



# URBAN FEEDING OF FUR-BEARING WILDLIFE

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Literature Review  
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Prepared for The Fur-Bearers by:  
Amelia Porter, M.Sc., EP, RPBio.

*Additional recommendations and information about the 2020/2021 Stanley Park coyote case study were added to this literature review.*

### **About The Fur-Bearers**

Established in 1953, The Fur-Bearers is a leading Canadian wildlife protection charity whose mission is to protect fur-bearing animals through conservation, advocacy, research and education (C.A.R.E).

# INTRODUCTION

## Background

The practice of intentionally feeding wildlife in parks and neighborhoods has become an important issue with increasing urbanization. Recent stories in the Canadian media report of people feeding wolves and bears at national parks, coyotes in city parks and neighborhoods, and raccoons and squirrels in parks and backyards. People are often motivated to feed wildlife in green spaces and backyards as a means to seek experiences with nature, cultivate personal wellbeing, or they are concerned for the welfare of wildlife.

Feeding may be carried out with good intentions; however, there are a number of detrimental consequences to both wildlife and humans. Ultimately, feeding wildlife leads to shifts in behaviour and ecology, dependence on unreliable food sources, aggression, and human-wildlife conflict (Cox and Gaston, 2018). In the long-term, feeding can cause suffering and poor welfare of animals (Dubois and Fraser, 2013a). Where problem situations arise from humans feeding wildlife and the subsequent progression of food-conditioned behaviours, species individuals or populations are often killed (Cox and Gaston, 2018; Dubois and Fraser, 2013a). In severe cases, feeding-induced aggression has led to human fatalities (Orams, 2002).

Despite a number of direct species benefits cited in the literature, (e.g., increased survival, productivity, and population growth), intentional recreational feeding has been evaluated in the scientific literature as an inappropriate and unacceptable form of feeding (Dubois and Fraser, 2013a; Murray et al., 2016). Experts have deemed intentional recreational feeding as unacceptable since it results in poor animal welfare, human-wildlife conflict, is poorly controlled, it does not serve a conservation purpose (Dubois and Fraser, 2013a), and has negative consequences for wildlife nutrition and disease spread in both wildlife and humans (Murray et al., 2016).

## Purpose and Objectives

The purpose of this literature review is to provide an overview of the state of knowledge on urban wildlife feeding. Specifically, the drivers and consequences of intentional urban wildlife feeding are discussed. Sources reviewed include scholarly journal articles, books, and government resources. The literature review is organized by relevant topics and combines both summary and synthesis of information. Sources are discussed in the context of their contribution to the understanding of the subject. Relationships are discussed between works where applicable and interpretations are made. Following the literature review, a summary of key findings is outlined, research gaps are identified, and recommendations are provided.

## **Types of feeding**

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There are various forms of intentional and unintentional wildlife feeding. Unintentional feeding includes anthropogenic foods from garbage, compost, landfills, gardens, fruit trees, and pet food. Conversely, intentional feeding may be carried out for captivity and rehabilitation, research, management, tourism, and opportunistic reasons (Dubois and Fraser, 2013a). Opportunistic feeding is defined as the intentional act of feeding wildlife at roadsides, public spaces and in backyards, and is the focus of this literature review. Literature on tourism feeding may also be included if deemed applicable since it is similar to opportunistic feeding, in that they are both recreational.

## **Wildlife species**

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Fur-bearing species such as bears, coyotes, squirrels, chipmunks, and raccoons are discussed in this review. Deer and birds are excluded, however if applicable, they may be referred to due to their prominence in the literature. Effort is made to use Canadian and North American examples as much as possible, but others are included where appropriate.

## **Questions**

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This review aims to provide insight into urban opportunistic feeding and answer the following three main questions:

1. Why do people feed urban wildlife? (What are the drivers?)
2. What are the impacts to wildlife and humans in terms of behavior, health, ecology and conflict? (What are the consequences?)
3. What are proven and potential mitigation strategies?



# LITERATURE REVIEW

## Human Dimensions

### **Why do people feed wildlife?**

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#### ***Extinction of experience***

Globally, half of all people resided in a city or town by the year 2007 (Cox et al., 2018). Cox et al. (2018) point to the 'extinction of experience'; they argue that opportunities for nature interactions are progressively declining. The extinction of experience is largely attributed to growing urbanization of the human population in conjunction with loss of habitat and biodiversity, as well as more human sedentary pastimes (Cox et al., 2018). Simply, there are fewer incidences of human interactions with nature, and therefore, people in urban areas intentionally seek these experiences by feeding wildlife around the home or visiting green spaces for wildlife interactions. Attracting wildlife increases the frequency, duration, and intensity of experiences with nature (Cox et al., 2018).

A study conducted at Bunya National Park in Australia found three main reasons why people feed wildlife: to interact with wildlife, for personal pleasure, and because other people were doing it (Parkin, 2001). People may perceive benefits of others engaging in wildlife feeding and also want to participate in the experience, even if they didn't plan to feed animals on their visit (Parkin, 2001).

Related to experience, (Dubois & Fraser, 2013a) cite a number of reasons why humans feed wildlife. Specifically, benefits to people include feelings of pleasure, usefulness, gained trust of animals, education for adults and children; entertainment; aesthetic benefits; and to observe or photograph animals. Further, some people may even associate wildlife as their own domestic inhabitants, with feelings of attachment, as in a case involving bears in British Columbia or birds in Australia (Dubois & Fraser, 2013a.)

#### ***Human health and wellbeing***

There is a wealth of evidence demonstrating that interaction with nature has positive impacts to human physical and mental health as well as social wellbeing. Urban bird feeding has been associated with psychological benefits, such as feelings of pleasure, relaxation and connection to nature (Cox and Gaston, 2018). Gains in health and wellbeing from feeding wildlife may encourage even more feeding (Cox and Gaston, 2018).

Despite immediate feelings of connection with nature and positive wellbeing, feeding animals in the long-term often results in negative human health consequences, due to subsequent animal suffering, poor welfare and increase in human-wildlife conflicts (Dubois and Fraser, 2013a; Cox and Gaston, 2018). Cox and Gaston, (2018) highlight a potential missing feedback loop where people who benefit from feeding interactions may not experience the negative impacts or associate their actions with welfare issues. This is why there is a need for effective education to influence and modify human behaviour.

### Concern for wildlife conservation & welfare

Many people feed wildlife because they feel they are helping. They may have concerns for the welfare of the animals or they feel they are assisting with conservation (Cox and Gaston, 2018; Howard and Jones, 2004). Wildlife conservation benefits, real or perceived, may include improved survival and population growth (Dubois & Fraser, 2013a.)

Howard and Jones (2004) conducted a survey of managers and wildlife feeders in Australia. Dependency was a common theme in responses, however managers perceived this as a negative factor for welfare, while wildlife feeders perceived it to be positive. The authors concluded the differing constructs of wildlife to arise from the two different means in which information is attained: wildlife managers being strongly knowledge based, while experience based for feeders.

Wildlife feeding interactions may support increased public awareness, thereby fostering further support for conservation (Dubois & Fraser, 2013a.) Fewer interactions with nature have implications for how people relate to nature. In particular, people show less affinity and interest, less value placement, and less inclination to participate in pro-environmental behaviours (Cox and Gaston, 2018). An increased daily interaction around the home has been associated with a greater understanding and empathy toward nature.

Ethical reasons may also play a role, which in turn can motivate more people to feed (Dubois & Fraser, 2013a.). People may believe that they are counteracting negative human impacts such as habitat destruction or lack of natural foods by providing anthropogenic sources (Dubois & Fraser, 2013a).

### Social Demographics

Western societies are currently the focus of literature related to opportunistic wildlife feeding (Chapman and Jones, 2009; Cox and Gaston, 2018). Bird feeding in particular is popular in North America, Europe, Australia and New Zealand (Dayer, 2019). This is an area requiring further research to better understand the role of culture and socio-demographics in intentional wildlife feeding, particularly with fur-bearing animals.

Statistics Canada was contacted for numbers related to Canadians engaging in wildlife feeding, however they did not have any information. Annually in the USA, out of 59 million households feeding wildlife around the home, 97% (57 million) fed wild birds, and 25% (15 million) fed other wildlife (U.S. Fish and Wildlife Service, 2018)<sup>1</sup>. In the USA, there has been an overall decreasing

<sup>1</sup> Note that some people fed both birds and other wildlife.

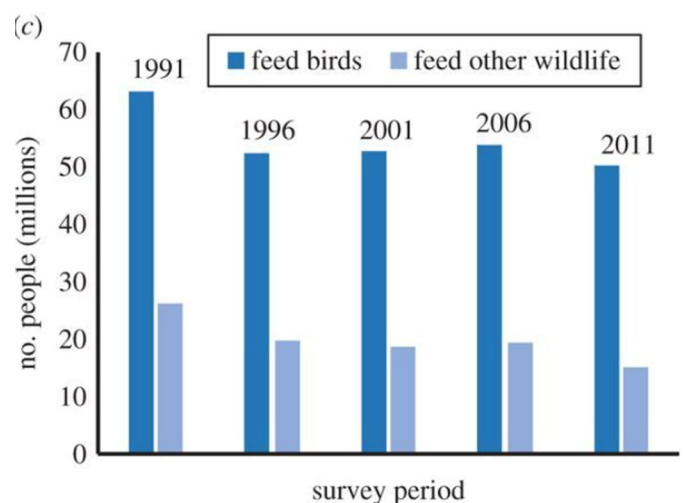


Figure 1 – USA trends in wildlife feeding around the home (adopted from Cox and Gaston, 2018)

trend since 1991 in the number of people feeding other wildlife, suggesting that people may be becoming more aware of the potential issues of wildlife feeding (Figure 1; Cox and Gaston, 2018; U.S. Fish and Wildlife Service, 2018). More research and surveys are needed to understand the prevalence of wildlife feeding in Canada.

## Wildlife Implications

### Wildlife Behaviour

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Behavioural plasticity is the developmental capacity of an individual to exhibit a wide range of behaviours (Gilbert, 1989). Mammalian flexibility or ability to alter behaviour has evolved as a function of large brains and is central to carnivore behaviour and ecology (Gilbert, 1989). Recent research demonstrates the significance of this adaptability feature, even in small mammals (i.e., foraging shifts in the rodent *American pica*), showing that behavioural plasticity may help species survive increasing temperatures associated with climate change. This is because the lag time between behaviour response and environmental change is short (and reversible). Behavioural plasticity can allow organisms to adapt to urban environments faster than genetic evolution due to the quick response time capable of one individual (Murgui and Hedblom, 2017). However, genetic mechanisms influencing behaviour such as microevolution in urban habitats may also play a role (Murgui and Hedblom, 2017).

Certain characteristics make some species more capable of surviving in urban environments such as the propensity to exhibit behavioural plasticity, genetic factors influencing behaviour, together with being a dietary ecological generalist. Specialist species which favour a specific diet or habitat may be most impacted by growing urbanization (Beckmann & Berger, 2003). Therefore, generalist species such as coyotes, bears, raccoons, and squirrels are common in urban environments and are susceptible to food-conditioning and human-wildlife conflict. With increasing urbanization and species capacity to live in close proximity to humans, there is a need to facilitate coexistence safely by avoiding wildlife feeding and food-conditioned behaviour.

### ***Food-conditioning and human-wildlife conflict: species examples***

#### ***BEARS***

Food-conditioning is the attraction of wildlife to human-sources of foods which leads to increased incidence of human-wildlife interaction and conflicts. For example, bears have become increasingly habituated to people (i.e., tolerance of proximity) due to the positive-reinforcement association made with food. Bears learn quickly where food is located, encouraging conflict behaviours such as breaking and entering and intimidation of humans, behaviour that can be observed and learned across generations (Gilbert, 1989; Peine, 2001). In a nature versus nurture study in Alberta, the propensity of grizzly bears to exhibit conflict behaviour was dictated by social learning and not genetic inheritance (Morehouse et al., 2016). Specifically, offspring of problem mothers, not fathers, were more likely to display the same behaviour, highlighting the need to prevent food conditioning of female bears in particular.



For these reasons, there is a long history of human encounters with habituated and food-conditioned bears in neighbourhoods and parks, which are seen as a nuisance problem or threat, and are consequently killed (Gilbert, 1989; Peine, 2001; Dubois and Fraser, 2013b). To put this into perspective, every year in British Columbia, 10,000 bear complaints are made to the government and several hundred black bears are killed (Dubois and Fraser, 2013b).

While most human-bear conflict arises from unintentional feeding attractants (e.g., fruit trees, garbage), one prominent case in Christina Lake, British Columbia is an example of an intentional direct illegal bear feeding operation (Dubois and Fraser, 2013b). In 2010, police discovered that over 20 black bears were fed dog food from a residence for over two decades. What's more is that people in the local community were aware of the ongoing issue and did not perceive it as causing animal harm (see further discussion in Mitigation Strategies below). Habituated and reliant on the food source, officials killed 24 black bears (Dubois and Fraser, 2013a).



## COYOTES

Coyotes are ubiquitous in North America, yet attacks on humans are rare despite the perceived risk by the public and management response. However, in cases where attacks involving biting or scratching have occurred in Canada, food conditioning has been implicated in the majority of incidents (Alexander and Quinn, 2011; Boelens, 2006; University of British Columbia Wiki, 2021). The City of Vancouver first saw incidents of children being bitten by coyotes in 2000 and 2001, but after inception of the Co-Existing with Coyotes public education program by the Stanley Park Ecology Society, cases seized (Boelens, 2006). Unusually, in 2020 and 2021 there was a steep surge of attacks in Vancouver's Stanley Park on both children and adults. Wildlife experts attribute this to increased feeding by people during the COVID-19 pandemic, ultimately resulting in habituation and loss of fear to humans (UBC Wiki, 2021). In response, 11 coyotes were culled by the Ministry of Forests, Lands, Natural Resource Operations & Rural Development (UBC Wiki, 2021). Similarly, in recent reporting of coyote attacks in the City of Calgary, officials say neighbours were deliberately feeding meat and providing water to coyotes (Kaufmann, 2021; Lukasik and Alexander, 2012).



Oftentimes, the problem of human feeding is not addressed. Notwithstanding evidence in the scientific literature suggesting solutions for food-conditioning and the ineffectiveness of lethal methods for long-term population control, mass coyote

culling programs have occurred across Canada (e.g., Nova Scotia, Saskatchewan, Alberta and Ontario) (Alexander and Quinn, 2011). This often occurs in response to sensationalized media and misplaced public fear and risk perceptions (Alexander and Quinn, 2012). Research has shown that culling of coyotes on a large scale is not an effective or reasonable approach since (1) typically incidents involve individuals within populations (not entire populations); (2) under pressure from culling, breeding increases among younger individuals, increasing birth rate to compensate; (3) liability issues arise for urban residents and companion animals; (4) there are excessive costs for disproportionate success and sustainability (UBC Wiki, 2021). The Co-existing with Coyotes program in Vancouver has had success over the years through hazing (intensely scaring), education, and feeding avoidance. However, programs like this need to be a pillar within a much wider strategy of solutions embedded within urban planning and management, and our responsibility for continued research on how to coexist and value urban wildlife (UBC Wiki, 2021).

Coyotes are considered keystone predator species, playing a key role in urban ecosystem function to suppress small carnivores and regulate abundant species populations (Alexander and Quinn, 2011; Lukasik and Alexander, 2012; UBC Wiki, 2021). Removing them has implications for urban species assemblages and control of populations seen as pests such as deer, rabbits and Canadian geese.

Similar to coyotes, highly adaptable wildlife will ultimately persist in urban environments. Conflict will continue if the issue of human feeding is not addressed. Scientists and academics are calling for public education and measures for effective coexistence. Particularly, in regard to avoidance of food-conditioning, a precursor for human-wildlife conflict.

### *CHIPMUNKS*

At a national park in Utah, researchers noted that even small and infrequent feeding might foster food-attraction behaviour in chipmunks (Marion et al., 2008). Furthermore, when food rewards were reduced, chipmunks competed with each other, becoming more vigorous and aggressive. The authors suggested further research to understand what level of food reduction and time would be required to wean chipmunks from anthropogenic foods and back to natural foraging.

### *SQUIRRELS*

Grey squirrel population density and its relationship to aggression were studied at parks in Washington, DC and Baltimore, MD. The researchers found a statistically meaningful relationship between higher squirrel population density and increased aggression among the squirrels (Parker and Nilon, 2008). They also found that in the squirrel populations with higher density, the squirrels were less fearful of humans. Anthropogenic food comprised 35% of the diet at one park and all of the parks were assessed as not having enough natural foods available to support the existing populations. Foods provided by humans were found to sustain the populations, and elevate populations to unnatural levels. Higher







population densities may promote aggressive behaviours and less weariness to humans (Parker and Nilon, 2008).

### *SKUNKS AND RACCOONS*

Cat food is often used as a food-attractant for small carnivores. Theimer et al. (2015) conducted a study of backyard feeding in neighborhoods in Arizona, using motion-activated cameras. Spilled birdseed had already resulted in attraction on skunks and raccoons, however when a bowl of cat food was added, the number of visits by the animals (and cats) doubled (Theimer et al., 2015). Pet food provided in dish, represented a high-quality 'clumped' source of food distribution, as opposed to the spread out birdseed. The research also showed that, in the presence the bowl of cat food, the number of instances where more than one animal was present together increased, with obvious displays of aggression. Aggressive behaviour included biting

and nipping. Increased wildlife aggression at feeding sites is commonly reported in the literature (Murray et al., 2016), as well as its association with disease transmission (e.g., rabies in raccoons, tuberculosis in wild boars, respiratory diseases in voles and chimpanzees) (Murray et al., 2016).

## **Wildlife Health**

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### ***Nutrition, immunity and disease***

Feeding wildlife has implications for nutrition, stress, immunity, and disease. Murray et al. (2016) conducted a comprehensive review of supplemental feeding and wildlife health (i.e., malnutrition and stress) and pathogen transmission and disease, spanning 68 species and 35 countries; half of the studies were from North America. Although the studies reviewed also included birds and deer, findings generalized to wildlife showed that feeding negatively affected health. Negative health outcomes were attributed to pathogen transmission from increased contact rates, stress, injury, malnutrition and immunosuppressive contaminants. Health outcomes were also examined by feeding categories (i.e., game management, conservation, tourism, and residential areas). Conservation feeding largely provides positive health outcomes, while recreational feeding (i.e., tourism and residential) is associated with negative health outcomes (Murray et al.; 2016).

Generally, research on disease and immunity as it relates to wildlife feeding is limited. Wildlife pathologists stress the need for a better understanding of wildlife immunity and urban pathogen dynamics (Becker et al., 2015; Strandin et al., 2018). In any case, evidence does show that wildlife-feeding impacts on infection are highly dependent upon specifics of the host-pathogen interaction (Becker et al., 2015). In different circumstances, food provisioning can have both positive and negative implications for wildlife nutrition, immunity and disease (Becker et al., 2015; Strandin et al., 2018). Thus, management of urban wildlife pathogens should be addressed by focusing on specific wildlife species, food sources and pathogen types, as this is what drives the variation in infection outcomes discussed in the literature (Becker et al., 2015).

Additional broad conclusions have been made in this regard. Food provisioning and subsequent changes related to (1) contact and movement behaviour, (2) demographics, and (3) immune defences have the potential to influence pathogen invasion and prevalence (Becker et al., 2015; Strandin et al., 2018). Aggression, increased contact, and altered population densities associated with competition between and within species can also amplify transmission (Becker et al., 2015). Individuals with the poor physiological condition are least able to resist infection, compounding risks of poor condition and infection loads (Strandin et al., 2018). Immunity may become impaired due to poor anthropogenic food sources containing contaminants (e.g., antibiotics, pharmaceuticals, metals) or absence of key nutrients found in natural diets (Strandin et al., 2018). Food of low nutritional quality, such as a lack in protein, can inhibit immune defences (Becker et al., 2015). Public outreach is necessary to create awareness of the potential affects of wildlife feeding on the spread of pathogens within wildlife communities and risk to human exposures (Becker et al., 2015).

### ***Implications for human and domestic animal health***

Human wildlife feeding can facilitate transmission among wildlife, but wildlife pathogens can also present risks for humans. For example, raccoon roundworm is a parasite problem in many parts of the world and can infect humans, and other animals including dogs. Raccoon roundworm has long been an issue in Nova Scotia (Anderson, & Mills, 1991). Public messaging for the province states that although rare in humans, confirmed cases typically involve children coming into contact with feces and that feces should be carefully disposed (Government of Nova Scotia, 2021).

The lethal parasite *Echinococcus multilocularis* is an emerging public health concern in North American, Europe and other parts of the world as it can cause a disease called Alveolar echinococcosis in humans. The parasite is a wildlife-borne intestinal tapeworm, particularly prevalent in foxes, but also coyotes and domestic dogs (Catalano et al., 2012; Higglin et al., 2015). The parasite is now reported in red foxes and coyotes in the southern reaches of Ontario, Manitoba, Saskatchewan and Alberta, as well as 13 states of the USA (Catalano et al., 2012). Recent research at the University of Guelph found the parasite in one in four foxes and coyotes in Southern Ontario, suggesting it is well established (Kotwa et al., 2019). Increasing positive attitudes of urban people toward foxes has encouraged foxes to become less fearful of humans, exhibiting more tameness (Higglin et al., 2015). Researchers advocate for keeping foxes shy and abstaining from feeding (Higglin et al., 2015). Increased awareness is necessary in cities (e.g., Calgary) where the human and domestic dogs populations are growing, due to the prevalence of urban coyotes and/or foxes (Catalano et al., 2012).

## Cascading Ecological Impacts

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Literature sources investigating impacts to ecological systems that are specific to both intentional feeding and fur-bearing wildlife are lacking. However, there are related studies, which offer valuable insight into potential cascading ecological consequences that would be conceivable within other influenced ecological systems.

Focusing on urban recreational bird feeding, Shutt and Lees (2021) investigated the implications to biodiversity from widespread resource provisioning. Direct benefits and risks are known for target bird species, however, they hypothesized that such vast inputs into the environment is likely to have a number of indirect negative ecological consequences. Using British garden birds for illustration, they demonstrate how well-intentioned feeding creates unbalanced ecosystems, altering community structure such that it becomes more homogenous with reduced biodiversity. Compared to more adaptable species, species of concern may decline due to competition, increased predation, new predators, and increased disease. The research suggests that the implications for non-target species (i.e., competitors, prey and predators) are not adequately considered and that there could be extensive adverse impacts on biodiversity (Shutt and Lees, 2021). Galbraith et al. (2015) showed similar findings, demonstrating that bird feeding shapes the structure of bird communities in urban areas, altering the balance between native and introduced species. Finally, while these studies focused on birds, ecosystem cascades are likely to occur to varying degrees in all provisioned ecosystems (Shutt and Lees, 2021).

Ore et al. (2013) synthesized the literature on anthropogenic food subsidies that are provided as wastes (e.g., dumps, crop residuals and fishing discards) and argue that these subsidies have shaped ecological communities we know today. Generally, for opportunistic species these subsidies mean increased survival and population growth. However, this in turn alters processes of competition, predator-prey dynamics, and nutrient transfer with wider implications for communities, food webs and ecosystems (Ore et al., 2013). Based on the researchers meta-analysis of examples in the literature, they illustrated the effects at individual, population, and community and ecosystem levels, as shown in Figure 2. The diagram shows that while direct effects to individuals may be positive, there are a number of negative cascading and indirect effects that reshape wildlife communities and have evolutionary implications. The pervading impacts to entire ecosystems, as shown in Figure 2, has potential to alter stability, flexibility and persistence (Ore et al., 2013).



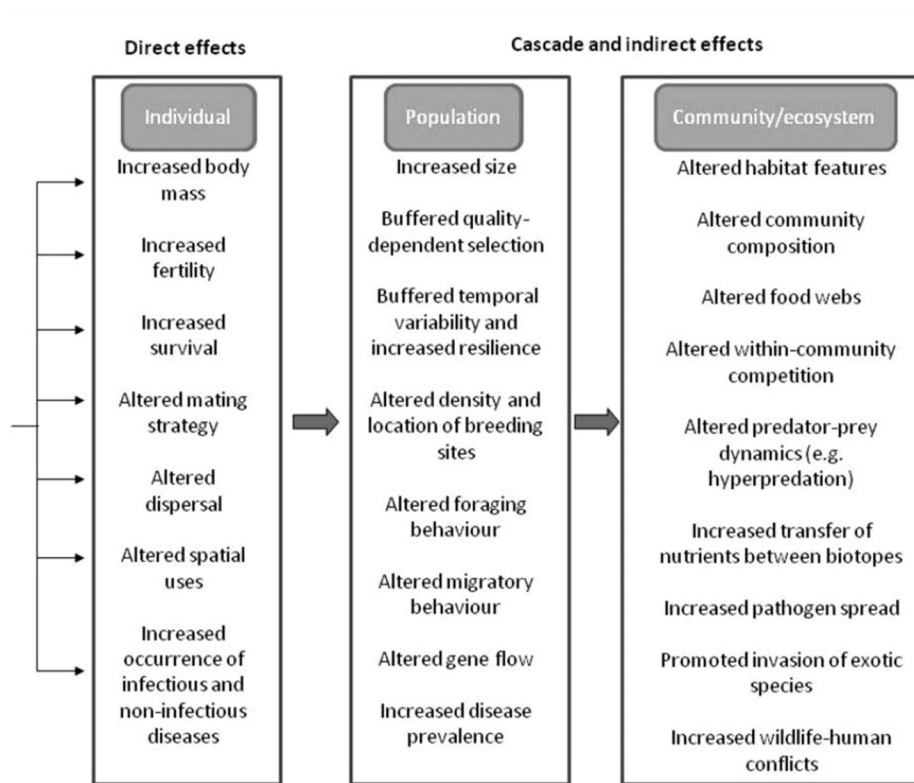


Figure 2 – Influence of food subsidies at the individual, population and community or ecosystem level. Adopted from Ore et al. (2013)

The work by Ore et al. (2013) highlights the complexity of ecological systems, and how food energy inputs can have far-reaching cascading consequences. Other research studies have shown that inputs into ecological systems can shift competition, destabilize communities, and lead to the extinction of non-target species (Ore et al., 2013), which is conceivable through species exploitation of human provided foods over a long period. For example, Tanner et al. (2011) used an invasive crab as a model to demonstrate that modifications to food distributions by humans (i.e., spatially clumped) can lead to aggression, altering species competition dynamics and allow invasive species to populate and persist in highly disturbed landscapes like urban areas.

Similar to Ore et al. (2013), Newsome et al. (2015) conducted a comprehensive global review of studies on the ecological effects of human food subsidies, exclusive to provision for terrestrial mammalian predators. Based on their review of studies from 34 countries, findings revealed that human-provided foods caused changes in predator behaviour and populations, inducing cascades across levels of the food web. Specifically, due to availability of human foods, predator abundance increased, dietary preferences shifted, survival, reproduction and sociality shifted, and predator home ranges and movement shifted. These modifications facilitated predation and competition, thereby indirectly affecting other species.

# Mitigation Strategies

Tools to assist managers and educators are discussed first, followed by indirect and direct management actions as they pertain to the human dimensions of wildlife feeding. Mitigation strategies for management of human-wildlife conflict generally fall into two categories: indirect and direct management actions. Indirect practices attempt to influence individual decision-making through public education while direct interventions prohibit unwanted behaviour through regulation and enforcement (Marion et al., 2008). Both recognize the importance of altering human behaviour as a long-term solution (Baruch-Mordo, 2011).

## **Tools for Managers and Educators**

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### ***Framework to Identify Unacceptable Feeding***

Implementation of an evaluative framework may help managers and educators clearly identify and articulate to the public the appropriateness of various forms of wildlife feeding. Opportunistic feeding is deemed unacceptable; however, mixed messaging among other forms of feeding can be confusing to the public. Application of a formal framework may help guide communication.

Dubois & Fraser (2013a) presented a unique framework for policy makers, educators and managers to distinguish between acceptable and unacceptable forms of wildlife feeding. The framework is intended to assist in making decisions that are rooted in both ethics and biology. In their paper, they applied their framework to evaluate four types of feeding (i.e. research, management, tourism, and opportunistic). The framework uses three factors to assess wildlife feeding: the ability to control the activity, its effects on conservation, and on the long-term welfare of animals. They provide a number of examples from British Columbia, demonstrating that feeding is often motivated by good intentions, but can lead to public safety and conservation problems that are detrimental to the welfare of animals. They found that cases of opportunistic wildlife feeding were generally unacceptable and that this form of feeding is unlikely to change until it becomes seen as socially unacceptable.

Disease transmission associated with wildlife feeding aggression has become a prominent factor in the literature. As such, Murray et al. (2016) built upon the original framework of Dubois & Fraser (2013a) by adding evaluations of health and disease. Specifically, mechanisms for changes in health (i.e., contact rates, immune function, stress hormones, contaminants, and nutrition) were assessed as negative, no effect, or positive.

Wildlife feeding acceptability framework: four types of feeding activities evaluated by their ability to be controlled (C) and their effects on conservation (E) and animal welfare (W).

Factors (C, E, W)	Research	Management	Tourism	Opportunistic
C: feasible to regulate/monitor/intervene	++	+	-	--
C: safe for the public	++	+	-*	-*
E: contributes to understanding the species	++	+	+	-
E: contributes to saving endangered species	+	++	-	-
E: contributes to population survival	+	+	-	-
E: does not facilitate poaching or disease	+	-*	-	-*
E: contributes to public education	N/A	N/A	+/- **	+
E: provides economic benefits	N/A	+	+/- **	-
W: effects relatively few animals	++	+	-**	--
W: does not cause physiological stress to animal	+	+	-*	-*
W: does not cause physical harm to animal	+	-*	-*	-*
W: affects only a small portion of lifespan	++	+	--*	--*
W: does not disrupt natural foraging	+	-	--*	--*

Items are rated high (++), somewhat high (+), somewhat low (-) or low (--), not applicable (N/A) based on general knowledge of the literature. The use of \* indicates that the evaluation may vary for different cases; specifically, \* = depends on the species involved and \*\* = depends on the tourism operator.

### **Coexistence plan**

Coexistence plans emphasizing food-conditioning avoidance and effective response is necessary. The University of Calgary campus has implemented Living with Wildlife, a peaceful coexistence program led by Dr. Shelley Alexander, with four cornerstones: prevention, education, enforcement and mitigation. Dr. Shelley Alexander, a wildlife ecologist specializing in wolves and coyotes, offers a Wildlife Co-Existence Outreach Program for communities via free virtual webinars. Encouraging communities to seek this expert advice may help with adoption of coexistence practices including prevention of food-conditioned wildlife.

### **Urban and Park Design**

Green park features can be designed or adapted such that they minimize human-wildlife interactions. Using the red squirrel, Uchida et al. (2021) studied how park characteristics influenced the degree of human avoidance behaviours (i.e., flight initiation distance and tree climbing height). Findings demonstrated that high feeding intensity decreased the degree of these human avoidance behaviours, while high green space, high tree density, and high density of recreational

equipment increased the degree of human escape behaviours (Uchida et al., 2021). In situations where the intended goal is to minimize human-wildlife interactions, parks can be designed with higher density of trees and recreational equipment. Manipulating such characteristics can be one effective tool for park managers, as part of their repertoire of strategies to decrease opportunities for wildlife feeding to occur.

## **Education and Messaging**

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Education programs are capable of successfully imparting knowledge and reducing undesirable human-induced environmental and social outcomes (Marion et al., 2008). There is a large body of research demonstrating that the effectiveness of education programs intended to shift behaviour are dependent upon peoples' inherent values and beliefs, and social norms, in conjunction with messaging content and delivery (Marion et al., 2008). In order to prevent or address wildlife feeding problems, managers are tasked with achieving the following:

- (a) Communicate that feeding wildlife is an inappropriate and harmful activity,*
- (b) develop effective educational efforts that discourage intentional or unintentional wildlife feeding,*
- (c) monitor wildlife feeding and wildlife food attraction behaviours, and*
- (d) modify human behaviours (Marion et al., 2008, p.430).*

### **Message characteristics**

Marion and Reid (2007) conducted a review of a number of educational programs carried out in protected areas and made drew several broad conclusions. They found that all studies of education programs positively influenced human knowledge, behaviour, attitudes and/or impact. Therefore, suggesting that visitor education is an effective management strategy. Researchers in this field have identified four critical components to educational efficacy: message content, delivery, audience characteristics, and theoretical grounding, as summarized from Marion and Reid (2007) below.

#### *Message content*

- Message objectives need to be set and agreed upon.
- Messages should be simple, interesting, clear and concise, while providing useful information limited to a small number of topics and clearly identifies desirable and undesirable behaviour.
- Message content must be consistent in order to achieve successful effectiveness.
- Messages containing ecological rationale rather than social reasons, may be more effective in altering behaviour.
- Message content should target defined audiences who are more likely to engage in wildlife feeding in order to address their behaviour, as research indicates variation in impact behaviour among user groups.

### *Message delivery*

- Messages should be delivered at the correct timing. Evidence demonstrates that education must occur near the timing and location of potential wildlife feeding (Hockett, 2000).
- Messages should be provided by creditable sources as research shows the degree of creditability influences persuasion.
- Messages should be delivered via multiple media methods to maximize effectiveness. Research is unclear on which method (i.e., personal, signs, brochures, or computers) is best. Although communication theory supports personal delivery, some findings agreed with this while others found it no more effective than other methods. This is further discussed below.
- Messaging should be widespread and repetitive.

### *Audience characteristics*

- Awareness of the audience's level of knowledge related to wildlife feeding impacts. Understanding the audience and their receptivity to education allows for targeted messages that resonate with different audiences.
- Communication should target specific fundamental beliefs shared by the target audience, rather than only factual information on the problem human behaviour. Understanding which beliefs influence wildlife feeding behaviour can help improve messaging content.

### *Theoretical basis*

- Managers can better understand the mechanisms influencing behaviour by incorporating a theoretical basis for their educational program. Theoretical paradigms to explain how people make decisions, outlined in Marion and Reid (2007), include moral development, reasoned action/planned behaviour, decision- making, and persuasion. For example, Hockett and Hall (2007) drew from the Elaboration Likelihood Model of Persuasion to explore moral and fear based messaging. Theoretical motivations which underlay wildlife feeding, and its application in education, is an area that could benefit from further research.
- Researchers have demonstrated that a multifaceted approach is more effective than no theoretical basis or only a single focus (e.g., incorporating persuasive and moral techniques or targeting multiple stages of moral development).

### *Message delivery: case study*

Research conducted by Marion et al. (2008), at a national park in Utah, was aimed to evaluate human and wildlife feeding behaviour in response to a message delivered via two approaches: posted signage and personal conveyance. Observations of visitor feeding behaviour and chipmunks success in obtaining food as well as food attraction behaviour were documented. Although results for both signage and personal conveyance showed significant improved visitor behaviours and reduced human food available to chipmunks, differences between the two methods were



marginal. Findings among similar studies in the literature were inconsistent on effectiveness of personal versus printed messages.

The researchers suggest that other messaging characteristics as described above (Marion and Reid, 2007) may have comparable or greater importance. For example, the timing and location of message relative to the occurrence of wildlife feeding, as well as source credibility. However, while the literature generally acknowledges the benefits of interpersonal communication, it's not the most efficient when used alone. Recent research studies support mixed media communication approaches for greater effectiveness (Abrams et al, 2020).

#### *Messages of morality for wildlife feeding*

Hockett (2000) and Hockett and Hall (2007) found that both moral and fear appeals were effective in reducing the behaviour of deer feeding. Although the fear based message affected attitude to a greater degree, the authors concluded moral may affect behaviour as much or more since people were reminded of already held knowledge at the most advantageous timing. It is also important to note that the moral appeal used humour, which has mixed results in the literature; therefore moral messaging requires deeper analysis.

Further, the authors found that people discounted the fear of deer, suggesting that the effectiveness of fear appeals is species dependent. Therefore, fear based messaging should be carried out cautiously and based on empirical evidence, particularly with large carnivores. Other research discusses the unnecessary social amplification of risk and how it ultimately negatively impacts species. Case in point, coyotes are regularly persecuted more as a function of public perceptions than the actual reality of risk, highlighting the need for clear risk communication (Alexander and Quinn, 2011). Both theories of fear and moral based messaging can be applied with appropriate considerations.

Fear appeals should not solely be relied upon, especially when risk perceptions are low, as researchers have noted in some cases for bears and deer (Dubois and Fraser, 2013a; Abrams et al, 2020). Some research shows fear messaging is less effective than those that facilitate connection to conservation (Schaffner et al., 2015).

Recent research assessing wildlife value orientations found that mutualism focused messages, and not fear based, better predicted agreement with distance-related wildlife messages (Freeman et al., 2021). Mutualist individuals respect the rights of wildlife, are less likely to engage in activities harmful to wildlife and are more caring and empathetic toward wildlife. Freeman et al., (2021) discuss how park visitors are more likely to be characterized by holding mutualism values and that wildlife viewing is related to these values. This is likely also the case with people who engage in wildlife feeding. Therefore, messages grounded in mutualism may be more successful. Examples of mutualist messages are provided below (adapted from Freeman et al., 2021):

*"You can respect the rights of wildlife and keep them healthy, safe, and wild by maintaining safe distances."*

*"You are entering the home of many wildlife species. It is your responsibility to maintain safe distances."*

Research conducted by Williams et al. (2021) linking beliefs of the intrinsic value of wildlife to sustained pro-nature behaviour, is in agreement with that of Freeman et al., (2021). The researchers found that sustained behaviour is related to internalised moral standards and a pro-nature social circle. Relevant to wildlife feeding, the authors suggest that those who already recognize the intrinsic value of wildlife but are not yet engaging in pro-nature behaviour may be more persuaded by messaging which creates awareness of harm caused to species. This is an area requiring further testing.

### ***Personal benefit messages and procedural knowledge***

Recognizing that there are some barriers to acting on environmental consciousness alone, Abrams et al. (2020) recommend that messages emphasizing the benefits in visitor experience (behavioural compromise). In their study drawing from the theory of planned behaviour, distant-related messaging featured the benefit of safe distance for people at a national park. They also point to a previous study where residents of Ohio had more tolerance for bears when messaging highlighted the benefits of bears to people and ecosystems. Further, the distance campaign considered peoples' desires and addressed behavioural barriers by providing information on getting photographs from a safe distance: "give them room, use your zoom."

The authors employed procedural knowledge into their messaging, clearing communicating what people should do, like how far to stay away from wildlife. When measuring message likability, Schaffner et al. (2015) found that the most likable messaging employed positive emotions but were also informative and provided procedural knowledge. Related to this, appealing graphics is important, such as info-graphic style visualizations to show distance in bus lengths (Schaffner et al., 2015; Abrams et al., 2020).

Abrams et al. (2020) concluded that their approach works better than fear appeals but where problems of food-conditioning and habituated wildlife already exist; additional wildlife and visitor interventions are necessary (Abrams et al., 2020). As such, where there is potential, prevention is crucial.

## **Law Enforcement**

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Laws, fines and enforcement are direct management tools to alter human behaviour to reduce conflict. In Canada, wildlife feeding is largely prohibited or discouraged in cities and regional, provincial, and federal parks at applicable levels of government (i.e., local, provincial and federal). Federally, intentionally and unintentionally feeding wildlife at a national park is illegal and you can be charged under the Canada National Parks Act (Parks Canada, 2021). In British Columbia, feeding dangerous wildlife (i.e., bears, cougars and wolves) is prohibited and subject to fines, but enforcement is complaint based (Wildlife Act, 2022). In response to food-conditioned aggression in coyotes, the Vancouver Park Board recently implemented fines of \$500 for people feeding birds and wildlife in city parks (Vancouver Board of Parks and Recreation, 2021).

Currently the City of Toronto is undergoing a review of their wildlife feeding bylaw for private and public neighborhood properties as feeding is only restricted in city parks (City of Toronto, 2022). The City of Hamilton has fines up to \$10,000 upon first offence and \$25,000 thereafter

(City of Hamilton, 2012). Surrounding Toronto, wildlife feeding is subject to fines in cities including Vaughn and Mississauga. Despite regulation from multiple levels of government, human-wildlife conflict due to feeding is common.

Baruch-Mordo et al. (2011) conducted a study to evaluate commonly applied education and enforcement measures in the context of human-black bear conflict related to neighbourhood garbage attractants. Surprisingly, they found that the Bear Aware program had no effect, enforcement by patrolling had no effect, but enforcement by warning notices did change human behaviour. In terms of enforcement, they suggest use of proactive methods (e.g., written notice of the infraction) for greater compliance success. The researchers underscore the importance of developing more effective education programs that are evidence-based and grounded in social science so that resources aren't wasted. Further, after implementation, effectiveness of education programs must be rigorously evaluated. Coupling education and enforcement into management programs is recommended.

Commonly there is the issue of disjoint between law and enforcement (Murray et al. 2016). When regulations and bylaws are enacted, it is assumed there will be compliance. However, without active enforcement, there is often a lack of compliance (Baruch-Mordo et al., 2011). Studies have shown that in order to best improve compliance with wildlife protection laws, an increase in both detection of violations and subsequently enforcement actions must occur (Baruch-Mordo et al., 2011).

There are challenges to understand choices and decision-making of rule-breaking behaviour. Models of enforcement traditionally focus on economic incentives, but Keane et al. (2008) propose the development of a new field of study on the theory and application of enforcement and compliance in conservation. This would help by providing guidance for managers for optimal design of enforcement programs.

Generally, managers and park visitors have favoured indirect educational methods (Marion et al., 2008; Marion and Reid, 2007), however the overall weight of evidence suggests that multiple lines of effort including both indirect and direct methods can be complimented together for maximum impact.

# DISCUSSION

Perhaps by ignorance or intended goodwill, the human behaviour of feeding wildlife plays a defining role in perturbation of wildlife aggression and conflict behaviour. As urbanization continues to expand, the need for proactive management through effective education and enforcement will become increasingly important to ensure safe coexistence of people and wildlife. This literature review intended to answer three main questions pertaining to wildlife feeding: what are the drivers, what are the consequences and what are potential mitigation strategies?

Drivers of wildlife feeding are rooted in human behaviour, which is consistent with the current wildlife conservation era emphasizing management of human behaviour, human-wildlife interactions and coexistence. Largely documented in Western societies, people feed wildlife in order to seek experiences with nature as a result of extinction of experience in urban environments. People seek pleasure in interacting with nature, and also experience benefits to health and wellbeing. Finally, people often feed wildlife out of concern for conservation and welfare.



Consequences of opportunistic wildlife feeding include human-wildlife conflict, animal welfare issues, health and disease, and cascading ecological impacts. Intentional feeding interferes with normal foraging and population numbers, enables dependence on humans, and often leads to aggressive behaviour. Generalist species such as coyotes, bears, raccoons and squirrels are common in urban environments and susceptible to food-conditioning behaviour. Food-conditioning behaviour in wildlife can be learned and transferred across generations. Further, recreational feeding has been associated with negative health outcomes including malnutrition, stress, poor immunity and disease. Wildlife aggression has been found to further increase disease transmission among wildlife and with humans. Ecosystem impacts can be far reaching, and include altering processes of competition, predator-prey dynamics, and nutrient transfer with wider implications for communities, food webs and ecosystems (Ore et al., 2013).

Species capacity to survive in urban areas can be attributed to the concept of behavioural plasticity, underlying genetic factors and/or the ecological classification as dietary or habitat generalist. Wildlife species that have these characteristics are able to coexist within the urban communities, and can also provide beneficial ecosystem services. For example, coyotes act as urban keystone predators in controlling rodent populations (Alexander and Quinn, 2011; Lukasik and Alexander, 2012). This highlights that healthy wildlife assemblages can be sustained through natural urban food webs and the necessity for safe coexistence practices in human dominated landscapes.

Ultimately, mitigation strategies need to change social acceptance of intentional wildlife feeding. Scientists and academics are calling for effective measures using the combination of education and enforcement in order to change societal perceptions toward wildlife feeding in urban spaces. Public education has been proven to change attitudes and change behaviour, and shown to reduce the occurrence of wildlife feeding in parks and urban spaces. The utility of education as a mitigation strategy can be significantly improved with enhanced message content, delivery, audience awareness, and theoretical basis. While research supports the effectiveness of evidence-based education, authors consistently suggest further research to improve effectiveness (Dubois & Fraser, 2013a; Marion and Reid, 2007; Baruch-Mordo et al., 2011). Law and regulation can also alter human behaviour, although compliance is ineffective without appropriate enforcement. An increase in both detection of violations and enforcement actions is needed. For maximum impact, both education and legal enforcement together are recommended in the literature.

There are still a number of research gaps related to intentional wildlife feeding, particularly as they relate to an apparent disconnect between scientific evidence, management, public understanding, and altering behaviour. This literature review aims to bridge some of those gaps, and points to areas needing further research in the following section.

## Research Gaps

### *Human dimensions*

- Western societies are currently the focus of literature related to opportunistic wildlife feeding (Cox and Gaston, 2018). Further research is necessary to better understand the role of culture and socio-demographics in intentional wildlife feeding.
- The extent of opportunistic wildlife feeding pertaining to fur-bearing animals is a research gap. It is difficult to assess due to a lack of a reliable proxy, such as purchases of seed and supplies as with bird feeding. Public surveys on large scales (e.g., national, provincial) or local (e.g., cities, neighbourhoods, parks) would benefit this understanding. This would provide socio-demographic data, as well as estimates of energetic inputs (Cox and Gaston, 2018).

### *Wildlife impacts*

- Future research, in the form of multi-year assessments or ongoing monitoring programs, is needed to understand what level of food reduction is required to reverse food attraction



behaviour on a species-specific basis.

- There is a need for baseline data on wildlife populations as human distribution continues to expand. Beckmann & Berger (2003) highlight a significant knowledge gap in terms of large carnivores and the lack of temporal datasets on behavioural and ecological parameters. Long-term datasets would aid in conservation by understanding population patterns (distribution and abundance) and recovery targets.
- Further study is necessary to understand the consequences of opportunistic feeding on food web interactions (i.e., population dynamics, non-target species and community structure and trophic cascades). Researchers especially highlight the need to better understand cascades (Dubois and Fraser, 2013; Shutt and Lees, 2021).
- In the context of urban feeding, better understanding of wildlife immunology, disease pathology, transmission and spread dynamics using modern techniques as proposed in the literature:
  - Detailed characterization of immune processes via high throughput molecular techniques, possibly exploring associations with genetic adaptation, behavioural plasticity, or resource competition (Strandin et al., 2018).
  - Predictions of feeding impacts on wildlife pathogen dynamics using mathematical modelling; modelling may capture parasite transmission, impacts on host survival, understanding of spatial scales and movement, shifts in feeding resources, seasonality, predator-prey interactions, and potential consequences for human health (Becker et al., 2015).

## **Mitigation**

- Further research is necessary to evaluate the efficacy of educational programs and messaging in improving the human behaviour of feeding wildlife. Most of the current efficacy research focuses on improvements in knowledge uptake and not how this translates to altered behavioural and reduced feeding impacts.
- Opportunity exists for research exploring the efficacy of utilizing computers (i.e., park websites, community platforms and social media) as delivery methods for wildlife feeding education.
- Exploring different theoretical frameworks specific to wildlife feeding behaviour is an area of future research that could benefit urban park and backyard feeding education programs. Theoretical paradigms to explain how people make decisions, outlined in Marion and Reid (2007) could be explored in terms of the human behaviour of wildlife feeding (i.e., moral development, reasoned action/planned behaviour, decision making, and persuasion).
- Further understanding of the theory behind enforcement and compliance as it relates to wildlife feeding. Keane et al. (2008) suggested the development of a new field of study on the theory and application of enforcement and compliance in conservation.

# Recommendations

- Ensure access to nature and encourage safe interaction. Research demonstrates the importance of connection with nature for human health and wellbeing (MacIntyre et al, 2020), and why people intentionally seek out opportunities to feed wildlife (Cox et al., 2018). In urban areas, it is important to ensure access to green space and adequate opportunities are provided for people to safely connect with and enjoy nature. Further, it is recommended to communicate and educate the public on ways to increase connection with nature in a safe manner.
- This literature review focused on direct feeding of mammals. Although birds were excluded, there is an extensive body of literature on the impacts of bird feeding. Further, a subset of this research is dedicated to the cascading impacts of massive bird food provisioning inputs into the ecosystem (e.g., Shutt and Lees, 2021) and impacts on mammal species assemblages. Therefore, given the widespread practice bird feeding and cascading effects to other species, it is recommended that the literature be reviewed on this issue and communicated to the public. This would provide understanding of the impacts of bird feeding to fur-bearing animals and how they can be mitigated through best practices.
- Change terminology; rather than habituation, use 'proximity tolerance' which is more fluid and correctly alludes that the behaviour is in fact reversible (e.g., through hazing scare methods) (UBC Wiki, 2021). In addition, negative terms like 'human-wildlife conflict' exists, but positive terms need increased use such as human-wildlife coexistence and human-wildlife benefits.
- Recognize benefits human-wildlife interactions. Too often, conflict is highlighted through media and within communities, but in order for policy makers and the public to have all the information for optimal risk-benefit decision-making, benefits need to be understood. Beneficial roles in urban ecosystems and intrinsic values need to be highlighted for each species (UBC Wiki, 2021).
- Design communities and parks to foster connection with nature and to minimize feeding. Greater greenspace connectivity in urban areas promotes wildlife movement so that people may experience more natural interactions without the need to attract wildlife (Cox and Gaston, 2018). In situations where the intended goal is to minimize human-wildlife interactions, parks can be designed with more wooded areas, or higher density of trees and recreational equipment (Uchida et al., 2021).
- Plan the development of urban areas for coexistence by considering the impacts to wildlife and their evolution, using modelling projections of future development. Considerations include how urban habitats can best mitigate conflicts, optimization of connectivity for road accident prevention and gene flow, and green infrastructure and wildlife corridors for safe movement and human avoidance.
- Develop coexistence plans that integrate opportunistic wildlife feeding communication, education and issue response framework. Programs and education need to be components within much wider strategies of solutions embedded within urban planning

and management, with a need for continued research on how to coexist and value urban wildlife (UBC Wiki, 2021).

- Researchers consistently emphasize the coupling of effective education and regular enforcement (Beckmann & Berger, 2003; Baruch-Mordo et al., 2011; Dubois and Fraser, 2013a) in order to change public perceptions on wildlife feeding to render it socially unacceptable.
- Apply the evaluative framework developed by Dubois and Fraser (2013a), for policy-makers, managers and educators to better identify and articulate unacceptable forms of wildlife feeding.
- Undertake participatory research/surveys in potential and existing conflict areas, as well as considering applications of citizen science (e.g., the Stanley Park Ecology Society's Co-Existing with Coyotes sightings map).
- Implement education programs on wildlife feeding as evidence demonstrates this as an effective management strategy when applied strategically.
  - Education and messaging should be based on a supported theoretical framework.
  - Message content should be clear, consistent and provide ecological rationale.
    - Moral messages are reportedly more effective than fear based messaging and awareness of harm caused to species may help influence behaviour.
    - Procedural knowledge, clearly communicating what people should do is also important.
    - Info-graphic style visualizations are helpful.
  - Message delivery should occur near the timing and location of potential feeding, by a credible source, and through multiple mediums. It should be widespread and repetitive.
  - Communication should target specific fundamental beliefs shared by the target audience, rather than only factual information on the problem human behaviour.
    - For example, human behaviours leading to conflict are often connected to animal lovers. Therefore, materials can target animal lovers explaining human behaviours necessary to avoid conflict. Information can be distributed via organizations and businesses associated with animal lovers such as veterinarians, pet stores, and outdoors stores (UBC Wiki, 2021).
- Park managers should evaluate the efficacy of various management interventions or conduct ongoing monitoring of visitor feeding and strength of wildlife food attraction behaviour on a species basis, using comparable methods to Marion et al. (2008). This can also be adapted by municipal officials where there are known cases of backyard feeding in the community.

- Implement wildlife-feeding bylaws and fines where they are not currently in place. Proactive methods such as written notices or fines have been demonstrated to be effective (Baruch-Mordo et al., 2011). Further, enforcement must be adequate to ensure compliance. Researchers have called for public officials across multiple jurisdictions to enhance policy and enact laws and regulations to prohibit both intentional (and unintentional) feeding of wildlife (Beckmann & Berger, 2003).

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