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Research article

Public perspectives on the management of urban coyotes

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Abstract

In recent years there has been much attention to coyote (*Canis latrans*) management in urban areas in the USA. Many urban wildlife managers are searching for ways to reduce and prevent human–coyote conflict that are both effective and acceptable to their constituents. This article presents the findings of research that surveyed two neighboring suburbs in the Denver, Colorado metropolitan area that differed in their management approaches to coyotes, both formally and informally. These findings provide an interesting case study with comparative power for urban/suburban locations where human–coyote conflict is active and well-publicized, and where different management policies themselves spark controversy. Using a mixed methodology approach, this study demonstrates that formal management plans do not completely describe the on-the-ground reality of management efforts. This is a critical because many urban wildlife populations are managed across multiple jurisdictions, and capturing local-level effects is necessary to have a complete understanding of these populations. A survey of residents of both towns demonstrated that specific beliefs and attitudes are important predictors in determining the likelihood of supporting broad-based lethal control over policies that emphasize hazing and education. It also shed light on the differences between the towns that might have driven the differing policies. In addition, understanding how people make use of local green spaces and their own yards, as well as identifying potential barriers to people modifying their property so as to reduce conflict (by example for installing a fence in areas pets are let off-leash) can inform managers' goals and actions.

Key words: coyote, *Canis latrans*, human–wildlife conflict, coyote management, urban wildlife

Introduction

Human–wildlife conflict (HWC) has become a well-known and discussed threat to wildlife, most notably to carnivores (Distefano, ND; Nyhus et al. 2003; Madden 2004; Inskip and Zimmermann 2009). In some cases, this is because of increased proximity of wildlife to humans, either due to human encroachment into rural areas, or because wildlife find their way into cities.

Although HWC is sometimes about tangible conflict between humans and wildlife, oftentimes the conflict is actually an outward manifestation of other social issues and basic beliefs

about wildlife (Scarce 1998, 2005; Capek 2005; Jerolmack 2008; Baruch-Mordo et al. 2009; Madden and McQuinn 2014; Draheim et al. 2015; Sprague and Draheim 2015). Examples of human–carnivore conflict that fall into this category are plentiful. For example, in Hawaii conflict over monk seals, including who has responsibility for their management, can be traced back to the complex relations between native Hawaiians, mainlanders who move to the Islands, and the federal government (Sprague and Draheim 2015). Similarly, human–wolf conflict near Yellowstone National Park is driven in part by concerns over private property rights and interference by the federal government (Scarce 1998). In India, conflict over leopards in and around Mumbai is complicated by competing visions of leopards, from local indigenous groups who view them as the personification of the deity Waghoba to wealthier and more recently arrived residents who believe leopards are a hindrance to how they want to live their lives (Ghosal 2018). In all of these cases, perception of conflict can be as, if not more, important than actual physical conflict between people and wildlife (Madden 2004; Draheim et al. 2015); therefore it is important to examine the social drivers behind HWC.

While traditionally urban residents have had less support for predator control than rural residents (Reiter, Brunson, and Schmidt 1999; Martínez-Espiñeira 2006), there is a growing recognition that the situation is more complicated than it first appears. Personal experience can be important in forming attitudes towards a species. If a particular species causes an individual harm or inconvenience, negative attitudes are more likely to form (Bjerke and Østdahl 2004); this is true with coyotes in particular (Martínez-Espiñeira 2006). Although many studies have shown that urban residents tend to hold more positive attitudes towards predators than rural residents (Hook and Robinson 1982; Kellert 1987; Williams, Ericsson, and Heberlein 2002), the reality is more complex. For example, Heberlein and Ericsson (2005) found that multigenerational city residents actually held stronger negative views of wolves (and wildlife in general) than those who either lived in rural areas or urban residents who had regular experience in rural areas. Proximity of predators to urban areas also seems to be a factor (Bjerke and Østdahl 2004). Zimmermann, Wabakken, and Dotterer (2001) found that negative attitudes towards large carnivores peaked as the animals came closer to heavily human-populated areas, and then decreased over time (presumably as people adjusted to their presence). Similarly, Jackman and Rutberg (2015) found that tolerance for coyotes in an urbanized area has increased over time, while acceptance of lethal control has decreased.

Demographic variables are an important predictor of attitudes towards wildlife and wildlife management policies (e.g. Czech, Devers, and Krausman 2001; Lauber, Anthony, and Knuth 2001; Bjerke, Østdahl, and Kleiven 2003; Bjerke and Østdahl 2004; Casey et al. 2005). For example, studies have consistently found that men are more supportive of lethal control than women (e.g. Williams, Ericsson and Heberlein 2002; Casey et al. 2005). However, given the complex nature of urban and suburban residents' relationships with wildlife (Whatmore and Thorne 1998; Philo and Wilbert 2000), it is likely that there are other important variables that help account for management preferences, whether or not residents think that they can coexist with a predatory species, or even if it is worth trying to do so (Goedeke 2005; Goedeke and Herda-Rapp 2005).

Human–carnivore conflict control can, at a simplified level, be split into lethal and non-lethal methods. Non-lethal control can further be split into methods directed at wildlife, e.g. hazing (using aversive conditioning to scare coyotes away from human; White and Delaup 2012) and translocation, which can actually increase HWC in some situations (Athreya et al. 2011); and methods targeting humans, e.g. education and outreach (Skupien, Andrews, and Larson 2016; Pienaar, Telesco, and Barrett 2015) or policies restricting human activities (for example, bans on feeding wildlife). Likewise, lethal control can be split into targeted control, where individual animals associated with conflict are killed, or non-targeted lethal control, where control is aimed at the population level (Swan et al. 2017). Lethal control of predators is increasingly being seen as problematic in the conservation biology and wildlife management communities (Treves, Krofel, and McManus 2016; Bergstrom 2017). Similarly, within the for-profit nuisance wildlife management community, there have been increasing calls to examine management options including lethal control (Warburton and Norton 2009). The efficacy of lethal control has been challenged, and some studies have found little or no evidence that lethal control works to decrease HWC (McManus et al. 2015; Treves, Krofel, and McManus 2016; Stone et al. 2017; Wallach, Ramp, and O'Neill 2017), and in some cases can even increase conflict (e.g. Treves, Krofel, and McManus 2016; Wallach, Ramp, and O'Neill 2017). There can also be collateral damage to other species and the wider ecosystems when non-targeted lethal control is implemented, such as when non-targeted species are killed (Bergstrom et al. 2014).

Due to the lack of studies investigating these issues with a rigorous experimental design, there have been requests to examine the effects of lethal control (targeted and non-targeted) on HWC reduction (Lennox et al. 2018). However, the same might be true for non-lethal interventions such as hazing (Bonnell and Breck 2017; Breck, Poessel, and Bonnell 2017; Eklund et al. 2017). Because at least some segments of the general public prefer non-lethal solutions to HWC (e.g. Kellert 1987; Reiter, Brunson, and Schmidt 1999; Mitchell, Jaeger, and Barrett 2004), in many places predator control is shifting from non-targeted lethal control to a combination of targeted lethal control, killing only specific animals that display unwanted behaviors (Swan et al. 2017; DeCesare et al. 2018), and non-lethal control, including efforts to change human behavior and increase tolerance for the presence of predatory species (Sillero-Zubiri and Switzer 2004). Targeted lethal control might be more acceptable to the general public (Swan et al. 2017) and can be an effective way to reduce conflict. Swan et al. (2017) points out that selective lethal control might have to take place on a recurring basis, but this is likely true of most HWC interventions, except where physical objects are implemented such as fences (and even then, these objects need to be kept in good repair).

The case of coyotes

Coyotes are a mid-sized carnivore that can readily adapt to the fragmented habitat often found in urban settings (Tigas et al. 2003; Gehrt 2006). While listed under the IUCN as a species of Least Concern (IUCN 2016), coyotes can and do play an important role in local ecosystems, including boosting species diversity (Sovada, Sargeant, and Grier 1995; Rogers and Caro 1998; Crooks and Soulé 1999; Henke and Bryant 1999; Silverstein 2005) and limiting invasive species (Kays et al. 2015). In some places residents of urban areas perceive them as being an important threat to human health and safety (Gehrt 2004), although the risk to humans is relatively small (White and Gehrt 2009). However, humans have been bitten by coyotes, and there are other concerns residents have about the presence of coyotes in their neighborhoods, including potential harm to pets, damage

to property and simply a feeling of discomfort from knowing that they are present in their neighborhood.

Although people have long focused on coyotes for non-targeted lethal control campaigns, they are an adaptable and intelligent species that has been able to live near humans while surviving attempts to eradicate them (Bekoff 1995; Gehrt 2006), and have only increased their range over time (Bozarth et al. 2011; Hody and Kays 2018). In fact, lethal control efforts aimed at decreasing coyote populations are likely to fail (Sterling, Conley, and Conley 1983). Because coyotes immigrate from other populations, lethal control does not suppress coyote densities beyond the initial effort as there is a large pool of potential immigrants that are drawn to areas vacated by coyotes because of lethal removal. As coyote populations are widespread in both urban and rural areas, it seems unlikely that population suppression is a viable solution (Crabtree and Sheldon 1999; Hinton, van Manen, and Chamberlain 2015; Kilgo et al. 2017). Lethal control might also have the effect of otherwise destabilizing the social structure of packs in the area, which can cause a shift in the age structure of the population and an increase in the number of female coyotes breeding (Connolly and Longhurst 1975; Sterling, Conley and Conley 1983). Coyotes can even have larger litter sizes and pup survivorship when under lethal control pressure because of increased availability of food resources for breeding coyotes (Crabtree and Sheldon 1999).

Hazing and targeted lethal control are attractive coyote management possibilities in urban areas. Research conducted in the Denver metropolitan area, close to the sites in this study, has examined the efficacy of both options. For example, Breck, Poessel, and Bonnell (2017) examined both non-lethal management in the form of hazing and targeted lethal management for coyotes with a history of problematic behavior in the Denver area. They found that hazing had little or no effect when used in a reactive fashion (e.g. using it on coyotes that had already exhibited extreme behavior such as attacking people or showing aggression towards pets that were on leash), and posited that targeted lethal control might be necessary for these individuals. Although they believe that hazing can provide a feeling of security for residents and a tool to remove themselves from situations they feel are dangerous, it showed little effect on coyotes that had already displayed extreme behavior. However, proactive hazing aimed at all coyotes before extreme behavior occurs, within standard parameters of when coyotes should be hazed, can be effective.

Research questions

This study examines variation in coyote management plans from the public's perspective, and what variables, demographic and otherwise, can help explain preferences for or against lethal control. We chose two sites, Greenwood Village and Centennial, Colorado, with differing management plans and implementation processes, but that possibly share a common coyote population. Both towns were actively and publicly dealing with human–coyote conflict at the time of the study. This study was part of a larger, mixed-methods project undertaken to explore why the conflict occurred and how it is maintained, as well as the larger social issues at play that underpin the situation. This paper examines two research questions: (i) what differences between the two towns might inform the policy preferences of Centennial and Greenwood Village residents and (ii) what variables best predict an individual's level of support for lethal control? While the first question speaks specifically to the study sites, the information used to answer both will help to inform natural resource managers working in towns either developing new or revising existing coyote management plans through an examination of two jurisdictions with different experiences with coyote management. As coyotes move across the eastern coast of the USA, Central America and South America (Hody and Kays 2018), case studies such as these can provide guidance for managers in urban areas where coyote populations are newly establishing.

Human–coyote conflict in the Denver metropolitan area

The Denver Metropolitan area has been a focus of research on human–coyote conflict for several years, due in part to spikes in reports of conflict in several jurisdictions over the last decade or so, although it is unclear if there was an actual increase in conflict, or if increased media coverage or a simplification in reporting caused more people to report conflict (Poessel et al. 2013).

Between January 2003 and June 2010, Poessel et al. (2013) found that only 12.7% of coyote reports were about conflict; the rest (87.3%) of reports were of coyote sightings only. Of those, 92.4% were attacks on pets and 2.5% were attacks on humans, highlighting the importance of pets in human–coyote conflict. Of the 13 cases of attacks on humans, 6 involved pets (for example, the person was walking a dog on-leash), 4 did not and the other 3 did not offer additional information. For pet attacks, only 52.4% (247 out of 471) reports provided additional information. Of those, 45.8% of attacks occurred near a house, 20.2% were pet attacks in fenced yards and 0.8% were attacks of dogs on leash. Only 15 cases involved dogs in parks and other greenspaces, although this could be because owners of dogs who are off-leash in on-leash only areas might be less likely to report incidents. A full 55.0% of observations and 57.0% of conflicts were reported in 2009, a period of high awareness of coyotes in both Greenwood Village and Centennial (see below). It should be noted that this does not capture perceived conflict, where people might be upset with either seeing a coyote (even if they report a sighting, their feeling about seeing the coyote is unknown) or even just knowing that one is present in the area.

Human–coyote conflict in Greenwood Village and Centennial

Greenwood Village and Centennial, two adjacent suburbs outside of Denver, CO, USA, have in recent years experienced incidents that have increased awareness of human–coyote interactions. Although the two towns share a border and thus possibly interact with the same coyote population, the approaches the two towns have taken to deal with human–coyote conflicts differed significantly.

Site characteristics

Greenwood Village and Centennial, Colorado are located just south of Denver in Arapahoe County. Located in the eastern plains region, the towns share a semi-arid climate with short grasses being the predominant natural vegetation (Colorado State University Extension 2010). Both towns have extensive open space, including a shared border with a state park, and a trail system that links the open spaces together. Because of their shared borders and green spaces, it is likely that they also share a coyote population.

The two towns share similar demographic characteristics. Both towns are predominately Caucasian (87.7% for Greenwood Village and 87.3% for Centennial; U.S. Census Bureau 2011), and educational attainment is also somewhat similar (98.0% of

Greenwood Village residents have graduated from high school, and 70.6% have a Bachelor's degree or higher; in Centennial, 96.9% of the residents have graduated from high school, and 54.2% have at least a Bachelor's degree; U.S. Census Bureau 2011). However, the similarities do not extend to economic characteristics. On average, Greenwood Village residents are wealthier than their Centennial counterparts. The median family income in Centennial is $92 852, as opposed to $147 468 in Greenwood Village, and the median home value in Centennial is $289 300 compared with $757 600 in Greenwood Village (U.S. Census Bureau 2011).

Although Greenwood Village had undertaken non-targeted lethal control for years, it was only in 2007 that their program became more widely known when two domestic dogs were caught in leg-hold traps left in a local park to catch coyotes. The town's trapping license was subsequently rescinded by Tri-County Health Department after the department determined that coyotes posed no threat to humans in Greenwood Village. In February 2009, the town council amended an ordinance to allow for a private contractor and the town's police force to shoot coyotes on sight in public areas and parks, and to do the same on private property if the landowner agreed. Neither the contractor nor the police force was trained in wildlife management (Draheim 2012). Eventually, the arrangement with the private contractor was terminated and the police department was given sole authority to carry out lethal control. In March of the same year, Greenwood Village passed a coyote management plan, described below, but which did not change their management actions.

In 2008, awareness of the presence of coyotes also grew in Centennial. Centennial did not have a history of lethal coyote control, and when the town passed their own coyote management plan in 2009 it emphasized education and outreach while allowing for targeted lethal control under narrow parameters. The management plan called for both city staff and volunteers to implement programs aimed at educating Centennial residents, monitoring complaints and hazing coyotes. At the time of the study, human–coyote interactions were heavily covered in both towns through the local press, in government materials and at government meetings.

Coyote management plans

In general, Greenwood Village's official plan had a lower threshold for when lethal management could be used as compared with Centennial, and in some cases the plan sanctioned lethal control for normal coyote behaviors. Moreover, lethal control was also used unofficially in non-targeted ways, which was in keeping with their long-standing trapping program. For example, respondents in the qualitative portion of this study stated that residents circumvented the official plan by calling the police or their town council representatives directly to perform lethal control for a variety of reasons, including in one case because a residents' sleep was being disturbed because of a coyote making vocalizations nearby (Draheim 2012).

Definitions are key to any management plan, as they drive the management action. There are two significant ways that the towns' definitions of coyote-human interactions differ. Greenwood Village defines an 'incident', the lowest level of interactions, as 'an unsafe situation where a coyote displayed abnormal behavior', while Centennial defines the same as 'a conflict between a human and a coyote where a coyote exhibits behavior creating an unsafe situation for the human. Most attacks on pets fall within this definition' [underlining original]. Greenwood Village does not mention pet attacks in their plan, allowing for differing interpretations for attacks on or aggression towards pets.

The highest level of contact, an 'attack', is also defined differently by the two plans. In Centennial, to be defined as an attack, human injury or death must occur. In Greenwood Village an 'attack' occurs when there is 'an aggressive action initiated by the coyote that involves physical contact with a human', and does not require injury. Some reports of contact between humans and coyotes, often involving pets, fall into this contact without injury category, so would be categorized differently in Greenwood Village and Centennial.

The two plans also differ in how they define coyote behavior. Again, although most of the definitions are similar or identical, there is a key difference in how they define a 'menacing' coyote. In Centennial, coyotes are labeled as menacing when they display abnormal behavior that 'could potentially endanger public safety'. In Greenwood Village, the definition is similar but abnormal behavior is defined more broadly, including 'stalking or chasing people or domestic animals'.

Both of the towns state that lethal control can and should be used in cases where public safety is in jeopardy, but again there are important differences between the two. In Centennial, targeted lethal control can occur when an attack happens or a coyote displays dangerous behavior, which does not include habituated, depredating and menacing coyotes. Care must be taken to try and target the coyote displaying problematic behavior, and education and hazing must be attempted first, unless human safety is in immediate danger. In Greenwood Village, lethal control can occur when a coyote displays menacing or dangerous behavior, or if human safety is in immediate danger; as noted above, the towns' definitions of menacing behavior are different. In addition, 'a public notification/outreach plan should be part of this strategy'. In effect, what biologists might consider natural, non-aggressive displays of behavior could trigger lethal control. Although this was not necessarily the intent of the authors of the plan, this is the way the plan is often implemented (Draheim 2012).

In addition, Centennial requires that education and hazing efforts be used before lethal control is considered unless there is an immediate threat to human safety. Although Greenwood Village's plan also calls for—but does not require—education and hazing efforts, there is no requirement that other efforts must be exhausted before lethal control is implemented. When making a decision about whether or not to implement lethal control, Centennial must 'request and consider direction' from experts. In Greenwood Village, the decision lays in the hands of the Greenwood Village Police Department, leaving many local experts out of the picture.

Finally, in Centennial any lethal control that is conducted must be followed-up by an extensive education and awareness program in the neighborhoods involved, in recognition that it was likely human behavior which ultimately caused the coyote behavior change. Greenwood Village does not require such efforts, although clearly their plan does place some importance on such efforts as an initial strategy. For a further discussion of other aspects of the management plan, see Draheim (2012).

Methodology

This study is part of a larger, multi-methods study, which started with an analysis of a series of interviews and existing documents (Robson 2002; Berg 2007). Using grounded theory methodology (Charmaz 2006), the qualitative portion of the project set out to understand why people supported the

management options they did and explored what might be relevant differences between Greenwood Village and Centennial (Draheim 2012). Based on this analysis, we created a survey questionnaire to test what attitudinal and demographic characteristics predicted respondents' level of support for lethal coyote control, as well as to describe any differences between the two towns. A benefit of using grounded theory to inform questionnaire development is that question items and variables reflect on-the-ground research, making it more likely that the survey represents the reality of a particular study site (Rust et al. 2017). For the purposes of this study, since Greenwood Village was engaging in de facto non-targeted lethal control, we simplified the questions to focus on lethal vs. non-lethal control, as this was at the heart of the debate and controversy surrounding these towns (see discussion for more on this; Draheim 2012).

The questionnaire was piloted with a group of Washington, DC residents to ascertain clarity. In the fall of 2011, the revised survey was administered to Greenwood Village and Centennial residents via telephone. The survey was conducted by the George Mason University Center for Social Science Research, using the Computer-Assisted Telephone Interviewing system, *On*Q and a standardized methodology to reduce non-response rate. The telephone numbers were taken from a random sample obtained from a national vendor, and the interviewers verified that each respondent did live in one of the two towns. Respondents who did not meet these criteria were discarded. The survey was again piloted at this stage; those initial attempts were not included in this analysis.

A total of 625 completed surveys were included in this analysis, with 324 from Greenwood Village and 301 from Centennial, with a response rate of 13.8% (based on the American Association for Public Opinion Research's Response Rate #4; see AAPOR.org). Results from the *On*Q system were loaded into SPSS 20 for Mac OSX for analysis.

Demographic information requested from respondents included how many (if any) children were present in the household, dog or cat ownership, political affiliation, gender, age, racial identity, level of educational attainment, and income.

Respondents were asked questions that looked at human–coyote interactions from a variety of perspectives (see supplementary material for full questionnaire), including their awareness of the local coyote population, whether they believed individuals or local government holds the most responsibility for preventing human–coyote conflict, whether or not they believed that humans and coyotes can coexist, and whether or not coyotes belonged in their community. These questions were scored on a five-point Likert scale.

Four questions, also scored on a five-point Likert scale, were asked to determine respondents' level of concern relating to coyotes in various scenarios (concern about a coyote attacking or harming the respondent, a pet, or a child, and concern over a coyote damaging the respondents' personal property). A 'fear' scale was created to measure the level of concern each respondent felt about coyotes by using the sum of the total scores for each question for each respondent, with one equaling the least amount of fear and five the greatest amount of fear. The scale was found to be internally reliable (Cronbach's $\alpha = 0.80$), and there was no increase in reliability if any one of the items was removed.

Respondents were asked seven questions to specify under what circumstances they would call animal control, the police, or another government official if they saw a coyote in a specific area or performing a specific behavior. Both active (e.g. witnessing a coyote chasing a pet) and passive (e.g. hearing a coyote howling at night) scenarios were used. An 'act' scale was created using the sum of the responses from the seven items, with a zero representing respondents who were the least likely to call officials, and seven the most likely to call. The scale was internally reliable (Cronbach's $\alpha = 0.72$), and there was no increase in reliability if any item was removed. Respondents were also asked if they would support killing a coyote for each of the same seven scenarios, and a 'lethal' scale was similarly created, with zero indicating a respondent was least likely to support lethal control, and seven indicating he or she was most likely to support lethal control. Again, the scale was internally reliable (Cronbach's $\alpha = 0.80$), and there was no increase in reliability if any item was removed.

Survey participants were asked a series of five questions to determine their level of knowledge about coyote-human interactions and ecology. The language of these true/false statements was taken directly from Colorado Division of Wildlife outreach materials. Although we attempted to create a 'knowledge' scale, it was not internally reliable (Cronbach's $\alpha = 0.20$), and the reliability of the scale could not be improved by eliminating any of the items or by controlling for whether or not people knew coyotes lived in the area before they moved there. However, responses to individual items were retained as part of this analysis as having an understanding of what respondents know (and do not know) about human–coyote conflict as presented by the state provides important context to understanding their views on human–coyote conflict prevention and reduction.

A series of three questions was asked about coyote-proof fences, a common tool used to decrease human–coyote conflict, but one that is not allowed by many Home Owners Associations in Greenwood Village and Centennial. Respondents were asked on a five-point Likert scale how much they believed or did not believe that fences were an important tool to reduce human–coyote conflict, a yes/no question to determine whether or not they have a coyote-proof fence on their property, and a follow-up question where, if they answered 'no' to the previous item, they were asked why they did not have such a fence. An independent-samples *t*-test was performed to determine whether or not there was a significant difference in response between the two towns for the first question, while χ^2 tests were run to compare the responses of the two towns for the other two.

A 'willingness to live with coyotes' (WLC) scale was also created by using the sum of the total scores of two questions about whether or not coyotes belonged in the respondents' communities and how strongly they believed coexistence between humans and coyotes is possible. In this scale, a one indicated a respondent had little WLC, and a five indicated a respondent had great WLC. The scale was internally reliable (Cronbach's $\alpha = 0.73$).

A step-wise multiple regression was performed to look at what variables best predicted the strength of respondents' support for lethal coyote control, using the lethal scale as the dependent variable. We tested whether or not respondents had any children, and, if so, children broken into age categories: 5 and younger, 6–12, and 13 years and older. We also tested for dog and cat ownership, political beliefs, educational attainment, income, age, gender, Act scale scores, WLC scale scores and Fear scale scores, the preferred role of government vs. individuals, and town residency. We also included a knowledge question concerning the effectiveness of eradication programs.

Regression assumptions were tested by examining normal probability plots of residuals versus predicted residuals. Only respondents who answered all items used in the model were used ($n = 272$). No violations of normality, linearity, or homoscedasticity of residuals were detected. The independent variables' collinearity tolerance and VIF statistics were also examined in order to determine any multicollinearity problems with the model. The values for both the tolerance and VIF tests were well within expected ranges: the lowest tolerance statistic was 0.72, while the highest VIF statistic was 1.47, demonstrating that none of the independent variables were highly correlated with each other.

Results

Demographic information

The respondent population was fairly mature, with 6.4% of respondents between the ages of 18 and 34 years old, 11.4% between 35 and 44 years old, 52.5% between 45 and 64 years old, and 29.7% 65 years old or older; there was no significant difference in this age dispersal between the two towns ($P = 0.17$).

A 44.7% of respondents had children, and more Greenwood Village respondents had children than Centennial respondents (52.4% vs. 36.4%, Pearson's χ^2 13.48, $P < 0.01$). Of those who did have children, the most common age categories were between 6 and 12 (19.5% of respondents) and 13 and older (32.1% of respondents). More respondents in Greenwood Village had children thirteen and older than Centennial respondents (39.3% vs. 24.1%; Pearson's χ^2 13.87, $P < 0.01$). A slight majority of respondents owned a dog (57.7%), and more Greenwood Village respondents owned dogs than Centennial respondents (63.6% vs. 51.4%; Pearson's χ^2 8.02, $P < 0.01$). Most respondents (78.1%) did not own a cat, and there was no significant difference in cat ownership between the two towns.

Most respondents were female (61.5%; no significant difference between the two towns), Caucasian (93.6%) and not Hispanic (97.5%; no significant difference between the two towns). This is similar to the US 2010 census data which showed that 87.7% of Greenwood Village and 87.3% of Centennial residents were Caucasian. A majority of respondents had either Bachelor's or Associate's degrees (39.0%) or graduate or professional degrees (42.1%). More Greenwood Village respondents had graduate or professional degrees than Centennial respondents (48.7% vs. 35.1%; Pearson's χ^2 13.72, $P < 0.01$), again tracking with census data showing that educational attainment was higher in Greenwood Village, although both towns were relatively well-educated. According to 2010 census data, 72.3% of Greenwood Village residents held bachelor's degrees or higher, compared with 54.2% of Centennial residents.

Greenwood Village respondents were more likely to have higher incomes than Centennial residents, with 54.8% of Greenwood Village respondents having incomes exceeding $150 000 compared with 16.5% of Centennial respondents making the same income (Pearson's χ^2 60.122, $P < 0.01$). Census data showed income disparities between the two suburbs as well. The US 2010 census data show that 39.5% of Greenwood Village residents had household incomes of $150 000 or more, compared with only 19.1% in Centennial.

A slight majority of respondents considered themselves to be Republican (31.3%), while 25.7% called themselves Democrats, 29.4% called themselves Independents, 3.3% considered themselves Libertarians and 13.6% selected other; there was no significant difference between the two towns ($P = 0.50$). On the spectrum between liberal to conservative, 28.1% of respondents stated that they were liberal, 34.4% said that they were moderates and 37.5% said that they were conservative; there was no significant difference between the two towns ($P = 0.24$).

Awareness of coyotes

Most respondents from both towns knew that coyotes lived in the area before they moved there (Greenwood Village = 63.6%; Centennial = 63.0%). More Greenwood Village residents stated that they had seen coyotes on their property (74.1% vs. 44.5%; $t_{(528)} = 7.259$, $P < 0.01$), had seen coyotes in their community (92.3% vs. 85.5%; $t_{(526)} = 2.54$, $P < 0.05$), and that people in their neighborhood have had pets attacked by coyotes (76.9% vs. 51.9%; $t_{(450)} = 5.76$, $P < 0.01$) as opposed to Centennial residents.

Political responsibility, belief in coyote residency and coexistence

Respondents were asked whether they believed addressing human–coyote conflict was the responsibility of residents or of local governments. Most respondents felt the responsibility was shared equally between individual residents and the local government (48.0%). There was no significant difference between the two towns ($P = 0.16$).

Respondents' opinions were varied about whether or not coyotes belonged in their neighborhood (Table 1), with 42.6% strongly or somewhat believing that coyotes belonged in their neighborhood, 18.4% remaining neutral and 39% somewhat or strongly disagreeing. Most respondents either strongly agreed (45.6%) or somewhat agreed (31.7%) with the statement: 'I believe that people and coyotes can coexist'. The WLC Scale (Cronbach's $\alpha = 0.73$) had a minimum possible score of one (indicating a strong WLC) and a maximum possible score of five (indicating no WLC) (mean = 3.48, SD = 1.19, median = 3.5, skewness value = 0.60, SE = 0.11).

Fear, willingness to act and lethal scales

Respondents were most concerned in decreasing order about: (i) coyotes attacking pets (55.8% of respondents somewhat or strongly agreed); (ii) coyotes attacking children (55.0% of respondents somewhat or strongly agreed); (iii) coyotes attacking the respondent (24.5% somewhat agreed or strongly agreed); and (iv) coyotes damaging personal property (7.6% somewhat or strongly agreed) (Table 2). The scale (Cronbach's $\alpha = 0.80$) had a minimum score of one (indicating the least amount of fear) and a maximum of five (indicating the greatest amount of fear) (mean = 2.54, SD = 1.11, median = 5.5, skewness value = 0.23, SE = 0.11). There was no significant difference between the two town's fear scale scores ($P = 0.14$).

The Act scale (Cronbach's $\alpha = 0.71$) had a minimum possible score of zero (indicating they were the least likely to call officials about coyotes) and a maximum possible score of seven (indicating they were the most likely to call officials about coyotes; mean = 2.92, SD = 1.5, median = 3.00, skewness = 0.47, SE = 0.11). Respondents were most likely to call the authorities if they: (i) saw a coyote biting a person (91.0%); (ii) saw a coyote in an area where children were playing (79.8%); (iii) saw a coyote chasing a pet (62.3%); (iv) saw a coyote on their property (30.9%); (v) heard a coyote howling at night (8.8%); (vi) saw a coyote near a road (8.2%); and (vii) saw a coyote chasing a rabbit (7.4%) (Table 3). There was no significant difference in Act Scale scores

Table 1: Willingness to live with coyotes

To what extent do you agree with the following statement:	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Coyotes belong in your neighborhood	22.7%	16.3%	18.4%	26.3%	16.3%
I believe that people and coyotes can coexist	8.8%	7.2%	6.7%	31.7%	45.6%

Items used to create WLC scale. Cronbach's α=0.73. One = less willingness to live with a coyote, five = more willingness to live with a coyote. Mean = 3.48 (SD = 1.19), a median of 3.5 and a skewness value of 0.59 (SE = 0.11).

Table 2: Fear scale scores

Rank	Prompt: I worry about a coyote...	Response					Mean (SD)
		Strongly disagree	Somewhat Disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	
1	Attacking or harming a pet	23.3% (*n*=120)	12.5% (*n*=64)	8.4% (*n*=43)	24.9% (*n*=128)	30.9% (*n*=159)	3.28 (1.57)
2	Attacking or harming a child	21.6% (*n*=111)	18.3% (*n*=94)	5.1% (*n*=26)	23.3% (*n*=120)	31.7% (*n*=163)	3.25 (1.58)
3	Attacking or harming me	50.8% (*n*=261)	19.3% (*n*=99)	5.4% (*n*=28)	16.3% (*n*=84)	8.2% (*n*=42)	2.12 (1.39)
4	Damaging my property	70.8% (*n*=363)	17.3% (*n*=89)	4.3% (*n*=22)	4.3% (*n*=22)	3.3% (*n*=17)	1.52 (1.00)

Cronbach's α=0.80. One = least amount of fear, five = greatest amount of fear (mean = 2.54 (SD = 1.11), median = 2.5, skewness = 0.228, SE = 0.11).

Table 3: Willingness to act scale

Rank	Prompt	Response	
		Yes	No
	I would call animal control, the police, or another government official if I...		
1	Saw it biting a person	91.0%	9.0%
2	Saw it in an area where children are playing	79.8%	20.2%
3	Saw it chasing a pet	62.3%	37.7%
4	Saw it on my property	30.9%	69.1%
5	Heard it howling at night	8.8%	91.2%
6	Saw it near a road	8.2%	91.8%
7	Saw it chasing a rabbit	7.4%	92.6%

Cronbach's α=0.71. Zero = least likely to call officials, seven = most likely to call officials (mean = 2.92 (SD = 1.5), median = 3.00, skewness = 0.47, SE = 0.11).

between Centennial and Greenwood Village respondents ($P = 0.86$).

Similar to the Act Scale, the Lethal scale (Cronbach's $\alpha = 0.80$) had a minimum score of zero (indicating least likely to support lethal control and a maximum score of seven (indicating most likely to support lethal control; mean = 1.72, SD = 1.61, median = 1.00, skewness value = 1.16, SE = 0.10)). The situation where people were most likely to support lethal control was if they: (i) saw a coyote biting a person (91.0%); (ii) saw a coyote in an area where children were playing (48.1%); (iii) saw a coyote chasing a pet (42.1%); (iv) saw a coyote on their property (14.1%); (v) heard a coyote howling at night (7.6%); (vi) saw a coyote chasing a rabbit (4.6%); and (vii) saw a coyote near a road (4.2%) (Table 4). An independent-samples *t*-test determined that Greenwood Village residents demonstrated greater support for lethal control than Centennial residents ($t_{(450)} = 3.10$, $P < 0.01$). In terms of individual items within the scale, there was a significant difference between respondents in the two towns in four cases. Greenwood Village respondents were more likely to support lethal control if they heard them howling at night (10.3% Greenwood Village vs. 4.7% Centennial; $t_{(523)} = 2.40$, $P = 0.02$), if they saw one on their property (17.3% vs. 10.8%; $t_{(515)} = 2.10$, $P = 0.04$), if they saw one chasing a rabbit (7.4% vs. 1.6%; $t_{(521)} = 3.19$, $P < 0.01$) and if they saw one near a road (6.3% vs. 2.0%; $t_{(523)} = 2.45$, $P = 0.02$).

Knowledge

The majority of respondents answered each of the five knowledge questions correctly. Independent-samples *t*-tests demonstrated that there was a significant difference in response between the two towns for one of the items: more Greenwood Village residents erroneously believed that coyote eradication programs in North American cities have proven to be effective than Centennial respondents (31.4% Greenwood Village respondents vs. 23.0% Centennial respondents; $t_{(433)} = -1.99$, $P = 0.05$).

Fences

Respondents were asked if they felt that coyote-proof fences were important in reducing human–coyote conflict. About an equal number of respondents believed that fences were an important tool, with 44.6% of respondents somewhat or strongly agreeing and 43.3% of respondents somewhat or strongly disagreeing (12.0% of respondents neither agreed nor disagreed). Most respondents (66.3%) did not have a coyote-proof fence at their residence, and more Centennial respondents (41.9%) had coyote-proof fences than Greenwood Village respondents (26.0%; $P < 0.01$). If a respondent stated that he or she did not have a coyote-proof fence, he or she was then asked why this was the case; a majority of respondents stated that they either did not want such a fence (36.4%) or that they lived in a neighborhood where they were not allowed to have such a fence (30.9%; Table 5).

Multiple regression model

Stepwise multiple regression analysis revealed that five variables significantly predicted support for lethal control: gender (men were more likely to support lethal control than women; $t = 4.258$,

Table 4: Lethal scale

Rank	Prompt	Response: Yes	Response: No
	I would support killing a coyote if I . . .		
1	saw it biting a person	91.0%	9.0%
2	saw it in an area where children are playing	48.1%	51.9%
3	saw it chasing a pet	42.1%	57.9%
4	Saw it on my property[a]	14.1%	85.9%
5	Heard it howling at night[a]	7.6%	92.4%
6	Saw it chasing a rabbit[a]	4.6%	95.4%
7	Saw it near a road[a]	4.2%	95.8%

Cronbach's α=0.80. Zero=least likely to support lethal control; seven=most likely to support lethal control (mean = 1.72 (SD=1.61), median=1.00, skewness value=1.16, SE=0.10).

[a]Items where there was a significant difference ($P < 0.05$) between respondents in Greenwood Village and Centennial; Greenwood Village residents were more likely to support lethal control in those cases.

Table 5: Why respondents do not have coyote-proof fences

Reason	Percentage
I do not live in a single-family house or townhouse.	6.1% (n=21)
I do not want such a fence.	36.4% (n=125)
I do not have the resources to build such a fence.	5.0% (n=17)
My homeowner's association or neighborhood regulations do not allow for such fences.	30.9% (n=106)
Other	11.8% (n=74)

$P < 0.01$), Act scale scores (being willing to call authorities in situations predicted more support of lethal control; $t = 5.245$, $P < 0.01$), WLC scale scores (not being willing to live with coyotes predicted more support for lethal control; $t = -6.957$, $P < 0.01$), Fear scale scores (having more fear of coyotes predicted more support for lethal control; $t = 3.667$, $P < 0.01$), and town residency (Greenwood Village residents were more likely than Centennial residents to support lethal control; $t = 3.821$, $P < 0.01$).

Variables that were tested but that were not found to be significant predictors were whether respondents believed it was the role of individuals or the government to deal with human–coyote conflict (Q6); whether or not respondents believed that eradication programs in urban areas work; whether respondents had any children, children 5 and younger, children 6–12, or children 13 and older; dog and cat ownership; political beliefs, educational attainment; income and age (Table 6).

Table 6: Stepwise regression predicting support for lethal control (n= 272)

	B	SE B	Beta	t
Constant	1.854	0.404		4.585
Fear scale score	0.249	0.068	0.169	3.667
Act scale score	0.275	0.052	0.246	5.245
WLC scale score	−0.462	0.066	−0.336	−6.957
Gender	0.578	0.136	0.173	4.258
Town residency	0.503	0.132	0.154	3.821

Total R^2=0.399, $F(9, 257)$=12.20, $P < 0.01$.

Discussion

Our model found five variables that were significant predictors of support for broad non-targeted lethal control measures. We are defining these preferences as for non-targeted lethal control measures (as opposed to targeted) for four reasons: (i) Greenwood Village had a history of non-targeted lethal control, including using leghold traps; (ii) Greenwood Village's management plan at times targeted coyotes displaying natural behaviors for lethal control; (iii) informal non-targeted lethal management was ongoing in Greenwood Village at the time of the study; and (iv) some of the items on the lethal scale asked respondents whether or not they would support killing coyotes under conditions where coyotes were present but not actively causing conflict or interacting with humans (hearing one howling at night, and seeing one chasing a rabbit or near a road). Greenwood Village respondents were more likely to support lethal control under those three conditions, none of which would prompt lethal control from management plans that utilized only targeted lethal control such as Centennial's.

The model demonstrated that significant predictors as to whether or not a respondent would support lethal control include fear of coyotes (the Fear scale, $B = 0.25$); a desire to involve authorities under more situations, including the same variables mentioned above that involve seeing or hearing coyotes where no conflict is occurring (the Act scale, $B = 0.28$); a belief that it is possible for humans and coyotes to coexist and that coyotes belong in communities (the WLC scale, $B = -0.46$); gender ($B = 0.59$); and town residency ($B = 0.50$).

Those who deal with urban wildlife issues professionally might field questions from their constituents about whether or not coyotes actually belong in their neighborhoods, and whether or not they can be eradicated. Being a relatively large carnivore with a history of predation on pets and occasionally hurting people, the idea that coyotes live in their neighborhoods can be alarming to some members of the public. Some urban residents believe that wildlife, beyond perhaps favored species such as songbirds, does not belong in human-dominated landscapes like urban and suburban areas (Philo and Wilbert 2000). Coupled with specific concerns about a predator living near them, this worldview might prompt people to question whether or not they can get rid of wildlife they find undesirable and out of place. On the other hand, some residents find great enjoyment in sharing their neighborhoods with animals like coyotes, and still others enjoy the idea of it but have specific concerns about living close to this species. Given this breadth in opinion, it is not surprising that belief about whether or not wildlife belongs in the respondents' neighborhoods was part of the WLC scale, which was a significant predictor of support for lethal control ($B = -0.46$).

Although most respondents believed that people and coyotes can coexist (the other questionnaire item that made up the WLC scale), 'coexistence' was not defined in the questionnaire. It is possible that people have different definitions of this concept, with perhaps some believing that coexistence is possible as long as problem coyotes are removed. However, the definition of a 'problem coyote', and what behaviors that coyote displays, varies greatly. Further research into the question of how people define coexistence in this context could be interesting and useful.

Gender was also a significant predictor in the model. Men were more supportive of lethal control than women, which is a relatively common finding in the literature (e.g. Williams, Ericsson, and Heberlein 2002; Casey et al. 2005). It is notable that

gender was the only demographic variable that was a predictor in the regression model. This suggests that characteristics beyond simple demographics such as education and income are more relevant in predicting preferences for coyote management; future research using qualitative and quantitative methods should explore this.

The fact that there was more support for lethal control of coyotes among residents in Greenwood Village than in Centennial, and that significantly more residents of Greenwood Village believed that coyote eradication programs in North America have been effective, could demonstrate that support for non-targeted lethal control in some instances is tied to a misguided belief in its effectiveness. Outreach efforts to dispel this misconception might be effective in creating public support for non-lethal control methods. This could be more akin to an advertising or marketing campaign—where basic preferences for lethal vs. non-lethal control are targeted—than to a campaign that attempts to change the underlying values, attitudes and beliefs often associated with those preferences. While this might not change hearts and minds quickly, persuasively-presented facts might move the management preferences of those on the fringe of opinion towards non-lethal options (Messmer, Reiter, and West 2001). In other words, it might be that with the right information (e.g. an increased understanding that lethal control does not reduce human–coyote conflict), and the right motivation (e.g. not wanting a coyote to come into conflict with an individual), those with weaker beliefs about coyotes and coyote management might be persuaded to support effective management strategies. In this case, achieving the desired objective of reducing public desire for ineffective non-targeted lethal control would not require a personal cost, monetary or otherwise, to the public, which is often cited as a reason that many conservation outreach programs do not work (Schultz 2011).

Fences are an imperfect tool, as coyotes have been known to find ways over them (Draheim 2012), but one study on urban coyotes in Canada found that coyotes were 66 times less likely to be found in backyards surrounded by fences, demonstrating their potential importance (Murray and St. Clair 2017). Although most respondents did feel that coyote-proof fences could be an important tool to reduce human–coyote conflict, most respondents did not have such a fence on their property. However, significantly more Centennial residents had coyote-proof fences than people who live in Greenwood Village; an increase in the number of residences that have such fences might decrease conflict. Most people who did not have a coyote-proof fence simply did not want one, but a significant number lived in a neighborhood where homeowners' associations (HOAs) or neighborhood regulations did not allow such fences to be built (several neighborhoods do not allow backyard fences even though the yards open onto parkland; personal observations). Changing these regulations is likely to be a difficult endeavor in some neighborhoods, but doing so could be a valuable step towards reducing human–coyote conflict. Not allowing for fences on properties that border nature preserves and other green spaces might be an indication that some HOAs are not sensitive to conservation and wildlife issues, so programs that seek to find effective ways of working with HOAs might be effective.

On the other hand, changing behaviors related to pets could reduce some conflict usually prevented or reduced by coyote-proof fences without the need to build a fence. For example, if small dogs and cats are not left outside unsupervised, especially at night, coyotes would not be able to prey on them regardless of whether or not there is a suitable fence in place. Although the survey described coyote-proof fences as being at least six feet tall with no spaces large enough for a coyote to fit through, there have been reports in the area of coyotes getting over fences that tall. Adding the so-called 'coyote rollers', comprised of a pipe that can roll freely on the top of a fence to prevent coyotes from getting over a fence, would make these fences even more effective, but might face more concerns because of added expense and aesthetic preferences. In general, the expense of building, installing and maintaining fences might be too difficult of a barrier to overcome in some cases. Some residents might also feel that building a fence around their backyard might be seen as not neighborly or otherwise unfriendly. The use of fences, then, should be further investigated from both an ecological perspective (do they work, and how can we make them more effective) and a socio-cultural perspective (what are the social barriers to using them, and what strategies might overcome these barriers).

The understanding that responsibility for dealing with human–coyote conflict lies with individuals or local governments was not significantly different between the two towns; most respondents felt it was equally the responsibility of individuals and the government, and this item was not a significant predictor in the multiple regression model. This was surprising, based on the results from the qualitative research conducted prior to this survey (Draheim 2012). Many of the people interviewed in the first phase of this study stated that they believed people who supported lethal control were more likely to feel that dealing with human–coyote conflict was the responsibility of the government and not individuals. This variable was captured in only one item in the survey, so it is possible that the single question did not adequately capture the complexity of this idea. Alternatively, it is possible that this is a misconception held by study participants. Future research should explore this question further as there are potential impacts on best practices for outreach and education materials; for example, Rodgers and Pienaar (2017) found that reinforcing the fact that protecting livestock from Florida panthers (*Puma concolor coryi*) was the responsibility of livestock owners might be a useful message in reducing human–Florida panther conflict.

Finally, more Greenwood Village respondents stated that they had seen coyotes on their property, in their community, and that people around them have had pets attacked by coyotes than Centennial respondents. Ecological fieldwork that looks more precisely at habitat use in the two towns might be useful in untangling whether or not this was because coyotes were more likely to be seen and hunt or attack pets in Greenwood Village, or if Greenwood Village respondents were primed to notice coyotes and be more reactive because of the larger controversy going on at the time.

This study adds to our body of knowledge by comparing two suburbs that border each other and presumably share a coyote population through connections in parks and other greenways, and yet have different management policies, both formal and informal. For the purposes of this study, the informal management in Greenwood Village is as relevant as the formal management plan. Based on interviews and other qualitative research conducted in 2010–1 we found that the management plan was often set aside, with residents seeking out Greenwood Village officials and asking for coyotes to be killed for a variety of reasons not specified in the management plan. Greenwood Village was very sensitive to residential wants and needs (Draheim 2012), so it is perhaps not surprising that the management plan was informally modified to address their concerns. Comparing

Centennial with Greenwood Village offers some insight into how and why non-targeted lethal control is preferred, which can offer wildlife managers, animal control officers and others charged with dealing with human–coyote conflict some guidance into how to navigate the social complexity that generally surrounds conflict with predators. This might be especially beneficial to jurisdictions that have yet to create formal or codify informal management plans. Many cities and towns on the east coast, particularly in the mid-Atlantic region, have not yet run into enough negative human–coyote interactions to react by creating such plans, and the same is true in parts of Central and South America. In addition, such insights can also benefit places where there is a need or a call to modify existing plans.

Research into the more nuanced differences between different jurisdictions in other urban areas is called for, especially as wildlife populations in many urban and suburban areas are managed in multiple cities and towns, making consistent management difficult. All of this also makes it difficult if not impossible to understand what management methods are best achieving stated goals. If urban wildlife is to be managed at a landscape level, understanding the drivers and motivations of multiple publics is important. At the same time, capturing informal management, which might include officials circumventing the official plan, nuisance animal control companies hired by residents, or residents undertaking management themselves, is important in order to gain a greater understanding of what is actually happening in urban and suburban landscapes. Qualitative research that goes beyond obtaining official records can be useful in this respect.

While changing attitudes is important in the long-term, in order to prevent and mitigate HWC in the short-term it might be beneficial to look at behavioral change strategies such as community-based social marketing (McKenzie-Mohr 2011; Schultz 2011) in order to change behaviors that are directly linked to conflict. In urban areas, this might include keeping anthropogenic food secured in backyards and keeping large dogs on-leash (Poessel et al. 2013; Murray and St. Clair 2017).

Presenting factual information in an effort to change management preferences away from ineffective lethal control can be trickier than it might seem. A wealth of communications research has highlighted several important lessons that the conservation community can use when creating outreach materials (McKenzie-Mohr 2011). For example, research in the public health field has a robust literature about how to persuade people of the facts surrounding public health issues such as vaccination. One common strategy to dispel myths is to use a 'myth/fact' format, where something that is not true is cited as being a myth, and a follow-up statement provides the truth. However, these messages are prone to the 'backfire effect' (Skurnik et al. 2005; Skurnik, Yoon, and Schwarz 2007; Peter and Koch 2016), where the myth is in fact reinforced rather than dispelled. Following this advice, materials that say that lethal control of coyotes does not reduce conflict are likely to be ineffective or even backfire. It might be more effective to include positive messages such as 'One of the best ways to reduce human–coyote conflict is to stop feeding coyotes, intentionally or unintentionally'. (When coyotes start to associate food with people, they can become food conditioned, which can lead to conflict over time as coyotes become bolder and seek out humans as a supply for food; Conover 2002.)

One potential limitation of this study is that we did not explicitly explore the role emotions play in human–coyote conflict. Although emotions were clearly an important factor in the qualitative portion of this study, the strongest emotions were directed not at coyotes or the interactions between humans and coyotes, but about those people whom with they disagreed on this issue—to be very general, between those who supported lethal control in Greenwood Village and those who did not (Draheim 2012). Therefore, we did not include affective variables in the questionnaire. However, it is increasingly clear from the literature that emotions play an important role in humans' reactions, beliefs and attitudes towards wildlife (Hudenko 2012; Jacobs 2012; Jacobs, Vaske, and Roemer 2012; Slagle, Bruskotter, and Wilson 2012; Sponarski, Vaske, and Bath 2015; Frank et al. 2016), and the potential role of emotions in driving support for non-targeted lethal control should be explored in future research. Future research on emotions should focus not only on emotions towards wildlife and HWC, but also affective feelings towards the people involved in HWC.

In addition, although the benefits of coyotes came up in some of the interviews for the qualitative portion of this study, it was not a constant thread and so was not included as a tested variable in the questionnaire. However, several studies have shown that describing the benefits predators bring to local ecosystems can increase tolerance, so messages about benefits might be persuasive (Zajac et al. 2012; Slagle et al. 2013; Skupien, Andrews, and Larson 2016). In the future, further investigation on the role that persuasive messages describing the benefits of urban coyotes to urban ecosystems would be useful in further developing best practices for such messages. Also, although our study did not address this issue, managers might want to take into consideration the ethical implications of their management decisions, an aspect of management that has become of increasing scrutiny both within the field and by the public (Bekoff 2013; Dubois and Harshaw 2013; Warburton and Norton 2009).

Finally, the response rate for this survey was low, which is increasingly a problem in telephone survey research (Davern et al. 2010). Although response rates are commonly used as an indicator for potential bias, in fact there is no clear link between response bias and response rate (Groves 2006; Davern et al. 2010; Davern 2013). Multi-mode survey collection (e.g. door-to-door and mailed surveys) might reduce bias more than pursuing an increased response rate (Davern et al. 2010). However, response bias is a real concern in any survey work. Davern (2013) offers some suggestions to test for bias. One suggested method is to compare the survey sample to the population in some key variables, which we have done here in terms of demographic variables. Other options that could be used to further examine potential response bias include replicating the survey or conducting additional on-the-ground qualitative work such as focus groups.

Conclusion

Greenwood Village and Centennial provide an interesting case study of an urban/suburban location where the use of lethal control was being debated and human–coyote conflict, real and/or perceived, was active. As the need for urban and suburban wildlife management grows, managing at the landscape scale—not just per jurisdiction—is increasingly important. Ideally, metropolitan areas would be able and willing to coordinate their actions, using adaptive management to achieve agreed-upon goals. However, differing public perceptions of both problems and solutions in different jurisdictions can make this difficult. In addition, wildlife duties are sometimes split between different agencies, at times including those that are not trained in wildlife issues.

Finally, both formal and informal management might be taking place, at both the governmental and residential level (for example, through nuisance animal control companies). When exploring management on a landscape scale, being aware of these potential differences and complications can help inform how wildlife professionals do their work.

This study demonstrates that specific beliefs and attitudes are important predictors in determining the likelihood that someone will support broad-based lethal control. As such, those individuals demonstrating such traits would likely make good targets for outreach efforts. In addition, understanding how people make use of local green spaces and their own yards, as well as identifying potential barriers to people modifying their property so as to reduce conflict, by, for example, installing a fence in areas pets are let off-leash, can inform managers' goals and actions.

Many of the underlying motivations for the actions taking place in Greenwood Village would not have been known without the qualitative portion of this study; examining official policies do not tell a complete story. Additionally, some of the variables would not have been tested in this survey if not for the qualitative research done before the questionnaire was written. Although requiring more time and effort to produce interdisciplinary work, integrating qualitative methods with quantitative in cases such as HWC provide a more comprehensive picture of the complex socio-cultural conditions present at a study site and invariably lead to more effective policy actions (Rust et al. 2017).

Supplementary data

Supplementary data are available at *JUECOL* online.

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