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Research Paper

# More dogs less bite: The relationship between human–coyote conflict and prairie dog colonies in an urban landscape

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## HIGHLIGHTS

- We assess human–coyote conflicts in an urban landscape.
- We explore the role of black-tailed prairie dog colonies in impacting conflict.
- Rates of coyote conflict were highest near habitat fragments where prairie dogs were absent.
- Prey availability may influence human–carnivore conflicts in urban areas.

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## ABSTRACT

Human–coyote conflict in urban environments is an emerging concern throughout the U.S., but specific factors that influence rates of conflict remain largely unknown. We explored a possible link between coyote conflict rates and the distribution of black-tailed prairie dogs, a highly interactive species, in an urban landscape. Overall, rates of coyote conflict appeared elevated in proximity to undeveloped land, but these rates were highest near habitat fragments where prairie dogs were absent, and 15–45% lower within 400 m of fragments colonized by prairie dogs. Multivariate analyses comparing conflict points to random points generated in the same area also revealed that smaller and younger habitat fragments were associated with greater levels of conflict. However, the effect of nearby habitat fragments lacking prairie dogs was at least as strong as the effect of fragment area, a factor known to influence coyote distribution. We propose several possible explanations for reduced human–coyote conflicts on or near prairie dog colonies, including colonies acting as more preferred foraging habitat than backyards or neighborhoods, and changes in human behavior near colonies. Inter-species dynamics are rarely investigated in urban systems, and our study provides a first look at potential interactions between two politically controversial but ecologically important species. We suggest that future studies evaluate the impact of prey availability on human–carnivore conflicts to determine whether conservation of prey species may represent a valuable management strategy in urban areas.



## 1. Introduction

Cities were created to produce resources and opportunity for people around the world, but increasingly do so for wildlife species as well (Adams, 2005; Chace & Walsh, 2006; Forman, 2008; Magle, Hunt, Vernon, & Crooks, 2012; Mayer, 2010). While species diversity in urban areas can be reduced, species that are able to adapt to these altered landscapes often become quite abundant, sometimes attaining densities higher than those recorded in undeveloped areas (Magle et al., 2007; Prange, Gehrt, & Wiggers, 2003; Riley, Hadidian, & Mansky, 1998). Many urban species provide tangible benefits (e.g., pollination, Mendes, Balmer, Kaethler, & Rhoads, 2008), and the natural areas that attract wildlife are esthetically pleasing and can increase property values (Bolitzer & Netusil, 2000; Waddell & Moore, 2008). Unfortunately, when humans and wildlife share urban space, negative interactions can occur, including incidents of animal-vehicle collision (Forman, et al., 2003), damage to lawns and landscaping (Urbanek, Allen, & Nielsen, 2011),

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transmission of zoonotic disease (Bradley & Alitzer 2007), and animal attacks on pets, and rarely, people (Curtis & Hadidian, 2010; Gehrt & Riley, 2010; Poessel et al., 2013).

Many small and medium-sized carnivores thrive in urban areas, particularly those with generalist diets and opportunistic behavioral patterns (Crooks, 2002; Gehrt, Riley, & Cypher, 2010). Coyotes (*Canis latrans*) exemplify this archetype, and have become increasingly common in cities across North America (Gehrt & Riley, 2010; Gehrt, Anchor, & White, 2009; Poessel et al., 2013). While the majority of coyotes never create conflict (e.g. risks for pets and humans, Gehrt et al., 2009; Poessel et al., 2013), a subset of animals do create problems, particularly through attacks on pets (Grubbs & Krausman, 2009; Poessel et al., 2013; Timm, Baker, Bennett, & Coolahan, 2004). While rare, these incidents can negatively impact human safety and well-being, and have become a management priority (Lukasik & Alexander, 2011; Poessel et al., 2013). Variations in foraging behavior, human activity patterns, and territorial behavior with other species have all been suggested as explanations for the spatio-temporal variability in human–coyote conflicts in urban areas (Lukasik & Alexander, 2011; Poessel et al., 2013). Coyotes in urban areas appear to consume largely natural prey but will also forage on human-associated food items (Lukasik & Alexander, 2012; Morey, Gese, & Gehrt, 2007). Examination of unexplored ecological factors such as abundance of natural prey may help elucidate the mechanisms behind the varied rates of human–coyote conflict observed in urban systems.

For carnivores in urban areas, human pets might represent 'sink prey', defined as prey that, if solely consumed by the predator, decreases the fitness of the predator (Simoni, 2012). As humans typically capture and kill carnivores that focus on pets or livestock as their primary food source, this foraging strategy is unlikely to be sustainable in the long-term. Thus, carnivores should avoid these sink prey species, but animals with no other options, as well as injured or inexperienced individuals, may still target human commensals such as pets or livestock. Under these conditions, we would expect the presence of natural prey resources to potentially reduce the rate of conflict between coyotes and human pets.

In the Denver, Colorado metropolitan area, black-tailed prairie dogs (*Cynomys ludovicianus*) represent an abundant prey species (Magle et al., 2007). Prairie dogs are able to persist in urban areas, with no apparent sign of nutritional (Magle, 2008) or genetic (Magle, Ruell, Antolin, & Crooks, 2010) instability, and the vast majority of colony extinctions occur only as a direct consequence of habitat destruction or colony eradication by humans (Magle, Reyes, Zhu, & Crooks, 2010). Urban prairie dogs are frequently exterminated to make way for development or due to concerns regarding plague and impacts to landscaping (Magle, Reyes, et al., 2010). In grassland ecosystems, prairie dogs function as highly interactive or keystone species (Miller, Ceballos, & Reading, 1994; Miller et al., 2000, 2007; Soulé, Estes, Berger, & del Rio Martinez, 2003; Soulé, Estes, Miller, & Honnold, 2005), increasing diversity and altering ecosystem dynamics due to their burrowing activities. In urban areas their ecological role is not as well understood; although they continue to modify vegetative communities (Magle & Crooks, 2008), they do not enhance bird diversity as they do in the wild (Magle, Salamack, Crooks, & Reading, 2012). Prairie dogs are an essential prey item for both aerial and terrestrial carnivores in natural systems, including coyotes (Lomolino & Smith, 2003; Shaughnessy & Cifelli, 2004; Shipley & Reading, 2006). In fact, it has been suggested that when prairie dog populations are reduced, coyotes reliant on that food source may turn to predation on livestock (Reeve & Vosburgh, 2006). However, it is not known whether the prairie dog's ecological role as prey is conserved in urban systems, or what impacts urban prairie dogs may have on carnivore distribution and behavior.

While coyotes do sometimes capture prairie dogs in the Denver area (Magle, personal observation), it is not known whether prairie dogs represent a significant part of their diet. Prairie dog colonies are visually obvious and persistent on the landscape, and in addition to the prairie dogs present, burrows provide habitat for other potential prey species (Hoogland, 1995), such as cottontail rabbits (*Sylvilagus floridanus*). Thus, colonies could represent a reliable food resource for coyotes. In addition, human activities may alter patterns of conflict near prairie dog colonies, for example if people who live in proximity to colonies keep their dogs on leash due to concerns of contracting plague (*Yersinia pestis*) from prairie dogs (Cully, Biggins, & Seery, 2006) or to prevent dogs from harassing wildlife, which also prevents resultant competitive interactions between dogs and coyotes.

Our goal was to test the hypothesis that prairie dog colonies would be associated with reduced rates of human–coyote conflict (e.g., risk to pets and humans, Poessel et al., 2013) in the Denver, Colorado metropolitan area. Using data on coyote conflicts (Poessel et al., 2013) and prairie dog colony distribution (Magle, Reyes, et al., 2010), our specific objectives were to: (1) determine whether the presence of prairie dog colonies was correlated with the rate of human–coyote conflict, (2) investigate whether this correlation, if present, was also measurable within spatial buffers beyond the bounds of the colony itself, and (3) Quantify the relative impact of prairie dogs on coyote conflict rates compared to other landscape factors known to impact the distribution of coyotes, such as habitat availability and habitat fragment area, age, and connectivity (Crooks, 2002).

## 2. Methods

### 2.1. Study area

Our research was conducted in and near Denver, CO, USA, a rapidly urbanizing area of approximately 2 million people embedded in a shortgrass prairie biome (Fig. 1). Our study area (368.4 $km^2$) contains portions of 4 counties and represents a gradient of urbanization (Magle & Angeloni, 2011; Magle & Crooks, 2009; Magle, Reyes, et al., 2010; Magle, Ruell, et al., 2010). Within this area, each potential habitat fragment (for coyotes and/or prairie dogs) was identified, and the presence of prairie dogs was recorded. A habitat fragment was defined as any plot of undeveloped land with an area of at least 1/4 ha that was not regularly landscaped or manicured by humans, and that was embedded in a dissimilar, human-modified urban matrix (Magle & Crooks, 2009). In 2002, there were 384 habitat fragments within this study area, 54 of which were colonized by prairie dogs.

### 2.2. Overview

We conducted our study in three steps. First, we began by restricting our available data to the existing study area. Then, to investigate the potential role of habitat patches, prairie dog colonies, and other characteristics of the landscape such as habitat area, age, and connectivity in driving the distribution of human–coyote conflict, we performed two separate spatial analyses: (1) a spatial assessment of rates of conflict in proximity to habitat fragments with and without prairie dog colonies, and (2) a multivariate analysis evaluating the relative influence of prairie dog colonies and other landscape variables on human–coyote conflicts.

### 2.3. Data preparation

Coyote reports were recorded by 22 state and local entities from January 2003 to June 2010 in a 7 county area around Denver, CO,