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Impact of Location on Predator Control Preference Patterns

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In recent decades, interactions with carnivores have increased in suburban and urban areas. However, it is unknown how predator control preferences of urban, suburban, and rural residents compare. We sought to characterize predator control preferences regarding interactions with bobcats (*Lynx rufus*) and coyotes (*Canis latrans*), and compare these preferences among people living in urban, suburban, and rural areas. We also sought to determine the factors that predicted the likelihood of respondents changing their predator control preference. We conducted cross-sectional surveys of adult residents of the United States and the state of Ohio and embedded randomly assigned carnivore interaction scenarios in which respondents were asked to choose their preferred predator control in response to each scenario. We found that when both scenarios took place in an agricultural location, respondents became significantly more sensitive to changes in the severity (i.e., they were more likely to switch their preferred method of predator control). Subjects overwhelmingly indicated a preference for non-lethal forms of predator control. Specifically, 71.8% of respondents preferred non-lethal in response to both scenarios, 18.5% gave mixed responses (i.e., preferred lethal in response to one of the scenarios but non-lethal in response to the other scenario), and only 9.7% preferred lethal predator control in response to both scenarios. The tendency to prefer only non-lethal methods decreased along the urban-rural gradient such that 78.5% of urban respondents expressed a consistent preference for non-lethal forms of control, compared with 72.8% of suburban respondents, and 51.3% rural respondents. This suggests that most urban and suburban residents view lethal predator control methods as simply inappropriate—at least for the scenarios described. In practice, the management of human-carnivore interactions in urban and suburban areas is complicated by a variety of factors (e.g., the presence and density of humans and their pets) which reduce the flexibility of wildlife managers in these areas. Additionally, management options may be further restricted by the preferences of residents, especially given that management is likely to be more visible in these areas. Strong preferences against lethal control in urban and suburban settings may incentivize the development of novel methods for controlling human-carnivore conflicts in the future.

Keywords: urban, suburban, lethal control, predator control/management, bobcat (*Lynx rufus*), coyote (*Canis latrans*), non-lethal control, mesocarnivore

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INTRODUCTION

Modernization is reshaping the relationship between humans and wildlife both physically, via change in the interactions/experiences humans have with wildlife (Bruskotter et al., 2017), and psychologically, via a shift in values citizens have toward wildlife (Manfredo et al., 2009). These changes effectively alter the environment for wildlife. Perhaps in response to such changes, carnivores have become increasingly common in suburban and urban areas in the last decades. Some highly adaptable mesocarnivore species [e.g., coyotes (*Canis latrans*)] have even expanded into dense metropolitan areas (Gehrt et al., 2010; Bateman and Fleming, 2012; Lute and Carter, 2020). This increase in shared space between humans and wildlife can prompt commensurate increases in both interactions and conflicts between humans and wildlife (Timm et al., 2004).

People often will tolerate both positive and negative interactions with wildlife up to a limit without feeling the need to make a change. However, when this personal tolerance limit is exceeded, interactions become conflict that is unacceptable in the view of the individual (Bruskotter and Fulton, 2012). Conflicts generally prompt a response from wildlife managers—efforts to reduce, eliminate or otherwise "control" the conflict by managing people, habitat, or wildlife. As these efforts have become increasingly visible to the public, researchers have sought to characterize public preferences for various methods of controlling conflicts (Manfredo et al., 1998, 2009; Wittmann et al., 1998; Zinn et al., 1998; Decker et al., 2006; Martínez-Espiñeira, 2006; Whittaker et al., 2006; Bruskotter et al., 2009; Dietsch et al., 2016; Glas et al., 2019).

Most research on acceptable or preferred predator control either does not take the respondents' level of urbanization into account at all or exclusively examines one type of population (e.g., urban, suburban, or rural residents) (Wittmann et al., 1998; Decker et al., 2006; Martínez-Espiñeira, 2006; Whittaker et al., 2006; Glas et al., 2019; Lute and Carter, 2020). Few studies have compared the predator control preferences of respondents living at different levels of urbanization (Manfredo et al., 1998; Zinn et al., 1998) in response to the same set of direct or indirect human-carnivore interactions. The need to compare predator control preferences between urban, suburban, and rural residents is accentuated both by the increase of carnivores in urbanized areas and the impact urbanization can have on the relationship between humans and wildlife (Manfredo et al., 2009). To fill this knowledge gap, we compare the similarities and differences in lethal predator control preferences between urban, suburban, and rural respondents.

Beyond the general preferences of people living in different areas, there is also a lack of research on individuals respond to changes in the context of predator management. Here we use context to refer generally to attributes of the conflict (i.e., where it occurs, the severity of the incident) that might change how people judge the acceptability of lethal control. Past studies have focused on characterizing how individuals respond to different contexts when presented with hypothetical scenarios (Manfredo et al., 1998, 2009; Wittmann et al., 1998; Zinn et al., 1998; Decker et al., 2006; Martínez-Espiñeira, 2006; Whittaker et al., 2006; Bruskotter et al., 2009; Glas et al., 2019). However, to date no research explores what makes individuals more or less likely to be sensitive to changes in context.

The consistent or flexible nature of the public's predator control preferences can have implications for management. Individuals that have a particularly strong values, for example, might express a consistent preference for one type of predator control regardless of context. Strong preferences may lead to resistance or outright opposition toward management intervention among those who view a particular type of control as inappropriate (Zinn et al., 1998).

Conversely, flexibility in preferences suggests that an individual is sensitive to the context and willing to try a variety of control methods. Management may find that it is easier to work with individuals who are ready and willing to change predator control tactics to account for the current situation.

Understanding sensitivity to contextual differences could help agencies provide control methods that are appropriate to a particular place, culture, or population. It is unknown if flexibility or consistency in the public's predator control decisions is more or less likely to occur in certain location settings, and if the public is willing to be just as flexible in their control preferences for increases in severity as they are for decreases in severity. This study seeks to partially fill that knowledge gap. We also investigated if cognitive (i.e., values, affect) and demographic factors (i.e., gender, urban/suburban/rural residency) change the likelihood of a person reacting sensitively to the context of a new scenario and changing their preferred predator control. That is, we aimed to determine if consistent preferences for one type of predator control can be explained by strong values and affective reactions to wildlife.

METHODS

In 2016, we conducted an online survey of adult United States residents and adult Ohio residents using samples obtained from an online panel of respondents representative of the United States adult population (i.e., GfK's Knowledge Panel[1]). Using American Community Survey benchmarks, GfK provided weights for the population samples by gender, age, race, education, United States census region, household income, home ownership, and Metropolitan Statistical Area residency to closely match the demographics of the population for both the United States sample, and the Ohio sample.

Emails were delivered to 645 Ohio residents for the bobcat (*Lynx rufus*) survey and 651 United States residents for the coyote survey in July of 2016. These emails included an invitation for respondents to take the survey and an internet link to the survey on the Qualtrics[2] online survey platform. Three days after the initial invitation, email reminders were sent to those who had not yet responded. Additional reminder emails were sent to those who had still not responded on the 7th and 11th day of the study. We obtained 406 usable returns from the Ohio survey, an overall response rate of 63%. The United States survey yielded 397 usable returns, and an overall response rate of 61%.

[1]GfK's Knowledge Panel was later sold to Ipsos. https://www.ipsos.com/en-us/solutions/public-affairs/knowledgepanel.
[2]www.qualtrics.com

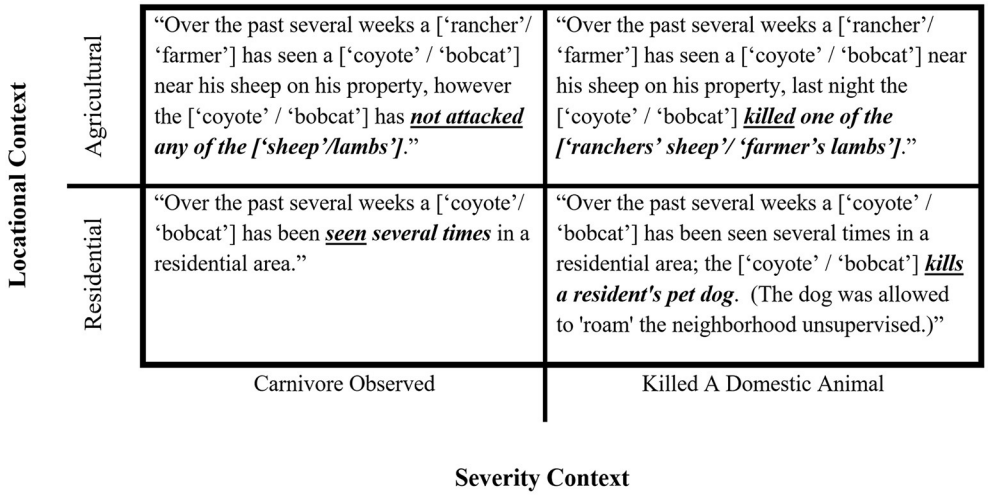

FIGURE 1 | Carnivore scenarios that respondents could receive.

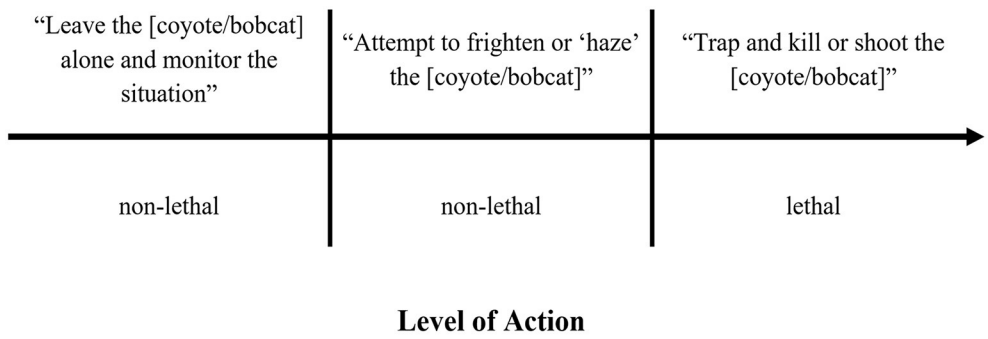

FIGURE 2 | Predator control options for responding to the carnivore scenarios given.

To observe the respondent's values surrounding wildlife, we calculated the respondent's wildlife value orientations which were assessed through measuring domination (i.e., wildlife is for human use) and mutualism values (Manfredo et al., 2009, 2016; i.e., animals have rights of their own). wildlife value orientations were measured by asking respondents on a 7-point bipolar response scale if they agree or disagree with a block of 19 statements that were taken from Manfredo et al. (2009). From the responses to this question block, we calculated separate mean domination and mutualism scores for each respondent which were treated as independent variables in subsequent analyses.

To observe the respondent's attitude toward bobcats or coyotes, we captured the respondent's affect toward either the bobcat or coyote species before they were presented with any conflict scenarios. Affect is the initial positive or negative association one has in response to a stimulus (Slovic et al., 2007). The survey measured the respondent's affect toward the species by asking the respondent on a 5-point bipolar response scale about their initial positive or negative feeling.

The focus of our study is on the mesocarnivore scenario section. Manfredo et al. (1998, p. 965) said that "A basic challenge in human dimensions research is to measure attitudes toward a range of management scenarios which are specific enough to ensure predictive validity but are also generic enough to be applied across a wide variety of situations." We followed this guidance in the scenario section of our survey. For this section we prepared a set of 4 hypothetical scenarios depicting common indirect human-mesocarnivore interactions. Respondents were randomly assigned to 2 of 4 possible human-carnivore interaction scenarios (**Figure 1**). These interaction scenarios were varied by location (agricultural setting or residential setting) and severity (carnivore observed or carnivore killed a domestic animal).

Both the scenarios that were given and the order they were given in, were randomized for respondents. The same scenarios were given on both the coyote survey and the bobcat survey, but with the subject mesocarnivore question context switched to either coyotes or bobcats accordingly. Then using a multiple-choice question format with four possible choices, respondents were asked which predator control method they thought to be the "most appropriate" for each scenario they were given. The three main predator control answer choices included two

non-lethal choices and one lethal choice (**Figure 2**). A fourth option stating "none of these actions are appropriate" was included in recognition that some respondents may reject to any type of management, while alternatively, others may consider options that are generally considered infeasible for management agencies (e.g., surgical sterilization, translocation).

Because our survey is concerned with how people *decide*, which requires both understanding of the scenario and at least some deliberation, we removed responses that suggested inadequate deliberation. Removing respondents who completed the survey abnormally fast helps to reduce possible error caused by respondents who distort their response due to inadequate attention (e.g., failure to read or process) the information presented (Leiner, 2019). Leiner (2019) suggested that a survey completion time of two times faster than the average can be used as a cut-off to identify respondents who might be guilty of giving meaningless answers without reading the questions. We used a slightly less strict cut-off time, as a cautionary measure to not exclude any legitimate responses, by only excluding completed-survey response times that were three times or more faster than the median survey completion time. Since the scenario section of the survey is the key focus of this study, we also excluded respondents who completed the scenario section of the survey five times or more faster than the median response time. Due to cautions stated by Leiner (2019), five was used instead of three as the cutoff because the section contains a paragraph with basic information about coyotes/bobcats (i.e., describes characteristic appearance). This paragraph could reasonably be skipped by respondents familiar with these species without it affecting their answers to the scenario questions. From 803 total respondents, 18 respondents were removed for completing the total survey three times or more faster than the median time, and then 7 respondents were removed for completing the scenario section of the survey five times faster than the median time. Respondents who chose "none of these actions are appropriate" in response to either of the carnivore scenarios given (United States sample $n =$ 65; Ohio sample $n = 64$; Total $n = 129$), were excluded from the analysis due to the wide range of possible reasons a respondent may choose this option. Additionally, because our analysis required complete data, 103 respondents were excluded for not completing portions of the survey. There were 546 respondents left for analysis after these case exclusions were made.

We used data from three different measures of residency, or residency perception, to create a robust ordinal measure that categorizes respondents as either urban, suburban, or rural residents. The new urban-suburban-rural residency variable accounts for the respondent's current actual residency, current perceived residency, and their perceived childhood residency (see **Supplementary Material**).

We considered respondents to be contextually *sensitive* to the carnivore scenarios if their preferred predator control differed between the two scenarios they were assigned. We considered respondents to be contextually *insensitive* to the carnivore scenarios if their preferred predator control was the same between the two random scenarios they were given.

The responses from the United States sample (coyote scenarios given) and from the Ohio sample (bobcat scenarios given) were combined for all the analyses presented here. Ohio residents have been used in research from other fields (e.g., political preferences, consumer tastes) to represent United States residents since they share similar demographics and balance between agriculture and industry (Knepper, 2003). Before combining the scenario section of the survey from these two samples, we tested for independence using a chi square test. It was confirmed that there is no association ($df = 1$, $p = 0.119$) between contextual *sensitivity*/*insensitivity* and the dichotomous variable depicting if respondents were from the United States sample (coyote scenarios given) or from the Ohio sample (bobcat scenarios given).

We used a binary logistic model to test what factors were significant in explaining the likelihood of sensitivity toward changes in the context of carnivore scenarios when choosing preferred predator control. As our predictor variables, we included the urbanization level of the respondent's residency (urban, suburban, or rural), a dichotomous control variable depicting if the respondents were from the United States sample (coyote scenarios given) or from the Ohio sample (bobcat scenarios given), the severity context pattern and the locational context pattern that the respondents received in the scenarios, and variables that have been found in previous literature to be significant in explaining variance in preferred or accepted predator control. These predictor variables from the literature included wildlife value orientations (Manfredo et al., 2009), affect toward the species of carnivore (Slagle et al., 2012), and the respondent's gender (Agee and Miller, 2009). We met both the minimum events per variable sample size requirement (i.e., 10x the number of regression coefficients to be estimated; Peduzzi et al., 1996), and the stricter overall sample size requirement of n $\geq$400 needed to be able to properly apply the Hosmer and Lemeshow Goodness of Fit Test to the Binary Logistic Regression (Hosmer et al., 2000). The suggested observation sample size for reliable estimates within each group of the dependent variable was also met [same as the minimum overall sample size requirement (10 multiplied by the number

TABLE 1 | Response proportions for types of predator control preferred within each carnivore scenario.

Predator control preference	Agricultural observed %	Agricultural killed %	Residential observed %	Residential killed %
"Attempt to frighten or 'haze' the [Coyote/Bobcat]"	49.5	55.1	46.6	52.9
"Trap and kill or shoot the [Coyote/Bobcat]"	5.8	36.8	12.3	21.4
"Leave the [Coyote/Bobcat] alone and monitor the situation"	44.7	8.1	41	25.7
Total	$n = 293$	$n = 272$	$n = 251$	$n = 276$

of predictor variables) but instead for each category of the dependent variable; Hair, 2014]. It was confirmed that there were no multicollinearity issues between the independent variables (VIF<1.6 for all predictor variables) according to the Variance Inflation Factor cutoff values suggested by Craney and Surles (2002). Additionally, the assumption that there is a linear relationship between the continuous predictor variables and the logit of the response variable was tested using a Box-Tidwell transformation test.

RESULTS

Scenario Responses

Results showed that respondents generally preferred non-lethal responses to all scenarios (**Table 1**) and this was true for both coyote and bobcat scenarios. Responses differed with shifts in contexts (i.e., location or severity of the scenario). The percent that favored lethal control in scenarios with an agricultural context was 20.7%, and in scenarios with a residential context it was 17.1% (Pearson chi-square = 28.23; $df = 6$; $p = 0.000$). The percent that favored lethal control was 8.8% in the low severity scenarios (i.e., carnivore observed), and 29.0% in the high severity scenarios (i.e., carnivore kills domestic animal) (Pearson chi-square = 40.60; $df = 6$; $p = 0.000$). Of the non-lethal options, the most preferred option was hazing in both agricultural (52.2%), and residential scenarios (49.9%). Likewise, hazing was the most preferred option in both low severity (48.2%) and high severity (54.0%) scenarios. The scenario that elicited the greatest preference for lethal control was high severity in an agricultural setting (36.8%). The scenario with the lowest preference for lethal control was low severity in an agricultural setting (5.8%).

Considering the responses from both scenarios each respondent received, 71.8% of respondents preferred only non-lethal forms of predator control, 18.5% preferred lethal control in response to one of the scenarios but non-lethal in response to the other scenario, and only 9.7% preferred lethal predator control in response to both scenarios. The tendency to prefer lethal methods or non-lethal methods of predator control was associated with urban, suburban, and rural respondent residency (**Figure 3**; Pearson chi-square = 22.87; $df = 4$; $p = 0.000$). The preference for lethal control increased along the urban-rural gradient, with suburban residents as intermediate between urban and rural preferences. However, the lethal preferences of suburban residents resembled that of urban residents (Pearson chi-square = 3.00; $df = 2$; $p = 0.223$) much closer than to the preferences of rural residents (Pearson chi-square =14.16; $df = 2$; $p = 0.001$).

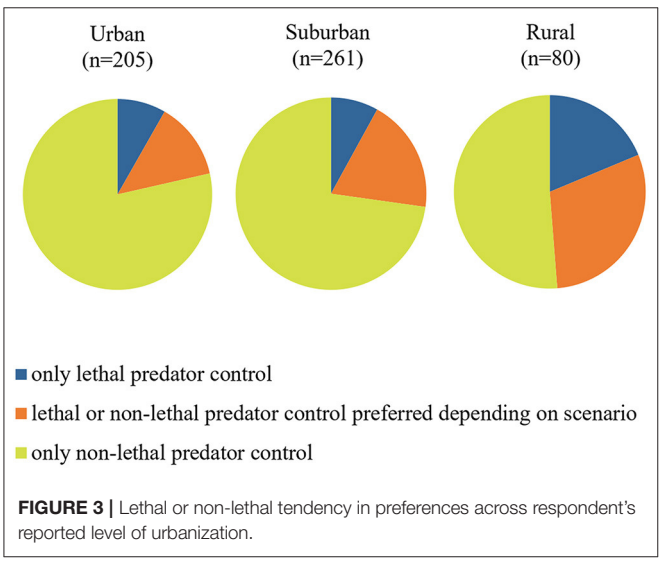

FIGURE 3 | Lethal or non-lethal tendency in preferences across respondent's reported level of urbanization.

Contextual Sensitivity

The primary purpose of this study is to explore "contextual *sensitivity*" in predator control preferences. Contextual *sensitivity* is operationalized here as changing one's response between the first and second scenario presented. Respondents who did not change their preferred predator control between the first and second scenario presented were labeled as contextually *insensitive* for the purpose of this study. Contextually *sensitive* respondents represented a minority (44%; $n = 240$), and contextually *insensitive* respondents represented 56% of the dataset ($n = 306$).

Table 2A shows that contextually *sensitive* and *insensitive* respondents were distributed fairly evenly across levels of

Table 2A | Proportions of contextually sensitive and insensitive responses among various cognitive and demographic sub-groups.

Cognitive and demographic Characteristics	Sensitive Respondents	Insensitive Respondents
Respondents used in analysis ($n = 546$)	44.0% ($n = 240$)	56.0% ($n = 306$)
Wildlife value orientation-mutualism		
High in Mutualism	43.1%	56.9%
Low in Mutualism	45.2%	54.8%
Wildlife value orientation-domination		
High in domination	45.2%	54.8%
Low in domination	40.4%	59.6%
Affect toward species		
Positive	44.1%	55.9%
Neutral	44.6%	55.4%
Negative	43.0%	57.0%
Respondent population sample		
Ohio sample (Bobcat scenarios received)	47.2%	52.8%
United States sample (Coyote scenarios received)	40.5%	59.5%
Respondent's Residency		
Urban	41.0%	59.0%
Suburban	45.6%	54.4%
Rural	46.3%	53.8%
Gender		
Female	44.8%	55.2%
Male	43.2%	56.8%

Table 2B | Proportions of contextually sensitive and insensitive responses from each possible carnivore scenario combination.

Location and severity context combinations in scenarios given to respondents	Sensitive Respondents	Insensitive Respondents
Respondents used in analysis ($n = 546$)	44.0% ($n = 240$)	56.0% ($n = 306$)
Severity context (both scenarios in order)		
Observed - Killed	58.0%	42.0%
Killed - Killed	44.4%	55.6%
Killed - Observed	36.5%	63.5%
Observed - Observed	33.0%	67.0%
Locational context (both scenarios in order)		
Agricultural - Agricultural	63.5%	36.5%
Residential - Agricultural	43.3%	56.7%
Residential - Residential	41.6%	58.4%
Agricultural - Residential	35.9%	64.1%

mutualism, levels of domination, affect, gender, and urban-suburban-rural residency. The ratios of contextual *sensitivity* to *insensitivity* across all the cognitive and demographic variables we tested were within 5% of the proportion of *insensitive* and *sensitive* respondents among the dataset as a whole. An even distribution of contextually *sensitive* and *insensitive* respondents among these variables means that there is unlikely to be any strong associations between these cognitive/demographic variables and the dichotomous variable depicting contextual *sensitivity* or *insensitivity*.

Contextual *sensitivity* differed depending on the severity or locational context combination respondents received, and the order they received it in (**Table 2B**; Pearson chi-square = 49.73; $df = 11$; $p = 0.000$). Having an agricultural setting in both scenarios led to a larger proportion of contextually *sensitive* respondents than any other context combination (19.5% above the percent of *sensitive* respondents among the dataset as a whole; Pearson chi-square = 18.14; $df = 1$; $p = 0.000$). The context combination that resulted in the second largest proportion of contextually *sensitive* respondents was a severity increase context switch (i.e., observed-to-killed; 14% above the percent of *sensitive* respondents among the dataset as a whole; Pearson chi-square = 19.56; df=1; p=0.000). However, counter intuitively, the inverse of this severity context switch (i.e., decrease in severity; killed-to-observed) tended toward contextual *insensitivity* among respondents (Pearson chi-square = 6.17; $df = 1$; $p = 0.013$).

Binary Logistic Regression

We began by testing all univariate models and plausible interactions for prediction of contextual *sensitivity*. We then ran a binary logistic regression that predicted contextual *sensitivity* using only the cognitive and demographic variables as factors. This was done to prevent the scenario context variables from drowning out any slight effects that cognitive and demographic variables might have had on contextual *sensitivity*. **Table 3A** shows that the cognitive and demographic factors most often used in literature to explain variance in predator control preferences/acceptance could not significantly explain the odds of *sensitivity* toward the context switch(s) between different common mesocarnivore scenarios ($p = 0.512$). We used the Hosmer and Lemeshow goodness-of-fit test as an indicator that this model did not suffer from poor fit ($p = 0.478$).

Next, we ran an all-inclusive binary logistic regression that predicted contextual *sensitivity* using the cognitive, demographic, and scenario context variables as factors. Results from the all-inclusive binary logistic regression suggested that some of the scenario combinations contributed to contextual *sensitivity* among respondents, but none of the cognitive or demographic variables were significant (**Table 3B**; Omnibus tests: $p = 0.000$; Pearson chi-square = 49.11, $df = 13$). We used the Hosmer and Lemeshow goodness-of-fit test as an indicator that this model did not suffer from poor fit ($p = 0.229$). Having an agricultural setting in both scenarios had such a powerful effect on contextually *sensitivity* that all the other location context combinations became significant toward contextual *insensitivity* when this group was used as the reference. Respondents who received the agricultural-to-residential location switch were 70.3% less likely to be contextually *sensitive* compared to respondents who received an agricultural setting in both scenarios [Exp(B) = 0.297; S.E. = 0.294; $p = 0.000$]. Respondents who received the residential-to-agricultural location switch were 55.9% less likely to be contextually *sensitive* compared to respondents who received an agricultural setting in both scenarios [Exp(B) = 0.441; S.E. = 0.299; $p = 0.006$]. Respondents who received a residential setting in both scenarios were 61.9% less likely to be contextually *sensitive* compared to respondents who received an agricultural setting in both scenarios [Exp(B) = 0.381; S.E. = 0.327; $p = 0.003$]. Severity of the interaction depicted also played a significant part in contextual *sensitivity*. Respondents who received the "killed" severity context in both scenarios were 93.6% more likely to be contextually *sensitive* compared to respondents who received the killed-to-observed severity switch [Exp(B) = 1.936; S.E. = 0.289; $p = 0.022$]. Respondents who received the observed-to-killed severity switch were 180.2% more likely to be contextually *sensitive* compared to respondents who received the killed-to-observed severity context switch [Exp(B) = 2.802; S.E. = 0.231; $p = 0.000$].

DISCUSSION

This study's randomized scenario design was used to describe how individuals respond to multiple predator control scenarios. In general, our study showed that place matters. We found that both the location of residence (i.e., whether they live in rural, urban, or suburban locations) and the location of the interaction appeared to impact individuals' judgments concerning the appropriateness of various forms of predator control.

Long-term shifts in societal attitudes concerning mesocarnivores (George et al., 2016) and their management

Table 3A | Binary logistic regression predicting the probability of contextual sensitivity or insensitivity using only cognitive and demographic predictors.

	B	S.E.	DF	Sig.	Exp(B)	95% C.I. for EXP(B)	
						Lower	Upper
Mutualism	−0.013	0.075	1	0.861	0.987	0.852	1.143
Domination	0.132	0.093	1	0.155	1.141	0.951	1.368
Affect toward species (Bobcat or coyote)	0.016	0.075	1	0.829	1.016	0.878	1.177
Ohio sample = 1, United States sample = 2	−0.27	0.183	1	0.14	0.763	0.533	1.093
Rural Residency (reference category)			2	0.697			
Urban Residency	−0.15	0.272	1	0.582	0.861	0.505	1.467
Suburban Residency	0.006	0.262	1	0.982	1.006	0.602	1.681
Gender (2 = Female, 1 = Male)	0.117	0.182	1	0.519	1.125	0.787	1.607
Constant	−0.05	0.485	1	0.918	0.951		

Table 3B | Binary logistic regression predicting the probability of contextual sensitivity or insensitivity using cognitive, demographic, and scenario context combinations as predictors.

	B	S.E.	DF	Sig.	Exp(B)	95% C.I. for EXP(B)	
						Lower	Upper
Mutualism	−0.027	0.078	1	0.732	0.974	0.836	1.134
Domination	0.156	0.096	1	0.105	1.169	0.968	1.412
Affect toward species (Bobcat or Coyote)	0.019	0.078	1	0.805	1.019	0.875	1.188
Ohio sample = 1, United States sample = 2	−0.261	0.191	1	0.170	0.77	0.53	1.119
Rural Residency (reference category)	2	0.445					
Suburban Residency	0.239	0.2	1	0.232	1.27	0.858	1.879
Urban Residency	0.019	0.287	1	0.947	1.019	0.58	1.79
Gender (2 = Female, 1 = Male)	0.111	0.19	1	0.557	1.118	0.771	1.622
Agricultural - Agricultural (reference category)	3						
Agricultural - Residential	−1.214	0.294	1	0.000	0.297	0.167	0.529
Residential - Agricultural	−0.818	0.299	1	0.006	0.441	0.246	0.794
Residential - Residential	−0.965	0.327	1	0.003	0.381	0.201	0.723
Killed - Observed (reference category)	3						
Killed - Killed	0.66	0.289	1	0.022	1.936	1.099	3.41
Observed - Killed	1.031	0.231	1	0.000	2.802	1.78	4.412
Observed - Observed	0.218	0.298	1	0.465	1.243		
Constant	0.11	0.488	1	0.821	1.117		

(Slagle et al., 2017) suggest a need to re-evaluate how managers approach interactions with these species. To that end, we also investigated respondent's tendency to prefer lethal methods, non-lethal methods, or situationally prefer lethal and non-lethal methods based on urban-suburban-rural residency. We found that suburban residents were intermediate between the lethal predator control preferences of urban and rural residents. However, the lethal predator control preferences of suburban residents were closer to urban views than they were to rural views. Importantly, regardless of residency, respondents generally preferred non-lethal methods of predator control (71.8% of respondents preferred only non-lethal forms of predator control in response to both scenarios). This is consistent with multiple studies which have shown a general preference for non-lethal forms of predator management among people living in the United Sates (Manfredo et al., 1998; Zinn et al., 1998; Bruskotter et al., 2009; Liordos et al., 2017; Slagle et al., 2017). However, the preference for non-lethal predator control appears stronger among urban residents than it is for rural residents both in our study and in past literature (Manfredo et al., 1998; Zinn et al., 1998).

Research indicates that modernization (indicated partially by a rise in urbanization) is causing a shift in wildlife value orientations away from domination values (wildlife is for human use) and toward mutualism values (animals have rights of their own; Manfredo et al., 2016). The domination wildlife value orientation has been positively linked with acceptance of lethal wildlife control measures (Manfredo et al., 2009; Sijtsma et al.,

2012; Dietsch et al., 2016; Glas et al., 2019). Thus, the already-low acceptance of lethal predator control among urban and suburban residents might decline even further over time if wildlife value orientations shift further in the direction of mutualism (Dietsch et al., 2016).

We also investigated what factors lead individuals to be responsive to changes in context (i.e., the location and severity) of human-carnivore interactions. We found an increase in severity between the context of the two scenarios given (i.e., "carnivore observed" to "carnivore killed a domestic animal") increased the likelihood of respondents being contextually *sensitive*. However, interestingly a decrease in severity between the two scenarios given (i.e., "carnivore killed a domestic animal" to "carnivore observed") resulted in proportionally more *insensitive* respondents than *sensitive* respondents. It is possible that status quo bias (i.e., the tendency of individuals to stick to a prior decision (Samuelson and Zeckhauser, 1988) has more of an effect on decreases in severity than it does on increases in severity in indirect human-mesocarnivore scenarios. People who lack an understanding of the difference in impact or consequences resulting from different types of predator control in different scenarios, may choose to be consistent in their predator control preferences, as long as the situation does not increase in severity, as a way to maintain a status quo in their decision and thereby avoid the risk of loss that change may bring (Samuelson and Zeckhauser, 1988). For management this could mean that some of the public may display resistance toward de-escalation in predator control if done too quickly after the conflict subsides.

Changes in the severity of interaction are not the only part of the scenario's context that increased the likelihood of respondents changing their preferred predator control (**Table 3B**). Interactions depicted as occurring in an agricultural location increased the likelihood of a respondent being contextually *sensitive* more than any other change in severity or location combination. We saw that when both scenarios took place in an agricultural location, respondents became significantly *more* sensitive to changes in the severity. It could be that these respondents become more sensitive to the severity in agricultural locations because they see mesocarnivores as needing more careful attention in agricultural settings where a producer's income is at stake, as opposed to "residential" settings. This is supported by the findings of Slagle et al. (2017) who found that the public is generally in support of attentive predator control in agricultural settings to protect against losses in livestock. It could be that respondents exhibited less contextual *sensitivity* in scenario combinations with a residential setting in one or more of the scenarios because much of the real-life human-carnivore conflict in urbanized areas, and in the high-severity residential scenario we used, is caused by individual humans "misbehaving" rather than the carnivore "misbehaving" (e.g., leaving pets unattended outside, feeding wildlife, or approaching a carnivore's offspring).

In addition to the purposeful manipulation of location and severity in our experiments, our scenarios contained other language that may have affected how subjects responded. In particular, our urban scenarios where a domestic animal was killed used the clause, "The dog was allowed to 'roam' the neighborhood unsupervised," a clause not contained in the rural treatment. Importantly, this clause was added to make the scenarios more comparable. In contrast to livestock, which generally wander unsupervised within large, fenced pastures, pets in urbanized settings are generally leashed and supervised when outside. Our added text was an attempt to correct for this difference (i.e., unsupervised livestock vs. supervised pet). We could have described the pet as being unsupervised in a fenced yard, but because the curtilage (the enclosed area) around urban homes is generally much smaller than a typical pasture, we reasoned that having a carnivore kill a pet within that area may have evoked concern for human residents (e.g., small children) that would not be evoked in the rural treatment. Had we used such a description, we may have observed larger differences between the location treatments.

We also investigated factors outside of scenario context for possible impact on likelihood of a person responding contextually *insensitive* to the scenarios in this study. We found that neither values (i.e., mutualism or domination) nor affect toward the species were significant in explaining the probability of contextual *insensitivity* among respondents. However, this does not mean that these variables do not play any significant role in individuals' predator control preferences in this dataset. It only means these cognitive factors held no significance in predicting the likelihood of an individual's predator control preferences being consistent or flexible in pattern. These cognitive factors might hold significance if the regression analyses were predicting a respondent's combination of predator control preferences instead of merely the consistent or flexible nature of this combination. Past literature has widely demonstrated the impact of wildlife value orientations (Zinn et al., 1998; Whittaker et al., 2006; Manfredo et al., 2009; Sijtsma et al., 2012; Dietsch et al., 2016; Glas et al., 2019), and affect toward the species of carnivore (Bruskotter et al., 2009; Slagle et al., 2012) on predator control preferences or acceptability. Future research will investigate if these cognitive variables, along with the demographic variables also tested here (i.e., gender, and urban-suburban-rural residency), can increase or decrease the likelihood of a respondent preferring a certain combination of predator control preferences (i.e., the combination of specific non-lethal or lethal control methods), and determine if respondents with preference combinations belonging to the contextually *sensitive* response pattern group used the same or different mental tools (i.e., heuristics) to make these predator control decisions as respondents with preference combinations belonging to the contextually *insensitive* response pattern group did.

Contextual *sensitivity* was unaffected by species in this study (i.e., bobcat or coyote). This is remarkable since this study contains a common species and an uncommon species. Coyotes are classified as nuisance wildlife and are widespread across the area of the population we sampled (United States). However, bobcats were still considered to be recovering across the area of the population we sampled (Ohio) according to a genetic study in 2015, 1 year before this survey was performed (Anderson et al., 2015). The fact that this difference in species had no effect on

the likelihood of contextual *sensitivity* in respondents means that it is possible these findings on contextual *sensitivity* might apply to interactions with other mesocarnivores in the United States as well.

CONCLUSION AND MANAGEMENT IMPLICATIONS

For wildlife management agencies, the potential implications of using management techniques that large majorities deem inappropriate include increased social conflict concerning management (Zinn et al., 1998; Agee and Miller, 2009) as well as decreased social trust toward the management agency (Zajac et al., 2012). In effect, where preferences are strong enough, wildlife management agencies should consider more closely aligning management techniques used to address common human-carnivore conflicts with societal preferences, while still promoting methods that are effective at managing the species. Failure to do so risks a decrease in trust and legitimacy among the public. This task is complicated when preferences differ across geographies.

Our study found that the tendency to prefer lethal methods or non-lethal methods of predator control was associated with urban, suburban, and rural respondent residency (**Figure 3**; Pearson chi-square = 22.87; $df = 4$; $p = 0.000$). Generally urban and suburban residents in this study found lethal predator control to be inappropriate in response to the indirect human-mesocarnivore interactions presented here. Prior research shows that urban residents often prefer translocation of problem carnivores rather than use lethal control when removal of a problem carnivore is desired (Lute and Carter, 2020). Ironically, translocated carnivores sometimes suffer from an increased mortality rate, which defeats the purpose of those who wished to avoid lethal control (Linnell et al., 1997; Bradley et al., 2005). Furthermore, translocated carnivores that do survive, often travel long distances to return to the original location or continue conflict-causing behavior in a new location (Linnell et al., 1997; Bradley et al., 2005). Thus, agencies may choose to preclude the use of translocation for managing human-carnivore conflicts.

Most common forms of active predator control were first developed with the rural environment in mind because historically that is where most human-carnivore conflict occurred (Huot and Bergman, 2007). This is true for both the common lethal forms of predator control (e.g., calling in coyotes to shoot to kill, trapping in a snare or leg-hold to shoot to kill, or selective lethal control with poisoned collars on livestock), and for the common forms of active non-lethal control (e.g., guardian animals, electronic sirens, flashing bright lights, fladry, or night-time corrals with extra tall fencing that also extends into the ground).

Yet in practice, the management of human-carnivore interactions in urban and suburban areas is complicated by the presence and density of humans and their pets (Russell and Stanley, 2018), which likely reduces the flexibility of wildlife managers in these areas. Changing social values when combined with the ability of mesocarnivores to adapt to urban environments has created the need for active forms of predator control that are specifically designed for the urban setting. Some efforts in urban areas have been made to employ careful urban planning to provide refuges for wildlife and reduce human-wildlife conflict (Gehrt et al., 2010). In the past decade or so the development of a new radical approach to predator control has already begun in the literature by emphasizing the importance of increasing tolerance toward wildlife to aid coexistence (Bruskotter and Wilson, 2014; Frank, 2016; Frank et al., 2019; where the self-interests of wildlife are also considered). Research has confirmed that raising the perceived benefits of wildlife can do more for raising tolerance of wildlife than using standard predator conflict control alone (e.g., lethal predator control, hazing, education public of the hazards, ect.; Lischka et al., 2019; Saif et al., 2019).

Wildlife management agencies, both private and government, should be aware that a large portion of the public might be consistent in their own management preferences for predator control in residential areas if given the choice when the problem carnivore is not causing a direct danger to human health or safety. This finding does not suggest that most indirect human-mesocarnivore scenarios should be dealt with in the same way in residential areas to please the public. However, this could mean that there is a large portion of the public that will be less understanding of why certain types of management tactics are used in certain scenarios and not in others (especially in response to indirect human-mesocarnivore interactions in residential locations).

Conversely, wildlife management agencies should also be aware that in this study residents from all levels of urbanization, when given scenarios with an agricultural context, were more likely to switch predator control preferences in an attempt to carefully match their preferred predator control to the scenario (i.e., contextual *sensitivity*). This could mean that the public will be less likely to be anchored to a single control preference for mesocarnivores in agricultural areas and more understanding of micro-management.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Office of Responsible Research Practices at the Ohio State University. The patients/participants provided their informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

JB and KS contributed to the conception and design of the study. MS performed the statistical analysis and

wrote the first draft of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcosc.2022.844346/full#supplementary-material

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