



Research paper

Environmental factors influencing the occurrence of coyotes and conflicts in urban areas

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HIGHLIGHTS

- We surveyed 105 urban areas in the United States regarding coyotes and conflicts.
- Larger urban areas were more likely to have coyotes and conflicts.
- Urban areas in the western regions were more likely to have conflicts.
- Cities with less forest and more development were more likely to have conflicts.
- Landscape design and citizen education may reduce human-coyote conflicts.

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ABSTRACT

The increase of global urbanization can have effects on wildlife species, including carnivores such as coyotes (*Canis latrans*). As coyotes continue to settle in more urban areas, reports of human-coyote conflicts, such as attacks on humans or pets, may also increase. Understanding environmental variables that might influence whether or not coyotes and human-coyote conflicts will occur in certain urban areas may assist wildlife officials in creating management plans for urban wildlife. We conducted a survey of 105 urban areas in the United States requesting information on the occurrence of coyotes and human-coyote conflicts. We analyzed the responses with data on human population size, geographic region, land cover, housing density, and precipitation. Larger urban areas were more likely to contain both coyotes and human-coyote conflicts, and were also more likely to have greater numbers of conflicts. Urban areas in the western regions with larger amounts of high-intensity development and less forested and agricultural areas were more likely to have conflicts. Most urban areas considered the management of conflicts to be of low priority and emphasized education of citizens rather than removal of individual coyotes. Our results may assist urban wildlife managers in understanding the geographic and demographic factors correlated with the occurrence of coyotes and human-coyote conflicts. Practices such as education campaigns and landscape design incorporating wildlife habitat modifications (e.g., reducing dense cover) may reduce human-carnivore conflicts in urban ecosystems.

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1. Introduction

Urbanization is increasing on a global scale, and by 2030 almost 5 billion people in the world will be living in urban areas (United Nations Population Fund, 2007). Urban expansion leads to significant changes in the landscape, including habitat loss

and fragmentation (Markovchick-Nicholls et al., 2008; McKinney, 2002), which can alter the structure of ecosystems (Niemela, 1999). Urbanization is one of the leading causes of species endangerment (Czech, Krausman, & Devers, 2000) and can have a negative impact on biodiversity (Mcdonald, Kareiva, & Forman, 2008; Seto, Güneralp, & Hutyra, 2012). However, in some cases, urbanization can enhance native wildlife species richness (McKinney, 2008) and increase densities of certain animal species (Magle et al., 2007; Prange, Gehrt, & Wiggers, 2003). To accommodate wildlife, resource managers in some urban areas have begun incorporating

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wildlife habitat requirements into landscape planning and design (Adams, 2005).

Some carnivore species have become established in urban environments (Bateman and Fleming, 2012; Gehrt, Riley, & Cypher, 2010). Carnivores residing in urban areas range from kit foxes (*Vulpes macrotis*; Cypher, 2010) and mountain lions (*Puma concolor*; Beier, Riley, & Sauvajot, 2010) in North America to red foxes (*Vulpes vulpes*; Soulsbury, Baker, Iossa, & Harris, 2010) and Eurasian badgers (*Meles meles*; Harris, Baker, Soulsbury, & Iossa, 2010) in Europe to leopards (*Panthera pardus*; Athreya, Odden, Linnell, Krishnaswamy, & Karanth, 2014) in Asia. Carnivores successfully occupying urban areas generally have small to medium body sizes, are dietary generalists, and behaviorally have a tolerance for humans (Fuller, DeStefano, & Warren, 2010). Coyotes (*Canis latrans*) embody these characteristics (Gese and Bekoff, 2004; Morey, Gese, & Gehrt, 2007) and have colonized urban landscapes throughout North America (Gehrt and Riley, 2010; Gehrt, Anchor, & White, 2009; Magle, Poessel, Crooks, & Breck, 2014).

Coyote populations generally respond positively to urban environments. In southern California, coyote occurrence increased with both proximity and intensity of urbanization (Ordeñana et al., 2010). In Indiana, coyotes occupied suburban areas with high housing densities adjacent to large forested patches, suggesting coyotes can tolerate high levels of human activity when protective cover is nearby (Atwood, Weeks, & Gehring, 2004). Similarly, in metropolitan Detroit, Michigan, locations on trails and roads with evidence of coyote use (i.e., carcasses, dens, scats, tracks, or sightings) were closer to forested tracts than expected in both urban and suburban areas (Dodgson and Kashian, 2013). Other studies have found urban coyotes selected natural habitat patches within their home ranges and minimized activity in developed areas (Gehrt et al., 2009; Gese, Morey, & Gehrt, 2012; Riley et al., 2003). However, some coyotes will utilize urban and suburban developed areas (Lukasik and Alexander, 2011; Poessel et al., 2013). Coyotes in captivity selected pens with a mixture of both natural and unfamiliar, anthropogenic structures, indicating coyotes preferred heterogeneous environments (Poessel, Gese, & Young, 2014). Hence, coyotes may thrive in highly developed areas when natural habitat patches are nearby and readily available.

Habitat selection by coyotes also may be influenced by the availability of water, in both arid sites, where coyotes primarily use water for drinking, and in moister environments, where coyotes use riparian areas for cover. In the Chicago metropolitan area, Gese et al. (2012) found home ranges of coyotes in less-developed and mixed-habitat areas contained more riparian habitats than were available in the study area; Gehrt et al. (2009) also determined water habitats (i.e., retention ponds) were consistently highly selected by coyotes in the same study area. In a desert site in west Texas, Atwood, Fry, and Leland (2011) found coyote activity near water features (i.e., stock tanks and impoundments) increased as the number of days since the last rainfall increased. In another arid site in Arizona, DeStefano, Schmidt, and deVos, Jr. (2000) determined coyote sign (e.g., scats and tracks) was seven times greater near water than away from water. These results indicated the potential importance of water or riparian areas to coyotes and that precipitation might influence coyote distribution.

Although the majority of urban coyotes tend to utilize the landscape in ways that avoid humans (Gehrt et al., 2009), some coyotes may become involved in coyote-human conflicts (hereafter, “conflicts”, defined in Table 1, question 2; Grubbs and Krausman, 2009; Poessel et al., 2013). Such conflicts might occur spatially in a non-random manner. In the Denver metropolitan area of Colorado, conflicts occurred more frequently than expected in developed areas and less frequently than expected in natural and agricultural areas (Poessel et al., 2013). In addition, conflicts occurred more often than expected in suburban areas and less often than expected

Table 1

List of questions included in the survey of 105 urban areas in the contiguous United States.

Number	Text of Question
1	Does the [city name] urban area currently have coyotes residing within it? This would not include an occasional, nomadic coyote coming into the city. Rather, this would include coyotes permanently living or residing within the metro area, either in urban areas or in open spaces contained within the metro area.
2	If coyotes do reside in the [city name] urban area, do you have human-coyote conflicts? A conflict is defined as either (1) a physical attack by a coyote on a human or pet; or (2) a coyote showing aggressive behavior toward a human or pet, e.g., baring teeth, growling, stalking, or other behavior that could potentially endanger human or pet safety.
3	If the [city name] urban area does have human-coyote conflicts, do you consider this to be an issue of high priority, low priority, or no priority? High priority would indicate a critical need to address or manage the conflict issue, no priority would indicate no concern and no management taken to address the issue, and low priority would be between these two, i.e., concern over coyote conflicts but little action is taken.
4	If the [city name] urban area does have human-coyote conflicts, can you provide an estimate of the number of conflicts during the last year (2013) or for the most recent year for which you have data? (a) 1–10 (b) 11–40 (c) 41–100 (d) >100

in exurban and rural areas. In Calgary, Alberta, the highest numbers of conflicts were in two small parks located near the urban core of the city, and the fewest conflicts were in two large, natural parks located near the city boundary (Lukasik and Alexander, 2011). Furthermore, conflicts were most often reported in close proximity to a river. Management of conflicts may be an important priority for wildlife officials in many urban areas, and an understanding of the various ecological factors that might be associated with such conflicts is becoming increasingly essential (Magle et al., 2014; Poessel et al., 2013, 2014).

Although others have examined the seasonality and types of victims of severe conflicts with coyotes (involving human injury; White and Gehrt, 2009), in this study we analyzed potential environmental variables that may influence urban coyote presence and conflicts, broadly defined, at a national and regional scale. Our primary objectives were to determine why certain urban areas in the United States have coyotes and why some of those have conflicts by examining geographic, demographic, and climatic characteristics of those urban areas, including human population size, geographic region, land cover, housing density, and precipitation. Additional objectives were to determine annual rates of conflicts and the priority level urban wildlife managers assign to the handling of such conflicts. We predicted that most urban areas would contain resident coyotes and that urban areas without conflicts would contain higher amounts of natural areas, higher rural or exurban housing densities, and higher precipitation levels. We further predicted that management of conflicts would be of high priority for most urban areas and that larger urban areas would have higher annual rates of conflicts. Our results may assist urban wildlife managers throughout the coyote’s range to understand the most likely areas to contain coyotes and conflicts and, accordingly, to consider implementing habitat management and educational programs to mitigate such conflicts.

2. Methods

2.1. Data collection

We surveyed 105 urban areas within the contiguous United States, focusing on coyotes and conflicts. We used the U.S. Census Bureau’s definition of an urban area: “a densely settled core

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