

**How residents of the Denver Metropolitan Area (DMA) discern aggression and boldness in coyotes
(*Canis latrans*); connecting value orientation theory to action**

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Abstract

Human-wildlife interactions are a fundamental aspect of urbanization, providing humans with a variety of direct and indirect benefits. However, certain human-wildlife interactions can result in conflicts endangering humans, pets, and property. With an established coyote population in Broomfield, Colorado, human residents regularly confront human-coyote conflicts. In this research, I investigate how Broomfield residents perceive coyote behavior and test whether they can distinguish between benign behaviors such as boldness and problematic behaviors such as aggression. Coyotes in urban environments are bolder and thus more likely to be exploratory and engage in escorting behaviors which can easily be confounded with aggression to an untrained eye. This is impactful since aggressive coyotes require wildlife managers to execute lethal management control to avoid future human-coyote conflicts. I use value orientation theory to identify participants with mutualistic values (wildlife as an essential element of the community with similar rights as humans) and domination values (utilitarian perspective on wildlife; wildlife is managed for human use). The variation in association with mutualistic wildlife values coincided with the gradient of knowledge regarding coyote behaviors. Participants that had the largest depth of knowledge on coyote behaviors (i.e., understood bold behaviors in coyotes, identified escorting behavior) had the highest association with mutualistic wildlife values and the lowest with domination wildlife values out of the entire group of participants. Conversely, the participants that confused aggression with boldness had relatively low mutualistic wildlife values. Combining social and biological science can yield results that provide a holistic depiction of human-wildlife conflicts and provide wildlife managers with a range of possible solutions.

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Preface

I have always been drawn to research that studies the effects of urbanization on ecosystems. I also am a self-proclaimed people person so studying how people interact with wildlife, especially a species as controversial as the coyote (*Canis latrans*), felt like a perfect match. The idea to study human-coyote conflicts locally evolved from a class in Yellowstone National Park with Dr. Lambert and reflects the emotional impact that the grey wolf (*Canis lupus*) has had on the community surrounding Yellowstone. Human-coyote conflicts can be quite impactful and emotional to people, especially when the result is a loss of a pet, which also motivated my research.

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Introduction

“The future of Earth’s ecosystem is increasingly influenced by human action, particularly the pace and pattern of urbanization. An ecology that does not include humans in its theories and experiments will rapidly evolve into paleoecology.” Marina Alberti (2008, p 251)

Urban environments are becoming ever-present as human populations explode. The expansion of these urban environments is contributing to habitat degradation and fragmentation, challenging our ability to preserve biodiversity. However, urbanization provides novel and viable habitat for many species including the coyote (*Canis latrans*). In Broomfield, Colorado, a suburb in the Denver Metropolitan Area (DMA), a resident coyote population has established. The effect is that human-coyote encounters are inevitable and prominent. Some of these encounters result in conflicts (e.g., attacks on pets and people) that occur throughout the city including in people’s yards, neighborhoods, and Open Spaces (i.e., protected land managed for the public interest by Broomfield governance). Human-coyote conflicts are a new and imposing task for local wildlife management. Indeed, my work centers on the fact that Broomfield’s thriving coyote population, in combination with the city’s continual urbanization, culminates into an increased likelihood of a human-coyote conflict. Moreover, it is necessary to study how human residents of Broomfield are interacting with coyotes since certain human behaviors can increase the likelihood of conflicts (e.g., off leashed dogs, feeding coyotes).

In my research, I focused on human perception of coyote behavior by people using Broomfield’s Open Spaces. I applied wildlife value orientation theory (i.e., characteristics of a person’s values and beliefs that will inform their behavior) to test whether someone’s beliefs affect how they perceive coyote behavior and if they respond in a manner based off those beliefs (Manfredo et al., 2003).

In Broomfield, human-coyote conflicts peaked in the early 2010s, resulting in Broomfield wildlife managers to investigate how to reduce these conflicts. This led to a coyote management action plan (Riley et al., 2012), recommending innovative educational campaigns, new regulations to limit human behaviors that encourage conflicts (e.g., feeding the wildlife), teaching and implementing hazing initiatives, and more. The action plan found immediate success in reducing human-coyote conflicts from 19 in 2013 to 3 in 2014. However, human-coyote conflicts have resurged recently, totaling 9 conflicts last year (2019) and 3 conflicts in the first few months of 2020. These numbers are likely an under-estimate; the likely number of actual conflicts is probably greater as people are less likely to report a conflict if their pet was unleashed due to leash laws. There has also been an increased reporting of aggression in coyotes in the Denver Metropolitan Area, which includes Broomfield (Lischka et al., 2018; Breck et al., 2019).

The increased reports of aggression could mean that the coyotes in Broomfield are acting more aggressively. However, if this was true there would have been a significant increase in aggressive behaviors and negative interactions with coyotes (e.g., attacks on humans and their pets) over the last few years. Alternatively, coyotes could simply be more habituated to living with humans. This would result in coyotes being bolder and approaching humans more frequently, expressing escorting behavior (i.e., following humans through the coyote's territory) retreating a shorter distance when approached by humans, and/or reducing flight distance upon detecting humans (Breck et al., 2019). Distinguishing between an aggressive coyote and a bold coyote is crucial for management responses since an aggressive coyote requires lethal management action, while a bold coyote does not.

In my research, I use wildlife value orientation theory to categorize participants into two major wildlife value groups: mutualism and domination. Wildlife value orientation theory argues that a person's wildlife values inform their attitudes and beliefs towards wildlife and ultimately reflect how that person will react (Manfredo et al., 2003). Mutualism wildlife values have an egalitarian viewpoint on wildlife, believing that wildlife should have similar rights as humans (Teel et al., 2007; Manfredo et al., 2009). Contrastingly, domination wildlife values hold a utilitarian ideology in regards to wildlife, believing that wildlife should be managed for human benefit (Teel et al., 2007; Manfredo et al., 2009). Connecting people's wildlife value orientation to their ability to assess coyote behavior will provide a more comprehensive analysis of how residents are interacting with coyotes in Broomfield. Furthermore, different wildlife value orientations have varying opinions on how wildlife should be managed, which can help inform Broomfield wildlife managers on how to more effectively manage coyotes (Manfredo et al., 2009).

My overarching research questions are: How do residents within Broomfield perceive behaviors such as aggression and boldness within the local coyote population? How are these interactions being discerned by the Broomfield population? Does someone's value orientation affect how they internalize wildlife interactions? With these questions in mind, I test the following **hypotheses**:

- i. Because most citizens are not experts in animal behavior, users of Broomfield Open Space are unlikely to distinguish between boldness and aggression in coyotes.
- ii. As aggression is the more salient behavior in human cognition (because of the perceived likelihood of attack), this will result in an inflated perception that urban coyotes are aggressive.

- iii. Overall, I predict that most people will have domination value's resulting in an inflated belief that coyotes are a pest species and generally more aggressive.
- iv. Moreover, Broomfield's historic farming community and projected aging population would generally coincide with a higher association with domination wildlife value's.

To address my questions and test my hypotheses, I used both open-ended interviews and close-ended surveys to: **(1)** identify how the interviewee perceived a specific encounter with a coyote (e.g., if they felt safe, what behavior the coyote was experiencing); **(2)** identify how well the interviewee can interpret coyote behavior, **(3)** determine what the behavior of the coyote was in the described encounter, and **(4)** utilize value-orientation theory to identify a person's values to predict their behavior.

Background

Impact of human settlements and urbanization: Since the agricultural revolution, humans have flourished in settlements allowing for populations to prosper. In the last 50 years, the human population has exploded, nearly doubling in size from about four billion humans on Earth to nearly eight billion (worlddata.org). The density of human settlements has mimicked our population explosion, evolving from small settlements to metropolises containing millions of people and perhaps most relevantly modifying land to do so. Land conversion is a fundamental component of expanding to high-density urban centers, however, environmental challenges such as habitat degradation and fragmentation are the resulting byproduct (Fischer and Lindenmayer, 2007).

The extent of which human's impact on ecological systems continues to be investigated, part of which is the rapid conversion of natural land (land that has negligible human development or considered pristine habitat) to altered (land that has been converted to agriculture or open spaces) or developed land (all converted commercial and developed land) (Manfredo et al., 2009; Seto et al., 2011). Habitat degradation and fragmentation is the effect, leading to a decrease in species richness and biodiversity from extrinsic (ecological circumstances originating outside the animal's biology) and intrinsic (originating from within the animal's biology) factors including but not limited to loss of habitat, food source, behavioral changes in response to a changing environment, and reduced reproductive success (Lindenmayer and Fischer et al., 2007).

Urban environments provide a challenge for most species, however, some species can utilize these habitats as they provide novel opportunities such as anthropogenic food sources and escape from natural predators (Bateman and Fleming, 2012). Conservation efforts trying to restore natural habitat in fragmented areas resulting from urbanization provides an incredible

challenge since it converges with necessary urbanized expansion, human interests, and limited land (Harrison and Bruna, 1999). The effects of humans on urban ecosystems are some of the most momentous factors, altering the natural equilibrium.

While urban landscapes reduce habitat availability for native species, they can also provide new opportunities for colonization of synanthropic species (i.e., species that benefit from living amongst human beings and their settlements) that inherently benefit from human activities and can utilize resources such as anthropogenic food sources, shelter, and protection leading to increased demographic patterns (DeStefano and DeGraff, 2003; Alberti, 2008; Magle et al., 2012). Certain biological traits are favored in an urban environment, one of which is being a generalist (Bateman & Fleming, 2012; Kowarik, 2011). Generalists can adapt to a changing environment more quickly than specialists giving them a competitive advantage in urban ecosystems that are prone to habitat disturbances and fragmentations (Rebele, 1994; Kowarik, 2011). Species that can adjust their behavior and have phenotypical plasticity tend to better adapt to the challenges present in cities (Lowry et al., 2013). Lowry et al., (2013) also suggest that certain species are more likely to succeed in cities due to preexisting temperaments (e.g., species that have bold temperaments).

Coyotes are one of the few predator species that have excelled at utilizing urban ecosystems allowing them to colonize new habitat throughout North and Central America (Gompper, 2002). Their movement into high-density areas has had a variety of effects on urban ecosystems (Gompper, 2002) including initiating a trophic cascade because of the arrival of a new apex predator (Ritchie & Johnson, 2009). Importantly, among the most relevant effect coyotes have had on urbanized landscapes, is their increased interactions with humans leading to new problems for local wildlife managers.

Coyotes in cities: Coyotes possess unique biological traits that help them excel in urban environments. Some of these traits include being dietary generalists, a flexible social system, and variable litter sizes in response to resource availability. Generalists by nature have an easier time adapting to new habitats and pressures through exploiting different food sources depending on their availability (Bateman & Fleming, 2012). Coyotes have a diverse diet, ranging from local and non-native plant species to rodents, other small mammals, and occasionally deer (Bekoff and Wells, 1986). They also readily exploit anthropocentric food sources (i.e., compost, fruiting trees, and pets) in urban ecosystems due to their high abundance, and reliability (Possel et al, 2014; Murray et al., 2015).

Previous research on urban coyotes have recorded coyotes eating a higher percentage of food sources that are associated with heavily urbanized areas such as non-native plants and rodents (Poessel et al., 2015; Murray et al., 2015; Possel et al., 2017). Fission-fusion, the ability for social groups to fluctuate between small and large group compositions depending upon resource availability, has helped coyotes maintain healthy populations (Smith et al., 2008). This is crucial for coyotes' ability to exploit urbanized areas since they are not dependent on large group compositions for survival, something that would be difficult to achieve in cities. Coyote litter sizes are also variable depending on how close the current population is to carrying capacity (Bekoff and Wells, 1986). The ability to alter litter sizes (known as compensatory breeding) makes it difficult for wildlife managers to completely eradicate any coyote population and emphasizes the importance of coexistence.

The spatial ecology of coyotes within the Denver Metropolitan Area patterns with most other studies regarding coyotes home range, habitat use, and resource selection in other cities

(Poessel et al., 2016). However, one key difference is that residential coyotes home range have a lower percentage of developed land, which differs from the findings in other studies performed in Chicago, Seattle, and other large cities with established residential coyotes (Poessel et al., 2016). This has implications for food resource availability and how coyotes in the DMA exploit their habitat (Poessel et al., 2016). Regardless of the total area, when in developed habitat coyotes are less vigilant because they are more habituated to humans (Poessel et al., 2016).

Coyotes may, in fact, be attracted to urban areas due to the synanthropic advantages present (e.g., anthropogenic food sources, positively correlated demographic response, alleviated hunting pressure). Some of the driving factors for this have been hypothesized and include ideas proposed by Gehrt et al., (2010) which state that coyotes are less likely to be hunted or trapped. Cities would provide a sanctuary from large killing pressures often present in rural areas (even though they come with their own challenges like an increase in vehicle-coyote collisions). Another thought could be that coyotes utilized anthropogenic food sources, which may be more abundant and consistent than natural food sources (Poessel et al., 2015). This information does conflict with previous studies performed by Poessel noting that the land type was a better predictor for a patch choice than food (Poessel et al., 2014; Breck et al., 2019). Even further confounding research performed by Gehrt et al., (2009) shows that coyotes in Chicago preferred natural lands over-developed while Poessel et al., (2016) found the inverse to be true. Since Poessel et al., (2016) performed their study in the Denver Metropolitan Area it can be concluded that the coyotes in Broomfield may favor altered landscapes like Open Spaces.

Urban environments present plenty of benefits to coyotes, but also have additive challenges that were absent in coyotes historic habitat (Gehrt et al., 2011; Poessel et al., 2014). Resident coyotes in Chicago Metropolitan Area have been found to be synanthropic, benefit

from anthropogenic activities, demographically having a slight increase in coyote population density and a drastic increase in juvenile survival rates (Gehrt et al., 2011). Challenges such as an increased probability that coyotes encounter humans have been abated by behavioral changes favoring human avoidance, resulting in crepuscular, active during dusk and dawn, activity patterns (Gehrt et al., 2011). The Denver Metropolitan Area exemplifies the costs and benefits for coyotes living in a dense human population showing demographic patterns indicating a synanthropic relationship to urban environments.

Dietary analysis adds further information on how coyotes may be utilizing anthropogenic food resources and how it may be contributing to the coyote population's success in urban areas. Murray et al., (2015), found that urban coyotes ate similar prey species as rural coyotes but also had the additive benefits of eating human-derived food like compost, non-native fruit, and bird feed. Anthropogenic food sources are resilient, common, and persistent (e.g., longer growing seasons), compared to other food sources that are seasonal (Murray et al., 2015). This can be seen in the winter (higher metabolic requirements), when coyotes had a higher proportion of anthropogenic food than other seasons (Murray et al., 2015).

Although anthropogenic food sources provide coyotes with higher diet diversity, they also tend to be protein-poor and can be a source of conflict (Murray et al., 2015). Low-protein diets are problematic for coyotes since it reduces their health and body condition (Murray et al., 2015) The availability of these resources results in less hunting, intensifying coyote's low protein diet (Murray et al., 2015). Compost is another common food source used by coyotes but has the potential for adverse health effects (Murray et al., 2016). Compared to alternative food sources, compost has a higher potential for hosting parasites (e.g., tapeworms) and can encourage the growth of fungi, some of which produce mycotoxins that can harm coyotes (i.e., acute illnesses

like vomiting or chronic illness like immune system suppression or organ failure) (Murray et al., 2016). These resources can also be a source of conflict since many of them are in neighborhoods or people's backyards, which increases the likelihood of human-coyote interactions (Murray et al., 2015). It may also increase a coyote's tolerance to humans, since this could associate humans with food, resulting in an increase in bold behaviors (Murray et al., 2016).

Urban landscapes may provide beneficial resources for coyotes (e.g., anthropogenic food sources and refuge from hunting), however, they do pose unique threats causing new mortality cases. Anticoagulant rodenticides are often used in cities to suppress/reduce the rodent population but are often responsible for secondary poisonings, including coyotes (Poessel et al., 2015). Poessel et al., (2015) tested five different coyote livers from the Denver Metropolitan Area, all of which tested positive for brodifacoum and bromadiolone (Poessel et al., 2015). Brodifacoum and bromadiolone are second generation poisons, more potent than first-generation poisons, which persist and accumulate in animal livers (Poessel et al., 2015). Two of the five coyotes that they tested were hypothesized to have died from these poisons (Poessel et al., 2015). On top of poisonings, mortality from vehicular collisions increases drastically in urban environments (Magle et al., 2012).

Boldness and aggression: Certain behaviors such as those associated with an urban behavioral syndrome may be advantageous in cities (Breck et al., 2019). Compared to their rural counterparts, coyotes in Denver and other urban areas are more **exploratory, bold, and aggressive** (Breck et al., 2019). Exploratory behavior is the likelihood for an individual to explore a novel food source, habitat, or object. Boldness is how an individual reacts to a risky

situation (i.e., approaching a human or another predator), and aggression is defined by how combative an individual is to a conspecific or another species (Breck et al., 2019). Overall, urban settings favor bolder animals. Indeed, Possel et al., (2014) have demonstrated that bolder coyotes favored urban environments, while less bold coyotes were more likely to choose natural habitats. Boldness can be easily perceived as aggression by non-experts. This explains why there has been increased reporting for aggressive coyotes in Broomfield. Similarly, Breck et al., (2019) found that human-coyote conflicts increased drastically after several generations had passed since the initial colonization, which also could be a factor for increased aggression amongst urban coyotes in Broomfield today.

It is imperative to understand coyote behavior in rural areas to fully grasp how living inside an urban system is potentially changing their behavior. Predicting where coyotes may reside in the future is directly related to what type of behavior the coyote may be expressing. Certain coyote behaviors (i.e., boldness, exploration) are expressed in urban landscapes compared to rural ones, but why this occurs is not necessarily known (Sol et al., 2013; Young et al., 2015; Breck et al., 2019). There are three hypotheses on what mechanisms are driving these behavioral changes (Sol et al., 2013). Behavioral plasticity -- phenotypical changes that occur quickly enabling an individual to rapidly adjust to an urban environment -- has the most supporting evidence (Sol et al., 2013). Literature showing that species that have quick behavioral changes in response to living in an urban environment, learned behavior (e.g., using new anthropogenic food sources), and that these behaviors are in response to living within an anthropogenic setting supports the idea that behavioral plasticity may be the most influential reason why species within urban settings have different behavior than their rural counterpart (Sol et al., 2013). Data from Denver, support the idea that behavioral plasticity has driven behavioral

change in urban environments (Breck et al., 2019). Coyotes showed a wide variety of behaviors, and low repeatability, which implies that it is a learned behavior (Breck et al., 2019).

A sorting process, the process that bolder individuals will colonize urban setting while shy individuals will reside in rural areas, is another potential mechanism for the behavioral differences between urban and rural individuals (Sol et al., 2013). However, there is little evidence for this theory within synanthropic species and coyotes (Sol et al., 2013; Breck et al., 2019). The final potential mechanism is that there may be an evolutionary response to individuals when they colonize an urban system (Sol et al., 2013). In theory, natural selection would select for traits that are uniquely advantageous in cities. Although there is little genetic evidence that this is true, Breck et al., (2019) found that conflict rates at the start of colonization compared to several generations after colonization increases drastically. This could be due to a behavioral selected for in response to urban ecosystems or it could be that as the coyote population increased in Denver, so did the conflict rate (Breck et al., 2019). Identifying the behavioral mechanisms responsible for altering coyote behavior in urban ecosystems could be imperative for management, the mechanism could alter which management plan is most effective (e.g., if behavioral plasticity is true than designing a plan that would discourage coyotes from approaching humans would be best).

Breck et al., (2019) hypothesized that urban coyotes have increased exploratory, bold, and aggressive behavior based on behavioral plasticity allowing coyotes to learn that humans are a lesser threat in urban environments. This hypothesis was found to be true through exploring the differences in flight-initiation distance (when approached by a human how far does the coyote flee) and novel object tests (how often a coyote approaches a novel object within its home range) which are both methods of testing exploration and boldness in coyotes (Breck et al.,

2019). Breck et al., (2019) found that urban coyotes had lower flight distance responses and were more likely to approach a novel object supporting their theory that urban coyotes are more exploratory and bolder than their rural counterparts. In rural areas, coyotes are often predated on by humans through hunting and trapping suppressing these behaviors, however, in urban systems, humans are much less likely to kill a coyote and in some cases, maybe encouraged to (e.g., when humans feed coyotes directly) (Breck et al., 2019).

While there appears to be behavioral syndrome associated with boldness and exploration in urban coyotes, there is no evidence that this behavioral syndrome is associated with higher rates of aggression (Young et al., 2015). Using three different methods (agitation score, novel object test, flight-initiation distance) Young et al., (2015) delved into possible behavioral syndromes associated with boldness and if aggression is connected. In brief, Young et al., (2015) found no association between boldness and aggression in either the flight-initiation distance test or the novel object test when compared to the individual's agitation score. The perceived aggression in animals living in national parks could be due to habituation to humans rather than boldness (Baudains and Lloyd, 2007; Stankowich, 2008). This could be one of the factors describing why animals living in urban environments may be perceived as more aggressive than their rural counterparts (Young et al., 2015). There is also the possibility that boldness may be a selected trait for animals living in urban systems (Young et al., 2015).

Human-wildlife conflicts: Across an urban matrix, there is plenty of opportunity for humans and wildlife to interact, especially with the recent emphasis for green spaces and the development and expansion of suburbia (Soulsbury and White, 2015; Soulsbury and White, 2016; Magle et al., 2016). Human-wildlife conflicts are one of the most prominent and memorable interactions

that can occur in urban areas and require the most action by management (Soulsbury and White, 2015; Soulsbury and White, 2016). The severity, frequency, and seasonality of human-wildlife conflicts vary drastically adding confounding elements to the complexity of this issue for management plans (Soulsbury and White, 2016). These conflicts can come in many forms (e.g., aggression, nuisance, property damage, and disease) but always result in some form of physical, emotional and/or economic damage (Soulsbury and White, 2015). The spread of disease can be especially destructive and costly and with modern-day urbanization, the spillover from zoonotic disease into humans will become extremely prevalent (Soulsbury and White, 2015). Property damage (e.g., loss of crops, road collisions, and yard destruction) is often cited, but has low severity and may not require action from managers (Soulsbury and White, 2015). Aggressive behavior from wildlife often can result in attacks on humans and pets, either due to predation, territorial defense, or perceived threats (Soulsbury and White, 2015). Human-wildlife conflicts stemming from aggression is most relevant to my research and can result in some of the more severe cases of human-wildlife conflicts (Soulsbury and White, 2015).

Perhaps one of the most difficult challenges for coyotes in urban environments is the increased likelihood that they encounter humans. Coyotes attacks on pets are some of the most common and emotionally scarring forms of conflicts that occur (Morey et al., 2007; Gehrt and McGraw, 2007; Poessel et al., 2017). Since 2010, Broomfield has had a total of 102 coyote related incidents, 94 of which involved pets (broomfield.org). In the Denver Metropolitan Area, human-coyote incidents were more common in developed lands, Open Spaces, and suburban areas probably due to increased interactions with residents and their pets (Poessel et al., 2013). Poessel et al., (2013) also found that there was an increase in conflict during the months of December-March which coincides with their breeding and pup-rearing season (Gehrt and

McGraw, 2007). Analysis of coyote scat provided further insight into how often coyotes and pets came into conflict. Poessel et al., (2017) found pet remains in 3% of coyote scat, with a slight increase during the pup-rearing season. When a human-coyote conflict occurs, Broomfield management is required to take lethal management action.

Coyote-human conflicts are an integral part of my research, especially within an urban matrix. In a study conducted in 2015, Poessel et al., considered what factors were most likely to increase conflicts within cities across the United States. Both high density (1,000,000 +) and medium density areas (500,000 – 999,999) had 100% reporting of resident coyote populations, 80% of which had conflicts (Poessel et al., 2015). Similarly, Soulsbury and White, (2015) found that conflicts were highest in areas with medium urbanization since it provides plentiful urban habitat and has a moderate human population density providing ample opportunity for interactions. This implies that it is inevitable there will be human-coyote conflicts in Broomfield (Poessel et al., 2015), and since a resident coyote population has been established for decades, Broomfield coyotes maybe more habituated to humans resulting in an even higher conflict rate (Breck et al., 2019). Poessel et al., (2013) also discussed the seasonality of conflicts, which was highest during the winter and early spring, corresponding with the pup-rearing season. Attacks on humans were very unlikely and mostly occurred with pets, meaning that coyotes do not pose a threat to humans (Poessel et al., 2013). The large majority of conflicts in the Denver Metropolitan Area involved pets and disproportionately pets that were off-leash (Poessel et al., 2013).

Methods for the study of human perception of coyote behavior - value orientation: Value orientation theory is an additive element to my research since it can provide information on how

someone will react to coyote behavior (Bright, 2008). Furthermore, wildlife value orientation theory can identify the need for policy changes, identify the different value orientations present in Broomfield and estimate what wildlife-related activities will be sought after (Bright, 2008). Understanding the values of stakeholders and other representatives can provide crucial information for the success of a wildlife action plan, investigating how the fundamental values of the public (which often reflect stakeholders) can help inform how well received the plan will be (Bright et al., 2000). Through using specific value-based cognitions, Bright et al., (2000) examined how residents in Colorado values differed. They identified two major groups and four subgroups that all differ in wildlife-related activities, sociodemographic variability, and political alignments (Bright et al., 2000). Value-orientations can help management understand the diversity of orientations that exist in local/regional populations, gauge the level of support for management plans, estimate the demand for wildlife-related activities, and spread information about wildlife and wildlife policies (Bright et al., 2000). There are two major value orientations that I am testing for – mutualism and dominations. Mutualistic wildlife value orientations are often defined by egalitarian ideologies and are represented through a person's preference to live harmoniously with wildlife and in a companionship manner (Bright, 2008). People who fall under mutualistic wildlife value orientations are more likely to enjoy recreational wildlife activities such as hiking and birding (Bright, 2008). A person with domination wildlife values often thinks of wildlife in a utilitarian manner, focusing on how humans can benefit from wildlife (Bright, 2008). Domination values often enjoy nature and wildlife through hunting and fishing (Bright, 2008).

Human-wildlife conflicts are becoming increasingly more common which is a direct result of increased urbanization (Teel et al., 2007). This is threatening conservation efforts and

will continue to threaten biodiversity, which is why it is imperative to consider the human factor (Teel et al., 2007). Understanding how humans value wildlife can help better management efforts and have the potential to reduce conflicts (Teel et al., 2007). Within the United States, there is evidence that wildlife values are shifting towards more mutualistic values, reflecting the societal shift associated with going from a materialistic society (domination/traditionalism values) to a post-materialistic society (mutualism) (Teel et al., 2007). This trend can also be seen on a more regional level in Colorado (Manfredo and Zinn, 1996; Manfredo et al., 2003). Manfredo et al., (2003) found that an increase in affluence and urbanization, along with higher education has a strong and inverse relationship with domination/traditionalism values. They also found that resident stability, the length at which a resident stays within state boundaries divided by age, has a strong positive relationship with domination/traditionalism values (Manfredo et al., 2003). In the last decade, Colorado has seen economic growth, over a 90% high school graduation rate, and increased urbanization with growing populations in Denver (Colorado Census Bureau). These factors will likely lead to a shift towards mutualistic values based on Manfredo's study (Manfredo et al., 2003). Similarly, an annual average of 242,500 people immigrated to Colorado and another 175,000 people emigrated out of Colorado between 2011 and 2016 (Colorado Department of Local Affairs). This contributed to a 7% annual population change and ultimately leads to high instability among the residents contributing further to a shift in public values towards mutualism (Manfredo et al., 2003).

Understanding how humans and coyotes interact is a central component to my research and through applying value orientation theory, I can predict how tolerant residents are towards them. I will also be able to evaluate the success and downfalls of current management plans. Carlos et al., (2009) examined this in a study combining social science with biological science to

provide the best management plan in Durango Colorado. Examining human-black bear conflicts in urban areas, which is increasingly common like human-coyote conflicts, Carlos et al., (2009) found that the favored management plan closely reflected the respondent's values. For example, people who had negative attitudes towards black bears favored intrusive management plans (e.g., lethal management and relocation) (Carlos et al., 2009). Similarly, Lischka et al., (2019) found that perceived benefits associated with a species greatly reflects the tolerance (e.g., people who think that coyotes enhance their ecosystem will have higher tolerance if a human-coyote conflict occurs). Since value orientations change slowly over time, distinguishing the attitudes towards coyotes in Broomfield can provide vital information on what management plan may be the most favorable. Creating a management plan that utilizes social sciences like value orientation theory is pivotal since it combines biological science with citizen's needs.

My research will help add another informational piece into the puzzle that is our knowledge of how human-coyote conflicts occur within the Denver Metropolitan Area. Through interviewing residents of Broomfield, I gained valuable insight into how people are perceiving coyote behavior and their ability to effectively judge whether they or their pet is being threatened by a coyote or simply experiencing bold behavior. In every interview I performed, residents described an encounter with a coyote that in some way concerned them, however, their ability to decipher if it was dangerous varied. Applying value orientation theory further enhanced my research, connecting social science with conservation efforts to provide a holistic view of the problem at hand. Most people identified more closely with mutualistic values than domination, which can explain certain themes and patterns found in the interviews (e.g., people were hesitant to label their coyotes as aggressive). Mutualistic values are associated with living harmoniously

with wildlife and often prefer non-lethal methods of management and are generally more engaged with decision-making.

Methods

Study design: In this study, I collected two primary sources of data from residents of Broomfield; value orientation and coyote encounter information. Data were collected by asking participants to take a 10-question close-ended survey aimed at identifying someone's value. After the survey, I conducted a semi-structured interview using open-ended questions that aim to elicit responses about any coyote interaction that the participant may have had. For examples of some of the interview questions, reference Table 1. Notably, I asked different questions depending on the discussion during each interview, using the prewritten questions as a guideline. This interview took approximately five minutes and revolved around coyote encounters in Broomfield, Colorado. Interview questions aimed to find information about how the interviewee perceived the coyote encounter through questioning how safe the participant felt both during the interaction and living with coyotes if the participant thought the coyote was threatening and what behavior the participant thought the coyote was experiencing. I also asked if the interviewee could explain the difference between aggression and boldness in coyotes and if that participant thought their encounter fit into either category (i.e., aggression, boldness, or something else). After the interview concluded, I attempted to identify what the coyote behavior may have been (i.e., aggression or boldness) by asking the interviewee to explain in as much detail as possible what the coyote was doing during that encounter. The 10-questions survey and examples some of the questions I asked can be found below in Tables 1 and 2.

Table 1: 10-questions close ended survey

To what extent do you agree or disagree with the following statements about coyotes in the area near your home?

(Please circle one number for each statement.)

| | Strongly Disagree | Slightly Disagree | Neither | Slightly Agree | Strongly Agree |
|---|-------------------|-------------------|---------|----------------|----------------|
| It is acceptable for people to kill wildlife if it threatens their safety. | 1 | 2 | 3 | 4 | 5 |
| It is acceptable for people to kill wildlife if it threatens pets. | 1 | 2 | 3 | 4 | 5 |
| The protection of wildlife should be secondary to human needs. | 1 | 2 | 3 | 4 | 5 |
| Management efforts for wildlife should be primarily focused on ensuring there is an abundance of fish and wildlife for hunting and fishing. | 1 | 2 | 3 | 4 | 5 |
| Hunting can be respectful towards animals and their well-being. | 1 | 2 | 3 | 4 | 5 |
| Living harmoniously with wildlife is important to me. | 1 | 2 | 3 | 4 | 5 |
| Wildlife should have similar rights to humans. | 1 | 2 | 3 | 4 | 5 |
| Wildlife is an integral part of my community and I want to protect it. | 1 | 2 | 3 | 4 | 5 |
| My relationship with wildlife provides me with a great sense of joy and comfort | 1 | 2 | 3 | 4 | 5 |
| I feel a strong emotional connection with local wildlife. | 1 | 2 | 3 | 4 | 5 |

Caption:

10-questions close-ended survey designed at examining the value orientations of the participants. The first five questions aim at domination wildlife values and the last five questions focus on mutualistic wildlife values.

Table 2: Open-ended questions for my semi-structured interviews

Questions regarding the interviewees experience with coyotes

“Have you had an encounter with a coyote in Broomfield within the last year? If so would you be able to describe the encounter in detail?”

“When recalling this coyote encounter, do you remember it in a positive or negative light?”

“How safe did you feel during this encounter?”

“Does the local coyote population enhance your experience using Broomfield Open Spaces?”

Questions regarding coyote behavior

“What behavior do you see in coyotes most often?”

“Would you define the difference between aggression and boldness in coyote behavior?”

“In your experience as a resident of Broomfield, do you see any changes in the coyote population or their behavior?”

Questions regarding management of coyotes

“How would you like to see the coyote population be managed. That is, do you think they should be protected, partially-protected or exterminated completely?”

“What action should be taken if a coyote attacks someone or someone’s pet?”

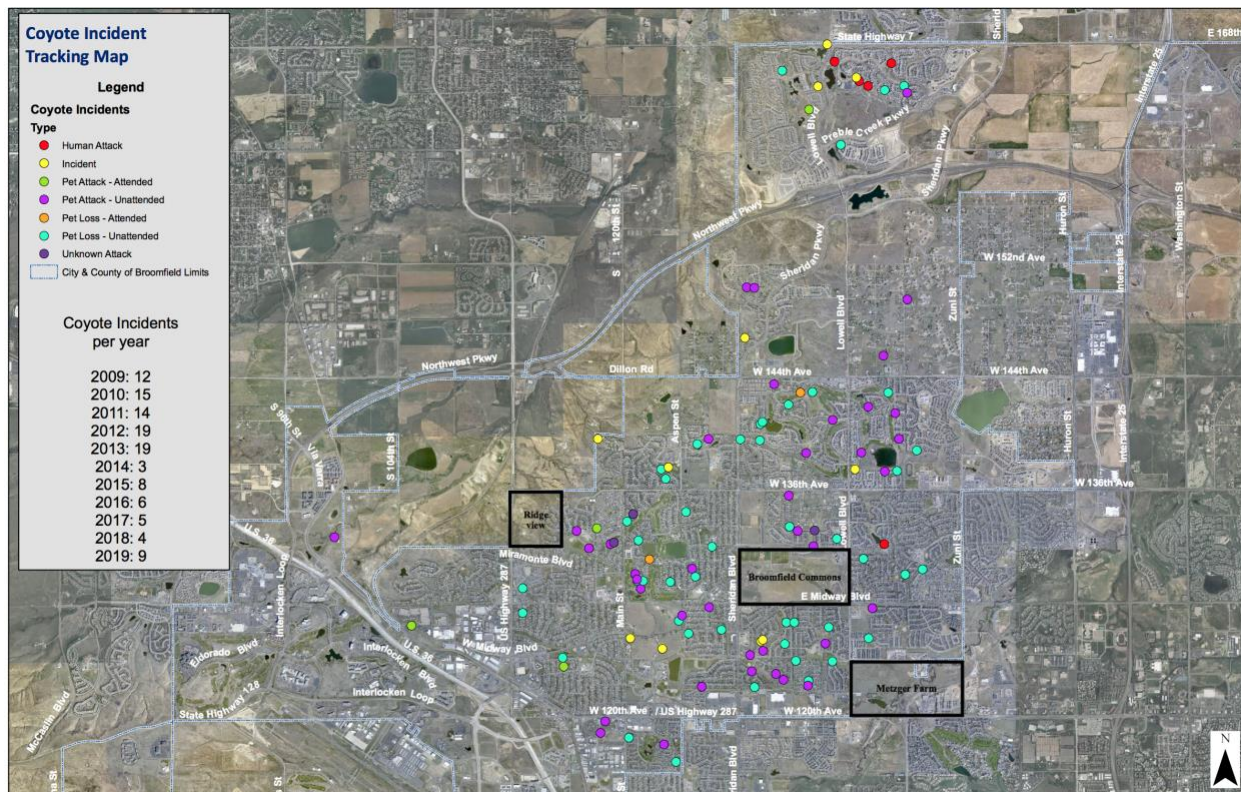
Caption: Table 1 provides examples of the questions I asked during my semi-structured interviews. Each section focuses on a different aspect of my study. For example, questions regarding coyote behavior aimed at helping me identify what behavior the coyote may have portrayed.

Due to the rarity of coyote conflicts, I would expect that most encounters with coyotes will be relatively mundane and easily identifiable (i.e., coyotes spend most of their time sitting,

walking, laying down). However, I think that most residents who have been living in Broomfield for a substantial period of time or who have outdoor pets (e.g., dogs, outdoor cats), especially smaller ones, will have had either an experience that is perceived as aggressive or frightening.

I chose my sites (Figure 1) based on the following criteria: (a) the site had to have an established resident coyote population; (b) it must be a part of Broomfield Open Spaces; (c) is adjacent to a neighborhood; (d) has a moderate amount of walking traffic, and; (e) previous research has been conducted at each site. As seen in Figure 1, all three of my sites are clustered around the majority of human-coyote incidents located in Broomfield. Ensuring the site had an established resident coyote population would increase the likelihood that the participants I enrolled would have had a previous encounter with a coyote. This segment of the Broomfield population may be desensitized to coyote encounters or have more experience in coyote behavior since they would interact with coyotes more regularly. Interviewing participants in Broomfield Open Space's would prepare them to be thinking about wildlife and help recall previous coyote encounters. Conducting my research in Open Space also provides a less invasive space to interview participants. Having the site neighbor a community will help increase the percentage of the participants who would be most vulnerable to a human-coyote conflict since coyotes will likely roam between the Open Space and the neighborhood. These three criteria helped me select my sites which were Broomfield Commons, Ridgeview, and Metzger Farms and can be seen on the map below.

Figure 1: Map (courtesy of Broomfield coyote information page) that shows the human-coyote conflicts since 2009. The black boxes indicate where my sites were located within Broomfield, Colorado.



After receiving approval from the University of Colorado Boulder Human Research Institutional Review Board (IRB) (11/15/2019), I began my data collection. From mid-November to early March I sampled residents throughout all three sites with the goal of sampling a total of 20-30 people. Throughout these months I approached 50 people of which 24 were enrolled leading to an enrollment rate of 48%, which is relatively high. Although this was lower than anticipated, I still managed to sample enough people to meet my goal. It should be noted that since my sampling period occurred in the winter, there were times that it was less than desirable weather conditions limiting the amount of activity present at my sites. Also, my sampling period coincided with the pup-rearing season, which is when Poessel et al., (2013) found the highest rate of human-coyote conflicts in the Denver Metropolitan Area.

Sampling methods: To ensure non-biased sampling I asked every fifth person to voluntarily enroll in my study. If I approached a group either the entire group will be enrolled using separate surveys but a group interview or only one person from the group will be enrolled and the interview will be directed at that person. Group participants can lead to social pressure skewing data. I generally tried to avoid group interviews because of the social pressure involved. All interviews were conducted at one of the three sites outlined above. Data was collected throughout the week with a slight sampling bias towards the weekends since there was higher walking traffic.

Data analysis: All data that was collected was analyzed using descriptive statistics to provide a broad understanding of the qualitative and quantitative data. Transcripts were analyzed through coding, searching for key phrases or themes, which helped isolate those themes into tangible data points, and each theme was reported out through figures and take-home messages. Descriptive statistics analysis was used to digest the close-ended survey data. The specific analysis method for each form of data (e.g., qualitative transcripts and quantitative surveys) can be found in the following subsections.

Quantitative – surveys: Survey data focused on a person's wildlife value orientation to help bridge a connection between theoretical value orientation and concrete human perception of a coyote encounter. The survey questions were categorized by two different values (mutualism and dominations), each category having five questions to ensure a more accurate depiction of a person's wildlife value. Upon completion, the survey results were transcribed from the sheet

into excel and broken down by their respective value orientation (i.e., the mutualistic questions quantified separately from the domination questions). A proportional value was assigned to each question and a bar graph was made to represent each value orientation.

Qualitative – transcripts: Transcripts provided me with in-depth information on how this segment of Broomfield was interacting with and internalizing interactions with coyotes. All transcripts were transcribed from audio recordings taken during the interviews. To analyze such information, I created a list of themes relevant to my research questions and the content in each interview (Miles et al., 1994). These themes were formed during my first cycle of coding, helping me organize participant's thoughts into categories relating to my research questions (Miles et al., 1994). I used descriptive coding, coding focused on assigning one-word nouns to a passage or topic enabling me to cross analysis my transcripts, and provide a detailed narrative about coyote interactions in Broomfield. I then went through the second cycle of coding, focused on condensing the information found in the transcripts into smaller analytical chunks (Miles et al., 1994). Through this cycle of coding, I could create and expand a cognitive map on how people are interacting with coyotes in Broomfield, how the participants value coyotes within their community if the participants can correctly distinguish between boldness and aggression in coyotes, and if the participants have experienced escorting behavior (Miles et al., 1994). Finally, to ensure I was encapsulating all of the ideas present in the interviews, I used jotting which is a method of note-taking while transcribing or rereading the interviews where you write any ideas, themes, or thoughts down on a separate piece of paper (Miles et al., 1994). These notes were transferred into an analytical memo and used to revise and refine my initial codes. Table 3 encapsulates all the final codes I created, ranging from a person's ability to understand coyote

behavior to social policing. For example, I created a code for communal values (i.e., a reoccurring theme discussing the importance that coyotes have to the participant’s experience in Broomfield) enabling me to condense interviews and notes into tangible numbers.

The final codes were used to create a tangible number, normally between zero and 1, for easy analysis. For example, when analyzing my data, I found that it was common for the participants to describe escorting behavior. However, the participant’s ability to properly recognize that the coyote behavior was not threatening or a form of aggression varied, providing me an opportunity to create a code. If the participants encountered escorting behavior but attributed it to aggressive behavior, then the code was a zero, but if the participant correctly identified that it was not threatening or perhaps encompassed a bold behavior, then the code was a one.

Table 3: Transcript codes and definitions. These helped me analyze my interviews to gain tangible data points. Turning major themes into codes can provide deeper knowledge of the content of the interviews.

| Codes | Descriptions | Example |
|---------------------------|--|---|
| Social Policing | Does the participant describe either a moment when they or someone else enforced a law (e.g., leash law) or behavior | “A lot of people keep their dogs off leash and if there dog goes to the coyote and is hurt that’s on them. If they are not going by law” Person 12 |
| Communal Value of Coyotes | Either states or describes how they value coyotes within their community and view them as a necessary component | “I think they are beautiful so I enjoy it” Person 12; “But I belief that wildlife has their rights to exist. And we should protect them.” Person 15 |

| Codes | Descriptions | Example |
|---|--|---|
| Expressing Fear or Discomfort Towards Situational Coyote Behavior | Describing a coyote encounter that the interviewee felt uncomfortable or fearful towards. However, at one point stated that this behavior is not aggressive. | “And I was running with my dogs and he was on the extended leash and I am always kind of watching and [...] I heard this song like a thousand times and I heard these lines “hurry, hurry, hurry there’s danger ahead”. And I felt like I needed to look up and there was a coyote standing right in front of my dog. It was one of those weird kind of moments. [...] there was my dog about to get potentially snatched up.” Person 7 |
| Used Aggression and Boldness Simultaneously | When describing a coyote encounter the interviewee used vernacular relating to aggression and boldness interchangeably. | “I can’t say I’ve really seen aggression. That was probably both right, where they keep coming towards you and they don’t completely do their own thing.” Person 2 |
| Ability to Decipher Between Aggression and Boldness | Correctly describes the difference between aggressive behavior and bold behavior within coyotes | “Aggression is that they are coming at us. Bold is that they are walking by us but aggression is that they’re coming at you with a gnarled face” Person 3 |
| Described Escorting Behavior | When discussing a coyote interaction, interviewee describes escorting behavior | “A coyote coming towards me, I think that would be bold” Person 10 |
| Identifying Escorting Behavior | Interviewee describes and correctly identifies escorting behavior. | “Several when they have escorted me. When they have followed me when I have my dog. Only when I have a dog” Person 7 |
| Explicitly States Dissatisfaction with Current Management Action | States how the current management plan is not satisfactory. | “I think the way Broomfield handles them is poor. I do not think that they should ever eliminate them.” Person 5 |

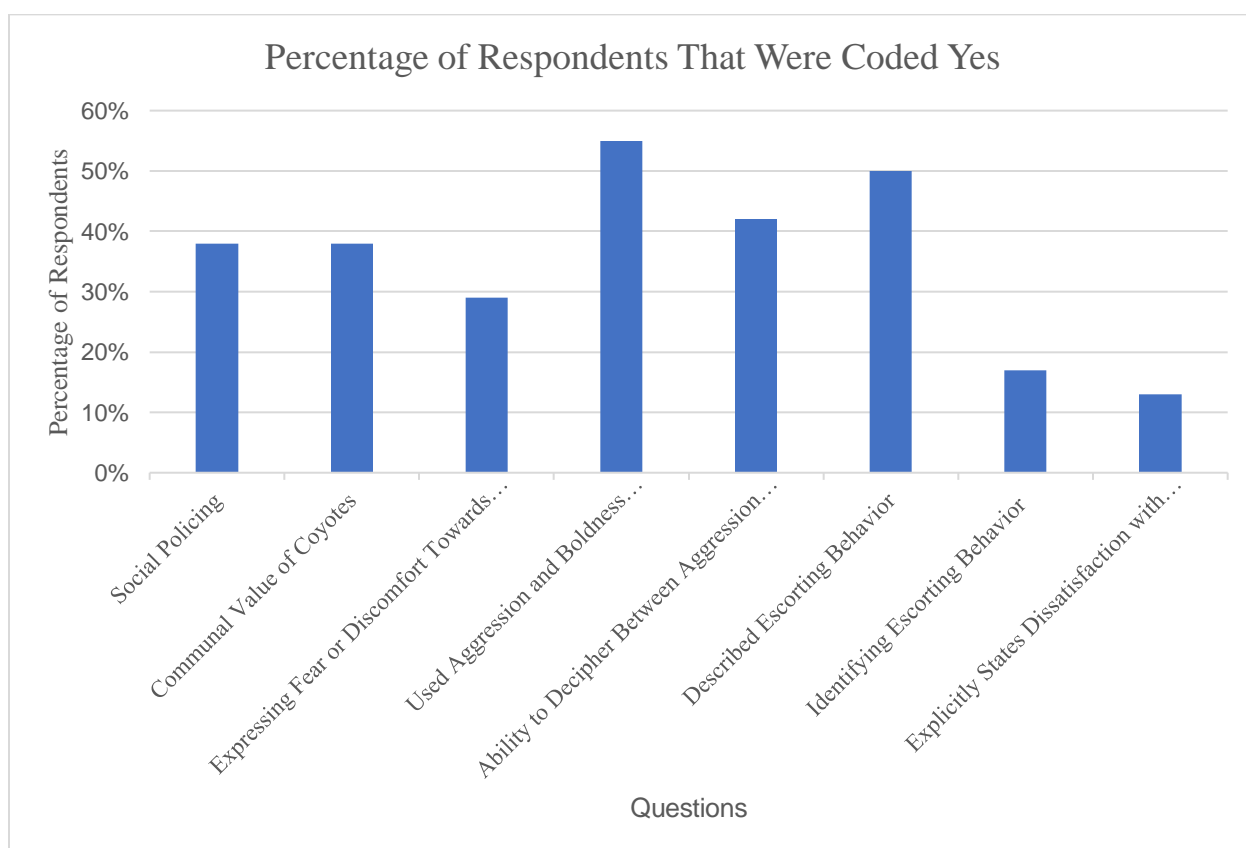
Results

In my study, I enrolled 24 people out of 50 possible candidates, which provided a 48% enrollment rate. I spent a total of 22 hours spanning across three sites (ten hours at the Broomfield Commons, seven hours at Metzger, and five hours at Ridgeview) in attempts to recruit people for my study. I dedicated a disproportional amount of time at the Broomfield Commons. This was the result of how I scheduled my site visitation. Normally I spent around 2-3 hours at each site and cycled through them starting with the Broomfield Commons and ending at Ridgeview. The Broomfield Commons received a higher surveying rate since it was the first site of each cycle and it generally had the highest visitation rate amongst Open Space goers. Ridgeview had the lowest visitation rate out of my three sites since I did not complete a full cycle (i.e., I went to Broomfield Common and Metzger but not Ridgeview) when I left for winter break and when I returned I restarted my cycle with Broomfield Commons. Regardless of the limitations of my study I still managed to gain valuable insight into the community in Broomfield and better understand the human-coyote conflicts that arise.

Perhaps one of the most consequential findings of my interviews was that every person had an interaction with a coyote at some point in Broomfield. This is indicative of the relevance of my research since human-coyote interactions are seemingly inevitable in an environment such as Broomfield. One participant went to the lengths of describing how they moved to Broomfield within the last six months and have had several coyote interactions. As referenced in Figure 2, a large portion of the participants (a little under 40%) explicitly described the inherent value (e.g., enjoy watching them) they gained from interacting with coyotes. This is probably underreported since I only included people who explicated described their appreciation for coyotes in their interviews. It can also be assumed that there are higher communal values towards coyotes since

the participants have high mutualistic wildlife values which can be seen with average scores above 4.75 for three out of five of the questions (i.e., living harmoniously with wildlife is important to me, wildlife is an integral part of my community and I want to protect it, and relationship with wildlife provides me with a great sense of joy and comfort) which is represented in Figure 3a.

Figure 2: Percentage of respondents that were coded for each category, showing the percentage of respondents that were coded for each theme that arose from my questions. Substantially the use of aggression and boldness were often confused by the participants.



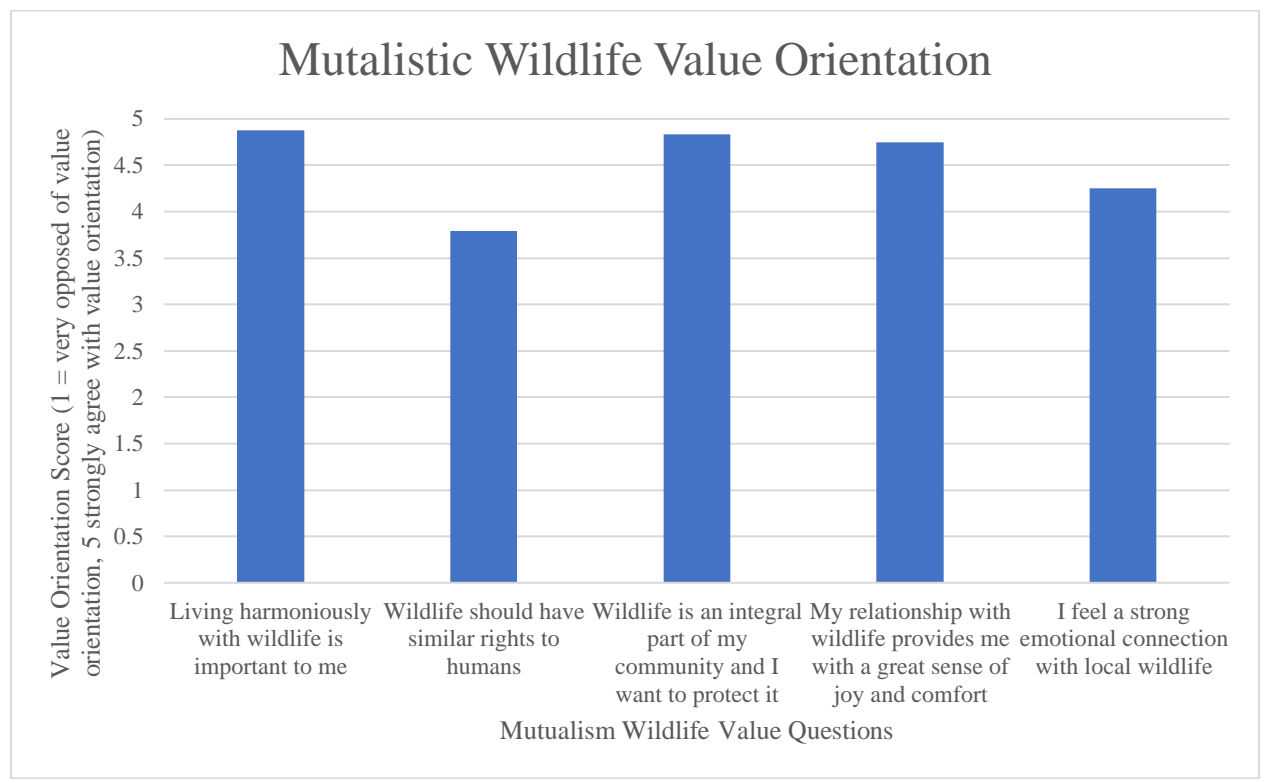
In my interviews, there was also a moderate rate (38%) of discussions around social policing about leash laws and how off-leash dogs were a source of conflict with coyotes (Figure 2). Several times, participants stated that human-coyote conflicts originated with and exacerbated by off-leash dogs. One participant stated that they did not think coyotes were aggressive in any manner and that human-coyote conflicts stemmed from off-leash dogs

approaching coyotes. This participant described the conflict behavior as an attribute of boldness and that coyotes were only defending their territory or protecting themselves. Thirteen participants (55%) used aggression and boldness interchangeably, which could be contributing to the increased reporting of aggression. Similarly, over a quarter (29%) of the participants felt fearful, nervous or uncomfortable during an encounter with a coyote. This further suggests that people could be reacting negatively to bold coyote behavior and contributing to the perception of aggression. 42% of the participants were able to correctly describe the differences between aggression and boldness and were able to recognize that bold behaviors were non-threatening to humans.

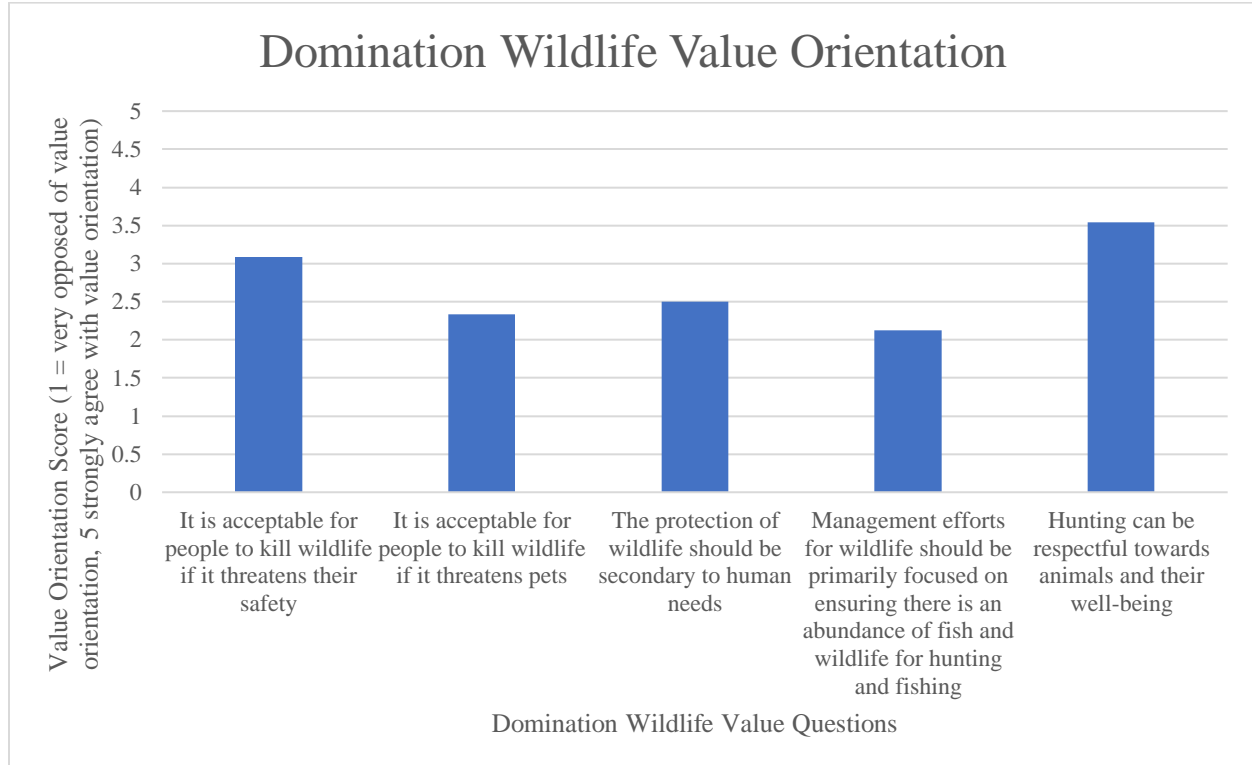
Half of the participants (12 people) described behavior that I believe could be identified as escorting behavior (i.e., a coyote following a person throughout their territory), while only a fraction (4 participants) could identify or describe escorting behavior. I included descriptions such as this one “[...] the coyotes going and they started following us and chasing us. You do not have to worry much but that one was pretty interesting because they just kept following us and they kept getting closer and closer,” as unidentified escorting behavior, where the participant described coyote behavior that resembles escorting behavior but the participant does not mention escorting or anything synonymous to it in their account. While participants who could identify, escorting behavior had descriptions like this one “several when they have escorted me. When they have followed me when I have my dog. Only when I have a dog [...] They escort you, I do not know if you ever have seen escorting behavior, but that’s what they are doing. They are coming after me and increase their pace and have followed me all the way up these fields when I have had a dog.” In this account, the participant clearly states and describes escorting behavior.

Figure 3a and 3b The mean of the total respondents towards each question. Figures 3a, 3b show the proportional scores for each question. Participants had a higher association with mutualistic wildlife values compared to domination wildlife values. Each question aims at a different facet of mutualism or domination wildlife values which explains the disparity in scores between questions. For example, the question stating that wildlife should have similar rights as humans is a subsection of mutualism termed social affiliation.

3a



3b



Participants were more closely aligned to mutualism wildlife values than they were to domination wildlife values. As seen in Figures 3a and 3b, the lowest scored mutualistic wildlife value question (3.79) was higher than the highest scored domination wildlife value question (3.54). This implies that the segment of the population that enrolled in my survey feels more connected to nature and more strongly that wildlife should be a part of the community. It would also have management implications, especially considering several participants discussed their displeasure with current management action. Communities with mutualistic wildlife values will be more inclined to be involved in decision-making and favor non-lethal management plans. The domination wildlife value questions had a lower range in score variability than the mutualistic wildlife value questions, which are another indication that the participants were less aligned with domination values.

Discussion

In this work, I address how people internalized coyote encounters (e.g., how emotional the experience was, if they felt safe, etc.) and whether they could correctly describe the coyote behavior that they experienced (e.g., bold or aggressive). My goals in so doing were to determine whether I could identify the behavior of the coyote the interviewee was describing, identify the participant's value orientation through a paper survey and relate it to how that they perceived their coyote encounter.

In summary, I found that every person I interviewed has had an encounter with a coyote, even though some of the interviewees stated that they had only lived in Broomfield for less than a year. This reinforces the findings of Poessel et al., (2015) in which they hypothesized that 100% of the residents within a moderate human density, in an area that has an established resident coyote population, would have a coyote encounter. These findings stress the importance of my research and research on human-coyote conflicts in the Denver Metropolitan Area since it is inevitable that coyote encounters will occur. Moreover, combining social and biological science can provide a holistic understanding of the current human-coyote interactions in Broomfield.

Utilizing wildlife value orientation theory, I was able to identify each participant's relationship to mutualism and domination wildlife values enabling me to further my analysis on how participants were internalizing coyote interactions. The high rate of mutualistic wildlife values was somewhat surprising since Broomfield has historical ties to farming (farmers have a strong association with domination wildlife values). I encountered a moderate rate of social policing in my interviews (38%), leading me to believe that this could have accelerated the rate at which mutualistic values developed in Broomfield (Figure 3a). Coupled with the high

encounter rates of wildlife and the natural transition towards mutualistic that is likely to occur in Broomfield, the resulting effect encouraged the growth of mutualistic values. Similarly, I saw an average association with domination wildlife values (Figure 3b), which was also surprising. However, given the increase of mutualistic values, which generally contrasts domination values, these results are sensible.

Discussing enrollment rates: I hypothesize several reasons for this moderately low enrollment rate. First, when interviewing on weekdays and in the mornings, people were more likely to be using Broomfield Open Space for an intensive workout before work and were less inclined to stop. It was also not uncommon for people to be running, especially in the morning or evening. Out of the 24 people who were enrolled only one was seen running before taking my survey. I hypothesize that since runners and bikers were using the Open Space trail for exercise, they are less likely to stop and take a survey since it is disruptive to their workout. There was a naturally occurring sampling bias towards the weekends, which had higher recruitment rates. This was due to the fact that there were substantially more people using the trails during the weekends and people were more likely to be walking. The limited number of participants restricted my ability to capture a broader segment of the Broomfield population, skewing my results slightly towards walkers, dog owners, and people using Broomfield Open Space,

My study was also limited by the time I had access to Broomfield, as well as the weather. To begin recruitment for my research, I had to wait until I received Institutional Review Board (IRB) approval which I received on November 14th of 2019. This would hinder the time allotted to recruiting in 2019 since I was only in Colorado for one month post-IRB approval (i.e., I went home to Philadelphia for Thanksgiving and Winter Break). Nevertheless, I still had 18 people

enrolled in my study by mid-December. Returning to Colorado in January produced new problems to my recruitment methods in the form of cold weather and snow restrictions. I quickly learned that the number of people utilizing Broomfield Open Spaces in weather below 40 degrees Fahrenheit were few and far between making my recruitment inefficient. There were limited days with weather surpassing 40 degrees Fahrenheit, however, I was outside recruiting on those days adding an additional eight participants.

Participants emotional reaction to coyote encounters: Through my interviews I was able to gain a deeper level of insight into how people in Broomfield are interacting with coyotes in Open Spaces. I found that the participants had a strong emotional attachment to coyotes; 38% of participants explicitly stated that they felt coyotes were an integral part of their community. The communal value (i.e., the implicit value coyotes provide within the Broomfield community) that coyotes have is probably underreported since I did not include a question revolving around this idea in my interviews. Instead, during my interviews, interviewees voluntarily discussed how important coyotes are to their livelihoods in Broomfield – this was not prompted by a question by me. It is notable that so many of my interviewees volunteered this attitude. Contrasting this viewpoint was the negative (i.e., fearful or uncomfortable) emotional response caused by the coyote encounter; this was expressed by 29% of the participants.

These results complicate the first research question regarding the emotional response and safety felt during the described human-coyote encounter. I would hypothesize that participants generally felt that coyotes had a place in their community, but when coyotes were portraying certain behaviors, they could be perceived as frightening. Evidentially, a strong mutualistic wildlife value held by most of the participants indicates that the Broomfield community supports

living amongst coyotes. In addition, I found that more than 55% of the participants used aggression and boldness interchangeably and generally failed to correctly identify escorting behavior. Furthermore, almost a third of the participants felt uncomfortable or fearful during the described coyote encounter. This supports the idea that residents of Broomfield have an inherent sense of joy from the presence of coyotes, however, when coyotes express certain behaviors, especially ones associated with boldness, it can create a sense of uneasiness. This discrepancy could be exacerbated by a lack of knowledge or familiarity in coyote behaviors resulting in subsequent discomfort and fear.

An alternative explanation is that my sample includes two distinctive sociocultural sub-populations, one that believes coyotes play a fundamental role in their experience in Broomfield Open Spaces, and the other that views coyotes as dangerous or burdensome. Historically, Broomfield was dominated by ranchers who would have viewed coyotes as a pest since they threaten livestock. Even though the population of Broomfield has grown substantially and the local economy diversified, these values may persist, especially considering values change over decades. A minority of the participants had a strong association with domination values, which could imply that the idea that coyotes are a nuisance is still present within at least one distinctive sub-population.

Differentiating between these two possibilities is an important distinction that would require different levels of management efforts to help abate future human-coyote conflicts. Overall, there was a distinct gradient of knowledge on coyote behaviors from the participants I interviewed and for some people there may be insufficient knowledge on coyote behavior which resulted in people thinking coyotes were being threatening when in reality they are expressing behavior syndromes associated with boldness and being habituated to humans. With increasing

immigration of people unfamiliar with coyotes, this disparity of knowledge may increase in the foreseeable future.

One way to address a lack of knowledge is to explicitly educate Open Space visitors on what aggression looks like, what situations may be dangerous, and the behavioral response of coyotes to habituating to humans. Since educational campaigns can be quite resource-intensive, both financially and manpower, I would recommend doing an educational blitz in the late summer and early fall months. This would be the most effective since coyote conflict rates are highest during the winter and early spring (pup-rearing season), so preparing people preemptively would be ideal. The locality of these campaigns also matters, so limiting efforts to local farmer markets and/or at Broomfield Open Spaces during high usage times. While this strategy would certainly help for the second hypothesis it may not be confronting the problem at its core.

Changing values towards wildlife including coyotes, which are in part a function of experience with coyotes, is a challenging endeavor, especially for management efforts. There will be a natural progression away from domination values and towards mutualistic values for several reasons. Firstly, Colorado State Demographic Office predicts that Broomfield will probably see a large growth in new residents, which will ultimately result in an increase in mutualistic wildlife values. Furthermore, there has been a national shift towards mutualistic values, including in Colorado (Manfredo et al., 2003). That being said, efforts focused on increasing people's tolerance to coyotes could help overcome wildlife value orientations. Presenting the benefits of having a resident coyote population (e.g., preying on rats and other rodent pests) could be the best approach since the tolerance of a carnivore is directly related to perception (Lischka et al., 2019). There is not an inherent way to provide coyotes with a positive

public relations (PR) campaign, so I would suggest developing a partnership with local artists aimed at creating art targeted at displaying coyotes in a positive light. Involving the community to help develop the solution could in itself, improve human perceptions of coyotes and increase the knowledge on coyote behavior (Treves and White, 2009).

Overall, most participants had a deep-seated connection to coyotes, which was reflected in both the high reporting of communal values and the partial exclusion of using aggression when describing coyote behavior. Furthermore, a high association with and a slow transition towards mutualistic values will continually drive the positive perception of coyotes. For these reasons, the participants tended to view coyote encounters in a positive light. However, there are exceptions, which can be seen through the 29% of participants that expressed fear or discomfort when describing a specific coyote-encounter. The effect could be that the community in Broomfield has a general sense of appreciation for the resident coyote population but may feel threatened during certain encounters, especially ones in which coyotes are expressing behaviors associated with boldness (e.g., escorting). Another possibility is that I sampled two different segments of the population, one that has a greater value for coyotes and another that considers them a nuisance. Although there is evidence supporting both, I cannot conclusively say if either is correct without further research. However, this does mean that outside of certain exotic behaviors, people generally enjoy coyotes within their community producing a positive perception of most coyote behaviors.

Participant's understanding of coyote behavior: The ability to recognize which coyote behaviors are threatening to humans or pets are critical to understanding human-coyote interactions. Behaviors associated with boldness (i.e., escorting behavior, not retreating when

being approached, or even approaching humans) and aggression (i.e., tail erect, ears pinned back, chasing humans or pets) are often confused and perceived as threatening which can lead to an over-reporting of aggressive coyotes. Recently, Broomfield Open Spaces' wildlife managers have expressed an increase in reports of aggressive coyotes. One possibility is that coyotes in Broomfield are becoming more aggressive, which would be reflected by a significant increase in human-coyote conflicts. Conversely, coyotes may be more habituated to humans, which could lead to an increase in boldness in coyotes. The increased reporting of aggression could be reflected in residents of Broomfield confounding aggression and boldness in coyote behavior. According to Broomfield Open Space's, there has been a slight increase in reported coyote conflicts in 2019 (from four in 2018 to nine in 2019) but nothing that would indicate a significant increase in aggression, especially considering that this is only one more than 2014. From my interviews, I was able to deduce that 50% of the participants used aggression and boldness interchangeably, leading me to the belief that the misunderstanding behaviors are the crux of coyote conflicts.

Coyote behaviors in urban environments are complex, especially considering that coyotes are more likely to express exploratory and bold behaviors which can be perturbing to people who don't have experience with or knowledge of coyotes (Young et al., 2015; Breck et al., 2019). As defined by Breck et al., (2019) exploratory behavior is the likelihood that a coyote approaches a novel object and bold behavior is the tendency that a coyote will enter into a risky situation. Exploratory behaviors can lead coyotes to forage in backyards, notably if a backyard contains food sources like fruiting trees or compost (Murray et al., 2015). Furthermore, bold behavior will decrease how cautious coyotes are towards humans, increasing the probability that coyotes will stay put/approach humans when sharing the same surroundings. Both exploratory and bold

behaviors are more prevalent in urban environments and increase the likelihood of a human-coyote encounter. Being able to distinguish between these behaviors and aggressive ones is crucial since when portraying aggressive behavior coyotes are at their most threatening towards humans and pets.

In my work, 42% of the participants correctly described the differences in boldness and aggression within coyotes and recognized that they vary in danger. Moreover, the participants that correctly identified boldness and aggression within coyotes were less likely to be fearful of their specific coyote-encounter. Presumably the greater knowledge on coyote behavior a person has, the less likely they will feel threatened from bold coyote behaviors. This is important information for management plans, opening the opportunity to provide a non-lethal, proactive, partial-solution to human-coyote conflicts. Baruch-Mordo et al., (2011) discusses the need to combine law enforcement with educational campaigns to ensure that human behaviors change. Proactive measures of abatement (i.e., methods of avoiding a wildlife conflict before it occurs) could be the best form of management moving forward since reactive measures only remove problem individuals and do not change the fundamental human behaviors causing the problem.

Identification of coyote behavior: I predicted that certain coyote behaviors associated with boldness (e.g., escorting behaviors) are more memorable than the majority of human-coyote encounters that participants have. More common coyote behaviors (e.g., sitting and/or standing in tall grass in Open Spaces) are perceived as and are non-threatening towards humans. However, escorting behavior (i.e., when a coyote follows a walking human until it is out of its territory) can be interpreted as dangerous or aggressive while it is not. Escorting behavior is a less common behavior associated with bold and exploratory behavior syndromes, which are

more prevalent in urban landscapes. Half of the participants I interviewed described an encounter that resembled escorting behavior and of those participants, only one third could accurately identify escorting behavior. The participants that did identify escorting behavior did not have fear towards these encounters and instead used words such as “peculiar or interesting” to describe their encounter. These participants also had the highest association with mutualistic values and low domination values. Conversely, the participants that did not describe escorting behavior but had an encounter that either was or parallel to escorting behavior also confounded aggression with boldness and were uncomfortable or fearful of the described encounter. Furthermore, these participants had a lesser association with mutualism than other participants. Their association with domination values were mixed, suggesting that having high mutualistic values may contribute to a better overall knowledge of wildlife and their behaviors.

Conclusion: connecting value orientation to human-wildlife conflict: People with mutualistic wildlife values will anthropomorphize wildlife, recognize the reciprocal relationship of human-wildlife encounters, hold the opinion that animals should not be harmed, and animals are deserving of compassion and rights (Jacobs, 2007; Teel et al., 2007). For these reasons, Teel et al., (2007) discuss the connectivity between human-wildlife relationships maturing into anthropomorphic connections with wildlife and providing a sense of social connectedness. Mutualistic value orientation can provide relationships with wildlife that revolves around compassion and comfort, leading to an emotional bond to wildlife and filling a niche for social affiliation (Teel et al., 2007). Generally, participants had a strong affiliation with mutualistic wildlife values, making the connection between humans and coyotes sophisticated.

The complexity of the human-coyote relationship provides a possible explanation for why people were hesitant to use the word aggressive when describing their encounter. Participants that were most knowledgeable on coyote behavior had strong mutualistic values implying that their relationship to wildlife could contribute to their knowledge. It could be that the residents of Broomfield who have high mutualistic values are attracted to Broomfield Open Spaces since the majority of the participants I interviewed had high mutualistic value scores. Even though in the interviews the participants did not describe an encounter that could be categorized as a human-coyote conflict, the participants that were most likely to confound aggression and boldness when encountering coyote escorting behavior had the lowest association with domination values. Presumably, these participants would be more likely to misinterpret coyote behavior and falsely report an aggressive coyote to wildlife managers.

In summation, the necessity to fully understand human-coyote interactions is essential to minimize future conflicts and help provide the wildlife managers with accurate information. All 24 of the enrolled participants had an encounter with a coyote highlighting the importance of this research and research like it. There was a large gradient of knowledge on coyote behavior resulting in different interpretations of behavioral syndromes and ultimately leading to misunderstandings of what constitutes a dangerous situation (e.g., a knowledgeable participant understood that behaviors associated with boldness were non-threatening). Fifty percent of the participants described a human-coyote encounter that resembled boldness in coyotes. Out of these participants only 1/3 correctly identified that the coyote behavior was non-threatening and a consequence of being habituated to humans (i.e., escorting behavior). This minority group had the highest association with mutualistic wildlife values and the lowest domination wildlife values out of all the participants in my study, implying that a person's relationship to wildlife could

increase their overall knowledge of wildlife behaviors. The group of participants that could not identify coyote behavioral syndromes relating to boldness were also likely to have been uncomfortable with or fearful of their described coyote encounter and confound aggression and boldness. On average, this group had lower mutualistic wildlife values comparatively leading me to believe that people with higher mutualistic values may be more skilled at recognizing coyote behavior.

This can help inform Broomfield wildlife managers in two major ways. Firstly, the majority of participants confused aggression and boldness, resulting in discomfort when encountering a bold coyote and potentially leading to an over-reporting of aggression in coyotes. Mutualistic wildlife values appreciate being involved in creating wildlife management action plans and favor non-lethal management tools. Currently, Broomfield wildlife managers have a one-strike policy (i.e., lethally remove the problem coyote) when an aggressive coyote is reported, resulting in a disparity between the public's needs and the wildlife management action plan. Moreover, with the over-reporting of aggression in coyotes, it is very likely that Broomfield is unnecessarily removing individual coyotes. With limited resources, the current coyote management plan is adequate but perhaps could be reenergized with a seasonal educational campaign and input from the residents of Broomfield creating a more effective plan that minimizes human-coyote conflicts.

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