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Emotions and political identity predict public acceptance of urban deer management

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Abstract

Addressing public preferences can enhance wildlife management effectiveness and reduce backlash. We conducted novel research on public acceptance of wildlife management by accounting for the role of underexplored drivers including emotion and political identity across an urban-to-rural gradient. Using data from a 2022 survey about white-tailed deer (*Odocoileus virginianus*) in Durham County, North Carolina, we analyzed drivers of acceptance for three management strategies: passive management, lethal management by hunting, and lethal management by professionals. Support for deer management varied across the urban-to-rural gradient, as rural residents favored hunting but were less supportive of passive management compared to urban and suburban residents. Emotions and general attitudes toward deer were the strongest predictors of management acceptance. Support for passive management was higher among residents with more positive emotions toward deer, whereas support for lethal strategies was higher among those with more negative emotions. Additionally, political identity emerged as a complex yet influential factor in shaping support for lethal management. Conservative respondents exhibited a higher acceptance of hunting, whereas liberal respondents exhibited a higher acceptance of professional sharpshooting. Collectively, our results demonstrate the ways in which emotions, politics, and other socio-demographic factors interact to influence public support for deer management across the urban–rural gradient. When direct experience with wildlife is lacking (e.g., in urban areas), emotions may act as heuristic guides that shape preferences. Managers aiming to increase deer management acceptability could integrate insights about emotional, political, and demographic drivers of public management support in communication efforts, potentially rendering urban deer management more effective.

Keywords Public preference · Political ideology · Wildlife acceptance · Tolerance · Urban wildlife · White-tailed deer · Wildlife management · Emotions

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Introduction

Urbanization makes wildlife conservation and management more difficult for several reasons. Urbanization fragments the landscape (Liu et al. 2016), changes which wildlife species persist in a place (McKinney 2002), brings some wildlife into closer contact with people (Magle et al. 2012), and makes wildlife management, and lethal management in particular, more challenging (Urbanek et al. 2012). In addition to ecological considerations, wildlife management is also shaped by sociocultural and political factors and forces (Bennett et al. 2017; Patterson et al 2003. These human drivers of wildlife management become more prominent in urban areas, where complex municipal governance processes typically make decision-making more difficult than in rural environments, with regulations including zoning and

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weapon discharge prohibitions (Corburn 2009; McCance et al. 2017). Further, lethal management is often met with strong resistance from urban residents based on ethical and safety concerns (Boulanger and Curtis 2016; Kilpatrick and LaBonte 2003; West and Parkhurst 2002). Attitudes toward wildlife management are typically highly polarized in urban areas due to conflicts over development, private property rights, and hunter access (Porter 1997). Decreasing parcel size and greater housing density make hunting access difficult, with challenges related to landowner permission and leasing (Burke et al. 2018; Harden et al. 2005), or even illegal due to firearm discharge limitations (Williams et al. 2013) or specific municipal ordinances prohibiting hunting of any kind. Safety concerns about hunting are high among suburban and urban landowners and are often cited as a top reason for restricting hunting access on their property (Siemer et al. 2016).

One particularly challenging urban wildlife species is white-tailed deer (*Odocoileus virginianus*; hereafter referred to as deer). Deer have become a significant concern in suburban and urban areas, impacting various aspects of human life and negatively affecting ecosystems. Urban deer provide an important urban wildlife management case study for several reasons. In North America, deer are tolerant of urbanized landscapes, becoming overabundant in many suburban and exurban areas (Westerfield et al. 2019), potentially because of the lack of predators and abundant food (Urbanek and Nielsen 2013). Additionally, low rates of hunting pressure from humans limit the harvest of urban deer, facilitating rapid population growth and high densities (Jones and Witham 1990; Burke et al. 2018; Kilpatrick et al. 2011). Nearly all (97%) U.S. wildlife biologists considered overabundant urban deer populations to be a problem in their state (Urbanek et al. 2011). Negative interactions between people and deer include deer-vehicle collisions (DVCs), the spread of zoonotic tick-borne diseases, and damage to gardens and ornamental plantings (DeNicola et al. 2000). In 2008, 2.1 million deer-vehicle collisions occurred in the United States annually, resulting in over $10 billion in economic losses (Huijser et al. 2008), 59,000 human injuries, and 440 human deaths (Warren 2011), and those rates tend to increase as deer density increases (Hothorn et al. 2015; Etter et al. 2000). In addition, there is a positive correlation between increased deer populations and tick abundance, increasing associated risks of contracting Lyme disease and other tick-borne pathogens (Stafford et al. 1998; Stafford et al. 2003). A majority of tick bite reports originate from suburban homeowners' yards (Stafford et al. 2017), with deer movement into residential zones contributing to greater exposure to tick-borne disease for humans (Roden-Reynolds et al. 2022). Deer-caused damages extend to gardens and ornamental plants, with Williams et al. (2006) estimating that in 2006, deer caused $1.5 – $2.0 million in direct damages to plants at nurseries and garden centers within Connecticut alone.

Given these challenges, especially for species like deer, scholars have begun exploring drivers of public tolerance for lethal wildlife management options in urban areas (Conejero et al. 2019; Lauber and Brown 2006; McCleery 2009). Urban and suburban residents are typically less accepting of lethal management options than rural residents (Koval and Mertig 2004; Drake et al. 2020; Heneghan and Morse 2019). These trends may reflect shifting wildlife value orientations (WVOs) because individuals with a mutualistic orientation are less supportive of actions resulting in death or harm to wildlife, and mutualistic orientations are more prevalent among urban residents than rural residents (Manfredo et al. 2021). Gender often predicts support for lethal management and is linked to WVOs, with women being approximately 20% less accepting of lethal strategies than men (Manfredo et al. 2021; Dougherty et al. 2003). Age has also been positively related to the support of lethal wildlife management (Clark et al. 2017; Menale et al. 2023). Additionally, lethal management acceptance tends to increase with the perceived severity of wildlife-related problems that a resident faces (Connelly et al. 1987; Messmer et al. 1997; Curtis and Lynch 2001; Urbanek and Nielsen 2013). Urban residents consistently show the highest support for non-lethal wildlife management strategies, including contraception, trap-and-relocate, and education for living with wildlife (Urbanek et al. 2012).

Emotions may be a particularly important, yet poorly understood, driver of public perceptions of wildlife management because they provide a common heuristic humans use to make decisions, especially when those decisions reference issues outside daily life experiences (Stinchcomb et al. 2023). In this context, emotions are defined as affective responses individuals experience when encountering wildlife, which can range in intensity and valence (e.g., positive to negative). For example, feelings of calm would be less intense and positive, whereas feelings of anger would be more intense and negative. Although attitudes towards wildlife have an affective component (i.e., general positive evaluation or negative evaluation of something), discrete emotions in a response to a specific stimulus, such as a wildlife encounter, are purely affective. Emotions have been recognized as a central aspect of human-wildlife interactions (Jacobs and Vaske 2019; Castillo-Huitrón et al. 2020), yet their role in shaping wildlife management preferences remains understudied.

However, some research has highlighted the potential role of emotions in shaping human-wildlife interactions. Feelings of anger (a negative emotion) and sympathy (a positive emotion) towards species such as wolves (*Canis lupus*; Slagle et al. 2012; Vaske et al. 2013) and invasive house sparrows (*Passer domesticus*; Larson et al. 2016)

explained substantial variance in residents' perceived acceptability of lethal management actions where negative emotions often led to increased acceptance of lethal actions. Similar trends may apply to deer. Stinchcomb et al. (2023) reported that anticipated emotions influenced the relationship between general attitudes toward deer and lethal control acceptability under multiple deer encounter scenarios. Specifically, a hypothetical encounter with a visibly diseased deer elicited predominantly negative emotions, increasing support for lethal management strategies (Stinchcomb et al. 2023). Building upon earlier qualitative research, these findings indicate that emotions can mediate normative judgments about deer management toward acceptance of lethal control measures (Stinchcomb et al. 2022). This is particularly relevant in urban contexts, where wildlife species such as deer are often perceived through a more eco-centric, mutualistic lens than the human-centered, utilitarian views prominent in rural areas (Manfredo et al. 2021). As a result, positive emotional responses to wildlife may be more prevalent in urban areas.

Scholars addressing drivers of wildlife management support have also highlighted a need to consider the role of political identity (Lerose et al. 2024; Casola et al. 2022) (i.e., formal association with a political party) and their corresponding values, which often extend beyond traditional party lines and are tied to social and cultural identities (Pew Research Center 2014). Political identity therefore describes personal alignment with broader ideological frameworks that influence people's views on societal issues, including wildlife conservation (West & Iyengar 2022). While identities related to race, ethnicity, gender, or place attachment, as well as social identities (e.g., hunter, armer, environmentalist; Bruskotter et al. 2019; Carlson et al. 2020) have also been shown to influence attitudes toward wildlife (Schroeder et al. 2021; Carlson et al. 2020), political identity stands out because it has become central to decision-making processes for many issues that are seemingly apolitical (West & Iyengar 2022; Kaplan et al. 2016). Thus, political identity may be more useful for predicting wildlife management preferences than traditionally studied demographic variables and identities (e.g., age, income, and gender (Lerose et al. 2024; Stinchcomb et al. 2024; Manfredo et al. 2020)). As such, political identity was chosen as a focal point in this study because it may more directly reflect the ideological underpinnings and perceived norms associated with wildlife management preferences than other previously studied identities (Stinchcomb et al. 2024).

In this manuscript, we evaluated how emotions and political identity shape wildlife management preferences across urban, suburban, and rural regions of Durham County NC, USA. Specifically, we modeled how positive and negative emotions, political identity, and resident location on the landscape, as well as potential interactions between these variables, predict public support for responding to three management strategies for overabundant white-tailed deer: passive management (i.e., educating people about living responsibly with deer; and letting nature take its course without human interference), reducing populations through hunting, and reducing populations through professional sharpshooters. Our research approach was novel because it accounted for renters, and the potential for confounding relationships between urbanity, political identity, and emotional responses to wildlife. We included variables to account for effects from gender, age, education, experience with deer damage, and the effects of homeownership. First, we characterized general levels of public tolerance for urban deer and support for different deer management strategies across urban, suburban, and rural regions. Second, we tested hypotheses that support for lethal management of deer would be higher among (H1) residents in rural areas (vs. suburban or urban); (H2) residents expressing more negative emotions towards deer (vs. positive emotions); (H3) residents with conservative political identities (vs. liberal); and (H4) homeowners (vs. renters). We expected similar results for both lethal management models and opposite trends for the passive response to overabundant deer.

Methods

Sampling

To assess public perspectives regarding urban deer management, we mailed self-administered surveys to 7,500 randomly selected non-industrial, private residents in Durham County North Carolina. We chose this study area due to its balanced representation of urban, suburban, and rural areas. Although most of the state's population lives in urban areas, there are still a large number of people residing in unincorporated regions, amounting to 4.6 million as of 2020, or approximately 44% of North Carolina's population (U.S. Census Bureau 2020). Durham County includes developed city centers and rural areas. We used stratified random sampling and attempted to survey 2,500 residents in urban, suburban, and rural strata, to ensure adequate coverage of residents across an urban-to-rural gradient. We classified each site as urban, suburban, or rural using Durham County GIS zoning definitions (Durham County Planning Department 2023) (Fig. 1). These definitions were developed using overlays to represent building density, major transportation corridors, airport information, and watershed protection (Durham County Planning Department 2023), and these definitions were used because they represent a local scale division of urbanity. We obtained the sample frame from the

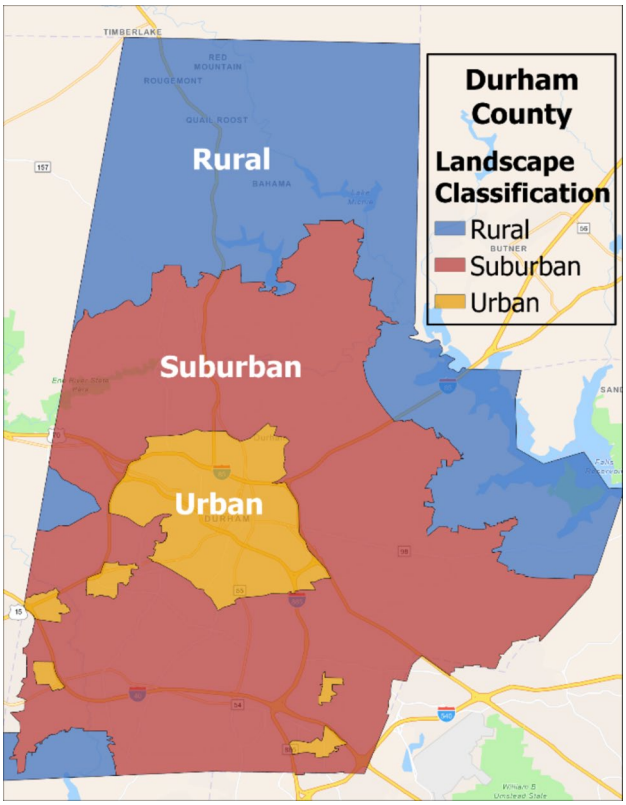

Fig. 1 Urban, suburban, or rural classifications using Durham County, NC GIS zoning definitions (Durham County Planning Department 2023). Map Source: Esri.

North Carolina Department of Agriculture and Consumer Services 2020 county parcel database, removing all industrial properties through a keyword search of 239 terms (i.e., Church, Corp., University, etc.); (Burke et al. 2018). It is important to include the perspective of renters on management acceptability, as most research focuses on homeowners (e.g., Kilpatrick et al. 2007; Urbanek et al. 2012), visitors to a particular site (Vaske et al. 2013), or convenience samples (Slagle et al. 2012). One-third (34.6%) of urban residents rented in 2021 (ACS 2021), and that group is growing (Pew Research Center 2022). Renters in the United States are also more likely to be young, and from racial and ethnic minority populations (U.S. Census Bureau 2017), so renters may represent future stakeholders better than property owners. Thus, the omission of renters represents a conspicuous gap in how urban sentiments toward wildlife management alternatives are assessed. To accurately represent both landowners and renters in Durham County within our sampling frame, we first used Census block data to determine the percentage of renters in each stratum. We then obtained rental contact information from the NC Department of Agriculture and Consumer Services 2020 county parcel database, separating residentially coded parcels. Next, we focused on parcels associated with at least one of the 239 industrial keywords (e.g., Church, Corp., LLC., etc.), presuming that renters likely occupied residential properties owned by businesses. Specific contact information, such as resident name, could not be ascertained for rental properties, so any contact with renters was addressed to "Durham County Resident".

Surveys were distributed from August to October 2022. We mailed a self-administered, mail-back booklet-format survey to each recipient to examine beliefs about deer management methods (Dillman et al. 2014). The first mailing was sent out in August 2022. Each sampled resident was sent a survey packet, with two follow-up survey packets and a reminder postcard sent to non-respondents at two-week intervals following the first contact. In the survey packet, each recipient was mailed a research information letter explaining the content of the study, an informed consent form, and a questionnaire booklet. We did not include an incentive with our survey packets due to logistic constraints.

Of the 7,500 questionnaires mailed, 977 were returned for an overall response rate of 13%. Within strata response rates were highest for rural residents at 16.6% and decreased as residents became increasingly urban, with a 13.8% response rate for suburban residents and an 8.8% response rate for urban residents. This reflects mail survey response rates typically being greater in rural areas than in urban areas (Dillman et al. 2014). There was a much higher response rate for homeowners (18.8%) than for renters (3.5%). The NC State University Institutional Review Board (IRB #24391) approved this study.

Questionnaire design

After developing the original questionnaire, we consulted with North Carolina Wildlife Resources Commission (NCWRC) biologists to ensure our questionnaire language and content were factually correct and easy to comprehend (Lerose et al. 2024). We also used a pretest of 200 randomly selected nonindustrial residents in Durham County (nonindustrial residents were identified from the North Carolina Department of Agriculture and Consumer Services 202 county parcel database) to identify any issues with skip patterns and item response rates. We measured the acceptability of six deer management methods: archery hunting; firearm hunting; drug, capture, and humanely euthanize deer; hiring trained sharpshooters; educating people about living responsibly with deer; and letting nature take its course without human interference. These management options were designed to cover two categories: lethal management (archery hunting; firearm hunting; drug, capture, and humanely euthanize deer; hiring trained sharpshooters), and passive management (educating people about living responsibly with deer; and letting nature take its course without human interference). In each case, respondents

were asked, "How acceptable are the following methods to manage deer?" with response options ranging from "very unacceptable" (1) to "very acceptable" (5), adapting questions from Shanahan et al. (2001). We also asked questions about the property using questions adapted from Burke et al. (2018): if the property was used to earn income, if they owned the property, and if they lived on the property. We included questions asking about deer damage to gardens and plantings around the home, crop losses due to deer, and deer-vehicle collisions over the previous 12 months. Residents were also asked to estimate the cost in dollars associated with any incidents of deer damage they reported (Connelly et al. 2008). Emotions were measured under a hypothetical encounter (Stinchcomb et al. 2023; Insinga et al. 2023), with residents being asked to assess the extent of their emotions if they were to see deer on their property, ranking each emotion separately on a scale from not at all (1) to extremely (8) (Straka et al. 2020). Seven emotions were evaluated: curiosity, fear, surprise, calm, sadness, anger, and excitement. Similar emotions have been identified in other studies of deer (Stinchcomb et al. 2023). To minimize bias, we chose to assess emotions linked to deer in the abstract (simply seeing them) rather than to deer doing something likely to elicit strong emotions (e.g., crossing a road, or browsing in a garden). General attitudes toward the local deer population were assessed by asking "Overall, how do you feel about the deer in your area", with answers ranging from very negative (1) to very positive (5)(Siemer et al. 2018). The questionnaire included items asking about age; gender; the highest level of formal education completed; if they personally hunt deer; and political identity. Political identity was assessed by asking "How do you identify politically", with five response options: very conservative, somewhat conservative, moderate, somewhat liberal, and very liberal.

Data analysis

We used exploratory factor analysis (principal components analysis with Varimax rotation) and Cronbach's alpha to test for scale validity and reliability. We examined individual scale items for management preferences and emotions to evaluate construct validity and to condense multiple survey items into scales representing latent constructs (Beall et al. 2022; Hair et al. 2014). Wildlife management measures loaded strongly on three factors (Table 1): lethal management by hunting (archery hunting; firearm hunting), lethal management by professionals (drug, capture, and humanely euthanize deer; hiring trained sharpshooters), and passive management (educating people about living responsibly with deer; and letting nature take its course without human interference). All factor loadings were above 0.57, indicating an acceptable relationship between the individual items and the latent constructs for management (Liu et al. 2003). Scores for latent variables (e.g., management preferences, and emotions) were calculated using the means of the separate items within each factor. For easier interpretation of the results, we calculated the percentage of respondents with positive scores above neutral on the acceptability index (e.g., the percentage of people reporting positive scores above neutral 3 on the acceptance scale).

Exploratory factor analysis for the emotion scale (Table 2) led to the removal of one item, 'calm', in response to the prompt 'To what extent do each of the following emotions reflect how you would feel if you saw deer on your property?' due to a low factor loadings (< 0.38) on both the positive and negative emotion factor. After the removal of this item, measures for each scale loaded strongly on two sub-dimensions of emotions. The negative emotions index (Cronbach's alpha = 0.923) consisted of fear, sadness, anger (Table 2). The positive emotions index (Cronbach's

Table 1 Exploratory factor analysis for deer management strategy items in Durham County, NC. Sample size = 977 respondents surveyed in 2022. Bold numbers reference the highest factor loading for each item. Analyzed using Principal Components Analysis with Varimax rotation

Item			Factor loading		
	Mean	SD	1	2	3
1. Lethal management by hunting (2 items, Cronbach's alpha = 0.960)	**3.50**	**1.27**			
Educate people about living responsibly with deer	4.24	0.99	−0.093	−0.127	**0.578**
Let nature take its course without human interference	3.17	1.23	−0.261	−0.212	**0.576**
2. Lethal management by professionals (2 items, Cronbach's alpha = 0.723)	**2.60**	**1.19**			
Allow regulated firearm hunting	3.32	1.34	**0.843**	0.110	−0.149
Allow regulated archery hunting	3.72	1.28	**0.804**	0.193	−0.184
3. Passive management (2 items, Cronbach's alpha = 0.551)	**3.68**	**0.95**			
Hire trained shooters	2.94	1.40	0.348	**0.733**	−0.161
Drug, capture, and humanely euthanize deer	2.33	1.28	0.023	**0.655**	−0.215
Eigenvalue			1.555	1.129	0.689
% of variance explained			25.9%	18.8%	11.5%

Table 2 Exploratory factor analysis for positive and negative emotions toward deer in Durham County, NC. Sample size = 977 respondents surveyed in 2022. Bold numbers reference the highest factor loading for each item. Analyzed using Principal Components Analysis with Varimax rotation

Item			Factor loading	
	Mean	SD	1	2
Calm	5.63	2.34	0.217	−0.371
1. Positive emotions (3 items, Cronbach's alpha = 0.499)	**4.02**	**1.88**		
Curious	4.97	2.23	**0.799**	−0.113
Excited	4.62	2.38	**0.609**	−0.331
Surprised	2.82	2.22	**0.593**	0.122
2. Negative emotions (3 items, Cronbach's alpha = 0.923)	**1.68**	**1.15**		
Angry	1.91	1.77	−0.358	**0.653**
Fearful	1.49	1.15	0.092	**0.6144**
Sad	1.77	1.55	0.021	**0.543**
Eigenvalue			1.547	1.376
% of variance explained			22.10%	19.65%

alpha = 0.499), consisted of curiosity, surprise, and excitement (Table 2). All factor loadings for the emotional scale were above 0.54, indicating an acceptable relationship (Liu et al. 2003) between the individual items and the latent constructs of either positive or negative emotions.

We used ordinary least squares (OLS) regression models to concurrently examine the effect of 10 independent covariates on three types of management: (1) the acceptability of lethal management with hunting, (2) the acceptability of lethal management by professionals, and (3) the acceptability of passive management. Before interpreting the models, we tested for assumptions of multicollinearity, linearity, and normality of residuals. Multicollinearity was assessed using variance inflation factors (VIFs) (Craney and Surles 2002), and tests indicated low levels of multicollinearity for all variables (VIF < 2.1). Linearity was evaluated by inspecting scatter plots of each independent variable against the dependent variables. Normality of residuals was checked using Q-Q plots and the Shapiro–Wilk test, and no significant deviations were found. We selected OLS regression because we treated the index scores of our dependent variables as continuous, and the relationships between the predictors and outcomes are assumed to be linear. OLS is an interpretable and widely used method that provides efficient, unbiased estimates. We also tested interactions between the following variables to determine if the effect of emotions related to wildlife on management acceptance varied depending on a respondent's political identity and urbanity: positive emotions and political identity; negative emotions and political identity; positive emotions and location on the urban-to-rural scale; and negative emotions and location on the urban-to-rural scale. In addition to standard errors and *p* values, we calculated the standardized beta for each variable to interpret the relative effect sizes of each variable on support for different types of deer management. To better understand significant patterns observed in the regression models, we used quartile comparisons of the variables. In addition, to facilitate comparisons, we collapsed the political identity scale to compare two categories: conservative (very conservative (1) and moderately conservative (2)) and liberal (moderately liberal (4) and very liberal (5)), excluding the moderate respondents (3).

Due to the relatively low survey response rate (13%), we assessed the potential for non-response bias by comparing respondents and non-respondents. To evaluate non-response bias, we randomly telephoned 600 non-respondents to ask a subset of questions. We were able to contact 279 non-respondents and achieved a 31.9% compliance rate (n = 89). To detect potential bias between respondent and non-respondent populations for several questions, including the primary constructs we wanted to study (e.g.; management acceptance), as well as demographics (e.g.; age, gender, political identity, and education), we used independent sample t-tests for numerical data (Lawson et al. 2019) and a chi-squared test for categorical data (Reisenwitz 2016). There were no significant differences detected between the initial respondents and the non-respondents samples for any of the variables tested.

Results

Most survey respondents (88.0%) were homeowners, but 12.0% were renters. More respondents lived in rural areas (42.4%) than suburban (35.2%) or urban (22.4%) areas. The mean age of respondents was 59 (SD ± 16.41) years old, and 58% identified as male. Most respondents (83.0%) had an associate's degree or higher. More survey respondents were slightly or very liberal (44.4%), compared to moderate (24.4%) or slightly or very conservative (31.2%) politically. About half of the respondents reported having experienced plant damage from deer within the last 12 months (54.9%). Respondents had more positive emotions associated with their local deer population ($\bar{x} = 4.02$, SD = 1.88) than negative emotions ($\bar{x} = 1.68$, SD = 1.15), although the overall attitude toward the deer population was neutral ($\bar{x} = 3.44$, SD = 1.07). Respondents reported moderate acceptance of lethal management with hunting ($\bar{x} = 3.50$, SD = 1.27) and passive management ($\bar{x} = 3.68$, SD = 0.95), with slightly lower acceptance for lethal management by professionals ($\bar{x} = 2.60$, SD = 1.19). About half of all respondents thought lethal management with hunting (54.7%) was acceptable; a

similar percentage (52.7%) believed passive management strategies were acceptable. Only 19.2% of respondents found lethal management by professionals to be acceptable. Overall attitudes toward deer were split, with 33.6% of respondents reporting general positive attitudes toward deer, 36.5% of respondents reporting neutral attitudes, and 29.9% of respondents reporting negative general attitudes toward deer. Positive emotions were fairly common, with 55.5% of all respondents reporting moderate to extreme positive emotions associated with deer. Negative emotions were far less common, with 7.1% of respondents reporting moderate to extreme negative emotions associated with deer.

Urbanity

Support for lethal and non-lethal deer management varied based on whether respondents resided in urban, suburban, or rural areas (Fig. 2; Table 3). Support for lethal management by hunting conformed to H1, where rural respondents were more accepting of this approach (85.0%) than suburban (70.3%) and urban (66.7%) respondents (Table 3). Support for passive management also conformed to H1 (Table 3), with rural respondents less accepting of passive management (83.8%) than urban (89.5%) respondents (Table 3); differences between suburban and rural respondents were not detected. We, however, did not observe differences in acceptance of lethal professional management among rural, suburban, and urban respondents (Table 3) (Fig. 2).

Emotions

Acceptance for lethal management of deer decreased with more positive emotions towards deer, providing support for H2 (Table 3). Acceptability of hunting was negatively related to positive emotions toward deer (Table 3). The percentage of respondents who supported hunting as a management strategy decreased from 90.0% acceptance among respondents in the bottom quartile of positive emotions to 62.0% among respondents in the top quartile of positive emotions. Acceptability of lethal management by professionals was also negatively related to positive emotions toward deer (Table 3). The percentage of respondents who supported lethal professional management of deer decreased from 93.9% acceptance amongst respondents from the bottom quartile of positive attitudes to 18.5% acceptance amongst respondents within the top quartile for positive emotions toward deer (Table 3). The opposite relationships were observed for negative emotions toward deer, which significantly impacted all management preferences except lethal management by hunting (Table 3).

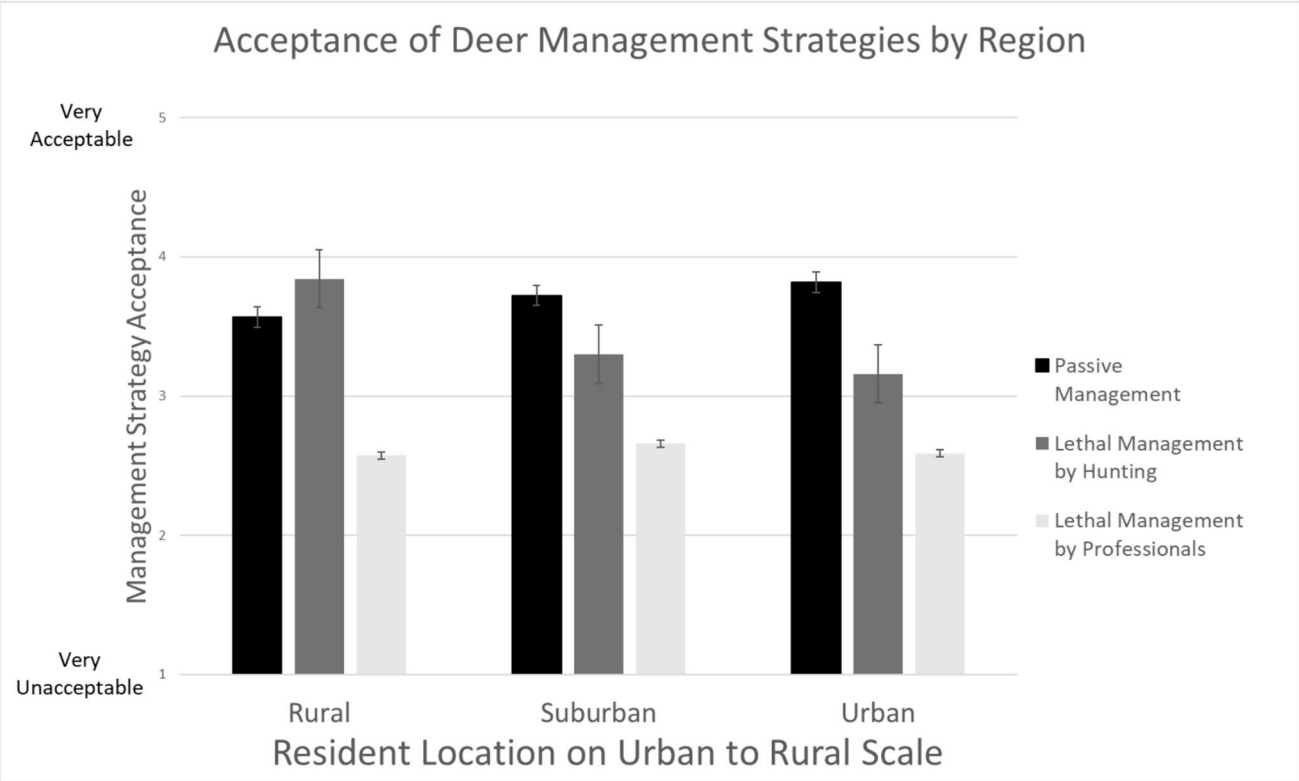

Fig. 2 Comparison of mean deer management strategy acceptance across rural, suburban, and urban respondents of Durham County, North Carolina, with standard error bars (2022)

Table 3 Ordinary least squares regression model parameter estimates, standard errors, and p values for covariates predicting acceptance of passive management, lethal management by hunting, and lethal management by professionals for white-tailed deer among residents of Durham County, NC, surveyed in 2022.

	Passive Management ($R^2 = 0.40$)			Lethal Management by Hunting ($R^2 = 0.29$)			Lethal Management by Professionals ($R^2 = 0.31$)		
Variable	β	Std. Error	Std. β	β	Std. Error	Std. β	β	Std. Error	Std. β
Suburban[a]	0.13	0.08	0.054	−0.40	0.10	−0.156 ***	−0.08	0.09	−0.026
Urban[a]	0.16	0.06	0.080 *	−0.27	0.13	−0.091 **	−0.14	0.11	−0.040
Positive emotions	0.06	0.02	0.115 ***	−0.14	0.04	−0.201 ***	−0.09	0.03	−0.132 ***
Negative emotions	−0.11	0.03	−0.129 ***	0.09	0.06	0.044	0.18	0.04	0.173 ***
Plant damage[b]	0.13	0.10	0.047	−0.48	0.14	−0.117 ***	0.09	0.13	0.022
Attitude toward deer	0.39	0.03	0.438 ***	−0.26	0.04	−0.219 *	−0.39	0.05	−0.350 ***
Homeowner[c]	−0.08	0.09	−0.050	0.07	0.13	0.039	0.08	0.12	0.037
Age	−0.002	0.002	−0.024	−0.02	0.003	−0.210 ***	−0.002	0.002	−0.032
Gender[d]	0.06	0.03	0.066 *	−0.20	0.04	−0.155 ***	−0.14	0.04	−0.118 ***
Education	−0.02	0.03	−0.018	0.06	0.04	0.041	0.11	0.04	0.092 **
Political identity	0.07	0.02	0.094**	−0.16	0.03	−0.123 ***	0.07	0.03	0.074 *
Hunter[e]	0.11	0.06	0.012	−0.72	0.03	−0.166 ***	0.14	0.09	0.017
Suburban * Positive emotion	0.05	0.37	0.072	−0.09	0.06	−0.102	0.01	0.05	0.017
Urban * Positive emotion	0.06	0.04	0.055	−0.17	0.07	−0.121 *	0.03	0.06	0.024
Suburban * Negative emotion	0.09	0.06	0.085	0.21	0.08	0.148 *	0.01	0.08	0.010
Urban * Negative emotion	0.001	0.07	0.0005	0.37	0.10	0.157 ***	0.07	0.09	0.033
Political * Positive emotion	0.001	0.01	0.0005	0.03	0.02	0.061	0.01	0.02	0.011
Political * Negative emotion	0.02	0.02	0.025	0.07	0.03	0.081 *	−0.03	0.03	−0.045

*, **, ***, denote statistical significance of standardized coefficient at = 0.05, 0.01, and 0.001, respectively

[a] Reference level: Rural

[b] Reference level: Experienced deer damage

[c] Reference level: Homeowner

[d] Reference level: Male

[e] Reference level: Hunter

Political identity

Acceptance of lethal management of deer also varied based on political identity, providing support for H3. Acceptability of hunting was positively related to more conservative political ideology (Table 3). The percentage of respondents who supported hunting as a management strategy increased from 72.0% among liberal respondents to 91.2% among more conservative respondents. However, conservative respondents were less likely to support lethal management by professionals compared to liberal respondents (Table 3). In contrast to the support for lethal management by hunting, only 38.9% of conservative respondents were accepting of lethal management by professionals, compared to about half of the liberal respondents (47.2%). Conservative respondents were also less likely to support passive management (Table 3). The percentage of respondents who supported passive management increased from 78.6% among conservative respondents to 89.2% among more liberal respondents.

Demographic attributes

Several demographic variables also predicted acceptance of deer management options. Male respondents were more accepting of hunting (88.0%) and lethal professional management (48.0%) than female respondents (66.2% and 41.0%, respectively; Table 3). In contrast, male respondents were slightly less accepting of passive management for deer (82.5%) than female respondents (88.3%; Table 3). Age and hunter identity were among the most important predictors of hunting acceptance (Std. β = −0.210 and Std. β = −0.166, respectively; Table 3). Older respondents were less supportive of hunting as a management tool. Self-reported hunters were more accepting of the use of hunting as a management tool for deer (95.8%) than non-hunters (74.8%). Education positively predicted support for lethal professional management (Table 3). Support for the use of lethal professional management for deer was higher amongst respondents with a college degree (44.3%) than for respondents with a high

school degree or lower (37.8%). Prior experience with deer-caused plant damage was an important predictor of hunting acceptance (Table 3). Respondents who had direct encounters with deer-caused damage within the previous 12 months were more supportive of lethal management with hunting as a management strategy (87.8%) than respondents who had not experienced damage during that time frame (74.0%). We did not observe a significant difference in acceptance of the other management options between those who had direct experience with deer damage and those who did not. We also did not detect a difference between homeowners and renters in acceptance of lethal management with hunting (Table 3) or lethal management by professionals (Table 3).

Attitudes

In addition, general attitudes towards deer emerged as the most influential factor across all of the deer management acceptance models (Table 3). Almost all (96.0%) respondents in the top quartile of positive attitudes toward deer supported passive management, compared to 22.4% of respondents in the bottom quartile (Table 3). In contrast, negative attitudes toward the local deer population predicted acceptance of lethal management by hunting (Table 3). Those with positive attitudes toward the local deer population were less accepting of hunting, with acceptance decreasing from 95.5% acceptance amongst the respondents who felt very negatively toward deer to 79.9% acceptance amongst respondents who felt very positively toward deer (Table 3). Attitudes toward the local deer population also negatively predicted acceptance of professional lethal management. Support of lethal professional management decreased from 93.9% acceptance amongst respondents who held very negative attitudes toward deer, to just 18.5% acceptance amongst respondents who held very positive attitudes toward deer (Table 3).

Interactions

The interaction terms tested were only significant in the model for acceptance of lethal management by hunting (Table 3). There was an interaction between political identity and negative emotions in the model predicting acceptance of lethal management by hunting (Table 3), complicating the observed relationship between political identity and acceptance of lethal management. Specifically, negative emotions predicted larger increases in support for lethal management by hunting among respondents with liberal political identities than among those with more conservative political identities (Fig. 3a). The relationship we observed earlier between urbanity of a resident and acceptance of lethal management by hunting does not always hold, as both positive and negative emotions interact with the location of residence when predicting support for hunting (Fig. 3b; Fig. 3c; Table 3). Increasing positive emotions had stronger associations with declining acceptance of hunting among urban residents than among their more rural counterparts. Negative emotions predicted larger increases in support for hunting deer among urban residents than among rural residents (Fig. 3c; Table 3). In short, emotions toward deer (both positive and negative) were stronger predictors of lethal management opposition (or support) among urban residents than rural residents.

Discussion

Support for lethal management of deer was greater among residents in rural areas than in suburban or urban areas, was greater for residents expressing more negative emotions towards deer, and was greater for residents with conservative political identities. Results also provide three additional insights about public support for deer management. First, attitudes remain among the most important predictors of support for both lethal and non-lethal management of wildlife (Liu and Sharp 2018; Manfredo et al. 2018), even after controlling for the influences of emotions, political identity, and urban residency. Second, positive and negative emotions can interact with urban residency such that emotions are stronger predictors of wildlife management preferences in urban areas. Third, negative emotions can create larger increases in support for lethal management with hunting among residents with liberal political identities. We also identified demographic correlates of support for lethal management reflecting those in the literature, with decreased acceptance among female respondents (Manfredo et al. 2021; Dougherty et al. 2003). Most residents, however, supported hunting even in groups with the lowest support levels for the practice.

Our study builds on the growing literature examining the role of emotions in wildlife management (Anderson et al. 2024; Jacobs et al. 2012; Wieczorek Hudenko 2012), indicating that emotions predict lethal management support, even after accounting for demographic factors and negative experiences with deer damage. The predictive potential of emotions for management acceptance may be explained by people relying more on mental shortcuts or heuristics (i.e., both emotions and social trust) rather than analytical processes when making judgments about management acceptance (Ghasemi et al. 2021; Jacobs et al. 2014; Wieczorek-Hudenko 2012; Zajonc 1980). Emotions may also have a more general influence on wildlife management preferences than demographic attributes and experience (e.g. prior experience with deer damage) because they transcend individual experiences. Essentially, emotions act as a heuristic guide when the respondent's actual lived experience, which acts as a tangible driver of

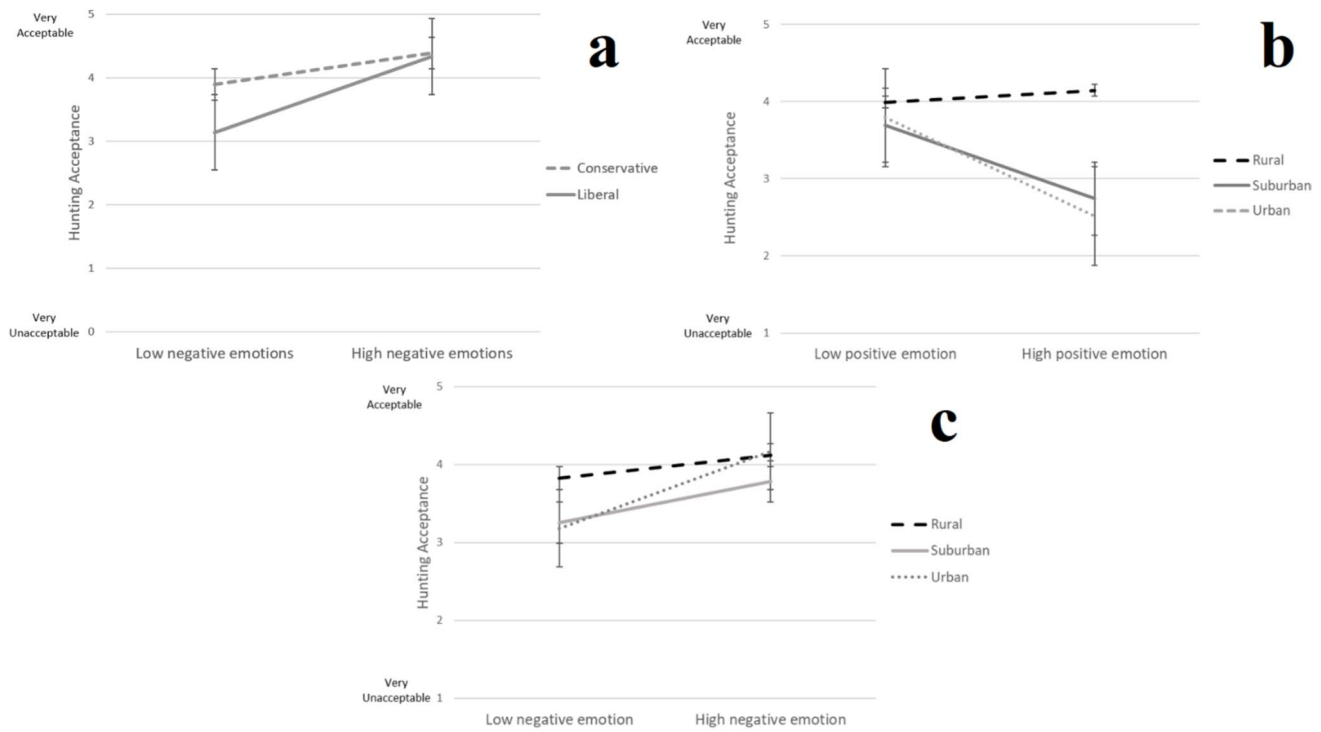

Fig. 3 Interaction effects for acceptance of lethal management of white-tailed deer by hunting among residents of Durham County, NC surveyed in 2022. From left to right: Interaction effect of negative emotions and political identity on acceptance of lethal management by hunting (**a**); Interaction effect of positive emotions and rural, suburban, and urban residency on acceptance of lethal management by hunting (**b**); Interaction effect of negative emotions and rural, suburban, and urban residency on acceptance of lethal management by hunting (**c**). Error bars represent a 95% confidence interval

decision-making, is weak or lacking. The tendency to rely on emotion can become more important in contexts where risks and benefits are less tangible (Straka et al. 2020), as in the case of hypothetical management for wildlife that is often seen from a distance and not directly interacted with, such as deer. This study determined that people generally hold more positive emotions than negative emotions toward deer, which is consistent with previous research, although other studies have noted that emotions toward deer can vary depending on the context (Stinchcomb et al. 2023; Hicks 2017). Emotional responses toward deer are often shaped by views about animal rights or the human-animal relationship, which can be further influenced by popular media representations (Stinchcomb et al. 2023). For instance, portrayals of deer in popular media, often idealized in stories or as symbols of innocence (i.e., the Bambi effect), can evoke strong positive emotions, which might clash with more utilitarian values that emphasize the need for population control (Stinchcomb et al. 2023). Our results also add to research demonstrating lower support for lethal predator management amongst urban residents (Drake et al. 2020; Heneghan and Morse 2019), indicating the relationship extends to non-predator species such as deer. Although urbanites are typically more resistant to lethal management, urbanity may be even more important for predicting resident acceptance of lethal deer management than has been the case for predators, including coyotes (*Canis latrans*; Drake et al. 2020), black bears (*Ursus americanus*; Heneghan and Morse 2019), and mountain lions (*Puma concolor*; Manfredo et al. 1998). Prior research reported that the acceptability of lethal management is mediated by perceptions of risk (Vaske et al. 2020), with acceptability varying depending on how serious risks posed by wildlife are considered (Straka et al. 2020; Jacobs et al. 2014). Urbanization-driven shifts in the prevalence of different wildlife value orientations, not measured in this study, may also explain why the perceived acceptability of lethal management differed across the landscape (Manfredo et al. 2021). Domination wildlife value orientations, which are more common among rural residents, are often linked with the acceptance of lethal wildlife management strategies, and hunting in particular (Manfredo et al. 2009; Sijtsma et al. 2012). Mutualistic values, on the other hand, are becoming increasingly more common among urban residents (Manfredo et al. 2009). The difference in the commonality of domination and mutualistic wildlife value orientations between rural and urban residents could explain why support for public hunting, one form of lethal management, is more aligned with more domination-oriented rural residents. Conversely, support for professional lethal management or

passive management strategies may resonate with more mutualistic urban residents, who prioritize ecosystem integrity and animal rights. These conflicting values and corresponding management preferences pose unique challenges for managers working across the urban–rural gradient (Anderson et al. 2024; Manfredo et al. 2017). But it is important to consider how emotions interact with urbanity as well, since emotions are generally better predictors of behavior than values (Castillo-Huitrón et al. 2020; Stinchcomb et al. 2023).

Stronger relationships between emotion and management preferences for urban versus rural residents may reflect an overreliance on emotional heuristics, rather than rational ones, because urbanites have more limited direct experiences with deer and with lethal management. Urban and suburban residents, who typically have less direct exposure to wildlife compared to their rural counterparts, often form their perceptions of wildlife, including assessments of risk, based on anthropomorphized portrayals in popular media (Teel and Manfredo 2010). When these depictions portray wildlife in a friendly and non-threatening manner it may lead to a greater positive emotion related to wildlife (Teel and Manfredo 2010). Although suburban areas may have relatively high deer densities, urban and suburban residents are often more socially isolated from wildlife, with many people in these areas having limited daily interaction with deer despite more abundant deer. This social isolation, shaped by factors like indoor lifestyles, may cause these residents to rely more on emotions rather than rational reactions, to guide behavior with respect to deer and other wildlife. Rural residents, who tend to have more direct experiences with deer (such as deer-related damage) may not always have stronger emotional reactions, as direct experience does not always correlate with heightened emotions. This is supported by the fact that models considering past experiences with deer-related vehicle collisions or plant damage did not detect a significant interaction effect with emotions.

The relationships between political identity and support for deer management detected in this study might be explained by lower trust in experts and more utilitarian wildlife value orientations (WVOs) among political conservatives. Political identity is often tied to support for lethal management, with conservative political identities more likely to express utilitarian WVOs (Hamilton et al. 2020; Schroeder et al. 2022). Hunting aligns with utilitarian values given the process provides several useful products to hunters (e.g., recreational value, venison), whereas lethal management by professionals does not. This might explain why acceptance of lethal management by professionals was higher among more liberal respondents. Liberal respondents may prefer professional management over voluntary hunting due to concerns about anti-gun sentiments, with professional sharpshooters potentially being viewed by these respondents as more controlled and skilled in firearm use than recreational hunters. Compared to their liberal counterparts, conservative residents typically have less trust in experts (Casola et al. 2022; Schroeder et al. 2021; Cacciatore et al. 2018; Manfredo et al. 2017), which may explain their decreased support for a management strategy that relies on expert implementation and control. Although hunting can occur without guns, sharpshooting typically involves the use of firearms, and liberal sentiments may reflect concerns about the type of person using the gun rather than the gun itself. This raises an interesting management implication: managers may need to ensure and convey that hunters are trustworthy and efficient gun users.

Similarly, stronger relationships between emotions and management preferences for more liberal residents may be driven by how people with liberal and conservative orientations process information about different issues through different emotional lenses (Kahan 2015). The motivated reasoning framework suggests that individuals tend to selectively process information in a way that aligns with their preexisting attitudes and beliefs (Kahan et al. 2012). Those who identify as more conservative politically often report lower importance of conservation issues than more liberal voters (Casola et al. 2022). Lower importance of conservation issues in general may relate to less emotionally driven responses to specific conservation issues including how to manage overabundant deer. In addition, conservative respondents may be more enamored by the tradition and culture surrounding hunting (van Eeden et al. 2021), and they would find hunting as a management strategy for deer to be acceptable irrespective of emotions, making emotions less powerful agents of change. Therefore, conservative individuals may evaluate the acceptability of lethal deer management strategies through a lens shaped by their political identity and preexisting beliefs rather than emotional responses (Stinchcomb et al. 2022). Although we did not detect an interaction effect of political identity and urban residency on wildlife management preferences, as has occurred in other research (Patterson et al. 2003), our study was unique in that our urban variable reflected where people lived at the moment in a specific county rather than urban background during childhood or urban versus rural regions of a larger geographic area (Drake et al. 2020).

Limitations and future research

A potential limitation of this study is the relatively low response rate, which could lead to potential non-response bias. Although we conducted non-response testing, the low response rate (32%) in this assessment suggests the possibility of some bias that may affect the generalizability of the findings. Additionally, while we used a standard definition of urbanity, it is worth acknowledging that the classification of urban versus rural areas can vary widely depending on

geographic context and regional definitions (McCleery et al. 2014). This variation may influence the outcomes in ways that were not fully captured by our study, and future research could explore how different definitions of "urban" affect perceptions of deer management across varying scales. In addition, our future research could measure emotional responses to specific deer interactions (deer eating garden flowers, deer-vehicle collision, etc.), rather than deer in general. Regarding the role of renters in urban deer management, our results suggest that the tendency to exclude renters from studies on urban wildlife management may not be critical. However, while renters did not show distinct patterns from homeowners in our results, further studies in other geographies and contexts are necessary to fully understand the potential role of renters in shaping management acceptance.

Research in other urban regions would facilitate efforts to understand how attitudes, emotions, and ideology shape the acceptance of deer management strategies across diverse cultural and geographic contexts. Additionally, employing alternative methods to measure emotions, such as observational studies, could provide a more comprehensive view of the dynamic between emotion and perceptions of deer management (Jacobs et al. 2014). Future research that considers additional factors like the perceived risk associated with deer will improve our understanding of differences in wildlife management acceptance in urban areas. It is also important to understand the tolerance of and management preferences for other urban species across the rural-to-urban gradient to gain a comprehensive understanding of how urbanization and political identity interact to influence public attitudes and behaviors.

Management implications

The results of our study underscore the complexity of devising effective and publicly acceptable deer management strategies that function across the rural to urban gradient. Integrating insights about emotional, political, and demographic drivers of public management support may render urban deer management more effective. For example, adapting management strategies based on primary political identity in an area (i.e., sharpshooters in more liberal neighborhoods; hunting in more conservative neighborhoods) could enhance management acceptance. Similarly, outreach efforts known to promote positive emotional associations with wildlife (e.g., encouraging time in nature or wildlife viewing (Curtin and Kragh 2014; Bell et al. 2018; Buijs and Jacobs 2021)) could be a viable strategy to increase resident acceptance of a decision to not alter wildlife populations in a given area. The mixed support for lethal methods in this study (e.g., conservatives are more likely to support lethal management with public hunting, whereas liberals are more likely to support lethal management by professionals) highlights the need to explore communication strategies that emphasize trust-building with hunters among urban and liberal residents. This could involve emphasizing hunters' professionalism, control over firearms, and efficient methods to ensure minimal harm to deer. Additionally, outreach programs could focus on promoting the ecological benefits of lethal management for urban areas where deer impacts may be less tangible but still significant, while emphasizing that many non-lethal management approaches (e.g., relocation or fertility control) have been deemed less effective than hunting (Raiho et al. 2015; Beringer et al. 2002; Jones and Witham 1990). In general, there is a need to embed emotional appeals in education and outreach surrounding management strategies, working towards balanced solutions that account for both efficacy and acceptability. For example, in urban contexts, negative emotions associated with perceived risks and deer-related problems (e.g., vehicle collisions, landscape damage) could be incorporated into communication strategies to increase support for lethal management. Ultimately, our study suggests that messages that align with social identities and evoke strong emotions could trigger affective responses that drive support for urban wildlife management (in general) and urban deer management (specifically).

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Data availability Data can be provided in Excel file format upon request.

Declarations

Competing interests The authors declare no competing interests.

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