Cities and the Environment (CATE)

Volume 12 | Issue 2 Article 1

2019

Are Coyotes "Natural"? Differences in Perceptions of Coyotes Among Urban and Suburban Park Users

Brielle R. Manzolillo
Pace University, brielle107@gmail.com

Carol S. Henger
Fordham University, chenger@fordham.edu

Tatyana Graham
Pace University, tgraham@pace.edu

Nadya Hall
Pace University, hallnadya@gmail.com

Anne H. Toomey
Pace University, toomey.ah@gmail.com

Recommended Citation

Manzolillo, B., Henger, C., Graham, T., Hall, N., and Toomey, A. (In Review). Are coyotes "natural"? Differences in perceptions of coyotes among urban and suburban park users. Cities and the Environment.

Are Coyotes “Natural”? Differences in Perceptions of Coyotes Among Urban and Suburban Park Users

By 2050 more than 65% of humans are expected to live in urban and suburban areas. This shift has gained the attention of conservation scientists and managers with more focus directed on conflict and coexistence between wildlife and urbanized populations. One species that is increasingly prominent in urban and suburban environments is the coyote (Canis latrans). Coyotes have established themselves as a keystone predator with a regulating effect on prey populations, thus playing an important role in the functioning of the urban ecosystem. However, research has shown that negative perceptions of coyotes are common and contribute to support for eradication-focused management strategies, such as broad-scale trapping or culling, which are expensive and largely ineffective. To better understand coyote acceptance and non-acceptance we conducted a comparative study of park users residing in two counties in the New York metropolitan area: a suburban county, where coyotes are already established, and an urban county, where coyotes have only recently begun to arrive. Our findings suggest that urban respondents have lower levels of coyote acceptance and higher preference for coyote removal than suburban respondents. We tested multiple predictor variables to determine which was the strongest driver of desire for removal: perception of threat to humans and pets, perception of coyote “naturalness” in the environment, and appropriateness of expressed reaction to a hypothetical coyote encounter. We found that perception of coyote “naturalness” was the strongest predictor of whether people felt that coyotes belonged in the region and thus should not be removed. Our results suggest that wildlife coexistence strategies could benefit from messages that instill in residents a sense that their local area is a place where coyotes and other wild animals belong.

Keywords

coyotes; perceived naturalness; human-wildlife conflict; human-wildlife coexistence; urban wildlife; perceptions; voluntary risk

Acknowledgements

This study was funded by Pace University. Special thanks to Gotham Coyote Project collaborators Mark Weckel and Chris Nagy. The manuscript additionally benefited from thoughtful comments by Suzanne Macey.

INTRODUCTION

It is projected that by the year 2050, over 5 billion people worldwide will live in urban areas, representing a major shift in relationships between humans and natural environments (Poessel et al. 2017). One issue that is gaining increasing attention in urban and suburban settings is human-wildlife conflicts (Soulsbury and White 2015). Traditionally a subject of rural study, where key concerns dealt with carnivores preying on livestock, human-wildlife conflicts have recently been attracting interest in cities as mid-sized carnivores, such as coyotes, move into urban areas (Grimm et al. 2008; Soulsbury and White 2015).

Coyotes have proven to be extremely adaptable and able to live in diverse landscapes, including urban environments, and are found in almost all major cities in the United States, including Chicago (Morey et al. 2007), Los Angeles (Elliot et al. 2016), and New York City (Toomey et al. 2012; Nagy et al. 2017). These canids have been described as resilient, undermining attempts to extirpate them from neighborhoods and other areas of high human density where conflicts arise (Sterling et al. 1983; Gese and Beckoff 2004). As opportunistic predators, coyotes have been known to prey upon domestic pets, angering pet-owners and others who feel that sharing the landscape is an inconvenience, injustice, and security risk. As such, coyotes can prompt fear or even hatred amongst many communities (Shivik 2014; Weckel and Wincorn 2016). However, most coyotes avoid human activity as much as possible and overall risk to people and pets remains low (White and Gehrt 2009; Gehrt et al. 2009).

As coyote encounters are increasingly common in urban and suburban areas, many municipalities have created coyote coexistence and conflict management plans, as well as informational messaging to educate the public about appropriate behaviors for mitigating risk. However, these plans are often based on assumptions about how people perceive wildlife, rather than robust social science, and can lead to misguided messaging or ineffective management approaches (Bateman and Fleming 2012; Dickman 2010). These perceptions can be defined as how humans interpret wildlife and the emotions that are elicited in reaction to this interpretation (Carbon 2014; Jacobs 2012). Thus, a better understanding of the key drivers of how urban and suburban dwellers perceive coyotes is crucial for promoting coexistence in densely populated areas.

Various studies have hypothesized several different factors that can predict the type of coyote management control that residents advocate, and to what extent these factors lead to desire for coyote removal from communities (lethal or otherwise) (Siemer et al. 2014; Sponarski et al. 2015a). Additional studies have looked at ways to increase "coyote acceptance" among residents, defined as the extent to which residents accept coyotes as inhabiting the same areas where they live (Jackman and Rutberg 2015). Frequently discussed factors in the literature are fear and perception of risk (Sponarski et al. 2015b), message framing (Siemer et al. 2014), lack of knowledge (Draheim et al. 2013), and prior experience with coyotes (Hudenko et al. 2008; Lu et al. 2016).

Negative perceptions of canids, including coyotes and wolves, are associated with social, cultural, and historical values and collective memory, such as the story of the "Big Bad Wolf," which was first popularized over two thousand years ago (Boholm 1998; Flores 2016). Some

researchers have additionally suggested that modern media coverage, which typically portrays negative stories about coyotes, can contribute to a false sense of heightened risk (Gehrt et al. 2010; Siemer at al. 2014). Fischhoff et al. (1978) demonstrated that the most vital drivers of risk perception and tolerance are a person's level of intrinsic dread and the novelty of the risk. Research has found that people are much more likely to be tolerant and accepting of a risk they take voluntarily as opposed to a risk that is externally posed (Starr 1969; Adams 1995). Thus, although people may have positive perceptions of coyotes living in "the wild", they may not necessarily feel the same if coyotes are in their backyard, where the perceived risk may be felt as involuntary (George et al. 2016).

Ideas about risk can also help us understand how coyotes are perceived differently in urban, suburban, and rural settings. While some studies have found urban dwellers to hold more positive views towards carnivores (Andersone and Ozolinš 2004; Martínez-Espiñeira 2006), other studies paint a more complex picture (Krester et al. 2009; Hudenko et al. 2008). On one hand, individuals such as ranchers may hold negative attitudes due to the economic costs that predators may incur to their livelihoods (McIvor and Conover 1994; Rust and Marker 2014). On the other, individuals in rural areas may have more awareness and knowledge (and perhaps less fear) of coyotes than those who live primarily in urban environments (Kellert 1985; Wine et al. 2015). Attitudes towards wildlife management methods depend heavily on community members beliefs about what is and what is not considered "natural" in a given environment (Fischer and Van Der Wal 2007; Lavau 2011). Thus, people for whom coyotes are a regular presence may perceive the animal differently than people living in areas newly colonized by coyotes (Krester et al. 2009). Dandy et al. (2012) concluded that different understandings of "naturalness" greatly influenced prefered strategies of how deer populations should be managed. In this sense, if people perceive that wildlife is "natural" in a region, then wild animals have a right to live there, free of human interference.

This paper explores perceptions of coyotes in two counties in the New York metropolitan area: the suburban county of Westchester, where coyotes are already established (Bogan 2012), and the more urbanized county of the Bronx, where coyotes have only recently begun to arrive (Toomey et al. 2012). We used a mixed methods approach to better understand the relationship between people's perceptions and desire for coyote removal from the local environment. We asked two main questions to guide the analysis of our data: 1) What are the main differences with regard to how Westchester and Bronx respondents perceive coyotes? 2) What are the main drivers that support desire for coyote removal from the local environment?

METHODOLOGY

Study area

Up until the 1990s, New York City was one of the few places left in the continental United States without a breeding coyote population (Gomper 2002; Toomey et al. 2012; Nagy et al. 2017). New York City (NYC) consists of five boroughs, four of which are located on islands (Manhattan, Brooklyn, Queens, and Staten Island), and one that is connected to the mainland (the Bronx). Coyotes moved into the Bronx from Westchester County, the county immediately north

of NYC; Westchester itself was colonized by coyotes during the 1970s (Fener et al. 2005, Nagy et al. 2017). Recent research in NYC has confirmed the existence of multiple family groups in the Bronx, with a few individuals living in Queens as well (Nagy et al. 2017).

To date, no research has been done on perceptions of coyotes in New York City, though several studies have focused on perceptions among suburban dwellers in Westchester County (Hudenko et al. 2008; Siemer and Decker 2011; Siemer et al. 2014). Coyotes are now common throughout Westchester County, and the region is considered to be a "hotspot" for human-coyote encounters, based on the number of reports and complaints received by authorities about the animal (Hudenko et al. 2008). Additionally, in March 2018, shortly prior to the data collection described in this paper, Westchester County had four highly publicized rabid coyote attacks on people that sparked a debate about coyote management in the county (Connors 2018; CBS New York 2018).

We conducted short interviews in city parks and local reserves, which are important gathering places for local residents (Kaźmierczak 2013; Campbell et al. 2016). Unlike national parks, which are popular tourist destinations, city and municipal parks primarily serve the communities that are geographically proximate, and are both cared for and frequented by local residents (Gobster 2002; Auyeung et al. 2015). Such parks are also ideal locations for conducting interviews with the public on issues pertaining to local wildlife, particularly in cities, as urban green spaces are one of the few places where city dwellers can connect with nature (Dickinson and Hobbs 2017).

In Westchester County, we collected data in three locations: Draper Park in Hastings-on-Hudson in the Town of Greenburgh, Rockefeller State Park Preserve in the Town of Mount Pleasant, and Gedney Park in the Hamlet of Millwood in the Town of New Castle (Figure 1). These locations were selected for their geographic differences, variable population densities, and popularity with local residents. They include a recently coyote-affected urban village in southern Westchester (Hastings-on-Hudson), a mid-county state park frequented by hikers, runners, bikers, and leisure walkers (Rockefeller State Park Preserve), and a mid-to-northern county village located in a town with a history of high coyote-controversy (New Castle) (Fitzgerald 2015). Demographically each location is similar with a majority white population and median household income between $100,000 and $200,000 (U.S. Census Bureau 2017).

In the Bronx, we conducted our research study in Pelham Bay Park, Riverdale Park, and Van Cortlandt Park. These three parks have had the largest recorded number of coyote sightings in the New York City area (Nagy et al. 2017). A social assessment of these parks conducted in 2013-2014 found that they are important spaces for local residents to recreate and gather socially (Auyeung 2016). Demographically, the areas surrounding the study locations were varied, with a majority white population in Riverdale, and majority hispanic and black populations in the census tracts bordering Van Cortland and Pelham Bay Park. The median household income among these areas ranged from less than $35,000 to $100,000 (NYC Open Data 2010).

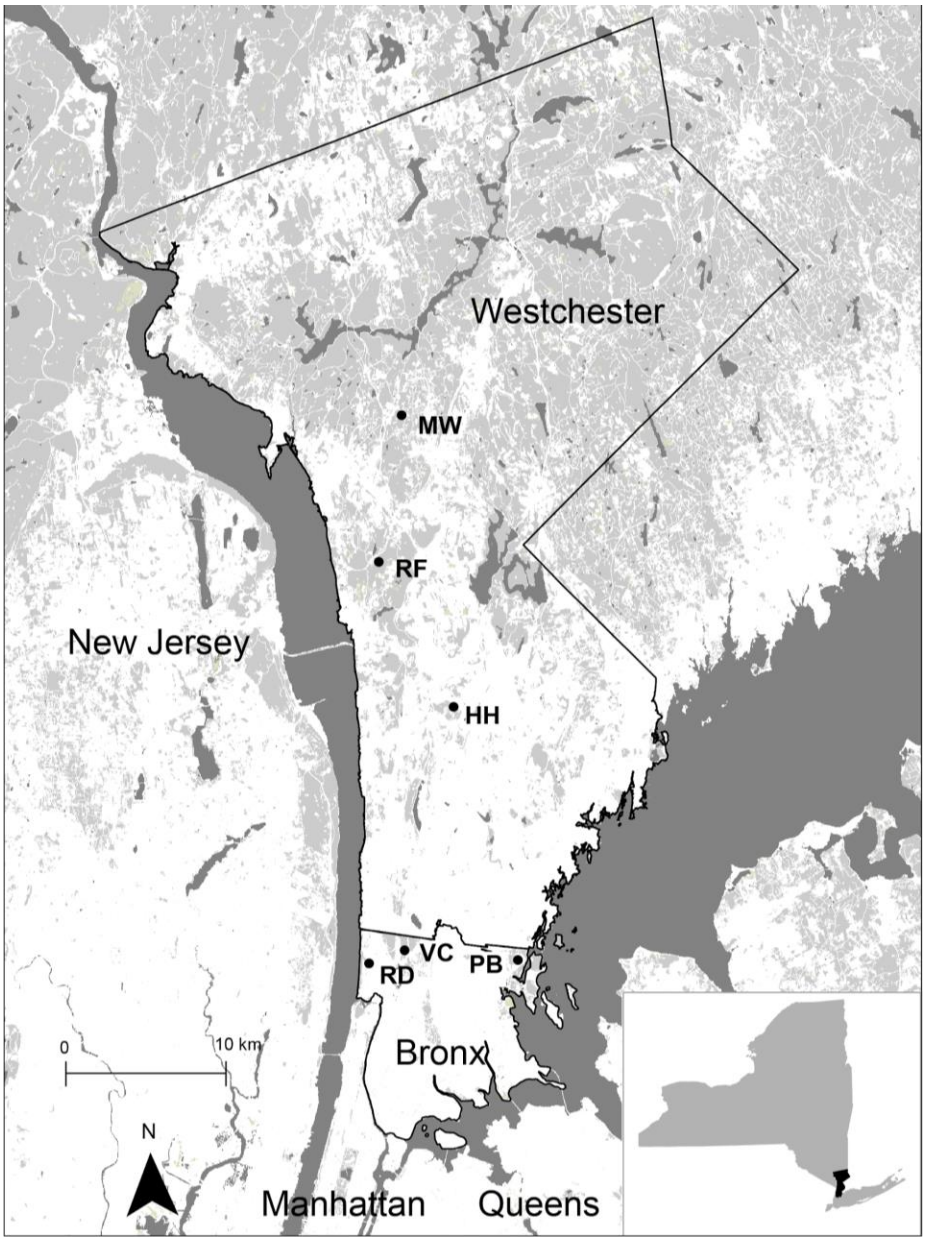

Fig 1. Map of the study area. Bronx and Westchester counties are outlined in black. The black dots indicate the parks where we interviewed participants. Regions of dark grey designate water and light grey areas depict forested land from the National Land Cover Database (Homer et al. 2015). Abbreviations of study locations are as follows: ML = Millwood, RF = Rockefeller, HH = Hastings-on-the-Hudson, RD = Riverdale, VC = Van Cortland, PB = Pelham Bay. The insert displays New York State with the study region filled in black.

Data Collection

A total of 140 short, in-person interviews were administered during three separate fieldwork periods. The first two periods, conducted between November-December of 2016 and March of 2017, were carried out in the Bronx, during which 82 park users were queried (59% of sample). The second fieldwork period was carried out in Westchester county between March-April of 2018, and gathered responses from 58 individuals (41% of sample). All participants were over

the age of eighteen, spoke English, and gave verbal consent to participating in the study. No identifying information was collected to ensure anonymity.

Our interview schedule consisted of nine questions and was designed to take no more than ten minutes. Short interviews (<30 minutes) are frequently used and recommended when seeking to rapidly assess perceptions and/or knowledge among a specified population (Fowler 2009; Moore et al. 2010). Specifically, we asked questions to gauge perceptions of coyotes with regard to various factors, including awareness of the local coyote population, direct experience with a coyote, perceived threats to humans and domesticated animals, desire for coyote removal, "perceived naturalness", and inappropriate behavior in the case of a direct experience with a coyote (see *Data Analysis* for more details on these classifications). Instead of requiring respondents to rank their answers on a predetermined Likert scale, our interview method used open-ended questions instead of presenting discrete choices (Table 1). This was done to generate more informative answers and to gauge better what the respondents considered to be important. Ethical approval was granted by the Pace University Institutional Review Board in September 2016, with amendments and additions approved subsequently in 2018.

Data Analysis

We organized responses to each question into discrete categories (Table 1). We added either Yes (Y) or No (N) to Awareness, Direct Experience, Perceived Threat to Humans, Perceived Threat to Pets, and Allowed to Live. We categorized responses to the question, "Should coyotes be allowed to live in the local environment?" into a "Removal" binary variable ("Yes, allowed to live" responses were coded as a "No" to Removal). We removed "unsure" answers from Perceived Threat categories, which left us with a dataset of 120 responses (Bronx: n= 64; Westchester: n = 56). For Question 6 (Perceived Naturalness), we grouped all affirmative responses into the Yes category, negative responses into the No category, and responses that indicated contingency on location (such as "Yes, but not in this city") in a third category called "Not here". The phrasing of this question slightly differed between interviews conducted in the Bronx and Westchester (in Westchester, the word "nature" was replaced with "ecosystem"), but interpretation of the results did not reveal that this change had an impact on responses (see *Results*).

To gauge "appropriate response", we analyzed how respondents would react in three different coyote encounter scenarios: 1) seeing a coyote in the distance, 2) a coyote approaching person or pet, and 3) a coyote on person's property. We measured only for two types of inappropriate responses: 1) an answer of "run away" to any of the questions, as this reaction could prompt a coyote to mistake a person as prey and instigate an attack (Cook County Urban Coyote Research Project 2018); 2) calling the police, 911, or animal control in the case of a coyote "sighting", either in reference to spotting a coyote in the distance or on one's property. We determined this latter response to be "inappropriate" unless the coyote in question is behaving aggressively or appears to be sick, and some police departments around the country have requested that residents do not call authorities to report sightings (Locke 2016; Fox12 2016). We created an additional categorical variable called "Inappropriate Response", which was marked Yes if any of the three responses was categorized as inappropriate based on the criteria above.

Table 1: Interview schedule

Column A: Specific question	Column B: Designed to gauge	Column C: Categorized Responses
1. Are you aware coyotes are living in The Bronx / Westchester County?	Awareness	Yes / No
2. Have you seen a coyote in The Bronx / Westchester County? If so, where?	Direct Experience	Yes / No
3. Do you believe that coyotes are a threat to humans?	Perceived threat to humans	Yes / No / Unsure
4. Do you believe that coyotes are a threat to domesticated animals, such as cats and dogs?	Perceived threat to pets	Yes / No / Unsure
5. Do you believe coyotes should be allowed to live in urban environments like The Bronx / suburban environments like Westchester?	Allowed to Remain / Removal	Yes / No
6. Do you believe that coyotes are a part of nature / ecosystem?	Perceived naturalness	Yes / No
7. What would you do if you saw a coyote in the a distance?	Appropriate behavior	Scored as "inappropriate response" if participant replied with "run away" or "call authorities"
8. What would you do if a coyote approached you or your pet?	Appropriate behavior	
9. What would you do if a coyote was on your property?	Appropriate behavior	

Statistical Analyses

We conducted a Fisher's exact test to determine whether there was a significant association between desired coyote removal and interviewee location (Westchester or Bronx). Fisher's exact test performs better than a chi-square test when expected values are less than five. We used a one-sided alternative hypothesis since we had an *a priori* assumption regarding the direction of the association (Bronx respondents more likely to support coyote removal).

To examine the strongest driver for coyote removal, we first performed two-sided Fisher's exact tests comparing the binary responses of each remaining six variables ("Awareness", "Direct Experience", "Perceived Threat to Humans", "Perceived Threat to Pets", "Perceived Naturalness", and "Inappropriate Response") to the binary responses "Removal" variable. To test for collinearity, we performed Cramer's V tests of correlation between all predictor variables (Cramer 1946). Cramer's V is used to measure the strength of association between nominal variables when at least one of the variables has more than two categories. We then performed a binomial logistic regression with all variables that the Fisher's exact test returned as significant ($p<0.05$) as the predictor variables and "Removal" as the response variable. We excluded participants who had responded with "Unsure" to the "Perceived Threat to Humans" or "Perceived Threat to Pets" variables. All statistical tests were performed in R, version 3.5.2 (R Core Team, 2018). We used the McFadden's pseudo R^2 value to assess the

improvement in model likelihood over a null model (McFadden 1974). We used the R package DescTools to calculate the McFadden's pseudo R^2 and Cramer's V (Signorell 2017).

RESULTS

Differences in perceptions of coyotes among urban and suburban park users

We found significant differences between Westchester and the Bronx for level of awareness, perceived threat, and knowledge about coyotes. Among Westchester park users, 98.3 % were aware that coyotes inhabited the area, while just over half (51.2 %) of Bronx respondents were aware that coyotes were living in New York City (Fisher's exact test, $p<0.001$, SE=0.050). Westchester park users were slightly more likely to have had a direct experience with coyotes (17.3%) compared to Bronx park users (7.3%; Fig. 2). Such experiences were reported as "sightings" – i.e. observing the animal from a distance, or spotting one while driving. Neither group of respondents reported personal encounters of a negative nature (i.e. perceived threat or attack on pet).

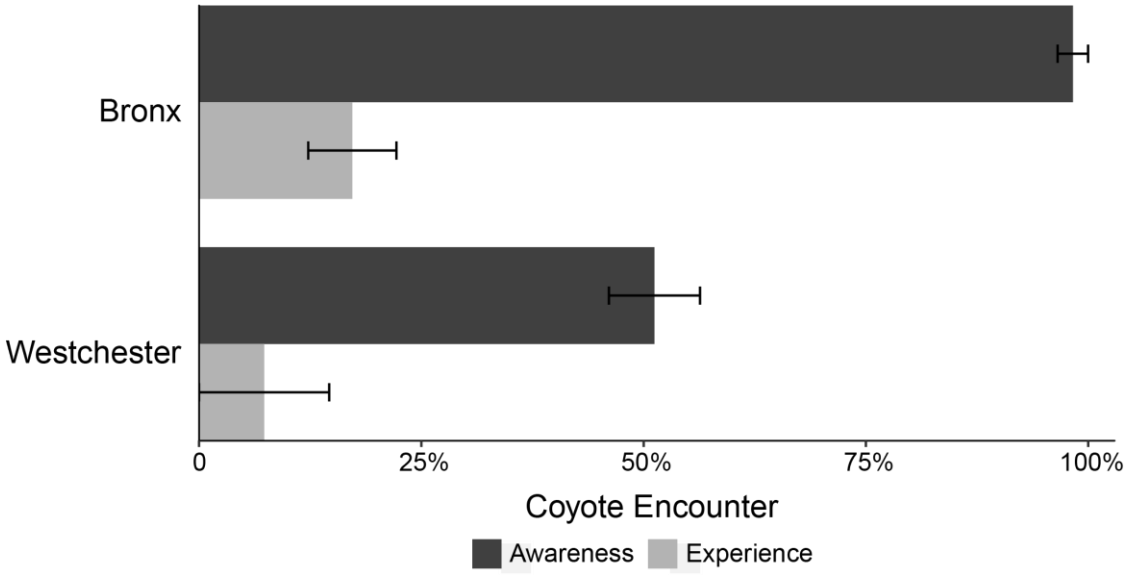

Fig 2. A larger proportion of Westchester participants were aware that coyotes were living in the area (n=57) and had a direct experience with coyotes (seen or heard them; n=10) than Bronx participants (n=42/6). Bars display the standard error.

A larger, though statistically not significant, proportion of Westchester respondents believed that coyotes pose a threat to humans (35.7%) compared to the Bronx (26.6%; Fisher's exact test, $p = 0.325$, SE = 0.082, Fig 3a). However, the majority of respondents from both locations did not believe that coyotes pose a threat to humans. Conversely, the vast majority of all respondents perceived that coyotes posed a threat to pets (85.7 % in Westchester and 95.3 % in the Bronx, Fig 3b). We also found that significantly more Westchester respondents said that

coyotes should be allowed to live in the local environment (86.2%) as compared to Bronx respondents (48.8%) (Fisher's exact test, $p<0.001$, SE=0.052, Fig 4).

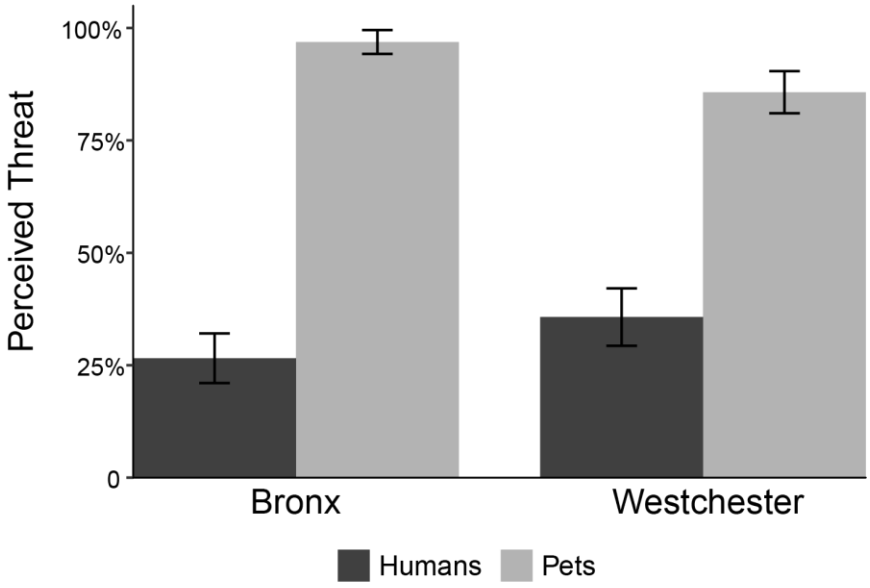

Fig 3. a) The majority of Bronx (n = 47) and Westchester (n = 36) respondents did not believe that coyotes pose a threat to humans. b) The majority of respondents from both locations (Bronx: n = 61; Westchester: n = 48) believed that coyotes present a threat to pets. Bars indicate standard error.

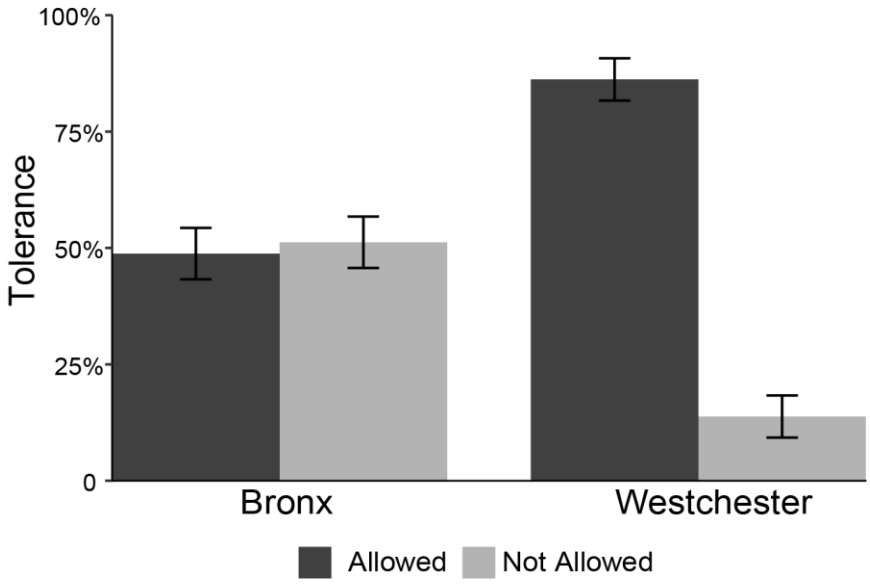

Fig 4. A significantly higher proportion of Westchester respondents (n=50) than Bronx respondents (n = 40) believed that coyotes should be allowed to live in the local environment. Bars indicate standard error.

The majority of respondents from both groups (87.9 % in Westchester versus 67.1 % in the Bronx, Fig 5) said that they believed that coyotes are "a part of nature". Interestingly, a new category of responses emerged as almost a third of Bronx respondents said that while they believed that coyotes are a part of nature, this did not include the Bronx ("yes, but not here"). This differed greatly from that of Westchester respondents, where only one respondent suggested that coyotes did not belong in the local environment.

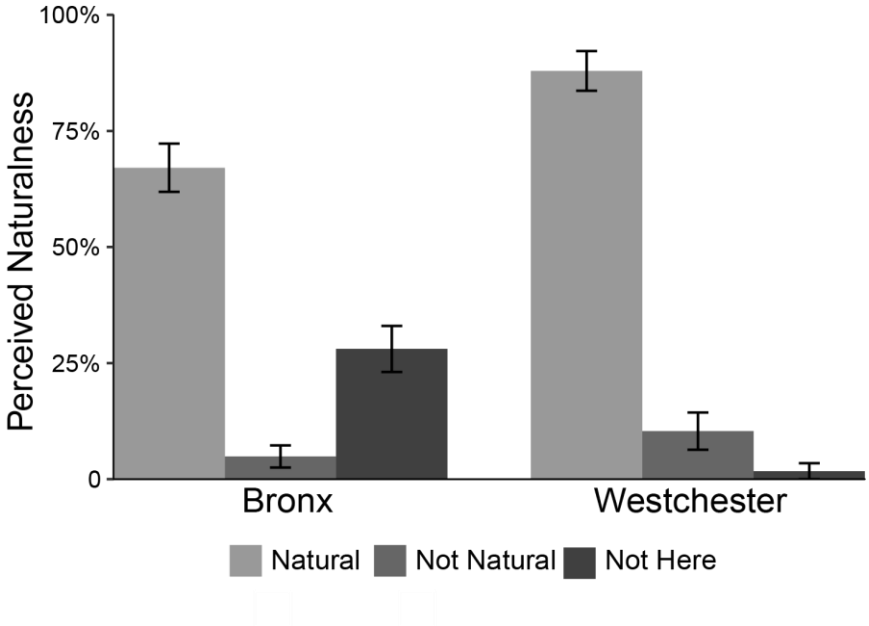

Fig 5. The majority of respondents from the Bronx (n=55) and Westchester (n = 51) believed that coyotes are a part of nature. However, a proportion of Bronx participants (n = 23) perceived that while coyotes are a part of nature, this does not include the Bronx.

Bronx respondents demonstrated a higher degree of inappropriate responses to hypothetical coyote experiences (37.80%) as compared to Westchester respondents (1.72%) (Fisher's exact test, $p<0.001$, SE= 0.031). For example, 11.0 % of Bronx respondents said that they would "run away" if approached by a coyote. In addition, Bronx respondents were far more likely to call emergency services upon seeing a coyote on their property (Table 2).

Table 2: Percentage of self-reported inappropriate responses to hypothetical coyote experience

Type of experience %	Inappropriate (Westchester)	Inappropriate (Bronx)
Coyote in Distance	0	15.85%
Coyote approaching person / pet	3.45%	12.20%
Coyote on property	1.72%	26.83%

Main drivers of desire for coyote removal

We aggregated all response data from both Bronx and Westchester subsamples to determine the main drivers for coyote removal. Removal responses were significantly different (Fisher's exact tests, $p < 0.05$) with regards to three of the six variables: "Perceived Threat to Humans" ($p<0.001$, SE =0.014), "Perceived Naturalness" ($p<0.001$, SE=0.039), and "Inappropriate Response" ($p< 0.035$, SE=0.096) (Fig 7). Participants who perceived coyotes to be a natural part of the ecosystem were significantly less likely to favor coyote removal. Conversely, those who gave inappropriate responses and those who responded that coyotes were a threat to humans were significantly more likely to favor coyote removal. The variables were not highly correlated with each other (Cramer's $V < 0.300$) and were all included in the model. Separating our response for "Perceived Naturalness" into "No", "Not Here", and "Yes" hampered model convergence. Therefore, we decided to group "Not Here" with "No" and have only two categories (Yes/No), which allowed our model to converge.

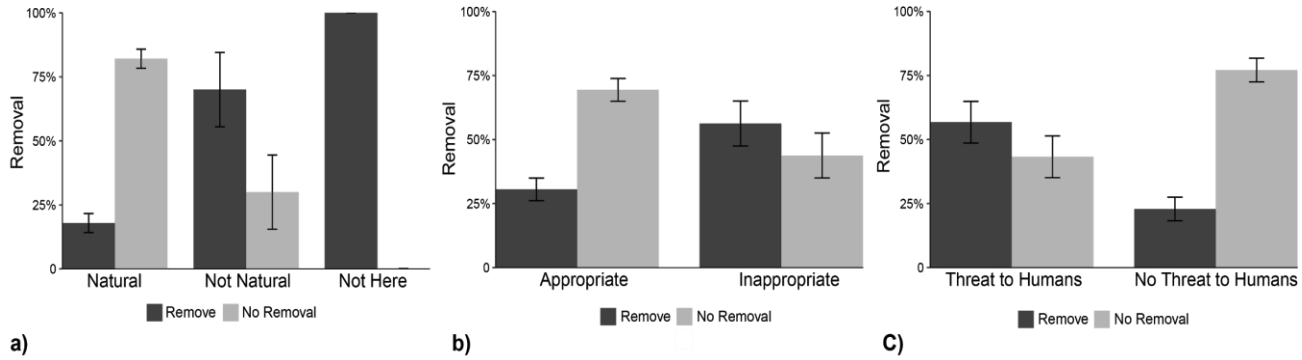

Fig 6(a-c). Removal responses were significantly different for the variables "Perceived Naturalness," "Inappropriate Response," and "Perceived Threat to Humans."

The McFadden's pseudo $R^2 = 0.42$, indicating that the model explained much of the variation in the data. The "Perceived Naturalness" predictor variable was the strongest driver of "Removal" responses (Table 3). Participants who responded "No" in response to the "Perceived Naturalness" question were approximately four times more likely to give a "Removal" response than an "Allowed to Stay" response. Similarly, the probability of a "Removal" response was 80.09% if the participant responded "No" to the question regarding coyote "Perceived Naturalness."

Table 3. Logistic Regression Model Results (* p-value below the significance threshold of 0.05.)

Variable	Estimate (β)	Std. Error	p-value	Odds Ratio (Exp(β))	Probability (Exp(β)/(1+Exp(β)))
Intercept	-2.532	0.456	<0.001*	0.079	7.32%
Perceived Naturalness (No)	3.924	0.732	<0.001*	4.023	80.09%
Threat to Humans (Yes)	1.281	0.576	0.026*	0.2862	22.25%
Inappropriate (Yes)	1.599	0.608	0.009*	0.3934	28.23%

DISCUSSION

Our research sought to explore differences and similarities in perceptions of coyotes among suburban park users in Westchester, where coyotes have been established, versus urban park users in the Bronx, where coyotes have recently arrived, and whether such perceptions are correlated with acceptance of coyotes in the local environment. We found similar perceptions with regard to risk to humans and animals, but key differences in other areas. In particular, our findings demonstrate that Westchester respondents are more likely to suggest that coyotes should be "allowed to live" in the region than Bronx respondents (86.2% versus 48.8%, respectively). In addition, while we found perception of risk to be an important driver of desire for removal, "perceived naturalness" was a stronger predictor variable. These findings add a new lens through which to examine understandings of how people view wildlife in urbanized areas.

Previous research on perceptions among urban, suburban, and rural residents has demonstrated shifting ideas about the value of wildlife based on proximity to human landscapes (Hudenko et al. 2008; Siemer and Decker 2011). For example, in a comparative study of attitudes towards wildlife among Americans between 1978 and 2014, George et al. (2016) found that as the nation has become more urbanized, perceptions of wolves and coyotes have become more positive. However, they also found that perceptions of so-called "nuisance" animals that are commonly found in urban environments, such as swans and raccoons, became more negative over this period, and suggests that this may be due to a higher chance for negative interactions due to increased exposure to such animals. Thus, while urban dwellers may appreciate wild animals in the abstract, this sentiment may not extend to one's immediate environment. This is supported in our study where almost a third of Bronx respondents said that while they believe coyotes are an important part of nature, this did not include the local area. This raises a further discussion with regard to whether large cities, such as New York, can be perceived to be "natural" (Fischer and Van Der Wal 2007), and the role that this perception may play in public support for wildlife coexistence. This disconnect has the potential to lead to significant human-wildlife conflict, especially as more wildlife adapt to urban environments (Dandy et al. 2012). Previous studies have found that the concept of what is natural and belongs in a given environment versus what is/does not is commonly used by conservationists to justify lethal management practices of non-native species to protect rare, native species (Mulcock and Trigger 2008; Shackleton et al. 2019). Alternately, studies of wolf reintroductions in the American West have found that people who favor eradication perceive the wolf as a symbol of government intrusion, rather than a natural part of the landscape (Wilson 1997; Browne-Nuñez et al. 2015). On such ethical and philosophical grounds, the question of what is deserving of life in a given environment may be strongly correlated with common perceptions of whether it is "supposed" to be there (Lavau 2011; Sponarski et al. 2015a).

In addition, we suggest that there may be a relationship between perception of risk and perception of what is natural. Previous carnivore-specific studies have emphasized perceptions of risk and the role that the media plays in promulgating risk (Siemer et al. 2014). As described earlier in this paper, people are more tolerant of voluntary rather than involuntary risk (Starr 1969; Adams 1995). If coyotes are seen to be non-natural to an area, this may be seen as constituting an involuntary risk, and thus may be less acceptable to residents living in the area. Research on suburban coyote tolerance has indicated that perception of threat from coyotes is

more likely to be greater among residents in areas where coyote presence is more recent (Hudenko et al. 2008). Lack of knowledge about the potential danger that an unfamiliar animal poses, and how to react during a potential encounter, may also be a contributing factor. In sum, our results suggest that perceived naturalness, perception of risk, and lack of knowledge about appropriate reactions to a coyote encounter are linked, and better understanding of these factors can shed light on the perceived significance of the presence of coyotes in a human-dominated environment.

This study had several limitations, including the relatively small number of people interviewed, as well as the limited number of questions asked in the interviews, which precluded deeper analysis of the results. Further research could expand the sample size and ask additional questions to better gauge preferences of specific management approaches, knowledge of coyote ecology and behavior, as well as more general beliefs and emotions with regard to wildlife. An additional limitation of our study was our focus on users of local parks, whose perspectives may not be representative of the wider population or may not adequately differentiate between general perceptions of coyotes and perceptions of the locations in which coyotes occur. Further research could more explicitly target the perspectives of urban and suburban residents through broader sampling methods, such as the distribution of a mail-in questionnaire, with specific questions related to residency and location.

Management Implications

Our results build on previous studies on key drivers of human perceptions of carnivores, and have implications for future research and management. Decision-making strategies for wildlife management have shifted models in recent years to reflect our evolving understanding, favoring an attitudinal carrying capacity based on stakeholder acceptance over biological carrying capacity. Therefore, understanding the psychology of coyote management is at least as important as ecological data. Common wildlife management practices stress the importance of educating people about wildlife often through passive modes such as flyers or websites (Sponarski et al. 2016). However, social science research questions these methods and stresses the importance of direct experience, emotion, and tradition in shaping knowledge and perceptions (Glikman et al. 2012; Jochum et al. 2014; Sjölander-Lindqvist et al. 2015). Our findings suggest that managers could expand current educational campaigns to include dimensions of wildlife "naturalness" in the environment. The City of New York has already taken steps in this direction with their WildlifeNYC campaign that aims to increase public awareness and promote coexistence between humans and wildlife (City of New York 2017). The campaign includes strategically-placed signs (in subway cars, in parks, and on buses) with images of various types of urban wildlife (e.g. deer, raccoons, coyotes, hawks), together with an arrow pointing to the animal and text that reads "New Yorker: City dwellers take many forms." This approach appeals to the public imagination of the city as a demographically rich and immigrant-friendly city, where all types of people and species can coexist.

Rapid urbanization and sprawl means a changing human landscape, and urban wildlife management strategies must adapt accordingly. Due to the ubiquity of coyotes across North America, urban and suburban wildlife managers alike are faced with the task of finding approaches to promote human-predator coexistence (Grubbs and Krausman 2009; Gehrt et al.

2010). Building community awareness of coyote presence and perception of "naturalness" in an urban environment, along with information about appropriate behavior, such as hazing techniques, can help empower residents with the confidence to enjoy the presence of wildlife in their neighborhoods. Sustainable coexistence is a long-term commitment that requires an adaptive and complementary approach to the physical and cultural landscapes served by a management plan. By developing a deeper understanding of the factors that favor coexistence versus eradication, local governments can help protect the safety of both human and ecological communities while fostering a sense of shared belongingness amongst residents.

LITERATURE CITED

Adams, J. (1995). *Risk,* UCL Press London, Bristol.

Andersone, Ž., and Ozolinš, J. (2004). Public perception of large carnivores in Latvia. *Ursus*, *15*(2), 181-187.

Auyeung, D. N., Campbell, L. K., Johnson, M., Sonti, N. F., and Svendsen, E. (2016). *Reading the landscape: citywide social assessment of New York City parks and natural areas in 2013-2014. Social Assessment White Paper No. 2*. New York, NY: New York Department of Parks and Recreation. 1-69.

Bateman, P. W., and Fleming, P. A. (2012). Big city life: Carnivores in urban environments. J*ournal of Zoology*, 287(1), 1-23. doi:10.1111/j.1469-7998.2011.00887.

Bogan, D. A. (2012). The suburban coyote syndrome, from anecdote to evidence: Understanding ecology and human safety to improve coexistence. (Dissertation). Cornell University, Ithaca, New York

Boholm, A. (1998). Comparative studies of risk perception: a review of twenty years of research. *Journal of risk research., 1*, 135–163.

Browne-Nuñez, C., Treves, A., MacFarland, D., Voyles, Z., and Turng, C. (2015). Tolerance of wolves in Wisconsin: A mixed-methods examination of policy effects on attitudes and behavioral inclinations. *Biological Conservation*, *189*, 59-71.

Campbell, L. K., Svendsen, E. S., Sonti, N. F., and Johnson, M. L. (2016). A social assessment of urban parkland: Analyzing park use and meaning to inform management and resilience planning. *Environmental Science & Policy,* 62, 34-44.

Carbon C. C. (2014). Understanding human perception by human-made illusions. *Frontiers in human neuroscience, 8,* 566.

CBS New York (2018). Coyote attacks continue in Westchester. Retrieved January 2019 from https://newyork.cbslocal.com/2018/04/30/coyote-attack/

City of New York (2017). WildlifeNYC. Retrieved December 2018 from https://www1.nyc.gov/site/wildlifenyc/index.page

Connors, B. (2018). The threat of coyotes should not be overlooked. *Poughkeepsie Journal.* Retrieved January 2019 from https://www.poughkeepsiejournal.com/story/sports/recreational/2018/03/07/threat-coyotes-not-overlooked/400639002/

Cook County Urban Coyote Research Project (2019). Retrieved December 2018 from https://urbancoyoteresearch.com/

Cramer, H. (1946). *Mathematical Models in Statistics,* Princeton University Press, New Jersey.

Dandy, N., Ballantyne, S., Moseley, D., Gill, R., Quine, C., and Van Der Wal, R. (2012). Exploring beliefs behind support for and opposition to wildlife management methods: A qualitative study. *European Journal of Wildlife Research*, *58*(4), 695-706.

Dickman, A. (2010). Complexities of conflict: The importance of considering social factors for effectively resolving human–wildlife conflict. *Animal Conservation, 13*(5), 458-466.

Dickinson, D. C., and Hobbs, R. J. (2017). Cultural ecosystem services: Characteristics, challenges and lessons for urban green space research. Ecosystem Services, 25, 179-194.

Draheim, M. M., Patterson, K. W., Rockwood, L. L., Guagnano, G. A., and Parsons, E. C. M. (2013). Attitudes of college undergraduates towards coyotes (Canis latrans) in an urban landscape: Management and public outreach implications. *Animals, 3*(1), 1-18.

Elliot, E. E., Vallance, S., and Molles, L. E. (2016). Coexisting with coyotes (Canis latrans) in an urban environment. *Urban ecosystems*, *19*(3), 1335-1350.

Fener, H. M., Ginsberg, J. R., Sanderson, E. W., and Gompper, M. E. (2005). Chronology of range expansion of the coyote, Canis latrans, in New York. *The Canadian Field-Naturalist*, *119*(1), 1-5.

Fischer, A., and Van Der Wal, R. (2007). Invasive plant suppresses charismatic seabird–the construction of attitudes towards biodiversity management options. *Biological Conservation*, *135*(2), 256-267.

Fischhoff, B., Slovic, P., Lichtenstein, S., Read, S., and Combs, B. (1978). How safe is safe enough? A psychometric study of attitudes towards technological risks and benefits. *Policy Sciences*, *9*, 127–152.

Fitzgerald, J. (2015). Upscale New York suburb embroiled in a wily debate over coyotes. Retrieved May 2019 from https://cnycentral.com/news/nation-world/upscale-new-york-suburb-embroiled-in-a-wily-debate-over-coyotes

Flores, D. (2016). *Coyote America: A natural and supernatural history*. Basic Books, New York.

Fowler, F. J. (2009). Survey Research Methods, Fourth ed. Sage Publications, Thousand Oaks, CA.

Fox12. (2016). Deputies: Don't call 911 to report coyote sightings. Retrieved January 2019 from https://www.kptv.com/news/deputies-don-t-call-to-report-coyote-sightings/article_165f63fa-ece8-5aee-8b6c-a9e7cbb05cb9.html

Gehrt, S., Anchor, C., and White, L. (2009). Home range and landscape use of coyotes in a metropolitan landscape: Conflict or coexistence? *Journal of Mammalogy, 90*(5), 1045-1057.

Gehrt, S., Riley. S, and Cypher, B. (2010). *Urban carnivores: Ecology, conflict, and conservation.* JHU Press: Baltimore.

George, K. A., Slagle, K. M., Wilson, R. S., Moeller, S. J., and Bruskotter, J. T. (2016). Changes in attitudes toward animals in the United States from 1978 to 2014. *Biological Conservation, 201,* 237-242.

Gese, E. M. and Bekoff, M. (2004). Coyotes (Canis Latrans). In C. Sillero-Zubiri, M. Hoffmann, D.W. Macdonald (Eds.), *Canids: Foxes, wolves, jackals and dogs. Status survey and conservation action plan*. IUCN/SSC Canid Specialist Group. Cambridge: IUCN Publications Services Unit, SSC Species Action Plans.

Glikman, J. A., Vaske, J.J., Bath, A.J., Ciucci, P.,Boitani, L. (2012). Residents' support for wolf and bear conservation: The moderating influence of knowledge. *European Journal of Wildlife Research, 58*(1), 295-302.

Gobster, P. H. (2002). Managing urban parks for a racially and ethnically diverse clientele. *Leisure sciences*, 24, 143-159.

Gomper, M. (2002). Top Carnivores in the suburbs? Ecological and conservation issues raised by colonization of northeastern North America by coyotes. *BioScience, 52*(2), 185-190.

Grimm, N. B., Faeth S. H., Golubiewski, N. E., Redman, C. L., Wu, J., Bai, X., and Briggs, J. M. (2008). Global change and the ecology of cities. *Science,* 319(5864), 756-760.

Grubbs, S. E. and Krausman, P. R. (2009). Use of urban landscape by coyotes. *The Southwestern Naturalist*, 54(1), 1-13.

Homer, C., Dewitz, J., Yang, L., Jin, S., Danielson, P., Xian, G., Coulston, J., Herold, N., Wickham, J., and Megown, K. (2015). Completion of the 2011 National Land Cover Database for the conterminous United States - Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing, 81*(5), 345-354.

Hudenko, H. W., Decker, D. J., and Siemer, W. F. (2008). Humans and coyotes in suburbia: Can experience lead to sustainable coexistence? *Human Dimensions Research Unit Department of Natural Resources,* Cornell University.

Jackman, J. L., and Rutberg, A. T. (2015). Shifts in attitudes toward coyotes on the urbanized east coast: The Cape Cod experience, 2005–2012. *Human Dimensions of Wildlife*, *20*(4), 333-348.

Jacobs, M. H. (2012). Human emotions toward wildlife. *Human Dimensions of Wildlife*, *17*(1), 1-3.

Jochum, K. A., Kliskey, A. A., Hundertmark, K. J., and Alessa, L. (2014). Integrating complexity in the management of human-wildlife encounters. *Global Environmental Change*, 26, 73-86.

Kaźmierczak, A. (2013). The contribution of local parks to neighbourhood social ties. *Landscape and urban planning*, 109(1), 31-44.

Kellert, S. R. (1985). Public perceptions of predators, particularly the wolf and coyote. *Biological Conservation, 31*(2), 167-189

Krester, H. E., Curtis, P. D., Francis, J. D., Pendall, R. J., and Knuth, B. A. (2009). Factors affecting perceptions of human–wildlife interactions in residential areas of northern New York and implications for conservation. *Human Dimensions of Wildlife*, *14*(2), 102-118.

Lavau, S. (2011). The nature/s of belonging: performing an authentic Australian river. *Ethnos*, 76(1), 41-64.

Locke, C. (2016). Someone is feeding meat to coyotes in Roseville, worrying residents. The Sacramento Bee. Retrieved January 2019 from https://www.sacbee.com/news/local/crime/article115304173.html

Lu, H., Siemer, W. F., Baumer, M. S., Decker, D. J., and Gulde, A. (2016). Effects of message framing and past experience on intentions to prevent human–Coyote conflicts. *Human Dimensions of Wildlife*, *21*(6), 506-521.

Martínez-Espiñeira, R. (2006). Public attitudes toward lethal coyote control. *Human Dimensions of Wildlife*, *11*(2), 89-100.

McFadden, D. (1974). Conditional logit analysis of qualitative choice behavior. In P. Zarembka (Eds.), *Frontiers in Econometrics* (pp. 105-142). Academic Press, New York.

McIvor, D. E., and Conover, M. R. (1994). Perceptions of farmers and non-farmers toward management of problem wildlife. *Wildlife Society Bulletin, 22*(2), 212–219.

Moore, J. E., Cox, T. M., Lewison, R. L., Read, A. J., Bjorkland, R., McDonald, S. L., Crowder, L. B., Aruna, E., Ayissi, I., Espeut, P., and Joynson-Hicks, C. (2010). An interview-based approach to assess marine mammal and sea turtle captures in artisanal fisheries. *Biological Conservation*, *143*(3), 795-805.

Morey, P. S., Gese, E. M., and Gehrt, S. (2007). Spatial and temporal variation in the diet of coyotes in the Chicago metropolitan area. *The American Midland Naturalist 158*(1), 147-161.

Mulcock, J., and Trigger, D. (2008). Ecology and identity: a comparative perspective on the negotiation of "nativeness". In *Toxic Belonging? Identity and Ecology in Southern Africa* (Vol. 178, No. 198, pp. 178-198). Cambridge Scholars Publishing in association with GSE Research.

Nagy, C., Weckel, M., Monzón, J., Duncan, N., and Rosenthal, M. R. (2017). Initial colonization of Long Island, New York by the eastern coyote, Canis latrans (Carnivora, Canidae), including first record of breeding. *Check List*, *13*(6), 901-907.

NYC Open Data (2010). 2010 Census Tracts by Department of City Planning. Retrieved January 2019 from https://data.cityofnewyork.us/City-Government/2010-Census-Tracts/fxpq-c8ku

Poessel, S. A., Gese, E. M., and Young, J. K. (2017). Environmental factors influencing the occurrence of coyotes and conflicts in urban areas. *Landscape and Urban Planning, 15*7, 259-269.

R Core Team (2018). R: A language and environment for statistical computing. R. Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org.

Rust, N. A., and Marker, L. L. (2014). Cost of carnivore coexistence on communal and resettled land in Namibia. *Environmental Conservation*, *41*(1), 45-53.

Shackleton, R. T., Richardson, D. M., Shackleton, C. M., Bennett, B., Crowley, S. L., Dehnen-Schmutz, K., and Marchante, E. (2019). Explaining people's perceptions of invasive alien species: A conceptual framework. *Journal of Environmental Management*, *229*, 10-26.

Shivik, J. (2014). *The predator paradox: Ending the war with wolves, bears, cougars, and coyotes*. Beacon Press. Boston.

Siemer, W. F., and Decker, D. J. (2011). The new norm: Westchester county residents' risk perceptions and experiences before and after local coyote attacks. *Human Dimensions Research Unit, Cornell University.*

Siemer, W. F., Decker, D. J., Shanahan, J. E., and Wieczorek Hudenko, H. A. (2014). How do suburban coyote attacks affect residents' perceptions? Insights from a New York case study. *Cities and the Environment (CATE)*, *7*(2), 7.

Signorell, A. (2017). DescTools: Tools for descriptive statistics. *R package version* 0.99.22.

Sjölander-Lindqvist, A., Johansson, M., and Sandström, C. (2015). Individual and collective responses to large carnivore management: the roles of trust, representation, knowledge spheres, communication and leadership. *Wildlife Biology, 21*(3), 175-185.

Soulsbury, C. D., and White, P. C. (2015). Human–wildlife interactions in urban areas: A review of conflicts, benefits and opportunities. *Wildlife Research*, *42*(7), 541-553.

Sponarski, C. C., Vaske. J. J., and Bath, A. J. (2015a). The role of cognitions and emotions in human–coyote interactions. *Human Dimensions of Wildlife 20*(3), 238-254.

Sponarski, C. C., Vaske, J. J., and Bath, A. J. (2015b). Attitudinal differences among residents, park staff, and visitors toward coyotes in Cape Breton Highlands National Park of Canada. *Society & Natural Resources 28*(7), 720-732.

Sponarski, C. C., Vaske, J. J., Bath, A. J., and Loeffler, T. A. (2016). Changing attitudes and emotions toward coyotes with experiential education. *The Journal of Environmental Education*, *47*(4), 296-306.

Starr, C. (1969). Social benefits vs. technological risks. *Science, 165*, 1232–1238

Sterling, B., Conley, W., and Conley, M. R. (1983). Simulations of demographic compensation in coyote populations. *The Journal of Wildlife Management*, *47*(4), 1177-1181.

Toomey, A., Nagy, C. M., Weckel, M., Burns, C. E., and Pletz, J. (2012). The last frontier: The eastern coyote in New York City. *Wildlife Professional, 6*, 54-57.

U.S. Census Bureau (2017). American Community Survey 1-year estimates. Retrieved January 2019 from Census Reporter Profile page for Westchester County, NY https://censusreporter.org/profiles/05000US36119-westchester-county-ny/

Weckel, M., and Wincorn, A. (2016). Urban conservation: The northeastern coyote as a flagship species. *Landscape and Urban Planning*, *150,* 10-15.

White, L. A., and Gehrt, S. D. (2009). Coyote attacks on humans in the United States and Canada. *Human Dimensions of Wildlife*, *14*(6), 419-432.

Wilson, M. A. (1997). The wolf in Yellowstone: Science, symbol, or politics? Deconstructing the conflict between environmentalism and wise use. *Society & Natural Resources*, *10*(5), 453-468.

Wine, S., Gagné, S. A., and Meentemeyer, R. K. (2015). Understanding human–coyote encounters in urban ecosystems using citizen science data: What do socioeconomics tell us? *Environmental management*, *55*(1), 159-170.