting of coyotes to the City 311 service (1 item), and demographic variables (12 items). The City administered the questionnaire through the Edmonton Insight Community, a pool of volunteers composed of Edmonton residents over the age of 15 who complete questionnaires and participate in discussions related to various municipal issues. In addition, the City posted an open weblink on its website and associated social media page, and Edmonton Urban Coyote Project members shared it with current volunteers and community liaisons. The survey was open for three weeks, from April 25, 2022, to May 15, 2022.

We used responses to two hypothetical coyote scenarios, one deemed by the research team to be benign and the other to be indicative of impending conflict, to assess predicted or anticipated 311 call behaviour. Scenario 1 read, "*Imagine you are walking alone along a trail in a park, greenspace, or River Valley in Edmonton during the day*, *and a coyote crosses the trail 15 m (one bus length) ahead of you and stops to look at you.* Scenario 2 read, "*Now imagine you are out walking alone in your neighbourhood during the day and see a coyote in the alleyway approaching yards. You know from your community social media site that several others have seen a coyote recently in the same area.* For each scenario, respondents were asked about their agreement that they would "…notify the City via the 311 phone line or app." which had responses (-2) = *Strongly disagree,* (-1) = *Somewhat disagree,* (0) = *Neither agree nor disagree,* (+1) = *Somewhat agree*, (+2) = *Strongly agree*, and *Unsure*. Unsure responses were coded as missing. To better assess the difference between those who tended to report benign sightings (Scenario 1) and those who tended to report conflict-prone coyotes (Scenario 2), we recoded these responses to 1 (*strongly disagree*) to 5 (*strongly agree*) and subtracted responses to Scenario 1 from responses to Scenario 2. We then used the difference in responses as our outcome variable, *anticipates reporting conflict over sighting*.

We selected a set of six potential predictor variables supported by the literature and survey questions that we believed to be most actionable by managers: The highest level of education attained by the respondent (*education*), whether an individual resided along a greenspace (*property on greenspace),* the respondent's knowledge of the consequences of food conditioning in coyotes (*knowledge of food conditioning*), the most severe interaction the respondent had had with a coyote in the past year (*coyote interaction severity),* the respondent's perceptions of risk posed by coyotes to their personal safety, pet's safety, children's safety, and the risk of zoonotic disease transmission (*risk perceptions*), and whether the individual had previously reported a coyote to 311 (*previously called 311*). For the purposes of this analysis, we left out outdoor pet ownership as the relationship between pets and human-coyote conflict is already well-established (Alexander and Quinn 2011, Lawrence and Krausman 2011, Poessel et al. 2013, Boydston et al. 2018).

Education was used to assess the highest education level that the respondent had attained. This item read, "What is the highest level of education you have completed?" to which respondents could answer *Elementary/grade school graduate; High school graduate; College/technical school graduate; University undergraduate degree; Post-graduate degree (e.g., Masters, PhD); Professional school graduate (e.g., medicine, dentistry, veterinary medicine, optometry); I prefer not to answer. I prefer not to answer* responses were coded as missing.

Property on greenspace served as a measure of an individual's proximity to coyote habitat, which may increase the likelihood of encountering a coyote. Property on a greenspace, ravine, or other natural area was targeted with the item "*Do you have a yard facing or back onto a park or natural area (e.g. ravine, river valley, utility corridor)?*" for which responses were *Yes, No, Don't know*, and *I prefer not to answer*. *Don't know* and *I prefer not to answer* responses were coded as missing.

Knowledge of food conditioning was assessed using seven Likert-like items: "Thinking of coyotes that regularly access human sources of food in urban areas, to what extent would you agree with each of the following statements?". *They are more likely to survive and reproduce, They lose their fear of people, They become dependent on human sources of food, They are more likely to carry diseases, including some that people can get, They are more likely to be aggressive towards people or pets, They are more likely to den nearby,* and *They are more likely to be killed by wildlife managers to protect the public.* We tallied the number of correct responses to create a single "Knowledge Score" variable.

Risk perceptions about coyotes regarding personal safety, children's safety, pet safety, and disease transmission were assessed on a 5-point Likert-type scale. These items were preceded by the prompt: "*Given the presence of coyotes in Edmonton, how do you feel about each of the following? I am concerned about…*". Items were: (a)*...my own personal health or safety;* (b)*…my children's health or safety*; (c)*…my pet's health or safety*; and (d)*…the spread of diseases carried by coyotes.* Responses were (-2) = *Strongly disagree,* (-1) = *Somewhat disagree*, (0) = *Neither agree nor disagree,* (1) = *Somewhat agree*, (2) = *Strongly agree*, and *Not applicable*. *Not applicable* responses to any items (e.g. those without pets (25%) or children (36%)) were coded as missing. To simplify the model, we calculated a composite score for risk beliefs by averaging each respondent's response to each risk item that applied to them (e.g., if an individual indicated that they did not have pets, the item about pet's health and safety would not be used as part of the calculation of their composite risk belief score). To verify that composite scores could be calculated, we assessed the internal consistency of the scale using confirmatory factor analysis and then Cronbach's alpha to test the validity of our composite risk variable. We assessed the fit of the CFA using the following goodness-of-fit indices: chi-squared ($\Delta\chi 2$, $\chi 2$/df), root mean square error of approximation (RMSEA, an acceptable fit is < 0.05), comparative fit index (CFI, an acceptable fit is > 0.90), and Tucker-Lewis index (TLI, an acceptable fit is >

0.90). If the CFA was acceptable, we calculated Cronbach's alpha ($\alpha > .60$) to double-verify the construct.

Coyote interaction severity was based on the most severe interaction an individual indicated from a list of options: "In the last 12 months, which kind of encounter(s) have you had with a coyote?". Responses were *I have had no encounter with a coyote in the past 12 months* (0), *I saw a coyote from a car or building* (1), *I saw a coyote when I was outside of a car or building from a distance of at least 50 metres (approximately 3 city bus lengths)* (2), *I saw a coyote when I was outside and it was closer than 50 metres* (3), *A coyote approached me while I was walking, jogging, or cycling* (4), *A coyote tried to bite me or my pet* (5), *A coyote bit or killed my pet* (6).

Previously called 311, whether a respondent had previously reported a coyote to 311, a civic call centre and app for various city services, was assessed using a single item, "Have you ever called 311 (the City of Edmonton) to report a coyote?". Responses were *Yes*, *No*, and *Not Sure. Not sure* responses were coded as missing.

We fit a path model that explored the direct and indirect effects on *Anticipates reporting conflict over sighting* (difference between agreement for the conflict-based vs. benign scenario) by *education, property on greenspace, knowledge of food conditioning, risk perceptions, coyote interaction severity,* and *previously called 311* (Fig 1.1). We controlled for respondent age and gender by regressing all other variables in the model on respondent age and gender. The path model was computed with the WLS estimator and linear regression in Mplus version 8.8 (Muthén and Muthén 1998). We assessed model fit locally by examining the residuals and globally using the following goodness-of-fit indices: chi-squared ($\Delta\chi2$, $\chi2$/df), root mean square error of approximation (RMSEA, an acceptable fit is < 0.05), standardized root mean residual

(SRMR, an acceptable fit is < 0.05), comparative fit index (CFI, an acceptable fit is > 0.90), and Tucker-Lewis index (TLI, an acceptable fit is > 0.90). In contrast to previous literature that explores reporting of wildlife using regression, using a path model allowed us to model both indirect and direct relationships between variables simultaneously, potentially better capturing the complex interactions between factors that may influence an individual reporting a coyote and reducing the risk of Type I error.

2.4 RESULTS

The questionnaire received a total of 5,926 responses. Of these, 4,959 responses came from Edmonton Insight Community members, 800 from the open weblink, 162 from the city surveys webpage, and 5 from the City of Edmonton website. Most respondents were over the age of 35 (85%). Over half were women (55%), did not identify as belonging to any marginalized or minority group (72%), and spoke English as the primary language in their household (93%). Complete descriptive information about the survey sample is detailed in Table 1, and complete survey results are provided in Appendix A.

Most respondents anticipated reporting a conflict-prone coyote more than a benign sighting, but only slightly (mean difference in scores = 0.734, median = 0). Most respondents (82%) had completed at least some post-secondary education (Table 1.1), and about one-quarter (28.7%) lived near a greenspace, ravine, or other natural area (Table 1.1). Individuals were generally knowledgeable about the consequences of food conditioning in coyotes (mean = 4.23 median = 4.00). On average, survey respondents were neutral regarding risk beliefs about coyotes (Cronbach's alpha = 0.897, composite mean = -0.061). Few respondents (11.1%) had experienced a severe interaction with a coyote, though most had seen a coyote within the past year (mean = 2.149, median = 2.00). All risk items mapped well onto a single construct representing overall risk perceptions (χ^2(2) =154.13, RMSEA = 0.11, CFI = 0.986, TLI = 0.96). Eleven percent of respondents had previously reported a coyote to the City of Edmonton 311.

Our final path model had good fit indices (Fig 2; χ^2(5) =35.224, RMSEA = 0.024, SRMR = 0.010, CFI = 0.982, TLI = 0.919), and the modification indices did not recommend any logical changes to our paths. Most of our path correlations were significant but had small effect sizes (Figure 2.2); converting the coefficients to R^2 values showed that significant correlations between path components explained between 0.03% and 15% of the variance. Six of the relationships in the path were consistent with our predictions: property on a greenspace increased with education and predicted more severe interactions with coyotes; severe interactions increased the likelihood of previously calling 311; more education reduced risk perceptions of coyotes; and the tendency to report a conflict over a benign sighting increased with lower risk perceptions and greater knowledge of food conditioning. Three of our predicted relationships were not significant in the final path model: knowledge of food conditioning did not increase the likelihood of having called 311, and neither interaction severity nor prior calls to 311 predicted a greater tendency to report conflict over benign sightings. One of our predicted relationships was significant, but opposite to what we expected; risk perceptions increased with knowledge of food conditioning.

2.5 DISCUSSION

Cities increasingly use citizen-provided reports of human-coyote interactions, but high volumes of reports that describe benign sightings of coyotes can increase the time spent processing all calls received and slow responses to reports that require management intervention. Using survey data in the City of Edmonton that described two sighting scenarios, we built a path model to test the potential direct and indirect causal effects of demographic, situational, cognitive, and experiential factors on an individual's tendency to report a conflict-prone coyote relative to a benign sighting of a coyote. We found moderate support for our predicted path, with our final path showing that a greater tendency to report conflict-prone coyotes decreased with risk perceptions and increased with knowledge of food conditioning. Risk perceptions, in turn, declined with education but increased with knowledge of the consequences of food conditioning in coyotes and predicted a greater likelihood of previous reporting. Previous reporting increased with the severity of past coyote interactions, which increased if respondents lived in property abutting greenspace and those residents had higher educations.

We found a positive association between proximity to greenspaces and more severe interactions with coyotes. This result was similar to patterns in California, where reported human-coyote conflicts disproportionately occurred in parks (Wilkinson et al. 2023), and Calgary, Alberta, where conflicts often occurred in small greenspaces and nearer to a river (Lukasik and Alexander 2011), and Colorado, where conflicts more commonly occurred in open and developing areas (Poessel et al. 2013). Coyotes in Edmonton are also known to access diverse anthropogenic resources along the ecotone between natural and residential areas (Raymond and St. Clair 2023), and exposure to these resources can contribute to habituation, food conditioning, poor health, and, ultimately, conflict-prone behaviour toward humans (White and Gehrt 2009, Murray et al. 2015*a*). Coyotes may also den in these ecotones, even incorporating anthropogenic materials into the structure of their dens (Raymond and St. Clair 2022). Human activity in greenspaces increases during the spring and summer months when coyotes are raising their pups, and conflicts are known to be more common during the pup-rearing season (White and Gehrt 2009, Farr et al. 2023, Wilkinson et al. 2023).

The positive relationship we found between knowledge of food conditioning and risk perceptions differed from our expectations, but we found support for our hypotheses that knowledge of food conditioning increased the tendency to report conflict, whereas higher risk perception reduced that tendency. Previous research has shown that knowledge can increase one's sense of agency over a situation and reduce risk perceptions (Poessel et al. 2017*a*), but we found that risk perceptions increased with knowledge of food conditioning. These apparently contradictory results may indicate two things. First, risk perceptions may approximate one's fear of a species (Hayman et al. 2014, Sponarski et al. 2018, Cimpoca and Voiculescu 2022), which is typically associated with less tolerance (Sponarski et al. 2018) and a greater likelihood of reporting the species whenever it is encountered (Hayman et al. 2014). Alternatively, our measures of risk perceptions may reflect respondents' awareness of the actual risks posed by coyotes, which are strongly associated with food conditioning (White and Gehrt 2009, Lukasik and Alexander 2011, Murray et al. 2015*a*). This awareness may also explain why respondents tended to be more concerned about the safety of children or pets than about their own personal safety. Although attacks on humans are rare, children are more commonly the victims of predatory attacks by coyotes (White and Gehrt 2009). Pets, meanwhile, are commonly involved in conflicts with coyotes (Alexander and Quinn 2011, Boydston et al. 2018), and areas with concentrations of pets and humans tend to be conflict hotspots (Poessel et al. 2017*a*). In addition to the risk of physical conflict, coyotes pose a risk of transmitting diseases to people and pets (Catalano et al. 2012, Houston et al. 2021). Messaging about diseases such as the tapeworm parasite *Echinococcus multilocularis* has increased in Edmonton (Houston et al. 2021), possibly bolstering public awareness of this risk.

As expected, those who had experienced a more severe interaction with a coyote in the past year were more likely to have higher risk perceptions, and they were more likely to have previously reported a coyote to the City of Edmonton 311 service. However, neither the severity of previous coyote interactions nor previous experience reporting to 311 significantly influenced whether an individual anticipated reporting a conflict-prone coyote relative to a benign sighting. Another study demonstrated that those who had experienced more interactions with black bears were likelier to report them (Wilbur et al. 2018). If the same applies to human-coyote interactions, individuals who live near coyote habitat and see coyotes more frequently may become sensitized rather than habituating to their presence, leading them to report even a benign sighting. Feedback or information provided to Edmonton residents by 311 operators may influence their perceptions of subsequent interactions with coyotes and what interactions warrant reporting.

There were some limitations to our survey and analytical approach that reduced the inferences our study can support. Importantly, the scenario we deemed benign, where a coyote stopped on a path 15 m away, would be much closer than many people have been to a coyote, even with the high rates of coyote observations our respondents described. This may have reduced the difference in conflict potential people perceived between the two scenarios and contributed to the generally small effect sizes we detected as predictors of our response variable for reporting conflict relative to benign scenarios. A second limitation is that people's hypothetical responses to survey scenarios often overestimate their actual actions (Celik and Cagiltay 2024, Mori et al. 2024), and they may also have reduced the difference between the two scenarios. Third, although our sample was large, it was non-random. Most respondents were Edmonton Insights volunteers, and our sample was biased toward English speakers, women, older adults, people with some secondary education, and pet owners, and is therefore not fully representative of all Edmontonians. Finally, our analysis focused on refining the types of reports received by the City of Edmonton 311 based on the needs the City has expressed. However, some municipalities may find value in reports of benign sightings. Other changes, such as modifying reporting systems to separate "benign" and "conflict-prone" reports, could offer the benefit of more information while still allowing managers to quickly and efficiently address conflict-prone scenarios.

Our results suggest that educational messaging to increase the frequency of reporting conflict-prone relative to benign observations of coyotes should be targeted in areas and seasons where coyotes are more frequently encountered, such as in residential areas adjacent to natural areas and during pup-rearing, when conflicts are more likely to occur. Educational messaging should promote knowledge of the conflict associated with food conditioning in coyotes and support realistic assessment of the risks posed by coyotes. This messaging should teach people to distinguish benign behaviour by coyotes in natural areas from food-seeking, conflict-prone behaviour in residential areas, where it might be mitigated with aversive conditioning (Sponarski et al. 2016, 2019, Lajeunesse et al. 2023). Lastly, 311 operators may be uniquely positioned to provide education when they receive a report by helping people identify conflict-prone behaviour and directing individuals to additional sources of information. While our study focused on coyote reporting to a civic call centre, similar practices could be applied to other entities that receive reports about wildlife species in conflict with humans, including bears (*Ursus spp.*) (Cimpoca and Voiculescu 2022, Parchizadeh et al. 2023, Ullah et al. 2023), elk (*Cervus canadensis*) (Found et al. 2018), and leopards (*Panthera pardus*) (Badhe and Jaybhaye 2023).

2.6 ACKNOWLEDGEMENTS

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2.7 TABLES

Table 2.1. Descriptive statistics for respondent demographics.

Demographic Item		Frequency	Percent
Age			
	18-24 years old	89	1.5
	25-34 years old	683	11.5
	35-44 years old	1210	20.4
	45-54 years old	1085	18.3
	55-64 years old	1264	21.3
	65 to 74 years old	1096	18.5
	75+ years old	228	3.8
	I prefer not to answer	266	4.5
	Under 18 years old	5	0.1
Gender			
	Man	2165	36.5
	Woman	3270	55.2
	Other	81	1.4
	I prefer not to answer	410	6.9
Membership in marginalized or minority groups			
	Racialized visible minority	356	6.0
	Persons with disabilities	407	6.9
	New to Canada	48	0.8
	None of these	4263	71.9
	Other	193	3.3
	I prefer not to answer	649	11.0
Primary language spoken in household			
	Arabic	4	0.1
	Cantonese	17	0.3
	English	5501	92.8
	French	36	0.6
	German	8	0.1
	Mandarin	6	0.1
	Other (Please specify)	72	1.2
	Punjabi	10	0.2
	Spanish	17	0.3
	Tagalog (Pilipino, Filipino)	11	0.2
	Ukrainian	14	0.2
	I prefer not to answer	230	3.9
Education			
	Elementary/grade school graduate	28	0.5
	High school graduate	577	9.7
	College/technical school graduate	1596	26.9

University undergraduate degree	1955	33.0
Post-graduate degree (e.g. Masters, PhD)	1094	7.4
Professional school graduate (e.g. medicine, dentistry, veterinary medicine, optometry)	239	4.0
I prefer not to answer	437	7.4

2.8 FIGURES

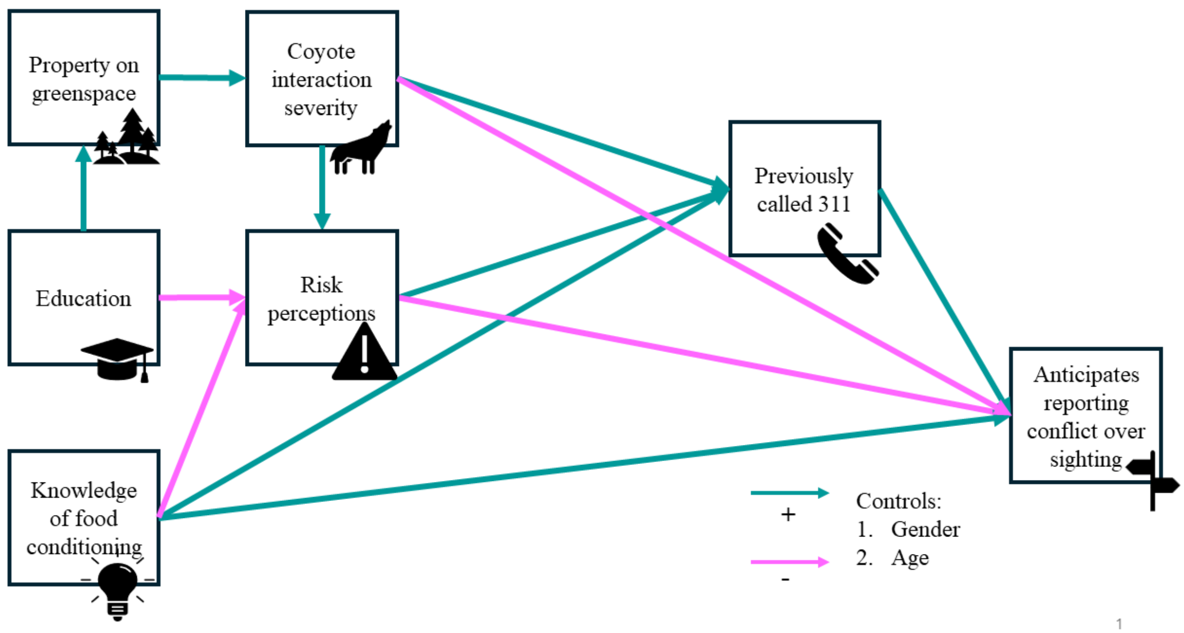

Fig 2.1 Hypothesized path model showing tendency to report a conflict-prone coyote as a function of demographic, situational, cognitive, and experiential variables. Paths hypothesized to be positive are shown in light blue, and paths hypothesized to be negative are shown in pink.

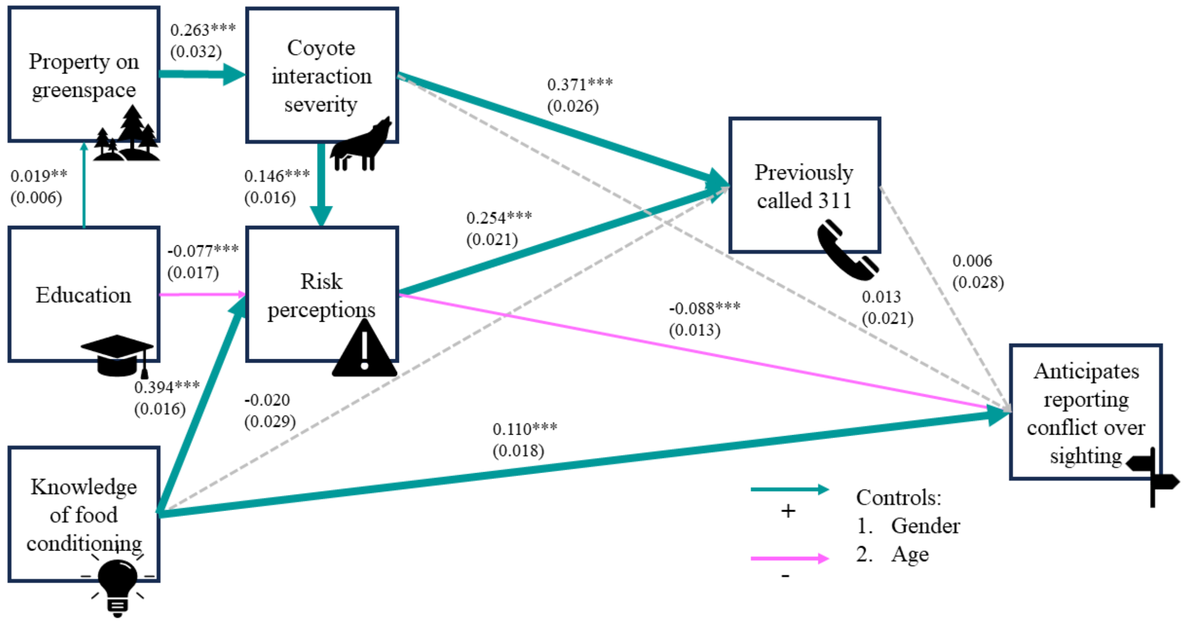

Fig 2.2 Final path model showing tendency to report a conflict-prone coyote as a function of demographic, situational, cognitive, and experiential variables. Parameter estimates are displayed above their corresponding path with standard errors in parentheses. * indicates a path was significant at $p \leq 0.05$, ** for $p \leq 0.01$, and *** indicates that a path was significant at $p \leq 0.001$. Thicker paths indicate stronger causal relationships. Positive causal relationships are shown in blue, and negative relationships are shown in pink. Dotted lines denote paths that were not significant at $p \leq 0.05$.

Chapter 3

Attraction to birdseed by non-target wildlife and implications for management of urban coyotes (*Canis latrans*)

3.1 ABSTRACT

Conflicts between humans and coyotes are increasing in urban areas across North America. Conflicts are often driven by access to anthropogenic food. In many cities, birdseed is an abundant but potentially underappreciated source of anthropogenic food that may attract coyotes (*Canis latrans*) and their prey to residential yards. As a result, birdseed may contribute to food conditioning and poor health in coyotes and could promote the transmission of zoonotic diseases, such as tapeworms that rely on canid and rodent hosts. We explored the attraction to birdseed, inadvertently spilled beneath feeders, by coyotes and mouse-sized rodents in 44 residential yards near urban greenspaces in Edmonton, Alberta. We used a before-after control-impact (BACI) study design to test whether seed hoops mitigate coyote and rodent attraction to bird feeders by reducing the accessibility of spilled birdseed. Coyotes and rodents visited bird feeders in most yards, but seed hoops did not significantly decrease the detection rates of either group. Coyotes tended to visit feeders that were located closer to the edge of a greenspace and provided sunflower seeds over those that were farther from the greenspace and provided mixed seed. Our results suggest that individuals who feed birds can discourage coyotes by placing feeders away from greenspace edges and providing seeds that are less palatable to coyotes. This study identifies potential strategies for mitigating coyote attraction to residential yards, thereby reducing the potential for human-wildlife conflicts and disease transmission.

3.2 INTRODUCTION

Conflicts between humans and coyotes (*Canis latrans*) are increasing in cities across North America (White and Gehrt 2009, Quinn et al. 2016, Farr et al. 2023). Generalist diets help coyotes to thrive in cities where they eat natural prey such as mice and voles (Cricetidae), other small mammals, berries, and anthropogenic resources such as garbage, cultivated fruits, compost, and birdseed (Murray et al. 2015*a*, Poessel et al. 2017*b*, Jensen et al. 2022). While coyotes play critical ecological roles as predators and seed dispersers, they can become involved in conflicts with humans when they become habituated to people or conditioned to associate people with food, creating risks for people and pets through aggressive behaviour and attacks. Coyotes can also carry diseases that may infect humans and pets (Roe et al. 2020, Worsley-Tonks et al. 2021), including the tapeworm *Echinococcus multilocularis* (hereafter *Em*) (Leiby et al. 1970, Gesy et al. 2013). This tapeworm relies on canids and rodents to complete its life cycle but it can infect humans when they accidentally ingest the microscopic eggs deposited in coyote scat (Houston et al. 2021) that may then contaminate soil (Inaba et al. 2003), vegetation (Lass et al. 2015), or pet fur (Nagy et al. 2011). In humans, *Em* causes human alveolar echinococcosis (AE), a disease that has a long incubation period, is difficult to diagnose, and has a lethality rate of 90% if left untreated (Massolo et al. 2019, Houston et al. 2021). AE has been detected in 34 Albertans to date (K Kowalewska-Grochowska, personal communication), far more than any other jurisdiction in North America. In Alberta, the hosts of *Em* include southern red-backed voles (*Clethrionomys gapperi*), meadow voles (*Microtus pennsylvanicus*), deer mice (*Peromyscus maniculatus*), and coyotes (Catalano et al. 2012, Liccioli et al. 2013, 2015), with coyotes in Edmonton, AB exhibiting an estimated prevalence of 53% (Sugden et al. 2020) to 62.5% (Catalano et al. 2012, Luong et al. 2020).

The potential for physical human-wildlife conflict, such as aggressive behaviour and attacks on humans (White and Gehrt 2009, Lukasik and Alexander 2011, Nowak et al. 2021), and the spread of zoonotic disease (Murray et al. 2016*a*, Sugden et al. 2023) can be increased by wildlife access to anthropogenic sources of food. Coyotes that regularly access anthropogenic resources and assimilate less protein into their diets are more likely to have poor health and carry tapeworms (Murray et al. 2015*a*, 2016*b*, Sugden et al. 2020). In turn, coyotes in poor health may have lower immunity to disease and are more likely to enter residential yards (Murray and St. Clair 2017) and become involved in conflicts with people and pets (Murray et al. 2016*b*, Sugden et al. 2020).

Birdseed is a common anthropogenic source of food that coyotes may access (Murray et al. 2015*a*, Poessel et al. 2017*b*), particularly in unfenced backyards that border greenspaces (Raymond and St. Clair 2023). Birdseed was detected in approximately one-third of coyote scats found near dwellings in Edmonton, Alberta (Raymond and St. Clair 2023), suggesting that it is an important but underestimated anthropogenic source of food for some urban coyotes. Although coyotes may readily consume birdseed, birdseed is difficult for coyotes to digest and may diminish their health. The health of coyotes may be further diminished through exposure to mycotoxins produced by fungi that grow on fallen birdseed (Hussein and Brasel 2001), as similar mycotoxins in compost appear to compromise coyote health (Murray et al. 2015). Birdseed may not only directly attract coyotes, but also indirectly attract them by drawing in prey species (Reed and Bonter 2018, Hansen et al. 2020), including mice and voles that also carry *Em.* While anthropogenic sources of food are known to contribute to food conditioning, physical human-wildlife conflict, and disease transmission, the impacts of birdseed on non-avian taxa are relatively understudied in the literature (Orros and Fellowes 2012, Orros et al. 2015, Reed and

Bonter 2018). If birdseed directly attracts coyotes, it may contribute to food conditioning and subsequent physical conflict with humans and pets. If birdseed also attracts rodents, it could accelerate interspecific disease transmission and increase the risk of exposure for humans to eggs shed in coyote feces.

The risk of physical human-coyote conflict and zoonotic disease transmission can be reduced through comprehensive, proactive management, including mitigating access to food attractants (Proctor et al. 2018). Citizens can contribute to these efforts by removing attractants in their yards or by making these attractants less accessible to coyotes and their prey. For bird feeders, a suspended catcher (hereafter "seed hoop") may represent a simple, affordable management tool (Theimer et al. 2015, Reed and Bonter 2018). Seed hoops vary in construction but typically include a porous tray suspended below a bird feeder to prevent birdseed that is jostled or thrown from the feeder from falling to the ground. Seed hoops are readily available, but their efficacy for reducing mammal attraction to bird feeders has not been assessed in the scientific literature. Measuring the role of birdseed as a direct and indirect coyote attractant and assessing the efficacy of seed hoops could aid in reducing the potential for human-coyote conflict and disease transmission associated with wildlife feeding.

Our study had three main objectives. First, we aimed to quantify activity at bird feeders in residential yards by coyotes and mouse-sized rodents that may carry *Em.* If birdseed attracts these animals, we expected to detect coyotes and mouse-sized rodents at bird feeders in yards via remote cameras and track and hair tubes. Second, we aimed to assess whether seed hoops reduce coyote and rodent attraction to bird feeders in residential yards. If seed hoops reduce attraction, we expected fewer detections of coyotes and rodents after the installation of seed hoops compared to (a) the same bird feeders before seed hoop installation and (b) bird feeders without seed hoops. Third, we sought to determine what other features of bird feeders and yards, such as the distance between the bird feeder and the nearest greenspace, food type offered, and the presence of other coyote attractants in the yard, influence both coyote and rodent detections at bird feeders in residential yards.

3.3 STUDY AREA

Our study took place in residential neighbourhoods in Edmonton, Alberta, Canada (53°32′04″N 113°29′25″W), a city of approximately 650 km^2 that hosts a population of approximately 1 million people (City of Edmonton 2019, Government of Alberta 2023). Located within the aspen parkland region of Alberta, Edmonton is characterized by a humid continental climate with mild summers (Jun-Sept) and cold winters (Nov-Mar) (Government of Canada 2024). Although Edmonton has extensive and increasing urban sprawl, the city also includes over 70 km^2 of urban greenspace and natural areas along the North Saskatchewan River Valley and its numerous adjoining ravines (City of Edmonton 2022*a*, *b*). Our study sites consisted of unfenced residential yards directly adjoining or, if residents reported seeing coyotes near their homes, near such urban greenspaces. Most greenspaces along the River Valley and in ravines were forested, dominated by coniferous trees, aspens, and shrubs, and had sloped ground, though some contained maintained grass lawns and sections of flatter topography.

3.4 METHODS

In the summer of 2023, we gained permission from residents to access 44 residential yards located on or near greenspaces (e.g., natural areas along ravines and the river valley, powerline rights-of-way, and similar spaces) throughout Edmonton, Alberta. We prioritized yards that lacked coyote-proof fences and which already had established bird feeders, though we included five yards that installed a suspended bird feeder for the purpose of supporting our study.

In each yard, we recorded the food type provided, the shortest straight-line distance from the bird feeder to the nearest greenspace, and the presence of other attractive features that may influence mammal activity. We recorded food type as either sunflower seeds or mixed seed, with the latter including mixed seed, bitter safflower, changes in seed offerings, and peanuts. We characterized attractive features according to four categories as described by Raymond and St. Clair (2023): hiding cover, prey habitat, anthropogenic sources of food, and novel objects. We defined hiding cover as the approximate area covered by sheltered areas accessible to coyotes, such as space under decks, sheds, and trees with low branches. We defined prey habitat as the approximate area covered by brush piles, stacks of wood rounds, rock retaining walls with small gaps, piles of lawn clippings, and similar items that may be attractive to mouse-sized rodents. We counted the number of anthropogenic sources of food in the yard including compost piles, pet food, fallen fruit, and small pets such as cats and small dogs that coyotes may perceive as prey. Last, we counted the number of novel objects that may interest coyotes, such as mittens and gloves, balls and other children's and pet toys, and discarded plastic pots.

We monitored coyote activity in each yard using motion-triggered infrared trail cameras (Reconyx Hyperfire PC900 and Browning BTC-7E-HP4). We affixed cameras to stakes, trees, or similar objects ~2.5 m away from bird feeders at a height of ~0.5 m. We aimed the cameras slightly downward to ensure they would capture animal activity beneath the bird feeder. We programmed the cameras to take a burst of three photos when triggered with no delay or quiet period. Because these cameras may not reliably detect mouse-sized rodents, we monitored rodents using combination track and hair tubes (Oyer 1946, Chiron et al. 2018) (Figure 3.1). The tubes were constructed from 30 cm long sections of 7.62 cm diameter PVC pipe. We cut slits horizontally into each opening, into which we placed strips of double-sided indoor/outdoor carpet tape (Cantech) to collect hair from animals as they moved through the tube (Schwingel and Norment 2010). Inside the tube, we placed a track plate made of corrugated plastic with a felt inkpad in its centre and sections of transparent contact paper (Con-Tact) taped to each side to record the tracks of animals that moved through the tube. We initially loaded the inkpads on the track plate with a freeze-resistant "ink" made of finely powdered charcoal blended into a mixture of 2 parts water to 1 part glycerin (Lane 1925), but later switched to non-reflective Sight Black spray (Birchwood-Casey), which was easier to use in the field and dries quickly to leave behind a fine carbon black powder. We baited the tubes with a small smear of peanut butter to encourage animals to enter the tubes. At each site, we placed one track and hair tube in the center of spilled birdseed beneath the bird feeder and pinned tubes to the ground with garden staples or tent stakes to reduce the risk of animals moving or disturbing them. We visited each site approximately every two weeks, during which we checked camera function, replaced carpet tape and contact paper, and replenished the ink and bait in the tubes.

We assessed the efficacy of seed hoops as a management tool for reducing coyote and rodent attraction to bird feeders using a before-after control-impact (BACI) study design (Stewart-Oaten et al. 1986, Christie et al. 2019). Yards were non-randomly divided into experimental and control groups to ensure both groups contained yards with similar features. Halfway through the study period, we installed 30" seed hoops (Seed-Hoop, Songbird Essentials) on feeders in yards assigned to the experimental group (Figure 3.2).

The cameras functioned for ~99 days from October through December 2023 for a total of ~4,356 trap nights. Photos were then uploaded into Wildtrax software (Bayne et al. 2018) for tagging. In Wildtrax, we separated images into independent detections (defined as detections of animals that occurred at least 30 minutes apart) and then scanned for sequences containing coyotes using the built-in Megadetector AI. We manually scanned the photo sets to ensure no sequences containing coyotes were misclassified and corrected any misidentified sequences. For each sequence containing a coyote, we tagged the number of coyotes present in the image, whether they approached the feeder, whether they interacted with the rodent track and hair tube beneath the feeder, and whether they showed any signs of poor health (e.g., injury, hair loss, otherwise poor body condition).

We collected tape and contact paper from each rodent track and hair tube during each site check. If the tape contained hair, we gently loosened the hair from the adhesive using isopropyl alcohol and placed one to five hairs onto a glass slide. We sealed glass cover slips over the hairs using clear nail polish (Sally Hansen Xtreme Wear). We then viewed the hairs under a compound microscope and identified them to the lowest taxonomic level possible by comparing them to reference slides prepared from museum specimens and information provided on the Alaska Fur ID Project website (Carrlee and Horelick 2010) and in several keys (Mathiak 1938, Oyer 1946, Mayer 1952). When tracks were found on contact paper, we pressed the adhesive side of the contact paper to a sheet of plain white printer paper to create a semi-permanent record of the tracks. We then identified tracks to the lowest taxonomic level possible using Elbroch and McFarland (2019) and had track identifications reviewed by a certified tracker (Sage Raymond). Due to the difficulty of identifying tracks and hair to species with confidence, we binned mouse and vole species into a single category, "mice and voles".

We quantified activity at bird feeders by coyotes by calculating the mean, median, SD, and range of weekly and total coyote visits to feeders (hereafter "visits", defined as sequences during which a coyote approached the feeder) across all sites. To control for the potential attractive effect of the rodent track and hair tubes, we removed from the analysis visits during which a coyote showed interest in the tube (e.g., by licking, biting, carrying, or otherwise investigating or manipulating the tube). We also quantified detections of only visibly diseased coyotes at bird feeders. In this case, we calculated the mean, median, SD, and range of weekly and total visits to feeders made by diseased coyotes regardless of whether they interacted with the track and hair tube. We assessed activity at bird feeders by mouse-sized rodents by calculating the mean, median, SD, and range of the number of site check periods during which a mouse-sized rodent was detected at each feeder. Finally, we also recorded all other mammal species detected at feeders across all sites, but we did not quantify activity at bird feeders by these species.

We analyzed the effect of seed hoops on coyote and rodent attraction to bird feeders by building generalized linear mixed models (GLMMs) using the function glmmTMB in the R package glmmTMB (Brooks et al. 2017). For coyotes, we created a GLMM with a negative binomial distribution (accounting for overdispersion of count values) modeling weekly coyote visits as a function of each site's treatment category (control or experimental), the treatment period (before or after the installation of seed hoops), and the interaction of treatment category and treatment period with site as a random effect to account for heterogeneity between sites and repeated measures through time. For mouse-sized rodents, we built a GLMM with a binomial distribution that modelled rodent presence or absence during each site check period as a function of each site's treatment category, treatment period, and the interaction between treatment category and treatment period with site as a random effect. Because the duration of each site check period varied somewhat and tubes were sometimes removed or damaged by coyotes, we included an offset term for the number of days that each tube was operational during each site check period. In both models, a significant interaction term would indicate a statistically significant effect of seed hoops on coyote and rodent attraction to bird feeders.

We explored the influence of other feeder and yard characteristics on coyote and mouse-sized rodent activity at bird feeders using a series of univariate generalized linear models (GLMs). For coyotes, we used negative binomial GLMs to examine total coyote visits to feeders at each site as a function of (1) food type provided at the feeder, (2) distance from the feeder to the nearest greenspace, (3) approximate area of hiding cover, (4) approximate area of prey habitat, (5) counts of anthropogenic food items and small pets, and (6) counts of novel objects in each yard. In each model, we included an offset term for the number of days each camera was active. For rodents, we created a series of Poisson GLMs examining the number of site check periods during which mouse-sized rodents were detected as a function of the same predictors as above with an offset term for the number of days each track and hair tube was operational. For our rodent model, we removed small pets (e.g., cats and dogs) from the count of potential sources of anthropogenic food.

3.5 RESULTS

We monitored coyotes and mouse-sized rodents for approximately three months at 44 bird feeders in residential yards near urban greenspaces. Halfway through our study period (~7 weeks), we installed seed hoops at 21 feeders that we assigned to our treatment group, while the remaining 23 feeders served as controls. Twenty-two sites provided sunflower seeds in the feeder, while the other 22 provided other sources that included mixed seed ($n = 15$), bitter safflower ($n = 4$), variation in seed types ($n = 2$), or peanuts ($n = 1$). On average, feeders were 14.20 m from the nearest greenspace, but with considerable variation (median = 5.50 m, SD = 25.9 m, range = 0 to 152 m). Twenty-two yards contained hiding cover such as sheltered space under decks, sheds, or trees with low branches (mean area = 1.64 m^2, SD = 5.32 m^2, range = 0 to 25 m^2). Twenty-seven yards contained prey habitat such as brush piles, wood rounds, and rock retaining walls (mean area = 3.02 m^2, SD = 6.41 m^2, range = 0 to 41 m^2). Twenty-eight yards contained anthropogenic sources of food such as compost, fallen apples, food wrappers in accessible garbage, pet food, or small pets (mean count = 0.91 items, SD = 0.83 items, range = 0 to 3 items). Twenty-six yards contained novel objects including gloves and mittens, hats, pet toys, and children's toys (mean count = 1.23 items, SD = 1.49 items, range = 0 to 6 items).

We detected coyotes (including diseased animals) visiting feeders at 36 / 44 sites (81.8%), with significant variation in the number of times they visited each feeder. Coyotes visited feeders an average of 1.19 times per week (median = 0 visits/week, SD = 2.03 visits/week, range = 0 to 12 visits/week) and 15.4 times during the three-month study (median = 9 visits, SD = 18 visits, range = 0 to 71 visits). Visibly diseased coyotes visited feeders an average of 0.16 times per week (median = 0 visits/week, SD = 0.76 visits/week, range = 0 to 8 visits/week) and 2.11 times over the whole study (median = 0 visits, SD = 6.76 visits, range = 0 to 41 visits). Mouse-sized rodents were detected at 26 feeders and were detected during an average of 1.25 site check periods per site (median = 1 site check period, SD = 1.37 site check periods, range = 0 to 5 site check periods). Other mammal species detected at feeders included red squirrels (*Tamiasciurus hudsonicus*), northern flying squirrels (*Glaucomys sabrinus*), porcupines (*Erethizon dorsatum*), white-tailed jackrabbits (*Lepus townsendii*), snowshoe hares (*Lepus americanus*), white-tailed deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*), domestic cats (*Felis catus*), domestic dogs (*Canis familiaris*), striped skunks (*Mephitis mephitis*), and red foxes (*Vulpes vulpes*).

For coyotes, we found no effect of seed hoops on visit frequency, no change in visits in the before and after treatment periods, and no interaction between treatment and treatment period (Table 3.1, Figure 3.3). Similarly, seed hoops had no effect on the probability of rodent detections, but the probability of decreased significantly in the second (after) treatment period (Table 3.1, Figure 3.3). Among the other variables we measured, visits to feeders by coyotes declined with increased distance between the feeder and nearest greenspace ($\beta = -0.03$, SE = 0.01, $p = 0.008$) (Figure 3.4). Coyotes visited feeders that offered sunflower seeds significantly more often than those that provided mixed seed ($\beta = 0.72$, SE = 0.28, $p = 0.0113$) (Figure 3.5). None of the feeder and yard characteristics we measured had a statistically significant effect on mouse-sized rodent detections at bird feeders.

3.6 DISCUSSION

Birdseed that spills from feeders potentially attracts diverse wildlife, including coyotes, in urban areas and may contribute to the spread of zoonotic parasites. In this study, we explored attraction to bird feeders in residential yards by coyotes and mouse-sized rodents using a BACI study design, remote cameras, and track and hair tubes to determine whether seed hoops reduced the attraction of these species to bird feeders. We also investigated how other characteristics of bird feeders and yards influenced the attraction of coyotes and mouse-sized rodents to bird feeders. Although coyotes and mouse-sized rodents visited feeders at most of the 44 sites we monitored, seed hoops did not reduce their attraction to bird feeders. Instead, coyotes more often visited feeders that were closer to a greenspace and feeders that provided sunflower seeds. None of the feeder or yard characteristics we measured had a significant influence on mouse-sized rodent detections at bird feeders.

Coyote visitation to a majority (36/44 or 82%) of the feeders we monitored suggests ubiquitous attraction to this source of anthropogenic food. However, we typically could not determine whether coyotes were consuming birdseed from still photos, often taken in the dark, that showed coyotes investigating the area around the feeder with their heads low to the ground. Additionally, we did not compare coyote visits to bird feeders to the absolute use of yards by coyotes. Still, previous research has found birdseed in the diets of coyotes across North America, including in Alberta (Raymond and St. Clair 2023, Raymond et al. 2024), New York (Duncan et al. 2020, Peterson et al. 2020), Colorado (Poessel et al. 2017*b*), and California (Larson et al. 2020). Rodents such as deer mice and southern red-backed voles may rely more heavily on seeds during the fall and winter (Jameson 1952, Lindroth and Batzli 1984). This coincides with the time of year when coyotes are known to consume more mammalian prey (Bowyer et al. 1983) and more seeds (Sperry 1933, Poessel et al. 2017*b*, Peterson et al. 2020), presenting an opportunity for spatial overlap and, subsequently, the transmission of diseases like *Echinococcus multilocularis.* In addition to coyotes and mouse-sized rodents, we detected a wide variety of other mammal species visiting feeders, including red foxes, domestic dogs, and domestic cats. All three of these taxa are potential hosts for *Em* and other parasites (Deplazes et al. 2011, Poulle et al. 2017), and domestic pets pose the additional risk of exposing humans to tapeworm eggs that become stuck to their fur (Nagy et al. 2011). The wide variety of mammals detected at bird feeders also provides opportunities for black-legged ticks (*Ixodes spp.*) during warmer months. Indeed, black-legged ticks, which are vectors for diseases including human granulocytic ehrlichiosis, babesiosis, and Lyme disease, have been found to congregate below bird feeders where they can easily quest for hosts including mice, voles, and coyotes (Kowalczyk and Smith 2008).

Given evidence that coyotes frequently consume birdseed in Edmonton (Raymond and St. Clair 2023), we were surprised that the installation of seed hoops had no effect on the visitation rates of coyotes. Similarly, the well-known attraction of mice and voles to seed (Janzen 1971, Pennycuik and Cowan 1990) made it surprising that seed hoops did not alter their detection rates either. It is possible that our study period was too short to see an effect. Reliable food sources are a powerful attractant to wildlife, and animals may persistently return to resource sites (Northrup and Boyce 2012) even after the resource is gone (Benn and Herrero 2002, St. Clair et al. 2019). Although previous literature suggests that rapid tracking of changing resources is exhibited by both coyotes (Gilbert-Norton et al. 2009) and rodents (Price and Waser 1985), the availability of accessible birdseed on the ground likely varied at each site. This variation in the accessibility of birdseed over time could serve as a form of intermittent reinforcement, which is known to slow the extinction of behaviours (e.g., returning to a specific bird feeder to acquire birdseed) (Górecki et al. 2023). However, if seed hoops are ineffective, individuals who feed birds may instead consider other methods that deter mammals from consuming birdseed, such as coating seeds in capsaicin which is unpalatable to mammals but does not affect birds (Fitzgerald et al. 1995, Curtis et al. 2000, Taylor et al. 2020), and using styles of feeders that are less accessible to non-target taxa (Willcox et al. 2014).

In contrast to the lack of effect of seed hoops, we found that visitation counts by coyotes were influenced by the characteristics of yards and feeders. Coyotes more often visited feeders located close to greenspace edges and feeders that provided sunflower seeds more than those that provided mixed seed. Feeders located closer to greenspace edges may be perceived as safer and more secure to coyotes by allowing them to remain closer to hiding cover. However, the proximity of hiding cover and attractants could also increase opportunities for coyotes to learn to associate human-dominated areas with food and reduce their typical avoidance of humans, fostering the potential for conflict with people and pets. Opportunities for food conditioning are increased by the prevalence of coyote dens in greenspaces near residential areas in Edmonton (Raymond and St. Clair 2022), which amplifies exposes for coyote pups in two ways; younger animals tend to suffer higher parasite loads than their older counterparts (Sugden et al. 2023), and young coyotes learn habituation to humans from their parents (Schell et al. 2018). The greater attraction of coyotes to sunflower seeds may stem from their relatively high rates of fat and protein (Jenkins and Ascanio 1993), which also attracted wild coyotes in Kansas (Sovada et al. 2000). In a choice experiment, sunflower seeds were preferred to other seed types by both raccoons (*Procyon lotor*) and gray squirrels (*Sciurus carolinensis*) (Brown 2021). We were surprised that none of the feeder and yard characteristics we measured had a significant effect on rodent detections. It is possible that relatively reliable supplemental foods like birdseed, regardless of type, are particularly attractive resources for rodents, especially as seasons change to harsher winter conditions (Johnsen et al. 2017), and the attractive effects of birdseed may be highly localized within a yard (Hansen et al. 2020).

Our study had several features that limit the inferences we can offer about the efficacy of seed hoops in reducing attraction by non-target wildlife. First, the feeder styles varied across our study sites. Some styles may have been more prone to spillage than others (Willcox et al. 2014), and the feeder style, food type provided, and location of the site could have attracted different species of birds (Willcox et al. 2014) which may have varied in their tendency to discard unwanted seeds by tossing them to the ground. Second, the hoops themselves may have been jostled by the wind or animals, reducing their effectiveness at keeping birdseed off the ground. Third, we experienced unusually mild weather conditions and a lack of snow cover over our study period, which may have influenced the accessibility of resources, including birdseed, and the behaviours of taxa that visit bird feeders. Fourth, we likely underestimated rodent detections because our tubes were often damaged or moved by coyotes, and rodents may not have entered the tubes. Fifth, the scent of peanut butter in the track and hair tubes may have also provided a consistent attractant to non-target taxa even after the installation of seed hoops. Finally, the relatively short time period of our study may not have provided us with enough time to see the effect of seed hoops if non-target taxa continued to visit the feeder even after birdseed was not readily accessible on the ground (Baral et al. 2022). Future research could address these issues and potentially draw stronger conclusions about the efficacy of seed hoops.

While bird feeding is a popular activity that can foster an interest in and sense of connectedness to nature among urban residents (Cox and Gaston 2018), those who feed birds should take steps to reduce its attractiveness to non-target taxa such as coyotes. These actions might include placing bird feeders away from greenspace edges and other types of hiding cover, providing foods other than sunflower seeds or coating seeds in substances that are unpalatable to mammals (Curtis et al. 2000, Taylor et al. 2020), and regularly maintaining and cleaning feeders and the areas around them. People can also use bird feeder styles that are less prone to spillage and access by non-target taxa (Willcox et al. 2014) and employ other strategies that reduce coyote attraction to residential yards, such as installing fences and securing other attractants (Baker and Timm 2017, Murray and St. Clair 2017, Raymond and St. Clair 2023). Further research can help refine best practices for provisioning birds that reduce deleterious consequences and identify low-impact ways for urban residents to connect with nature.

3.7 ACKNOWLEDGEMENTS

We respectfully acknowledge that our work was conducted on Treaty 6 Territory, which is a traditional gathering place for many Indigenous peoples, including the Anishinaabe/Ojibway/Salteaux, Blackfoot, Cree, Dene, Inuit, Iroquois, Nakota Sioux, Métis, and others. We are grateful to the many residents of Edmonton who participated in this study. Not only did they graciously allow us to access their yards, but they provided valuable observations and insights about the wildlife with whom they share space. We thank Sage Raymond for her tracking expertise and other helpful insights, Cameron Keller and Kate Rutherford for their helpful feedback and guidance on our analyses and associated code, and Cameron Keller and Noah Nelson for reviewing early drafts of this manuscript. Funding for this study was provided by an NSERC Discovery Grant to CCSC (RGPIN-2023-04892).

3.8 ETHICS STATEMENT

We received a research and collection permit from Alberta Environment and Parks (General Research and Collection Permit #23-451) and approval from the University of Alberta Animal Care and Use Committee (AUP00004431) to use baited track and hair tubes to monitor small rodents and to use trail cameras to monitor coyotes and other taxa.

3.9 TABLES

Table 3.1 Estimated regression parameters, standard errors, z-values, and p-values for change in detections of coyotes and mouse-sized rodents at 44 residential yards with bird feeders in Edmonton, Alberta.

	Measure	Effect	β	Standard Error	Z-value	p-value
Coyotes	Weekly coyote visits	Intercept	-0.48	0.29	1.66	0.10
		Treatment category (Control-Impact)	0.73	0.41	0.18	0.86
		Treatment period (Before-After)	0.02	0.15	0.13	0.90
		Treatment category:treatment period (BACI)	-0.01	0.21	0.05	0.96
Mouse-sized rodents	Detection during each site check period	Intercept	-3.52	0.40	-8.79	<2e-16
		Treatment category (Control-Impact)	-0.57	0.60	-0.95	0.34
		Treatment period (Before-After)	-1.85	0.50	-3.67	0.00
		Treatment category:treatment period (BACI)	0.75	0.72	1.04	0.30

3.10 FIGURES

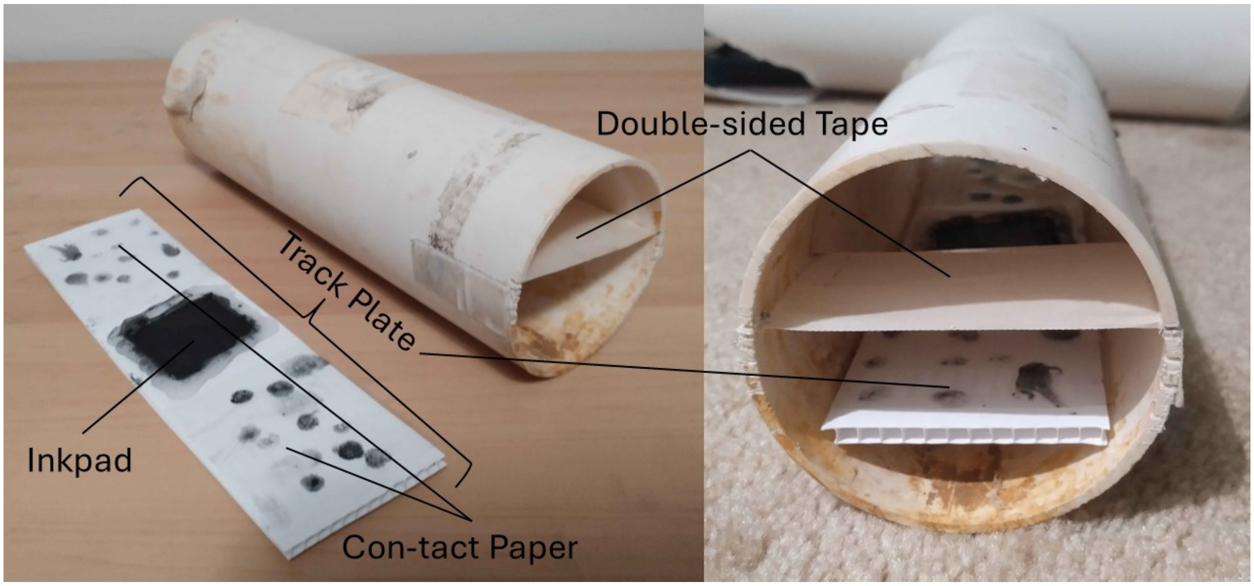

Fig. 3.1 Combination track and hair tube used to monitor small rodents. From October through December 2023, we monitored coyote and mouse-sized rodent activity at bird feeders in residential yards near urban greenspaces in Edmonton, Alberta (n = 44).

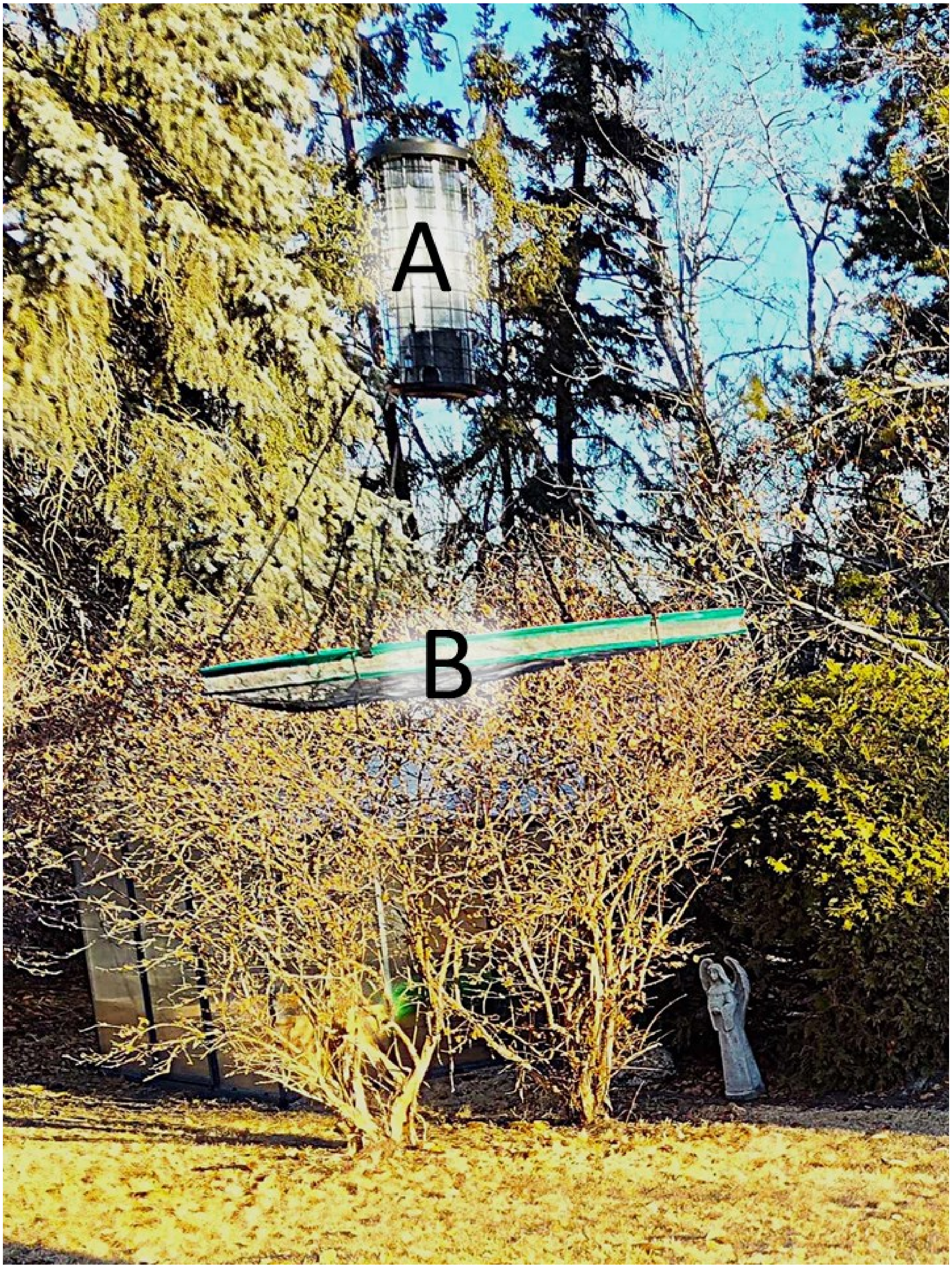

Fig. 3.2 Seed hoop setup. Example of a bird feeder (A) with a 30” diameter seed hoop (B) installed beneath it.

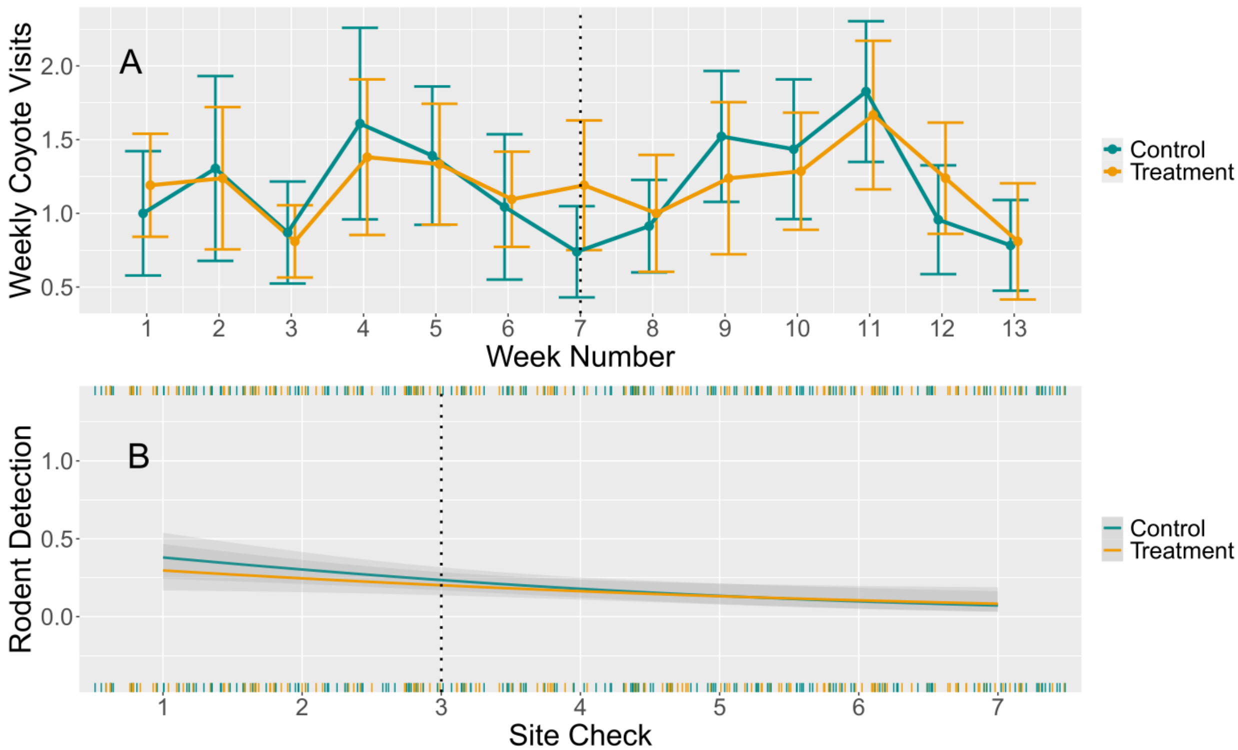

Fig. 3.3 Average weekly visits by coyotes (A) and estimated detection probabilities at bi-weekly site checks for mouse-sized rodents (B) to feeder sites in residential yards that were treated with seed hoops (n = 21, yellow lines) or served as controls (n = 23, green lines) over 8 weeks in October through December 2023 in Edmonton, Alberta. Error bars in panel A represent standard error and shaded areas in panel B represent 95% confidence interval. The vertical dotted line in both graphs represents the timing of seed hoop installation at treatment sites.

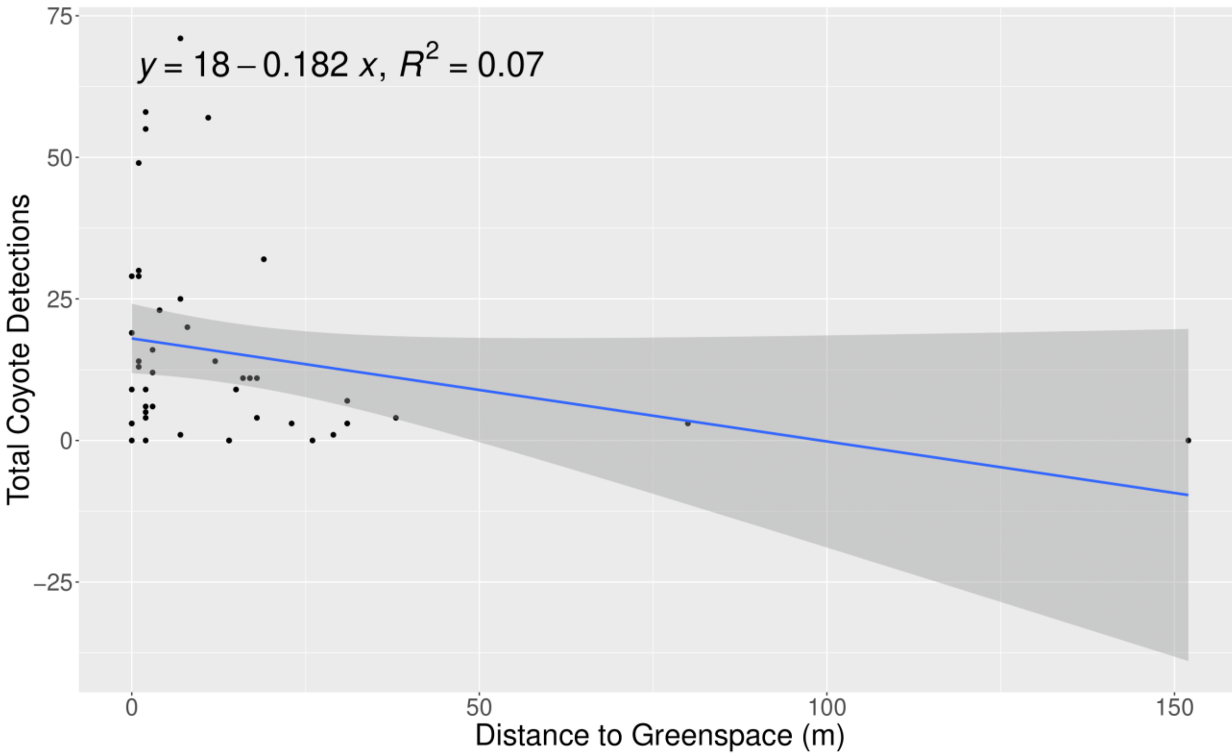

Fig. 3.4 Total coyote visits at bird feeders in residential yards (n = 44) as a function of the shortest straight-line distance (m) between the bird feeder in each yard and the nearest urban greenspace in Edmonton, Alberta. The shaded area represents the 95% confidence interval.

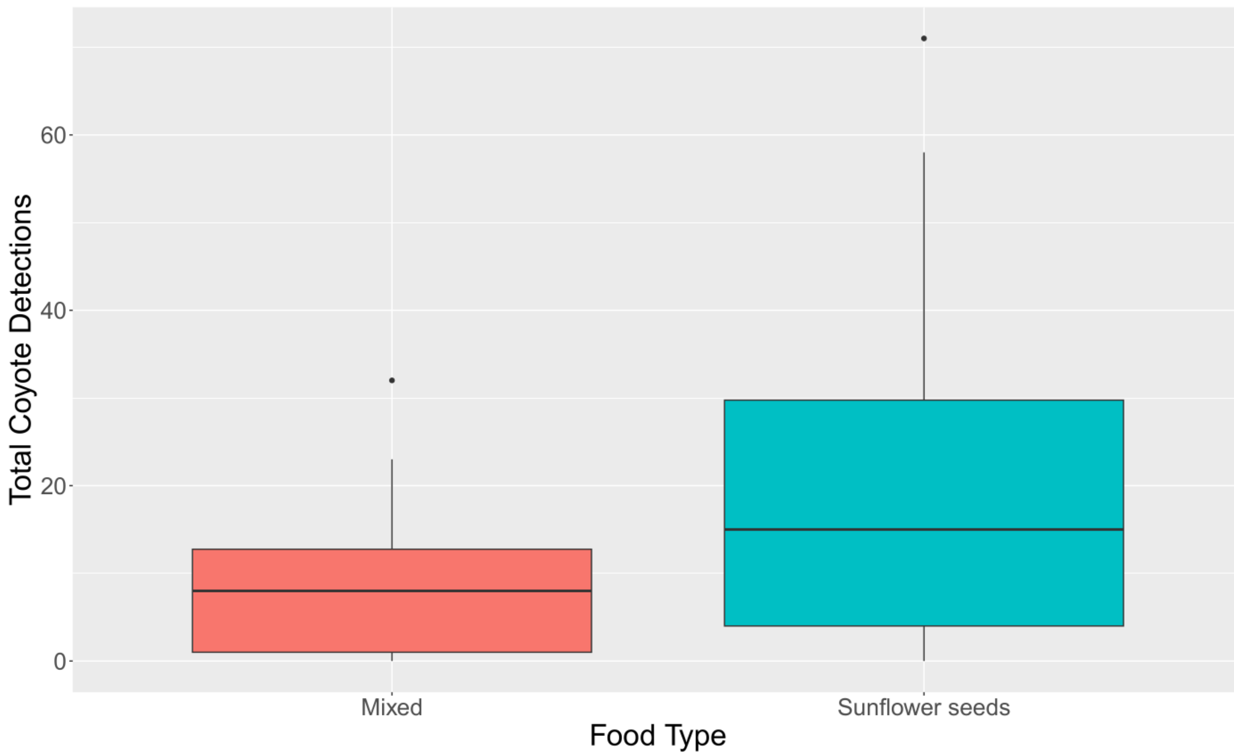

Fig. 5 Coyote detections at bird feeders by food type in Edmonton, Alberta (n = 44).

Chapter 4

General Discussion

Conflicts between humans and wildlife are increasing worldwide (Farr et al. 2023, Lamichhane et al. 2023) as opportunities for conflict arise because of urbanization, human encroachment into wildlife habitats, and wildlife adapting to survive and even thrive in human-dominated landscapes (Inskip and Zimmermann 2009, Soulsbury and White 2015). Although generalist carnivores like coyotes provide essential ecosystem services, their proximity to humans in urban areas and the lack of exposure to the persecution faced by rural coyotes (e.g., hunting, trapping) create ideal conditions for conflicts to arise (Breck et al. 2019). Proactive management actions are crucial for mitigating and, ideally, preventing conflicts. Common forms of proactive management include collecting information about potential conflicts in citizen-provided reports (White and Gehrt 2009, Hayman et al. 2014) and managing the drivers of conflict, such as anthropogenic sources of food that can contribute to poor health and food conditioning in coyotes and other wildlife (Murray et al. 2015*a*, Nowak et al. 2021). To support the proactive management of coyotes in Edmonton, Alberta, I addressed two broad goals in my thesis: (a) I explored the factors that influence the type of interactions with coyotes citizens anticipate reporting to a civic hotline, and (b) I quantified the attraction to birdseed by coyotes and their prey and tested a simple management tool, seed hoops, that may reduce coyote and rodent access to birdseed.

In Chapter 2, I used data from a City of Edmonton survey to build a path model that explored the relationships between demographic, situational, experiential, and cognitive factors and their influence on an individual's tendency to anticipate reporting a conflict-prone coyote relative to a benign sighting of a coyote. The model revealed that anticipating reporting a conflict-prone coyote more than a benign sighting of a coyote was directly precited by greater knowledge of the consequences of food conditioning in coyotes and lower risk perceptions about coyotes. In turn, greater risk perceptions were directly predicted by having greater knowledge and having experienced a more severe interaction with a coyote in the past year. Those with higher risk perceptions were more likely to have reported a coyote to 311 before. Individuals who lived near greenspaces were more likely to have experienced a more severe interaction with a coyote.

In Chapter 3, I used motion-triggered infrared trail cameras and rodent track and hair tubes to investigate the attraction to birdseed spilled beneath feeders by coyotes and their rodent prey. I targeted yards adjacent to greenspaces and natural areas, where coyotes may travel, live, den, and frequently encounter anthropogenic resources including birdseed, which creates opportunities for conflicts to arise. I used a before-after control-impact (BACI) study design to test whether seed hoops reduce coyote and mouse-sized rodent attraction to bird feeders. I found evidence that coyotes and mouse-sized rodents frequently visited feeders, indicating likely attraction to this resource. Other mammals, including deer, porcupines, red foxes, domestic dogs, and domestic cats, also visited feeders. I found no evidence that seed hoops reduce coyote and mouse-sized rodent attraction to feeders, perhaps owing to limitations of study duration, season, or experimental design. Coyotes more often visited feeders that were located closer to greenspace edges and provided sunflower seeds.

In combination, Chapters 2 and 3 provide insights that can be used to support the proactive management of urban coyotes. As described earlier, effective proactive management relies on managers having access to information about potential conflicts, which is often from citizen-provided reports. The results of the path model in Chapter 2 suggest that public education that aims to encourage reporting of conflict-prone coyotes should provide the public with knowledge about the consequences of food conditioning in coyotes and promote a realistic assessment of the risks posed by coyotes. This educational messaging should be focused in areas where severe conflicts are more likely, such as in residential areas that are adjacent to greenspaces where coyotes often travel, den (Raymond and St. Clair 2022), and access anthropogenic sources of food (Raymond and St. Clair 2023) that contribute to food conditioning and poor health (White and Gehrt 2009, Murray et al. 2015*a*).

Some anthropogenic resources accessed by coyotes, such as birdseed, may be overlooked or underestimated by the public. Birdseed is extremely common, but it is poorly digested by coyotes (Johnson and Hansen 1979) and may attract coyotes as well as the seed-eating rodents like mice and voles that they prey upon. In effect, this may create opportunities for food conditioning and physical conflict between humans and coyotes (Murray et al. 2015*a*, Murray and St. Clair 2017) as well as for the transmission of zoonotic diseases (Campbell et al. 2013, Murray et al. 2016*b*) like the tapeworm *Echinococcus multilocularis*. We detected multiple known hosts of *Em* visiting feeders, including coyotes (Catalano et al. 2012, Raymond et al. 2024), mice (Gesy and Jenkins 2015), voles (Liccioli et al. 2013), red foxes (Pilarczyk et al. 2024), domestic dogs (Toews et al. 2024), and domestic cats (Deplazes et al. 2011). The attraction of these species to bird feeders could facilitate the transmission of *Em* and increase the risk of exposure to its eggs by humans should they accidentally contact infected canid scats (Hegglin et al. 2015, Conraths et al. 2017) or ingest eggs carried on their pets' fur (Nagy et al. 2011).

Although we did not detect an effect of seed hoops on the attraction of coyotes and mouse-sized rodents to bird feeders, given the limitations of this study we assert that further research is warranted to better assess their efficacy. That coyotes tended to visit bird feeders that were nearer to greenspace edges and provided sunflower seeds indicates that coyotes might be deterred by placing feeders away from greenspace edges or similar cover that offers security to coyotes (Raymond and St. Clair 2023) and by offering foods that are less palatable to coyotes and other mammals (Taylor et al. 2020).

Although this thesis focused on urban coyotes, the objectives and approaches used could be further applied to support the proactive management of other wildlife that commonly come into conflict with humans, such as bears (Scharhag et al. 2021, Cimpoca and Voiculescu 2022). Understanding the types of interactions with wildlife that the public is inclined to report to managers can help managers assess public tolerance, identify areas of focus for public education efforts, and increase the efficiency of management actions by encouraging reporting of conflict-prone animals. Anthropogenic resources, including birdseed, often attract wildlife into spaces shared with humans (Murray and St. Clair 2017, Hansen et al. 2020, Nowak et al. 2021). While practices like bird feeding and observing wildlife present benefits to the public (Soulsbury and White 2015, Cox and Gaston 2018), the attraction of non-target taxa to anthropogenic sources of food can drive physical conflicts between people and wildlife (Murray et al. 2015*a*, Nowak et al. 2021) and create opportunities for the transmission of diseases (Campbell et al. 2013, Murray et al. 2015*b*). Understanding potentially overlooked attractants and developing accessible ways of reducing wildlife access to these attractants can support effective, proactive mitigation and management of human-wildlife conflicts and promote human-wildlife coexistence.

REFERENCES

Alexander, S. M., and M. S. Quinn. 2011. Coyote (*Canis latrans*) interactions with humans and pets reported in the Canadian print media (1995–2010). Human Dimensions of Wildlife 16:345–359.

Badhe, Y. P., and R. G. Jaybhaye. 2023. Human–leopard (*Panthera pardus fusca*) conflict trend and hotspot analysis in Junnar forest division of Pune Forest Circle, Maharashtra, India. European Journal of Wildlife Research 70:5.

Baker, R., and R. Timm. 2017. Coyote attacks on humans, 1970-2015: Implications for reducing the risks. Human–Wildlife Interactions 11:120–132.

Baral, K., S. Bhandari, B. Adhikari, R. M. Kunwar, H. P. Sharma, A. Aryal, and W. Ji. 2022. Anthropogenic mortality of large mammals and trends of conflict over two decades in Nepal. Ecology and Evolution 12:e9381.

Basak, S. M., E. Rostovskaya, J. Birks, and I. A. Wierzbowska. 2023. Perceptions and attitudes to understand human-wildlife conflict in an urban landscape – A systematic review. Ecological Indicators 151:110319.

Bayne, E., A. MacPhail, C. Copp, M. Packer, and C. Klassen. 2018. WildTrax. <https://wildtrax.ca/>.

Benn, B., and S. Herrero. 2002. Grizzly bear mortality and human access in Banff and Yoho National Parks, 1971-98. Ursus 13:213–221.

Blackie, I. R. 2023. Posttraumatic stress and psychological impacts of human wildlife conflict on victims, their families and caretakers in Botswana. Human Dimensions of Wildlife 28:248–264.

Blanco, G., J. A. Lemus, and M. García-Montijano. 2011. When conservation management becomes contraindicated: Impact of food supplementation on health of endangered wildlife. Ecological Applications 21:2469–2477.

Bowyer, R. T., S. A. McKenna, and M. E. Shea. 1983. Seasonal changes in coyote food habits as determined by fecal analysis. The American Midland Naturalist 109:266–273.

Boydston, E. E., E. S. Abelson, A. Kazanjian, and D. T. Blumstein. 2018. Canid vs. canid: Insights into coyote-dog encounters from social media. Human-Wildlife Interactions 12:233–242.

Breck, S. W., S. A. Poessel, P. Mahoney, and J. K. Young. 2019. The intrepid urban coyote: A comparison of bold and exploratory behavior in coyotes from urban and rural environments. Scientific Reports 9:1–12.

Brooks, M. E., K. Kristensen, K. J. van Benthem, A. Magnusson, C. W. Berg, A. Nielsen, H. J. Skaug, M. Mächler, and B. M. Bolker. 2017. glmmTMB balances speed and flexibility among packages for zero-inflated generalized linear mixed modeling. R Journal 9:378–400.

Brown, S. 2021. Seed Selection of Non-target Mammals at Backyard Birdfeeders. Tennessee Technological University. <https://www.proquest.com/docview/2618861307?pq-origsite=gscholar&fromopenview=true&sourcetype=Dissertations%20&%20Theses>. Accessed 24 Jul 2024.

Campbell, T., D. Long, and S. Shriner. 2013. Wildlife contact rates at artificial feeding sites in Texas. Environmental Management 51:1187–1193.

Carrlee, E., and L. Horelick. 2010. Alaska Fur ID Project. <https://alaskafurid.wordpress.com/>. Accessed 9 Jul 2024.

Catalano, S., M. Lejeune, S. Liccioli, G. G. Verocai, K. M. Gesy, E. J. Jenkins, S. J. Kutz, C. Fuentealba, P. J. Duignan, and A. Massolo. 2012. *Echinococcus multilocularis* in urban coyotes, Alberta, Canada. Emerging Infectious Diseases 18:1625–1628.

Celik, B., and K. Cagiltay. 2024. Did you act according to your intention? An analysis and exploration of intention–behavior gap in MOOCs. Education and Information Technologies 29:1733–1760.

Chiron, F., S. Hein, R. Chargé, R. Julliard, L. Martin, A. Roguet, and J. Jacob. 2018. Validation of hair tubes for small mammal population studies. Journal of Mammalogy 99:478–485.

Christie, A. P., T. Amano, P. A. Martin, G. E. Shackelford, B. I. Simmons, and W. J. Sutherland. 2019. Simple study designs in ecology produce inaccurate estimates of biodiversity responses. Journal of Applied Ecology 56:2742–2754.

Cimpoca, A., and M. Voiculescu. 2022. Patterns of human–brown bear conflict in the urban area of Brașov, Romania. Sustainability 14:7833.

City of Edmonton. 2019. Municipal Census Results | City of Edmonton. <https://www.edmonton.ca/city_government/facts_figures/municipal-census-results>. Accessed 10 Jul 2024.

City of Edmonton. 2022*a*. Natural Areas and Urban Biodiversity. <https://www.edmonton.ca/city_government/environmental_stewardship/natural-areas>. Accessed 7 Dec 2022.

City of Edmonton. 2022*b*. City of Edmonton Archives: River Valley. <http://cityarchives.edmonton.ca>. Accessed 10 Jan 2024.

Conraths, F. J., C. Probst, A. Possenti, B. Boufana, R. Saulle, G. L. Torre, L. Busani, and A. Casulli. 2017. Potential risk factors associated with human alveolar echinococcosis: Systematic review and meta-analysis. PLOS Neglected Tropical Diseases 11:e0005801.

Cox, D. T. C., and K. J. Gaston. 2018. Human-nature interactions and the consequences and drivers of provisioning wildlife. Philosophical Transactions B 373:20170092.

Curtis, P. D., E. D. Rowland, G. B. Curtis, and J. A. Dunn. 2000. Capsaicin-treated seed as a squirrel deterrent at birdfeeders. Wildlife Damage Management Conference - Proceedings. Volume 18.

Deplazes, P., F. van Knapen, A. Schweiger, and P. A. M. Overgaauw. 2011. Role of pet dogs and cats in the transmission of helminthic zoonoses in Europe, with a focus on echinococcosis and toxocarosis. Veterinary Parasitology 182:41–53.

Ditchkoff, S. S., S. T. Saalfeld, and C. J. Gibson. 2006. Animal behavior in urban ecosystems: Modifications due to human-induced stress. Urban Ecosystems 9:5–12.

Duncan, N., O. Asher, M. Weckel, C. Nagy, C. Henger, F. Yau, and L. Gormanzano. 2020. Baseline diet of an urban carnivore on an expanding range front. Journal of Urban Ecology 6:1–6.

Elbroch, M., and C. McFarland. 2019. Mammal Tracks & Sign: A Guide to North American Species. 2nd edition. Roman & Little Field Publishing, Lanham, Connecticut, USA.

Farr, J. J., M. J. Pruden, R. D. Glover, M. H. Murray, S. A. Sugden, H. W. Harshaw, and C. C. S. Clair. 2023. A ten-year community reporting database reveals rising coyote boldness and associated human concern in Edmonton, Canada. Ecology and Society 28.

Fitzgerald, C. S., P. D. Curtis, M. E. Richmond, and J. A. Dunn. 1995. Effectiveness of capsaicin as a repellent to birdseed consumption by gray squirrels. National Wildlife Research Center Repellents Conference. Volume 16.

Flamm, R. 2019. Development and launch of a comprehensive fish and wildlife reporting mobile application. Journal of Fish and Wildlife Management 10:676–690.

Found, R., E. L. Kloppers, T. E. Hurd, and C. C. St. Clair. 2018. Intermediate frequency of aversive conditioning best restores wariness in habituated elk (*Cervus canadensis*). PLoS ONE 13:e0199216.

Gesy, K., J. E. Hill, H. Schwantje, S. Liccioli, and E. J. Jenkins. 2013. Establishment of a European-type strain of *Echinococcus multilocularis* in Canadian wildlife. Parasitology 140:1133–1137.

Gesy, K. M., and E. J. Jenkins. 2015. Introduced and native haplotypes of *Echinococcus multilocularis* in wildlife in Saskatchewan, Canada. Journal of Wildlife Diseases 51:743–748.

Gilbert-Norton, L. B., T. A. Shahan, and J. A. Shivik. 2009. Coyotes (*Canis latrans*) and the matching law. Behavioural Processes 82:178–183.

Górecki, M., A. Kiełtyka-Kurc, and N. Solarska. 2023. Partial reinforcement increases resistance to extinction of operant task in mice trained with a clicker. European Journal of Ecology 9.

Government of Alberta. 2023. Edmonton - Population. <https://regionaldashboard.alberta.ca/region/edmonton/population/#/?from=2018&to=2022>. Accessed 10 Jul 2024.

Government of Canada. 2024. Canadian Climate Normals 1991-2020 Data - Climate - Environment and Climate Change Canada. <https://climate.weather.gc.ca/climate_normals/results_1991_2020_e.html?searchType=stnName_1991&txtStationName_1991=edmonton&searchMethod=contains&txtCentralLatMin=0&txtCentralLatSec=0&txtCentralLongMin=0&txtCentralLongSec=0&stnID=452000000&dispBack=0>. Accessed 10 Jul 2024.

Government of Canada, S. C. 2015. Purchases to feed, shelter or watch birds. <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3810001501>. Accessed 9 Nov 2022.

Hansen, C. P., A. W. Parsons, R. Kays, and J. J. Millspaugh. 2020. Does use of backyard resources explain the abundance of urban wildlife? Frontiers in Ecology and Evolution 8.

Hayman, R. B., R. G. Harvey, F. J. Mazzotti, G. D. Israel, and A. R. Woodward. 2014. Who complains about alligators? Cognitive and situational factors influence behavior toward wildlife. Human Dimensions of Wildlife 19:481–497.

Heathcote, G., A. J. Hobday, M. Spaulding, M. Gard, and G. Irons. 2019. Citizen reporting of wildlife interactions can improve impact-reduction programs and support wildlife carers. Wildlife Research 46:415–428.

Hegglin, D., F. Bontadina, and P. Deplazes. 2015. Human-wildlife interactions and zoonotic transmission of *Echinococcus multilocularis*. Trends in Parasitology 31:167–173.

Hody, J. W., and R. Kays. 2018. Mapping the expansion of coyotes (*Canis latrans*) across North and Central America. ZooKeys 759:81–97.

Hopkins III, J. B., P. L. Koch, C. C. Schwartz, J. M. Ferguson, S. S. Greenleaf, and S. T. Kalinowski. 2012. Stable isotopes to detect food-conditioned bears and to evaluate human-bear management. The Journal of Wildlife Management 76:703–713.

Houston, S., S. Belga, K. Buttenschoen, R. Cooper, S. Girgis, B. Gottstein, G. Low, A. Massolo, C. MacDonald, N. Müller, J. Preiksaitis, P. Sarlieve, S. Vaughan, and K. Kowalewska-Grochowska. 2021. Epidemiological and clinical characteristics of alveolar echinococcosis: An emerging infectious disease in Alberta, Canada. The American Journal of Tropical Medicine and Hygiene 104:1863–1869.

Hussein, H. S., and J. M. Brasel. 2001. Toxicity, metabolism, and impact of mycotoxins on humans and animals. Toxicology 167:101–134.

Inaba, T., K. Matsudo, and H. Kamiya. 2003. Detection of *Echinococcus multilocularis* eggs by centrifugal flotation technique: Preliminary survey of soil left in the ferryboats commuting between Hokkaido Island, where *E. multilocularis* is endemic, and mainland Japan. Japanese Journal of Infectious Diseases 56:118–119.

Inskip, C., and A. Zimmermann. 2009. Human-felid conflict: A review of patterns and priorities worldwide. Oryx 43:18–34.

Jackman, J. L., and A. T. Rutberg. 2015. Shifts in attitudes towards coyotes on the urbanized East Coast: The Cape Cod experience, 2005-2012. Human Dimensions of Wildlife 20:333–348.

Jameson, E. W. 1952. Food of deer mice, *Peromyscus maniculatus* and *P. boylei*, in the northern Sierra Nevada, California. Journal of Mammalogy 33:50–60.

Janzen, D. H. 1971. Seed predation by animals. Annual Review of Ecology and Systematics 2:465–492.

Jenkins, S. H., and R. Ascanio. 1993. A potential nutritional basis for resource partitioning by desert rodents. The American Midland Naturalist 130:164–172.

Jensen, A. J., C. J. Marneweck, J. C. Kilgo, and D. S. Jachowski. 2022. Coyote diet in North America: Geographic and ecological patterns during range expansion. Mammal Review 52:480–496.

Jiménez-Ruiz, S., N. Santos, J. A. Barasona, A. E. Fine, and F. Jori. 2024. Editorial: Pathogen transmission at the domestic-wildlife interface: a growing challenge that requires integrated solutions. Frontiers in Veterinary Science 11.

Johnson, M. K., and R. M. Hansen. 1979. Estimating coyote food intake from undigested residues in scats. The American Midland Naturalist 102:363–367.

Jonker, S. A., R. M. Muth, J. F. Organ, R. R. Zwick, and W. F. Siemer. 2006. Experiences with beaver damage and attitudes of Massachusetts residents toward beaver. Wildlife Society Bulletin 34:1009–1021.

Kowalczyk, J. P., and T. L. Smith. 2008. Bird feeders and the spatial distribution of ticks on a residential lawn in Worcester County, Massachusetts. Northeastern Naturalist 15:469–472.

Lajeunesse, G., E. W. Smith, H. W. Harshaw, and C. C. St. Clair. 2023. Proactive use of intensive aversive conditioning increases probability of retreat by coyotes. Ecosphere 14:e4676.

Lamichhane, B. R., G. A. Persoon, H. Leirs, S. Poudel, N. Subedi, C. P. Pokheral, S. Bhattarai, B. P. Thapaliya, and H. H. de Iongh. 2018. Spatio-temporal patterns of attacks on human and economic losses from wildlife in Chitwan National Park, Nepal. PLOS ONE 13:e0195373.

Lamichhane, S., A. Thapa, M. S. Thapa, S. Panthi, and A. J. Giordano. 2023. Understanding human-leopard conflict in the 'Mid-hill' region of western Nepal. Journal of Mountain Science 20:3464–3475.

Lane, L. B. 1925. Freezing points of glycerol and its aqueous solutions. Industrial & Engineering Chemistry 17:924–924.

Larson, R. N., J. L. Brown, T. Karels, and S. P. D. Riley. 2020. Effects of urbanization on resource use and individual specialization in coyotes (*Canis latrans*) in southern California. PLOS ONE 15:e0228881.

Lass, A., B. Szostakowska, P. Myjak, and K. Korzeniewski. 2015. The first detection of *Echinococcus multilocularis* DNA in environmental fruit, vegetable, and mushroom samples using nested PCR. Parasitology Research 114:4023–4029.

Lawrence, S. E., and P. R. Krausman. 2011. Reactions of the public to urban coyotes (*Canis latrans*). The Southwestern Naturalist 56:404–409.

Lawson, B., R. A. Robinson, M. P. Toms, K. Risely, S. MacDonald, and A. A. Cunningham. 2018. Health hazards to wild birds and risk factors associated with anthropogenic food provisioning. Philosophical Transactions of the Royal Society B: Biological Sciences 373:20170091.

Leiby, P. D., W. P. Carney, and C. E. Woods. 1970. Studies on sylvatic echinococcosis. III. Host occurrence and geographic distribution of *Echinococcus multilocularis* in the North Central United States. The Journal of Parasitology 56:1141–1150.

Liccioli, S., P. J. Duignan, M. Lejeune, J. Deunk, S. Majid, and A. Massolo. 2013. A new intermediate host for *Echinococcus multilocularis*: The southern red-backed vole

(*Myodes gapperi*) in urban landscape in Calgary, Canada. Parasitology International 62:355–357.

Liccioli, S., S. Rogers, C. Greco, S. J. Kutz, F. Chan, K. E. Ruckstuhl, and A. Massolo. 2015. Assessing individual patterns of *Echinococcus multilocularis* infection in urban coyotes: Non-invasive genetic sampling as an epidemiological tool. Journal of Applied Ecology 52:434–442.

Lindroth, R. L., and G. O. Batzli. 1984. Food habits of the meadow vole (*Microtus pennsylvanicus*) in bluegrass and prairie habitats. Journal of Mammalogy 65:600–606.

Lukasik, V. M., and S. M. Alexander. 2011. Human-coyote interactions in Calgary, Alberta. Human Dimensions of Wildlife 16:114–127.

Luong, L. T., J. L. Chambers, A. Moizis, T. M. Stock, and C. C. S. Clair. 2020. Helminth parasites and zoonotic risk associated with urban coyotes (*Canis latrans*) in Alberta, Canada. Journal of Helminthology 94:e25.

Martínez-Espiñeira, R. 2006. Public attitudes toward lethal coyote control. Human Dimensions of Wildlife 11:89–100.

Massolo, A., C. Klein, K. Kowalewska-Grochowska, S. Belga, C. MacDonald, S. Vaughan, S. Girgis, D. Giunchi, S. A. Bramer, M. A. Santa, D. M. Grant, K. Mori, P. Duignan, O. Slater, B. Gottstein, N. Müller, and S. Houston. 2019. European *Echinococcus multilocularis* identified in patients in Canada. New England Journal of Medicine 381:384–385.

Mathiak, H. A. 1938. A key to hairs of the mammals of southern Michigan. The Journal of Wildlife Management 2:251.

Mayer, W. V. 1952. The hair of California mammals with keys to the dorsal guard hairs of California mammals. The American Midland Naturalist 48:480–512.

McCullough, D. R. 1982. Behavior, bears, and humans. Wildlife Society Bulletin 10:27–33.

McInturff, A., J. R. B. Miller, K. M. Gaynor, and J. S. Brashares. 2021. Patterns of coyote predation on sheep in California: A socio-ecological approach to mapping risk of livestock–predator conflict. Conservation Science & Practice 3:1–15.

McNay, M. E. 2002. Wolf-human interactions in Alaska and Canada: A review of the case history. Wildlife Society Bulletin 30:831–843.

Mori, Y., T. Nakamata, R. Kuwayama, S. Yuki, and S. Ohnuma. 2024. Developing the littering behavior model focusing on implementation intention: a challenge to anti-environmental behavior. Journal of Material Cycles and Waste Management 26:776–791.

Murray, M. H., D. J. Becker, R. J. Hall, and S. M. Hernandez. 2016*a*. Wildlife health and supplemental feeding: A review and management recommendations. Biological Conservation 204:163–174.

Murray, M. H., A. Cembrowski, A. D. M. Latham, V. M. Lukasik, S. Pruss, and C. C. St. Clair. 2015*a*. Greater consumption of protein-poor anthropogenic food by urban relative to rural coyotes increases diet breadth and potential for human-wildlife conflict. Ecography 38:001–008.

Murray, M. H., M. A. Edwards, B. Abercrombie, and C. C. St. Clair. 2015*b*. Poor health is associated with use of anthropogenic resources in an urban carnivore. Proceedings of the Royal Society B: Biological Sciences 282:20150009.

Murray, M. H., J. Hill, P. Whyte, and C. C. St. Clair. 2016*b*. Urban compost attracts coyotes, contains toxins, and may promote disease in urban-adapted wildlife. EcoHealth 13:285–292.

Murray, M. H., and C. C. St. Clair. 2017. Predictable features attract urban coyotes to residential yards. The Journal of Wildlife Management 81:593–600.

Muthén, L. K., and B. O. Muthén. 1998. Mplus User's Guide. Eighth. Muthén & Muthén, Los Angeles, CA.

Nagy, A., I. Ziadinov, A. Schweiger, M. Schnyder, and P. Deplazes. 2011. Hair coat contamination with zoonotic helminth eggs of farm and pet dogs and foxes. Berliner und Munchener tierarztliche Wochenschrift 124:503–511.

Nation, P. N., and C. C. St. Clair. 2019. A forensic pathology investigation of dismembered domestic cats: Coyotes or cults? Veterinary Pathology 56:444–451.

Negi, M., M. Goswami, and S. Nautiyal. 2023. Agricultural loss due to wildlife: a case study on elephant depredation in a protected area of South India. Journal of Social and Economic Development 25:350–364.

Northrup, J. M., and M. S. Boyce. 2012. Mad cow policy and management of grizzly bear incidents. Wildlife Society Bulletin 36:499–505.

Nowak, S., M. Szewczyk, P. Tomczak, I. Całus, M. Figura, and R. W. Mysłajek. 2021. Social and environmental factors influencing contemporary cases of wolf aggression towards people in Poland. European Journal of Wildlife Research 67:69.

Organ, J. F., and M. R. Ellingwood. 2000. Wildlife stakeholder acceptance capacity for black bears, beavers, and other beasts in the East. Human Dimensions of Wildlife 5:63–75.

Orros, M. E., and M. D. E. Fellowes. 2012. Supplementary feeding of wild birds indirectly affects the local abundance of arthropod prey. Basic and Applied Ecology 13:286–293.

Orros, M. E., and M. D. E. Fellowes. 2015. Wild bird feeding in an urban area: Intensity, economics and numbers of individuals supported. Acta Ornithologica 50:43–58.

Orros, M., R. Thomas, G. Holloway, and M. Fellowes. 2015. Supplementary feeding of wild birds indirectly affects ground beetle populations in suburban gardens. Urban Ecosystems 18:465–475.

Oyer, E. R. 1946. Identification of mammals from studies of hair structure. Transactions of the Kansas Academy of Science 49:155–160.

Parchizadeh, J., K. F. Kellner, J. E. Hurst, D. W. Kramer, and J. L. Belant. 2023. Factors influencing frequency and severity of human-American black bear conflicts in New York, USA. PLOS ONE 18:e0282322.

Parsons, A. W., C. T. Rota, T. Forrester, M. C. Baker-Whatton, W. J. McShea, S. G. Schuttler, J. J. Millspaugh, and R. Kays. 2019. Urbanization focuses carnivore activity in remaining natural habitats, increasing species interactions. Journal of Applied Ecology 56:1894–1904.

Pennycuik, P. R., and R. Cowan. 1990. Odor and food preferences of house mice, *Mus musculus*. Australian Journal of Zoology 38:241–247.

Peterson, M., M. Baglieri, K. Mahon, R. J. Sarno, L. Ries, P. Burman, and M. M. Grigione. 2020. The diet of coyotes and red foxes in Southern New York. Urban Ecosystems.

Pilarczyk, B., A. Tomza-Marciniak, R. Pilarczyk, M. Bąkowska, I. Rząd, A. Stapf, L. Felska-Błaszczyk, A. Tylkowska, and B. Seremak. 2024. *Echinococcus multilocularis* and other intestinal parasites of the red fox (*Vulpes vulpes*) from the Pomerania Region, Northern Poland. Pathogens 13:490.

Poessel, S. A., S. W. Breck, T. L. Teel, S. Shwiff, K. R. Crooks, and L. Angeloni. 2013. Patterns of human-coyote conflicts in the Denver Metropolitan Area. The Journal of Wildlife Management 77:297–305.

Poessel, S. A., E. M. Gese, and J. K. Young. 2017*a*. Environmental factors influencing the occurrence of coyotes and conflicts in urban areas. Landscape and Urban Planning 157:259–269.

Poessel, S. A., E. C. Mock, and S. W. Breck. 2017*b*. Coyote (*Canis latrans*) diet in an urban environment: variation relative to pet conflicts, housing density, and season. Canadian Journal of Zoology 95:287–297.

Poulle, M.-L., M. Bastien, Y. Richard, É. Josse-Dupuis, D. Aubert, I. Villena, and J. Knapp. 2017. Detection of *Echinococcus multilocularis* and other foodborne parasites in fox, cat and dog faeces collected in kitchen gardens in a highly endemic area for alveolar echinococcosis. Parasite 24:29.

Price, M. V., and N. M. Waser. 1985. Microhabitat use by heteromyid rodents: Effects of artificial seed patches. Ecology 66:211–219.

Proctor, M., W. Kasworm, K. Annis, A. MacHutchon, J. Teisberg, T. Radandt, and C. Servheen. 2018. Conservation of threatened Canada-USA trans-border grizzly bears linked to comprehensive conflict reduction. Human–Wildlife Interactions 12.

Puri, M., K. L. Johannsen, K. O. Goode, and E. F. Pienaar. 2024. Addressing the challenge of wildlife conservation in urban landscapes by increasing human tolerance for wildlife. People and Nature 6:1116–1129.

Quinn, N., D. Fox, and J. Hartman. 2016. An examination of citizen-provided coyote reports: Temporal and spatial patterns and their implications for management of human-coyote conflicts. Proceedings of the Vertebrate Pest Conference. Volume 27.

Raymond, S., and C. C. St. Clair. 2022. Urban coyotes select cryptic den sites near human development where conflict rates increase. The Journal of Wildlife Management e22323:e22323.

Raymond, S., and C. C. St. Clair. 2023. Coyotes access diverse anthropogenic attractants at the ecotone between natural and residential urban areas. Urban Ecosystems 26:1589–1605.

Raymond, S., D. K. Steckler, M. A. Seguin, and C. C. St. Clair. 2024. Coyote scat in cities increases risk of human exposure to an emerging zoonotic disease in North America. Frontiers in Conservation Science 4.

Reed, J. H., and D. N. Bonter. 2018. Supplementing non-target taxa: Bird feeding alters the local distribution of mammals. Ecological Applications 28:761–770.

Roe, C. C., H. Yaglom, A. Howard, J. Urbanz, G. G. Verocai, L. Andrews, V. Harrison, R. Barnes, T. Lyons, J. R. Bowers, and D. M. Engelthaler. 2020. Coyotes as reservoirs for *Onchocerca lupi*, United States, 2015–2018. Emerging Infectious Diseases 26:2989–2993.

Scharhag, J. M., C. Sartini, S. M. Crimmins, S. E. Hygnstrom, and J. B. Stetz. 2021. Characteristics of non-fatal attacks by black bears: Conterminous United States, 2000-2017. Human–Wildlife Interactions 15:1–12.

Schell, C. J., K. Dyson, T. L. Fuentes, S. Des Roches, N. C. Harris, D. S. Miller, C. A. Woelfle-Erskine, and M. R. Lambert. 2020. The ecological and evolutionary consequences of systemic racism in urban environments. Science 369:eaay4497.

Schell, C. J., L. A. Stanton, J. K. Young, L. M. Angeloni, J. E. Lambert, S. W. Breck, and M. H. Murray. 2021. The evolutionary consequences of human–wildlife conflict in cities. Evolutionary Applications 14:178–197.

Schell, C. J., J. K. Young, E. V. Lonsdorf, R. M. Santymire, and J. M. Mateo. 2018. Parental habituation to human disturbance over time reduces fear of humans in coyote offspring. Ecology and Evolution 8:12965–12980.

Schwingel, H., and C. Norment. 2010. Use of hair tubes to detect small-mammal winter activity in a northern forest habitat. Northeastern Naturalist 17:531–540.

Smith, T. S., A. E. Derocher, R. L. Mazur, G. York, M. A. Owen, M. Obbard, E. S. Richardson, and S. C. Amstrup. 2023. Anthropogenic food: An emerging threat to polar bears. Oryx 57:425–434.

Somily, A., J. L. Robinson, L. J. Miedzinski, R. Bhargava, and T. J. Marrie. 2005. Echinococcal disease in Alberta, Canada: More than a calcified opacity. BMC Infectious Diseases 5:1–7.

Soulsbury, C. D., and P. C. L. White. 2015. Human–wildlife interactions in urban areas: A review of conflicts, benefits and opportunities. Wildlife Research 42:541.

Sovada, M. A., D. J. Telesco, and C. C. Roy. 2000. Coyote, *Canis latrans*, use of commercial sunflower, *Helianthus spp.*, seeds as a food source in western Kansas. Canadian Field-Naturalist 114:697–699.

Sperry, C. C. 1933. Autumn food habits of coyotes, a report of progress, 1932. Journal of Mammalogy 14:216–220.

Sponarski, C. C., C. Miller, and J. J. Vaske. 2018. Perceived risks and coyote management in an urban setting. Journal of Urban Ecology 4:1–5.

Sponarski, C. C., J. J. Vaske, A. J. Bath, and T. Loeffler. 2016. Changing attitudes and emotions toward coyotes with experiential education. The Journal of Environmental Education 47:296–306.

Sponarski, C. C., J. J. Vaske, A. J. Bath, and T. Loeffler. 2019. Retaining change in attitudes and emotions toward coyotes using experiential education. Wildlife Research 46:97–103.

St. Clair, C. C., J. Backs, A. Friesen, A. Gangadharan, P. Gilhooly, M. Murray, and S. Pollock. 2019. Animal learning may contribute to both problems and solutions for wildlife–train collisions. Philosophical Transactions of the Royal Society B: Biological Sciences 374:20180050.

Stewart-Oaten, A., W. W. Murdoch, and K. R. Parker. 1986. Environmental impact assessment: "Pseudoreplication" in time? Ecology 67:929–940.

Stimmelmayr, R., C. SimsKayotuk, M. Pederson, G. Sheffield, R. Frantz, J. Nayakik, and B. Adams. 2023. Anthropogenic waste ingestion of Southern Beaufort Sea polar bears, Alaska (2010–2020). Ursus 2023:1–7.

Støen, O.-G., T. R. Sivertsen, A. Tallian, G. R. Rauset, J. Kindberg, L.-T. Persson, R. Stokke, A. Skarin, P. Segerström, and J. Frank. 2022. Brown bear predation on semi-domesticated reindeer and depredation compensations. Global Ecology and Conservation 37:e02168.

Sugden, S., D. Sanderson, K. Ford, L. Y. Stein, and C. C. St. Clair. 2020. An altered microbiome in urban coyotes mediates relationships between anthropogenic diet and poor health. Scientific Reports 10:1–14.

Sugden, S., D. K. Steckler, D. Sanderson, B. Abercrombie, D. Abercrombie, M. A. Seguin, K. Ford, and C. C. S. Clair. 2023. Age-dependent relationships among diet, body condition, and *Echinococcus multilocularis* infection in urban coyotes. PLOS ONE 18:e0290755.

Taylor, J. B., K. L. Cass, D. N. Armond, M. D. Madsen, D. E. Pearson, and S. B. St. Clair. 2020. Deterring rodent seed-predation using seed-coating technologies. Restoration Ecology 28:927–936.

Theimer, T. C., A. C. Clayton, A. Martinez, D. L. Peterson, and D. L. Bergman. 2015. Visitation rate and behavior of urban mesocarnivores differs in the presence of two common anthropogenic food sources. Urban Ecosystems 18:895–906.

Toews, E., M. Musiani, A. Smith, S. Checkley, D. Visscher, and A. Massolo. 2024. Risk factors for *Echinococcus multilocularis* intestinal infections in owned domestic dogs in a North American metropolis (Calgary, Alberta). Scientific Reports 14:5066.

Ullah, I., Z. Ullah, J. Khan, S. Mahmood, Z. Iqbal, and N. Akhtar. 2023. Human-black bear (*Ursus thibetanus*) conflict and its mitigation strategies at Siran and Kaghan Valleys of District Mansehra, Pakistan. Pakistan Journal of Zoology 55:1605–1611.

White, L. A., and S. D. Gehrt. 2009. Coyote attacks on humans in the United States and Canada. Human Dimensions of Wildlife 14:419–432.

Wilbur, R. C., S. A. Lischka, J. R. Young, and H. E. Johnson. 2018. Experience, attitudes, and demographic factors influence the probability of reporting human–black bear interactions. Wildlife Society Bulletin 42:22–31.

Wilkinson, C. E., T. Caspi, L. A. Stanton, D. Campbell, and C. J. Schell. 2023. Coexistence across space and time: Social-ecological patterns within a decade of human-coyote interactions in San Francisco. People and Nature 5:2158–2177.

Willcox, E., M. Hostetler, M. Main, and M. Voigt. 2014. WEC 162/UW192: Attracting Backyard Birds: Bird Feeder Selection. Department of Wildlife Ecology and

Conservation, UF/IFAS Extension. <https://edis.ifas.ufl.edu/publication/UW192>. Accessed 24 Jul 2024.

Worsley-Tonks, K. E. L., S. D. Gehrt, C. Anchor, L. E. Escobar, and M. E. Craft. 2021. Infection risk varies within urbanized landscapes: The case of coyotes and heartworm. Parasites & Vectors 14.

Yeshey, R. M. Ford, R. J. Keenan, and C. R. Nitschke. 2022. Subsistence farmers' understanding of the effects of indirect impacts of human wildlife conflict on their psychosocial well-being in Bhutan. Sustainability 14:14050.

APPENDIX 1

Supplemental material for Chapter 2

Insight Survey: Coyote awareness and perception

Survey Responses

The City of Edmonton would like to know how you perceive urban coyotes and their behaviours, how you would react when you see a coyote in various scenarios, and when you would call 311 or expect assistance from the City. The survey will run from April 25, 2022 to May 15, 2022 and should take approximately 12-15 minutes to complete. Feedback from the survey will inform a coyote awareness campaign to help people and coyotes coexist peacefully.

Section 1: General knowledge of coyotes and other wildlife

1. Coyotes are about the size of a border collie, but with fluffy grey-brown coats, long ears and noses and a black tip on their bushy tails. Based on this description and the photo below, have you seen a coyote within the last 12 months anywhere in the City of Edmonton?
    a. Yes (**5,213 participants, 80%**)
    b. No (**646, 11%**)
    c. Not Sure (**67, 1%**) (for NS go to #4)

2. In the last 12 months, which kind of encounter(s) have you had with a coyote? (Click all that apply)
    a. I saw a coyote from a car or building. (**3743, 64%**)
    b. I saw a coyote when I was outside of a car or building from a distance of at least 50 metres (approximately 3 city bus lengths). (**2574, 44%**)
    c. I saw a coyote when I was outside and it was closer than 50 metres. (**2618, 45%**)
    d. A coyote approached me while I was walking, jogging or cycling. (**604, 10%**)
    e. A coyote tried to bite me or my pet. (**79, 1%**)
    f. A coyote bit or killed my pet (please describe below). (**50, 1%**)

g. Have had no encounter with a coyote in the past 12 months (**638, 11%**)

3. In the last 12 months, which of these animals have you seen in your neighbourhood (e.g., Strathcona)? (Check all that apply)

    a. Birds on the ground (**5311, 91%**)
    b. Jack rabbits (prefer open areas) or snowshoe hares (prefer wooded areas) (**5663, 97%**)
    c. Coyotes (**4672, 80%**)
    d. Deer (**821, 14%**)
    e. One or more dogs off leash (**3825, 65%**)
    f. One or more cats off leash (domestic or feral) (**4663, 80%**)
    g. Tree squirrels (**4878, 83%**)
    h. Small rodents (such as mice and voles) (**2687, 46%**)
    i. Other: _______ (**628, 11%**)
    j. None of the above (**15, 0%**)

4. In the last 12 months, have you seen any of the following items outside of fenced yards in your neighbourhood (e.g., Strathcona) and greenspaces (e.g., parks and ravines)? (Check all that apply)

	In your neighbourhood, outside of fenced yards	Parks, Greenspace, or River Valley	Not Seen
Bird or squirrel feeders hung above the ground	**2700, 46%**	**1696, 29%**	**2533, 43%**
Bird seed or peanuts on the ground	**2101, 35%**	**1249, 21%**	**3198, 54%**
Alfalfa pellets or hay	**173, 3%**	**203, 3%**	**5586, 94%**
Pet food on the ground	**394, 7%**	**130, 2%**	**5461, 92%**
Meat scraps or bones	**1162, 20%**	**464, 8%**	**4580, 77%**
Unsecured garbage (e.g., bags or overflowing bins)	**3789, 64%**	**1458, 25%**	**1857, 31%**
Unsecured compost (e.g., piles or bins with 3 sides)	**882, 15%**	**177, 3%**	**5004, 84%**
Fallen fruit on the ground from fruit trees	**3259, 55%**	**1297, 22%**	**2403, 41%**

If you have seen other, similar items, list them here _______________________________

5. Thinking of coyotes that regularly access human sources of food in urban areas, to what extent would you agree with each of the following statements?

	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
They are more likely to survive and reproduce.	**2479** **42%**	**2038** **34%**	**982** **17%**	**308** **5%**	**119** **2%**
They lose their fear of people.	**3121** **53%**	**2076** **35%**	**406** **7%**	**235** **4%**	**88** **1%**
They become dependent on human sources of food.	**2106** **36%**	**2,367** **40%**	**911** **15%**	**421** **7%**	**121** **2%**
They are more likely to carry diseases, including some that people can get.	**1030** **17%**	**1380** **23%**	**2427** **41%**	**743** **13%**	**6346** **6%**
They are more likely to be aggressive towards people or pets.	**2086** **35%**	**2109** **36%**	**1168** **20%**	**411** **7%**	**152** **3%**
They are more likely to den nearby.	**2289**	**2432**	**931**	**212**	**62**

	39%	**41%**	**16%**	**4%**	**1%**
They are more likely to be killed by wildlife managers to protect the public.	**1900** **32%**	**1718** **29%**	**1540** **26%**	**447** **8%**	**321** **5%**

Section 2: Attitudes toward coyotes

6. To what extent do you **agree** with each of the following?

	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
Coyotes provide ecological benefits in Edmonton.	**1646** **28%**	**2035** **34%**	**1353** **23%**	**521** **9%**	**370** **6%**
Coyotes injure and kill too many pets in Edmonton.	**603** **10%**	**1077** **18%**	**2242** **38%**	**1172** **20%**	**831** **14%**
The presence of coyotes in Edmonton is a sign of a healthy environment.	**953** **16%**	**1791** **30%**	**1794** **30%**	**935** **16%**	**452** **8%**
There are too many coyotes in Edmonton.	**952** **16%**	**1112** **19%**	**2112** **36%**	**935** **16%**	**814** **14%**

Coyotes frequently pose a threat to people in Edmonton.	**447** **8%**	**1060** **18%**	**1336** **23%**	**1668** **28%**	**1414** **24%**
If a coyote bites a human, the City of Edmonton should identify and kill the animal.	**1817** **31%**	**1357** **23%**	**1201** **20%**	**909** **15%**	**641** **11%**
Coyotes have a right to exist in my neighbourhood if they are not harming people.	**1900** **32%**	**1682** **28%**	**977** **16%**	**761** **13%**	**605** **10%**

7. Given the presence of coyotes in Edmonton, how do you **feel** about each of the following?

I am concerned about…	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**	**N/A**
…my own personal health or safety.	**592** **10%**	**1154** **19%**	**870** **15%**	**1324** **22%**	**1955** **33%**	**30** **1%**
…my children's health or safety.	**953** **16%**	**834** **14%**	**556** **9%**	**621** **10%**	**845** **14%**	**2116** **36%**
… my pet's health or safety.	**1339** **23%**	**1215** **21%**	**532** **9%**	**586** **10%**	**745** **13%**	**1508** **25%**

… the spread of diseases carried by coyotes.	**779** **13%**	**1462** **25%**	**1511** **26%**	**1079** **18%**	**1055** **18%**	**39** **1%**

8. Which of the following coyote behaviours would concern you and / or cause you to report to 311?

	Yes	**No**	**Not Sure**
A coyote is in a residential yard during the day.	**3236, 55%**	**1932, 33%**	**757, 13%**
A coyote is in a school yard at dawn or dusk.	**2077, 35%**	**3149, 53%**	**699, 12%**
Coyotes follow me within 50 m in a natural area.	**1985, 34%**	**3029, 51%**	**911, 15%**
A coyote follows me within 50 m in my neighbourhood.	**3605, 61%**	**1673, 28%**	**647, 11%**
A coyote is hunting small rodents in a field near houses.	**506, 9%**	**4912, 83%**	**507, 9%**
A coyote in a residential area does not run away after I	**3870,**	**1073,**	**982,**

attempt to intimidate it by shouting and throwing sticks.	**65%**	**18%**	**17%**
A coyote is eating food that appears to be left out for it intentionally on the edge of a natural area.	**3940, 66%**	**1329, 22%**	**656, 11%**
I hear coyotes howling and yipping from my home.	**624, 11%**	**4945, 83%**	**356, 6%**
A coyote approaches me and my large dog (on a leash) as we walk in my neighbourhood.	**3533, 60%**	**1308, 22%**	**1084, 18%**
I see a coyote that appears sick or injured to the point where it can't move.	**5320, 90%**	**405, 7%**	**200, 3%**
I see a coyote with other coyotes or pups at a distance.	**1215, 21%**	**4123, 70%**	**587, 10%**
I find a coyote den or see very young pups.	**1959, 33%**	**3095, 52%**	**871, 15%**

Section 3: Situations involving coyotes

We will describe two different situations involving you and a coyote. Think about what each situation would be like for you. Then identify the response closest to your feelings and opinions.

Scenario #1: Imagine you are walking alone along a **trail in a park, greenspace or the River**

Valley in Edmonton during the day and a coyote crosses the trail 15 m (one bus length) ahead of you and stops to look at you.

9. To what extent would you agree with the following statements?

I would …	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**	**Unsure**
… feel comfortable with this scenario.	**1084** **18%**	**1765** **30%**	**799** **13%**	**1455** **25%**	**773** **13%**	**49** **1%**
… think this scenario should not occur in Edmonton.	**401** **7%**	**602** **10%**	**991** **17%**	**1697** **29%**	**2169** **37%**	**65** **1%**
… run away.	**130** **2%**	**288** **5%**	**815** **14%**	**1665** **28%**	**2849** **48%**	**178** **3%**
… stand tall, talk loudly and try to back away slowly.	**1548** **26%**	**2235** **38%**	**980** **17%**	**640** **11%**	**337** **6%**	**185** **3%**
… stand still and do nothing until the animal leaves.	**770** **13%**	**2192** **37%**	**1101** **19%**	**1069** **18%**	**611** **10%**	**82** **3%**
… continue to walk and ignore the coyote.	**501** **8%**	**1369** **23%**	**901** **15%**	**1653** **28%**	**1363** **23%**	**138** **2%**
… approach the coyote while throwing objects towards it,	**616** **10%**	**1309** **22%**	**921** **16%**	**1257** **21%**	**1640** **28%**	**182** **3%**

banging a stick on nearby trees and otherwise trying to intimidate it.						
… notify the City via the 311 phone line or app.	**723** **12%**	**778** **13%**	**1112** **19%**	**1220** **21%**	**1685** **28%**	**407** **7%**

10. To what extent would you agree with the following statements?

Management Action	**Strongly agree**	**Agree**	**Neither**	**Disagree**	**Strongly disagree**	**Unsure**
311/City of Edmonton Park Rangers need to be made aware of this incident for tracking purposes only.	**847** **14%**	**1580** **27%**	**1175** **20%**	**1083** **18%**	**803** **14%**	**438** **7%**
311/City of Edmonton Park Rangers do not need to be notified of this incident.	**1038** **18%**	**1552,** **26%**	**1093** **18%**	**1103** **19%**	**750** **13%**	**390** **7%**
Public needs to be educated about safety around coyotes in this area.	**2904** **49%**	**2331** **39%**	**419** **7%**	**160** **3%**	**78** **1%**	**34** **1%**
Park Rangers should look for	**470**	**744**	**1331**	**1606**	**1493**	**282**

Management Action	Strongly agree	Agree	Neither	Disagree	Strongly disagree	Unsure
311/City of Edmonton Park Rangers need to be made aware of this incident for tracking purposes only.	**847** **14%**	**1580** **27%**	**1175** **20%**	**1083** **18%**	**803** **14%**	**438** **7%**
311/City of Edmonton Park Rangers do not need to be notified of this incident.	**1038** **18%**	**1552,** **26%**	**1093** **18%**	**1103** **19%**	**750** **13%**	**390** **7%**
the coyote and frighten it from the area.	**8%**	**13%**	**22%**	**27%**	**25%**	**5%**
Attempt to capture and relocate the coyote.	**583** **10%**	**695** **12%**	**873** **15%**	**1414** **24%**	**2134** **36%**	**227** **4%**
Attempt to capture and kill the coyote.	**5271** **5%**	**140** **2%**	**365** **6%**	**704** **12%**	**4340** **73%**	**106** **2%**

Scenario #2: Now imagine you are out walking alone in your **neighbourhood** during the day and see a coyote in the alleyway approaching yards. You know from your community social media site that several others have seen a coyote recently in the same area.

11. How would you respond to the following statements?

I would …	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Unsure
… feel comfortable with this scenario.	**640** **11%**	**1248** **21%**	**955** **16%**	**1843** **31%**	**1199** **20%**	**41** **1%**
… think this scenario should not occur in Edmonton.	**794** **13%**	**1179** **20%**	**1060** **18%**	**1518** **26%**	**1309** **22%**	**66** **1%**
… run away.	**121** **2%**	**313** **5%**	**823** **14%**	**1658** **28%**	**2807** **47%**	**204** **3%**
… stand tall, talk loudly and try to back away slowly.	**1092** **18%**	**2452** **41%**	**960** **16%**	**719** **12%**	**493** **8%**	**210** **4%**
… stand still and do nothing until the animal leaves.	**354** **6%**	**1927** **33%**	**1310** **22%**	**1333** **22%**	**774** **13%**	**228** **4%**
… continue to walk and ignore the coyote.	**459** **8%**	**1416** **24%**	**909** **15%**	**1620** **27%**	**1368** **23%**	**154** **3%**
… approach the coyote while throwing objects towards it, banging a stick on nearby trees and otherwise trying to intimidate it.	**659** **11%**	**1391** **23%**	**782** **13%**	**1211** **20%**	**1689** **29%**	**194** **3%**

… notify the City via the 311 phone line or app.	**1444** **24%**	**1582** **27%**	**881** **15%**	**771** **13%**	**884** **15%**	**364** **6%**

12. To what extent would you agree with the following statements?

Management Action	Strongly agree	Agree	Neither	Disagree	Strongly disagree	Unsure
311/City of Edmonton Park Rangers need to be made aware of this incident for tracking purposes only.	**1450** **24%**	**2235** **38%**	**825** **14%**	**641** **11%**	**481** **8%**	**294** **5%**
311/City of Edmonton Park Rangers do not need to be notified of this incident.	**515** **9%**	**816** **14%**	**1044** **18%**	**1739** **29%**	**1476** **25%**	**336** **6%**
Public needs to be educated about safety around coyotes in this area.	**3285** **55%**	**2070** **35%**	**368** **6%**	**82** **1%**	**76** **1%**	**45** **1%**
Park Rangers should look for the coyote and frighten it from the area.	**903** **15%**	**1577** **27%**	**1246** **21%**	**1036** **17%**	**882** **15%**	**282** **5%**

Management Action	Strongly agree	Agree	Neither	Disagree	Strongly disagree	Unsure
311/City of Edmonton Park Rangers need to be made aware of this incident for tracking purposes only.	**1450** **24%**	**2235** **38%**	**825** **14%**	**641** **11%**	**481** **8%**	**294** **5%**
Attempt to capture and relocate the coyote.	**1081** **18%**	**1349** **23%**	**836** **14%**	**1062** **18%**	**1349** **23%**	**249** **4%**
Attempt to capture and kill the coyote.	**321** **5%**	**167** **3%**	**378** **6%**	**793** **13%**	**4119** **70%**	**148** **2%**

Section 4: Perceptions and knowledge of the City of Edmonton's Coyote Response Strategy

13. 'Hazing' (also called 'aversive conditioning' or 'behaviour conditioning') is a method that makes use of deterrents to move an animal out of an area or discourage an undesirable behaviour or activity (example: approaching coyotes while shouting and throwing tennis balls weighted with sand or throwing sticks and stones near the coyote). Before today had you heard of hazing/aversive conditioning?
    a. Yes **(3691, 62%)**
    b. No (**2009, 34%**)
    c. Not Sure (**226, 4%**)

14. What would your comfort level be using hazing/aversive conditioning techniques to deter coyotes in a situation that could endanger pets or vulnerable people?

1 - Very uncomfortable (**700, 12%**)

2 - Uncomfortable (**943, 16%**)

3 - Neutral (**1101, 19%**)

4 - Comfortable (**1985, 33%**)

5 - Very comfortable (**1153, 19%**)

0 - N/A (**44, 1%**)

15. Have you ever called 311 (the City of Edmonton) to report a coyote?
    a. Yes (**642, 11%**)
    b. No (**5242, 88%**)
    c. Not Sure (**42, 1%**)

    a. [If yes to 15] What were the circumstances or coyote behaviours witnessed?
    ____________________ (open)

16. Do you have anything else you would like to share with us about coyotes? Open Optional

DEMOGRAPHICS

Answering the following demographic questions will help us ensure we are hearing from a variety of perspectives and providing inclusive information later.

1. Do you currently?

   Live in Edmonton (**5869, 99%**)

   Live in surrounding areas (**43, 1%**)

   I prefer not to answer (**14, 0%**)

2. [IF LIVE IN EDMONTON] Which neighbourhood do you live in?

   (Dropdown list including don't know/prefer not to answer)

Neighbourhood	%	Count
Abbottsfield	**0.1**	**7**
Albany	**0.2**	**15**
Alberta Avenue	**0.5**	**32**
Alberta Park Industrial	**0**	**1**
Aldergrove	**0.5**	**33**
Allard	**0.3**	**18**
Allendale	**0.4**	**29**
Ambleside	**0.3**	**18**
Anthony Henday Big Lake	**0**	**1**
Anthony Henday Castledowns	**0.1**	**6**
Anthony Henday Clareview	**0**	**1**
Anthony Henday South	**0**	**1**

Anthony Henday South East	**0**	**1**
Anthony Henday South West	**0.1**	**4**
Anthony Henday Terwillegar	**0.1**	**4**
Argyll	**0.2**	**12**
Aspen Gardens	**0.4**	**26**
Athlone	**0.2**	**16**
Avonmore	**0.8**	**51**
Balwin	**0.2**	**11**
Bannerman	**0.2**	**15**
Baranow	**0.1**	**4**
Baturyn	**0.5**	**33**
Beacon Heights	**0.2**	**11**
Bearspaw	**0.4**	**26**
Beaumaris	**0.4**	**24**
Belgravia	**0.5**	**32**
Belle Rive	**0.1**	**7**
Bellevue	**0.3**	**17**
Belmead	**0.3**	**22**
Belmont	**0.2**	**14**
Belvedere	**0.2**	**13**
Bergman	**0.1**	**9**
Beverly Heights	**0.4**	**25**
Bisset	**0.2**	**13**

Blackburne	**0.3**	**21**
Blackmud Creek	**0.3**	**17**
Blackmud Creek Ravine	**0.1**	**6**
Blue Quill	**0.5**	**32**
Blue Quill Estates	**0.1**	**6**
Bonnie Doon	**0.9**	**58**
Boyle Street	**0.2**	**13**
Brander Gardens	**0.3**	**20**
Breckenridge Greens	**0.2**	**11**
Brintnell	**0.3**	**18**
Britannia Youngstown	**0.3**	**22**
Brookside	**0.3**	**18**
Bulyea Heights	**0.4**	**28**
Caernarvon	**0.2**	**16**
Calder	**0.3**	**19**
Callaghan	**0.3**	**18**
Callingwood North	**0.4**	**23**
Callingwood South	**0.2**	**13**
Cameron Heights	**0.2**	**12**
Canon Ridge	**0.1**	**7**
Canora	**0.1**	**6**
Canossa	**0.2**	**10**
Capilano	**0.6**	**39**

Carlisle	**0.2**	**15**
Carlton	**0.4**	**23**
Carter Crest	**0.1**	**9**
Casselman	**0.2**	**12**
Cavanagh	**0**	**3**
Central McDougall	**0.1**	**7**
Chambery	**0.1**	**7**
Chappelle Area	**0.4**	**23**
Charlesworth	**0.2**	**14**
Clareview Town Centre	**0.2**	**15**
Cloverdale	**0.4**	**23**
CPR Irvine	**0**	**2**
Crawford Plains	**0.3**	**17**
Crestwood	**0.4**	**26**
Cromdale	**0.2**	**12**
Crystallina Nera East	**0**	**3**
Crystallina Nera West	**0.1**	**4**
Cumberland	**0.4**	**28**
Cy Becker	**0.2**	**13**
Daly Grove	**0.1**	**8**
Dechene	**0.2**	**10**
Delton	**0.2**	**16**
Delwood	**0.5**	**34**

Desrochers Area	**0.1**	**6**
Donsdale	**0.1**	**6**
Dovercourt	**0.3**	**21**
Downtown	**1.1**	**68**
Duggan	**0.7**	**48**
Dunluce	**0.4**	**23**
Eastwood	**0.1**	**7**
Eaux Claires	**0.2**	**16**
Ebbers	**0**	**2**
Edgemont	**0.4**	**24**
Edmonton Northlands	**0**	**1**
Ekota	**0.2**	**16**
Ellerslie	**0.2**	**15**
Elmwood	**0.2**	**12**
Elmwood Park	**0.1**	**4**
Elsinore	**0.1**	**7**
Empire Park	**0.2**	**16**
Ermineskin	**0.5**	**30**
Evansdale	**0.2**	**14**
Evergreen	**0.1**	**4**
Falconer Heights	**0.1**	**8**
Forest Heights	**0.6**	**37**
Fraser	**0.4**	**26**

Fulton Place	**0.5**	**33**
Gainer Industrial	**0**	**1**
Gariepy	**0.3**	**19**
Garneau	**0.6**	**41**
Glastonbury	**0.5**	**35**
Glengarry	**0.3**	**19**
Glenora	**0.6**	**38**
Glenridding Area	**0.2**	**11**
Glenwood	**0.2**	**14**
Gold Bar	**0.6**	**38**
Grandview Heights	**0.2**	**14**
Granville	**0.1**	**7**
Graydon Hill	**0.1**	**5**
Greenfield	**0.7**	**45**
Greenview	**0.4**	**25**
Griesbach	**0.7**	**44**
Grovenor	**0.4**	**29**
Haddow	**0.6**	**36**
Hairsine	**0.2**	**11**
Hawks Ridge	**0.2**	**10**
Hays Ridge Area	**0**	**1**
Hazeldean	**0.4**	**25**
Henderson Estates	**0.3**	**18**

Heritage Valley Area	**0.1**	**7**
Heritage Valley Town Centre Area	**0**	**1**
High Park	**0.2**	**10**
Highlands	**1.1**	**71**
Hillview	**0.3**	**19**
Hodgson	**0.1**	**8**
Hollick-Kenyon	**0.3**	**20**
Holyrood	**0.4**	**29**
Homesteader	**0.2**	**13**
Hudson	**0.2**	**14**
I don't know	**0.1**	**5**
I prefer not to answer	**0.8**	**51**
Idylwylde	**0.2**	**16**
Inglewood	**0.6**	**41**
Jackson Heights	**0.3**	**18**
Jamieson Place	**0.3**	**20**
Jasper Park	**0.1**	**6**
Kameyosek	**0.2**	**11**
Keheewin	**0.2**	**15**
Kenilworth	**0.3**	**21**
Kensington	**0.4**	**29**
Kernohan	**0.2**	**14**

Keswick Area	**0.2**	**11**
Kildare	**0.2**	**12**
Kilkenny	**0.4**	**25**
Killarney	**0.3**	**18**
King Edward Park	**0.8**	**49**
Kiniski Gardens	**0.4**	**23**
Kirkness	**0.3**	**18**
Klarvatten	**0.2**	**16**
La Perle	**0.7**	**46**
Lago Lindo	**0.2**	**16**
Lansdowne	**0.3**	**17**
Larkspur	**0.3**	**18**
Lauderdale	**0.2**	**14**
Laurel	**0.3**	**17**
Laurier Heights	**0.6**	**39**
Lee Ridge	**0.2**	**10**
Leger	**0.1**	**8**
Lendrum Place	**0.3**	**21**
Lewis Farms Industrial	**0.1**	**6**
Lorelei	**0.2**	**13**
Lymburn	**0.4**	**26**
Lynnwood	**0.4**	**27**
MacEwan	**0.5**	**32**

Mactaggart	**0.3**	**19**
Magrath Heights	**0.2**	**15**
Malmo Plains	**0.5**	**31**
Maple	**0.1**	**7**
Maple Ridge	**0**	**3**
Maple Ridge Industrial	**0**	**1**
Matt Berry	**0.2**	**15**
Mayfield	**0.2**	**14**
Mayliewan	**0.2**	**13**
McCauley	**0.2**	**14**
McConachie Area	**0.5**	**30**
McKernan	**0.1**	**9**
McLeod	**0.2**	**16**
McQueen	**0.2**	**15**
Meadowlark Park	**0.3**	**17**
Meadows Area	**0.3**	**22**
Menisa	**0.2**	**14**
Meyokumin	**0.2**	**13**
Meyonohk	**0.1**	**9**
Michaels Park	**0.1**	**8**
Mill Creek Ravine North	**0.2**	**13**
Mill Creek Ravine South	**0.1**	**6**
Mill Woods Golf Course	**0.1**	**4**

Mill Woods Park	**0.1**	**5**
Mill Woods Town Centre	**0.2**	**13**
Miller	**0.2**	**13**
Minchau	**0.2**	**12**
Montrose	**0.2**	**16**
Newton	**0.2**	**16**
North Glenora	**0.5**	**34**
Northmount	**0.1**	**8**
Norwester Industrial	**0**	**2**
Ogilvie Ridge	**0.1**	**9**
Oleskiw	**0.4**	**23**
Oliver	**2.4**	**157**
Ormsby Place	**0.4**	**25**
Other	**0.2**	**10**
Ottewell	**1.2**	**77**
Overlanders	**0.2**	**10**
Oxford	**0.2**	**15**
Ozerna	**0.2**	**12**
Paisley	**0.1**	**7**
Parkallen	**0.6**	**41**
Parkdale	**0.2**	**15**
Parkview	**0.8**	**49**
Parsons Industrial	**0**	**1**

Patricia Heights	**0.2**	**14**
Pleasantview	**0.5**	**34**
Pollard Meadows	**0.1**	**9**
Potter Greens	**0.2**	**11**
Prince Charles	**0.1**	**7**
Prince Rupert	**0.2**	**10**
Queen Alexandra	**0.5**	**31**
Queen Mary Park	**0.7**	**44**
Quesnell Heights	**0**	**2**
Ramsay Heights	**0.5**	**30**
Rapperswill	**0.3**	**17**
Rhatigan Ridge	**0.3**	**21**
Richfield	**0.2**	**11**
Richford	**0**	**3**
Rideau Park	**0.3**	**18**
Rio Terrace	**0.3**	**20**
Ritchie	**0.9**	**56**
River Valley Hermitage	**0**	**1**
River Valley Lessard North	**0**	**1**
River Valley Oleskiw	**0**	**1**
River Valley Riverside	**0**	**1**
River Valley Terwillegar	**0.1**	**8**
River Valley Victoria	**0**	**2**

River Valley Whitemud	**0**	**2**
River Valley Windermere	**0**	**1**
Riverdale	**0.7**	**46**
Riverview Area	**0**	**3**
Rosenthal	**0.1**	**9**
Rossdale	**0.2**	**12**
Rosslyn	**0.1**	**9**
Royal Gardens	**0.4**	**26**
Rundle Heights	**0.2**	**10**
Rural North East Horse Hill	**0**	**3**
Rural North East South Sturgeon	**0**	**1**
Rutherford	**1.3**	**86**
Sakaw	**0.3**	**18**
Satoo	**0.4**	**24**
Schonsee	**0.1**	**7**
Secord	**0.3**	**19**
Sherbrooke	**0.2**	**11**
Sherwood	**0.1**	**4**
Sifton Park	**0.1**	**7**
Silver Berry	**0.3**	**18**
Skyrattler	**0.3**	**18**
South Edmonton Common	**0**	**2**

South Terwillegar	**0.6**	**36**
Spruce Avenue	**0.1**	**8**
Starling	**0.1**	**7**
Steinhauer	**0.4**	**26**
Stewart Greens	**0**	**2**
Strathcona	**1.5**	**99**
Strathearn	**0.6**	**36**
Suder Greens	**0.1**	**7**
Summerlea	**0.1**	**4**
Summerside	**0.4**	**28**
Sweet Grass	**0.2**	**14**
Tamarack	**0.1**	**8**
Tawa	**0.2**	**10**
Terra Losa	**0.2**	**12**
Terrace Heights	**0.6**	**37**
Terwillegar Towne	**0.8**	**51**
The Hamptons	**0.4**	**26**
The Orchards At Ellerslie	**0.2**	**14**
Thorncliff	**0.2**	**11**
Tipaskan	**0.2**	**11**
Trumpeter Area	**0.2**	**13**
Tweddle Place	**0.2**	**10**
Twin Brooks	**0.7**	**43**

University of Alberta Farm	**0**	**1**
Virginia Park	**0.1**	**9**
Walker	**0.3**	**20**
Webber Greens	**0.2**	**14**
Wedgewood Heights	**0.1**	**6**
Weinlos	**0.1**	**9**
Wellington	**0.3**	**17**
West Jasper Place	**0.1**	**8**
West Meadowlark Park	**0.2**	**10**
Westbrook Estates	**0**	**3**
Westmount	**1.2**	**75**
Westridge	**0.2**	**11**
Westview Village	**0.1**	**4**
Westwood	**0.2**	**14**
Whitemud Creek Ravine		
North	**0**	**1**
Whitemud Creek Ravine		
South	**0**	**2**
Wild Rose	**0.2**	**14**
Windermere	**0.6**	**36**
Windermere Area	**0.2**	**11**
Windsor Park	**0.2**	**15**

Winterburn Industrial Area		
West	**0**	**1**
Woodcroft	**0.2**	**14**
York	**0.4**	**24**

3. [IF Edmonton Q1] What are the first 3 digits of your postal code?
    a. List
    b. I don't know
    c. I prefer not to answer

Postal Code	Percent	Frequency
T5A	**2.7**	**172**
T5B	**1.6**	**102**
T5C	**1.4**	**89**
T5E	**2.5**	**164**
T5G	**1.2**	**76**
T5H	**2.3**	**149**
T5J	**0.6**	**37**
T5K	**2.9**	**186**
T5L	**1.4**	**92**
T5M	**2.3**	**146**
T5N	**2.2**	**141**
T5P	**1.2**	**79**
T5R	**3**	**197**

T5S	**0.6**	**38**
T5T	**5.4**	**346**
T5V	**0**	**3**
T5W	**2.1**	**137**
T5X	**2.6**	**171**
T5Y	**2.9**	**190**
T5Z	**1.4**	**88**
T6A	**2.9**	**190**
T6B	**1.7**	**107**
T6C	**4**	**261**
T6E	**3.4**	**217**
T6G	**1.3**	**85**
T6H	**4.1**	**263**
T6J	**5.6**	**365**
T6K	**1.9**	**123**
T6L	**3.3**	**216**
T6M	**2.2**	**139**
T6N	**0**	**2**
T6P	**0.1**	**4**
T6R	**4.3**	**277**
T6T	**1.5**	**96**
T6V	**1.4**	**92**
T6W	**5**	**325**

T6X	**1.4**	**90**
T6Y	**0**	**1**
I don't know	**0.1**	**6**
I prefer not to answer	**1.5**	**96**

4. What type of a dwelling do you live in?
    a. Single detached home (**4207, 71%**)
    b. Townhouse, duplex, or fourplex (**761, 13%**)
    c. Condo/apartment (**822, 14%**)
    d. Other (Please specify) (**43, 1%**)
    e. I prefer not to answer (**93, 2%**)

5. Do you have a yard facing or back onto a park or natural area (e.g., ravine, river valley, utility corridor)?
    a. Yes (**1699, 29%**)
    b. No (**4146, 70%**)
    c. I don't know (**30, 1%**)
    d. I prefer not to answer (**51, 1%**)

6. Which of the following describes your household? (Please check all that apply)
    a. We have children under 13 in the household (**1113, 19%**)
    b. We have people 13-64 in the household (**3702, 62%**)

c. We have people 65 and above in the household (**1650, 28%**)

d. Other (Please specify): (**230, 4%**)

e. I prefer not to answer (**268, 5%**)

7. Which of the following describes pets in your home? (choose all that apply)

   a. I have one or more indoor cats (**1350, 23%**)

   b. I have one or more outdoor cats (that may sometimes escape my yard) (**320, 5%**)

   c. I have one or more small dogs (smaller than a border collie) (**1236, 21%**)

   d. I have one or more large dogs (as large or larger than a border collie) (**1298, 22%**)

   e. My dogs are sometimes off leash outside my yard (in or outside designated areas) (**759, 13%**)

   f. I have other outdoor pets named below. (**34, 1%**)

   g. Other ______________________ (**228, 4%**)

   h. I have no pets (**2233, 38%**)

   i. I prefer not to answer (**146, 2%**)

8. Are you?

   Under 18 years old (**5, 0%**)

   18-24 years old (**89, 2%**)

   25-34 years old (**683, 12%**)

   35-44 years old (**1210, 20%**)

   45-54 years old (**1085, 18%**)

   55-64 years old (**1264, 21%**)

65 to 74 years old (**1096, 18%**)

75+ years old (**228, 4%**)

I prefer not to answer (**266, 4%**)

9. What is your gender? Choose all that apply.

   Woman (**3270, 55%**)

   Man (**2179, 37%**)

   Non-binary (**57, 1%**)

   Transgender (**27, 0%**)

   Two-Spirit (**23, 0%**)

   Another gender not listed above (**24, 0%**)

   I prefer not to answer (**410, 7%**)

10. Are you a member of any of the following groups? (Please check all that apply)

    a. Racialized / visible minority (**356, 6%**)

    b. Persons with disabilities (**407, 7%**)

    c. Indigenous (**134, 2%**)

    d. New to Canada (**48, 1%**)

    e. None of these (**4263, 72%**)

    f. Other (Please specify): (**193, 3%**)

    g. I prefer not to answer (**649, 11%**)

11. What is the primary language spoken in your household?

English (**5501, 93%**)

French (**36, 1%**)

Arabic (**4, 0%**)

Cantonese (**17, 0%**)

German (**8, 0%**)

Mandarin (**6, 0%**)

Punjabi (**10, 0%**)

Spanish (**17, 0%**)

Tagalog (Pilipino, Filipino) (**11, 0%**)

Ukrainian (**14, 0%**)

Other (Specify) (**72, 1%**)

I prefer not to answer (**230, 4%**)

12. What is the highest level of education you have completed?

Elementary/grade school graduate (**28, 0%**)

High school graduate (**577, 10%**)

College / technical school graduate (**1596, 27%**)

University undergraduate degree (**1955, 33%**)

Post-graduate degree (e.g. Masters, PhD) (**1094, 18%**)

Professional school graduate (e.g. medicine, dentistry, veterinary medicine, optometry) (**239, 4%**)

I prefer not to answer (**437, 7%**)

Thank you for your feedback. This information will be used to inform a coyote awareness campaign. For more information on urban coyotes, visit edmonton.ca/coyotes or edmontonurbancoyotes.ca.