Bobcat and coyote management scenarios: evaluating the flexibility of management preferences in probable scenarios

Thesis

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Abstract

Coyotes (*Canis latrans*) are now commonplace in cities across the United States, and bobcats (*Lynx rufus*) are growing in numbers within city limits as years pass. These generalist mesocarnivores have adapted their behaviors to thrive in an anthropogenic environment. This phenomenon is largely unnoticed by much of the public. However, humans have struggled to adapt their behaviors in response to the increased presence of mesocarnivores in cities. The urban public in the United States is generally uncertain how to foster a healthy relationship with wildlife in urban areas. Management agencies tend to be more reactive rather than proactive in dealing with carnivores, but proactive management may be necessary to foster human-carnivore co-existence in urban areas. We sought to better understand residents' judgements of appropriate responses to interactions with coyotes and bobcats in scenarios not involving a threat to human safety. To do this 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 the most appropriate method of predator control in response to each scenario. In our first study (chapter 2) we determined the likelihood that an individual would switch their preferred method of predator control between two human-mesocarnivore scenarios. We found that switching was predicted best by the location in which the scenarios occurred (i.e., residential or agricultural area) and second

by an increase in severity between the two scenarios' context. Interestingly, a variety of cognitive (e.g., wildlife value orientations, affect towards the species of carnivore) and demographic (e.g., gender, level of urbanization in respondent residency) factors identified in prior studies is impacting judgments about the acceptability of various types of control had no impact on the odds of a respondent preferring the same form of predator control in response to different scenarios. In our second study (chapter 3) we found that an individual's predator control preferences in scenarios with no direct threat to human safety were moderately associated with the respondent's residential experience (i.e., the extent to which their current and childhood residences were located in more rural vs. urban locations). Additionally, wildlife value orientations were not as predictive as the urbanization level in respondent residency when predicting an individual's predator control preferences across multiple scenarios. Collectively, these results demonstrate (1) the importance of context (i.e., location and severity of conflict incidents) and (2) residential experience in explaining judgments concerning appropriate means of controlling predators.

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Chapter 1. Introduction

Bobcats (*Lynx rufus*) and coyotes (*Canis latrans*) in the United States have proven that they can adapt to urban environments. Research has found self-sustaining populations that exist within dense metropolitan areas for both bobcats (Young et al., 2019) and coyotes (Gehrt et al., 2010). Sharing living space with humans has inevitably increased human-mesocarnivore interactions and thus, the opportunity for human-mesocarnivore conflicts (Bateman and Fleming, 2012; Gehrt et al., 2010). This circumstance creates a persistent challenge for carnivore conservation: adequately mitigating conflicts that arise in urban and suburban settings, where people are often unaccustomed to dealing with these species. In these densely populated areas, lethal means of controlling carnivores can be limited and can elicit strong responses from concerned community members, but the deployment of many current non-lethal methods of predator control possess other complications in urban areas.

Urban residents are more limited than rural residents in the types of predator control they can perform on their own (Russell and Stanley, 2018). Gehrt et al. (2010) noted that urban and suburban residents rarely have direct interactions with carnivores and are generally uncertain what to do in response to different indirect or direct human-carnivore conflicts. Direct interactions with coyotes in urban areas of the United States have increased in the past decade since Gehrt et al. (2010)'s comment was made

(Draheim et al., 2019). However, it is possible that most urban residents are still generally uncertain what to do when there is a human-carnivore conflict because historically United States urban residents are not used to having to wild carnivores larger than raccoon in dense urban areas. 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 (Hout 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 leghold to shoot to kill, or selective lethal control with poisoned collars on livestock), and for many of the common forms of active non-lethal control (e.g., guardian animals, fladry, loud sounds, flashing bright lights, or extra tall fencing that also extends into the ground). However, many of these methods are impractical for urban use. Lethal predator control within city limits is often not an option for urban residents due to restrictions on the use of traps or discharging firearms, and non-lethal predator control is often limited to methods that do not disturb neighbors in urban and suburban areas.

Aversive conditioning through community-level hazing of coyotes is a public-involved method of predator control that is increasingly employed in urban areas (Sampson and Van Patten, 2020). However, the effectiveness of hazing as a method to reduce human-coyote conflict in urban areas is debatable, with some studies showing success when implemented before conflicts become serious (Bonnell and Breck, 2017), and some studies showing this method to be unsuccessful, especially when implemented after problem-behaviors have developed (Breck et al., 2016). Avversive conditioning is most effective when the entire community is dedicated to the effort (Sampson and Van

Patten, 2020). Still, there is uncertainty about how long the effects of aversive conditioning last (Bonnell and Breck, 2017; Gehrt et al., 2010). Regardless of the efficiency of community driven hazing of coyotes, there is wide support showing that education on how to appropriately haze coyotes has helped increase feelings of security among community members sharing the landscape with coyotes because it helps individuals feel they know what to do when interacting with this species (Bonnell and Breck, 2017; Breck et al., 2016).

Currently, the most effective and popular form of predator controls for urban areas are preventative measures that reduce the chances of carnivores engaging in problematic behaviors (e.g., prohibiting the feeding of wildlife, avoiding leaving pets outside unattended at night or during carnivore breeding season, keeping a safe distance from wildlife when viewing). These preventative measures help immensely because after a carnivore has developed problem behaviors, the behavior is difficult or sometimes impossible to reverse. Preventative measures reduce the chances of conflict developing in the first place, but the public rarely follow authority's rules consistently across time and space (Dietsch et al., 2018). When conflict with carnivores does develop in urban areas despite efforts to prevent it, wildlife managers are highly limited on the types of active predator control they can employ.

Prior research shows that when human-carnivore conflict has passed an individual's level of tolerance, and removal of the problem carnivore is desired, urban residents often prefer translocation rather than resorting to lethal control (Lute and Carter, 2020). Ironically, translocated carnivores sometimes suffer from an increased mortality rate, which defeats the purpose of using a non-lethal control method (Bradley et al., 2005; Linnell et al., 1997). 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 (Bradley et al., 2005; Linnell et al., 1997). Moreover, translocating wildlife is illegal in some states; even where it is legal, agencies may still choose to preclude the use of translocation for managing human-carnivore conflicts because of costs and unintended wildlife conflicts that arise post-translocation.

When carnivores threaten human safety (e.g., displaying excessive aggressive behavior towards humans; attack a human), lethal control is currently considered the best management option (Buteau et al., 2022) because problem-behaviors are particularly challenging and sometimes impossible to reverse in carnivores. However, using lethal control comes with its own set of complications. Lethal management of coyotes does not reduce the number of coyotes in the area for long because coyotes exhibit both compensatory natality and compensatory immigration in response to exploitation (Kierepka et al., 2017; Sterling et al., 1983). Lethal control of coyotes is only effective when the exact coyotes exhibiting the problem-behavior can be removed, and people otherwise are taking preventative measures to prevent problem-behaviors in other coyotes. Furthermore, the high intelligence of coyotes makes them difficult to trap even for experienced trappers. Even with sufficient trapping skills, the types of traps that should be used and/or the placement of these traps is limited in urban areas for safety reasons. For example, snares can result in death by strangulation for non-target animals, including pets. Foothold traps, which are hidden underneath a layer of dirt and debris when properly set, can cause injury and risks to non-target animals as well as any human unaware of exactly where the trap was set. In Stanley Park (located in Vancouver, Canada), managers used bright red signs to alert the public to where live traps for coyotes were set in public areas (Figure 1.1, photo obtained from B.C. Conservation Officer Service).

Figure 1.1 Live coyote trap sign placed in Stanley Park

Management limitations 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. Careful urban planning can leave fragmented green areas to provide refuges for wildlife and thereby reduce human-wildlife conflict (Gehrt et al., 2010). In the past decade or so, scholars have begun emphasizing the importance of attempting to coexist with wildlife (where the self-interests of wildlife are also considered; Carter & Linnell, 2016; Frank et al., 2019; Frank et al., 2015). Research shows that increasing the perceived benefits of wildlife can increase tolerance for wildlife, which, when coupled with information about how to avoid conflicts, may prevent the need for lethal control (Slagle et al., 2013). Science should continue to search for new methods of predator control designed expressly for urban areas to be used in addition to preventative measures. Improved proactive approaches to engaging the public in preventative measures will also be beneficial.

Further innovation in predator control for urban and suburban areas will likely require an understanding of both human behavior and carnivore behavior (Carter & Linnell, 2016). Researchers have studied the management preferences of the public living in areas experiencing human-carnivore conflict (Draheim et al., 2019; Manfredo et al., 1998; Whittaker et al., 2006; Wittman et al., 1998; Zinn et al., 1998). These studies help wildlife professionals gain a better understanding of public preferences regarding appropriate control measures and the factors associated with these preferences. However, it is also imperative to understand the public before interactions become conflict.

We conducted two cross-sectional surveys of adult residents of the United States and the state of Ohio to better understand how urban and suburban residents respond to probable interactions with bobcats and coyotes. We used rural residents as a comparison group against the behavioral preferences found among suburban and urban residents. The United States sample provided respondents with scenarios involving a coyote. The Ohio sample provided respondents with scenarios involving a bobcat. At the time of data collection during 2016, urban and suburban residents of Ohio were unlikely to have experienced conflict with bobcats, which were still recovering across Ohio (Anderson et al., 2015).

In the experimental portion of the survey, respondents were presented with two randomized scenarios that contained either a bobcat (for Ohio residents) or coyote (for U.S. residents) and were asked, in their opinion, which of the predator control actions listed would be most appropriate in each scenario. Exposing each respondent to randomized scenarios allowed observation of how changes in the scenario's location and/or severity context led to either rigidity (consistent response across scenarios) or flexibility in their preferences for predator control. Such an analysis may help with understanding locations of conflict where the public may be more receptive to changes in management. We also aimed to describe preferences for handling probable human-mesocarnivore scenarios that did not involve a direct threat to human safety, and compare the ability of cognitive and demographic factors in explaining the odds of an individual's preferences for predator control across multiple scenarios. We hope this approach will help managers better understand what preferences urban residents may have when human-carnivore interactions begin to increase.

Chapter 2. Impact of Location on Predator Control Preference Patterns

1. Abstract

In recent decades, interactions with carnivores have increased in suburban and urban areas. However, it is unknown how predator control preferences of urban and suburban 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, causing them to be more likely to switch predator control preferences. Subjects overwhelmingly indicated a preference for non-lethal forms of predator control. Specifically, 71.8% of respondents preferred non-lethal control methods in response to both scenarios, 18.5% gave mixed responses (i.e., preferred lethal control in response to one of the scenarios but a non-lethal method in response to the other scenario), and only 9.7% preferred lethal 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.

2. 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 towards 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 (Bateman and Fleming, 2012; Gehrt et al., 2010; 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 (Bruskotter et al., 2009; Decker et al., 2006; Dietsch et al., 2016; Glas et al., 2019; Manfredo et al., 2009; Manfredo et al., 1998; Martínez-Espiñeira, 2006; Whittaker et al., 2006; Wittman et al., 1998; Zinn et al., 1998).

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) (Decker et al., 2006; Glas et al., 2019; Lute et al., 2020; Martínez-Espiñeira, 2006; Whittaker et al., 2006; Wittman et al., 1998). 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. Dietsch et al. (2016) included urbanization but did not make comparisons between urban, suburban, and rural respondent groups. 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 how 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 (Bruskotter et al., 2009; Decker et al., 2006; Glas et al., 2019; Manfredo et al., 2009; Manfredo et al., 1998; Martínez-Espiñeira, 2006; Whittaker et al., 2006; Wittman et al., 1998; Zinn et al., 1998). 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 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.

3. 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 who were representative of the United States (i.e., GfK's Knowledge Panel[1]). 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 day 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%.

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 (i.e., animals have rights of their own; Manfredo et al., 2016; Manfredo et al., 2009). 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 towards bobcats or coyotes, we captured the respondent's affect towards 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 towards 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. (1998:965) 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 2.1). These interaction scenarios were varied by location (agricultural setting or residential setting) and severity (carnivore observed or carnivore killed a domestic animal).

Locational Context		Carnivore Observed	Killed A Domestic Animal
	Agricultural	"Over the past several weeks a ['rancher'/ 'farmer'] has seen a ['coyote' / 'bobcat'] near his sheep on his property, however the ['coyote' / 'bobcat'] has ***not attacked any of the ['sheep'/lambs']***."	"Over the past several weeks a ['rancher'/ 'farmer'] has seen a ['coyote' / 'bobcat'] near his sheep on his property, last night the ['coyote' / 'bobcat'] ***killed one of the ['ranchers' sheep'/ 'farmer's lambs']***."
	Residential	"Over the past several weeks a ['coyote'/ 'bobcat'] has been ***seen several times*** in a residential area."	"Over the past several weeks a ['coyote' / 'bobcat'] has been seen several times in a residential area; the ['coyote' / 'bobcat'] ***kills a resident's pet dog***. (The dog was allowed to 'roam' the neighborhood unsupervised.)"

Severity Context

Figure 2.1 Carnivore scenarios that respondents could receive

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 2.2). 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).

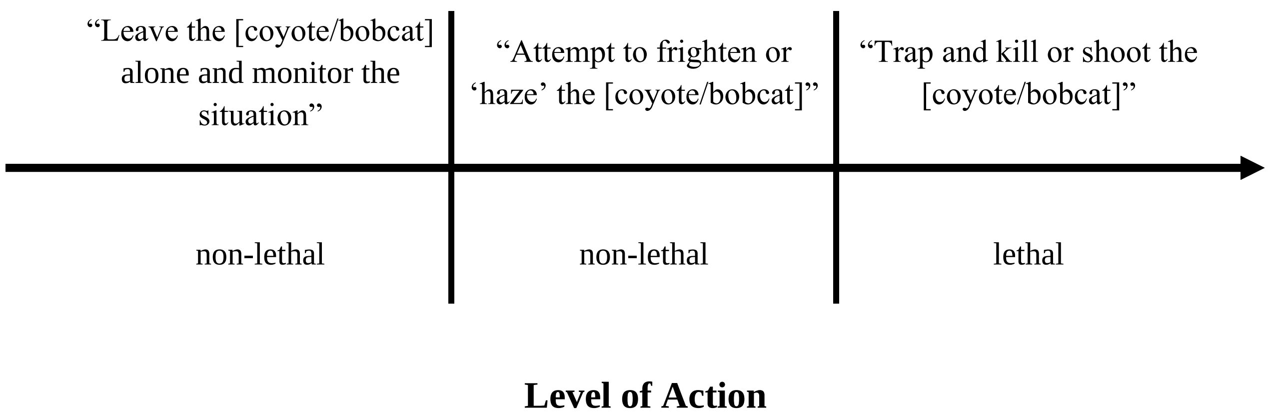

Figure 2.2 Predator control options for responding to the carnivore scenarios given

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 urban-suburban-rural residency variable accounts for the respondent's current actual residency, current perceived residency, and their perceived childhood residency (see Appendix A).

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 towards 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 towards 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 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

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

[2]www.qualtrics.com

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.

4. Results

4.1 Scenario Response Preferences

Results showed that respondents generally preferred non-lethal responses to all scenarios (Table 2.1) 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; $p < .001$). 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; $p < .001$). 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%).

Table 2.1 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

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 2.3; Pearson chi-square =22.87; df=4; $p < .001$). 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).

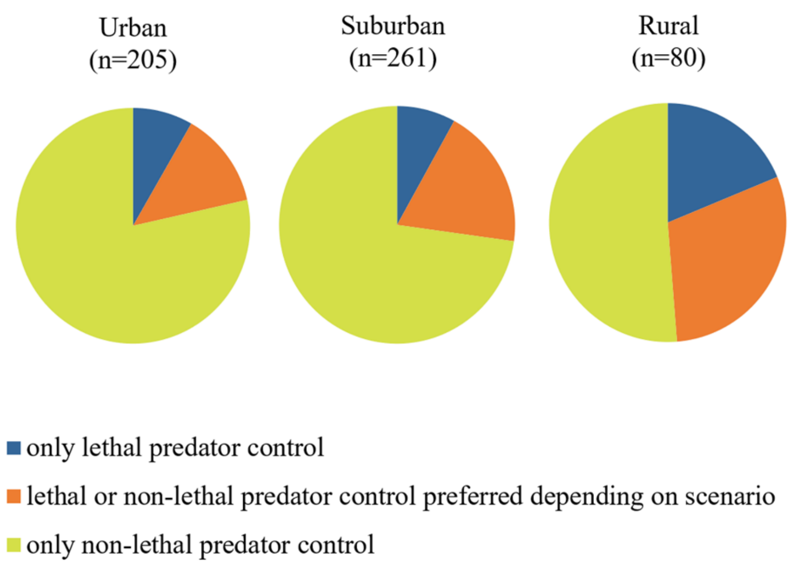

Figure 2.3 Lethal or non-lethal tendency in preferences across respondent's reported level of urbanization

4.2 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 2.2 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 Towards 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 2.2 shows that contextually *sensitive* and *insensitive* respondents were distributed fairly evenly across levels of 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*.

Table 2.3 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%

Contextual *sensitivity* differed depending on the severity or locational context combination respondents received, and the order they received it in (Table 2.3; Pearson chi-square =49.73; df=11; $p < .001$). 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; $p < .001$). 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; $p < .001$). However, counterintuitively, 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).

4.3 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 2.4 shows that the cognitive and demographic factors most often used in literature to explain variance in predator control preferences/acceptance could not significantly explain any variance of sensitivity towards 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).

Table 2.4 Binary logistic regression predicting the probability of contextual sensitivity or insensitivity using only cognitive and demographic predictors

	B	S.E.	DF	P-value	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 Towards 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		

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 2.5; Omnibus tests: $p < .001$; 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 towards 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; $p < .001$). 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; $p < .001$).

Table 2.5 Binary logistic regression predicting the probability of contextual sensitivity or insensitivity using cognitive, demographic, and scenario context combinations as predictors

	B	S.E.	DF	P-value	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 Towards 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		

5. 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 (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 (Bruskotter et al., 2009; Liordos et al., 2017; Manfredo et al., 1998; Slagle et al., 2017; Zinn et al., 1998). 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 towards 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 (Dietsch et al., 2016; Glas et al., 2019; Manfredo et al., 2009; Sijtsma et al., 2012). 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 towards 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 2.5). 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 (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 towards 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 (Dietsch et al., 2016; Glas et al., 2019; Manfredo et al., 2009; Sijtsma et al., 2012; Whittaker et al., 2006; Zinn et al., 1998), and affect towards the species of carnivore (Bruskotter et al., 2009; Slagle et al., 2012) on predator control preferences or acceptability. Future research should 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 respondents responding with certain combinations of predator control preferences, 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, one 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.

6. Conclusion and Management Implications

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.

7. Author Contributions

JB, KS equally contributed to the conception and design of the study. MS performed the statistical analysis. MS wrote the first draft of the manuscript, and all authors contributed to manuscript revision, read, and approved the submitted version.

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Chapter 3. Using Residential Experience to Predict Bobcat and Coyote Control Preferences

1. Abstract

Wildlife agencies are often tasked with managing and mitigating human-wildlife conflicts. However, shifting social values and socio-ecological conditions are changing the socio-ecological context in which these agencies operate. Urban, moderately populated, and rural residential areas each pose a different living environment for both humans and wildlife, which may in turn impact individuals' preferences for how human-carnivore conflicts should be handled in each of these areas. We conducted two cross-sectional surveys to assess the predator control preferences of residents of urban areas, moderately populated areas, and rural areas when given hypothetical management scenarios: one survey was conducted with United States residents and contained scenarios depicting coyote (*Canis latrans*) interactions, while the other survey was conducted with Ohio residents and contained scenarios depicting interactions with bobcats (*Lynx rufus*). We created a measure for individuals' average residential experience that included both childhood residency and current residency. We found that the collective predator control preferences of individuals were moderately associated with urban, moderately populated / mixed, and rural residential experience (Pearson chi-square =31.35; df=12; p=0.002; Cramer's V=0.17). Using multinomial logistic regression, we additionally found that urban, moderately populated / mixed, and rural residential

experience was a better predictor of an individual's combination of carnivore scenario management preferences than wildlife value orientations (i.e., a measure of one's overall beliefs about treatment and management of wildlife). Results from this study showed that residential experience (when measured using more than one point in time) shows promise for understanding an individual's carnivore management preferences. Results from this study also indicate tolerance for mesocarnivores among urban and moderately populated areas for human-carnivore conflicts where there is no human injury.

2. Introduction

Long-term research suggests that the values people hold about wildlife have shifted in recent decades away from an emphasis on the utilization of wildlife for human benefit toward recognition of wildlife as morally relevant (Manfredo et al., 2009; Manfredo et al., 2016). Research has also described a concurrent shift in trust, whereby people have become less trusting of government in general (Webster, 2018). The shifting social environment has challenged wildlife agencies by creating constituencies with fundamentally different views about how wildlife should be managed (Bruskotter et al., 2019).

One solution to the problem of shifting values is to 'tailor' management to be more in line with local concerns, while still promoting methods that are effective at managing species involved in human-wildlife conflict. Tailoring wildlife management to be more in line with local preferences could help ensure management is responsive both to preexisting and emerging constituencies, which could result in greater trust in agencies.

Failure to take the public's preferences into consideration risks a further decrease in trust and legitimacy among the public (Lute and Gore, 2014; Zajac et al., 2012). Among some constituencies this could result in an increased tendency to take wildlife management matters into one's own hands (e.g., poaching). When such efforts result in substantial mortality, they could make it more difficult to predict wildlife populations and associated impacts. Among others, lack of trust could manifest in skepticism of rules meant to prevent carnivore conflict (e.g., remain a safe distance from carnivores when viewing, don't feed wildlife), thereby increasing the chances of conflict with carnivores in these areas. Thus, past literature has striven to characterize predator control preferences among the public and gain a better understanding of what factors can explain variation in or predict the likelihood of these preferences (Decker et al., 2006; Glas et al., 2019; Zinn et al., 1998).

2.1 Residential Environment

Variation in infrastructure and human population density in urban and rural landscapes provide a vastly different living environment for both humans and wildlife, which can impact the human-wildlife interactions in these areas (Bruskotter et al. 2017). Some generalist species of mesocarnivores, such as coyotes (*Canis latrans*), are adept at quickly modifying their behaviors to not only survive but thrive with a decreased mortality rate in dense metropolitan areas (Gehrt et al., 2010). Dietsch et al. (2016) found that modernization (modernization measured by county-level urbanization, income, and education; in the state of Washington, U.S.) is strongly correlated with an increase in mutualistic wildlife values (i.e., wildlife deserve care and animals are worthy of one's social circle) and a decrease in domination wildlife values (i.e., wildlife are for human use; Manfredo et al., 2016; Manfredo et al., 2009).

Urban, suburban, and rural residential environments each offer different opportunities, and the opportunities available to a person where they live, impact the experiences they have and local social ties they develop (Feijten et al., 2008). Individuals develop values, attitudes, and opinions on the world around them through both their experiences and social ties. Social ties can dictate the behaviors that are seen as socially normal or socially acceptable (Rimal and Real, 2005). Experiences impact one's perceptions of the world around them.

When investigating the general influence of residential experience on people's opinions, it is vital to consider the level of urbanization where a person grew-up as well as the level of urbanization for the place in which they currently reside because both have an impact on attitude and value formation. Experiences from childhood play a critical part in the formation of core values that can last a lifetime (Rokeach, 1973). The influences from childhood residential experience and current residential experience are not necessarily independent because experiences from the past can impact what individuals believe and value in the future (Rokeach, 1973). Thus, combining childhood and current residency allows to better capture the totality of a person's residential experience during two important stages (i.e., now and while that person was developing).

Taking the public's management preferences into consideration is complicated when preferences differ across geographies, but necessary because state agencies that manage fish and wildlife are beholden to manage wildlife in the interest of the public under the ‘public trust doctrine’ (Freyfogle et al., 2019). Stanger et al. (2022) found that the propensity to prefer lethal predator control was associated with urban, suburban, and rural residency (measure included childhood and current residency). Preferences for lethal predator control increased along the urban-rural gradient. That research is generally consistent with another study showing that human-carnivore coexistence behaviors, and perceptions of carnivores differ between residents living in the urban core and residents living in the less-densely populated peripheral urban areas (Lute et al. 2020).

2.2 The Most Probable Human-Carnivore Conflicts in Urban Areas

Following prior studies designed to assess preferences for various types of control, we presented respondents with hypothetical scenarios containing either a coyote or a bobcat (*Lynx rufus*). Most bobcat and coyote activity in urban areas remains unnoticed by humans, so much so that urban residents are often completely unaware that they are sharing the landscape with these mesocarnivores (Gehrt et al., 2010). Buteau et al. (2022) surveyed urban residents in New Hanover County, North Carolina to determine the most common coyote interactions experienced by urban residents in that area. The authors found that simply observing the coyote in different urban areas were the first and second most common interactions reported. The third most common interaction was “Chasing or taking pets not on leashes during daylight hours”. None of the respondents reported a coyote “Attacking or taking pets on leashes or in close proximity to pet owners during daylights hours”. When Poessel et al. (2013) gathered reports of coyotes in the Denver Metropolitan Area, they found that ~87% of human-coyote interactions were observations (i.e., neutral or positive interaction) and ~13% of human-coyote interactions entailed conflict (i.e., interaction with a negative repercussion for the human). Among the reported conflicts with coyotes, ~92% were attacks on pets.

Most of past literature that has used hypothetical carnivore interaction scenarios in surveys to investigate the acceptance of, or preference for, different predator control methods each contained at least one scenario that either included the carnivore causing human injury or the carnivore posing a danger to human safety or health that is explicitly stated in the scenario (e.g., carnivore carrying a disease that is harmful to humans, or carnivore has shown aggressive behavior toward humans; Decker et al., 2006; Glas et al., 2019; Manfredo et al., 1998; Wittmann et al., 1998; Zinn et al., 1998). The inclusion of such scenarios could be concerning because it might create a response bias for other more benign scenarios presented to the respondent using the same species. Individuals with little knowledge of human-wildlife interactions might assume scenarios that involve injury to humans are more common than they really are, which, in turn, could affect their preferences for how such interactions with that species should be handled by management agencies. Accordingly, this study sought to construct hypothetical scenarios that depict the most common types of interactions, which may or may not be considered ‘conflicts’ by individuals.

Since none of the scenarios in this study include human injury or an explicit danger to human safety or health (unlike previous research on predator control preferences or acceptance among urban residents), it covers an understudied domain with a lower degree of personal risk. Filling this knowledge gap is crucial to understanding the typical predator control preferences of urban and rural residents in response to the most probable human-carnivore conflicts in the United States because human-carnivore interactions within the United States rarely result in human injury, even in urban areas (Buteau et al., 2022; Poessel et al., 2013; Soulsbury and White, 2015).

2.3 Predicting Combinations of Predator Control Preferences

Stanger et al. (2022) found that the likelihood of flexibility in an individual's predator control preferences between two probable human-mesocarnivore scenarios could be predicted best by the location in which the scenarios occurred (i.e., residential or agricultural) and second by an increase in severity between the two scenarios' context. Cognitive and demographic factors had no impact on the odds of a respondent preferring the same form or different forms of predator control in response to different scenarios. This analysis indicates a pattern of the individual's predator control responses (i.e., *rigid* or *flexible*), but does not indicate the individual's specific combination of responses (i.e., preference combination) regarding specific non-lethal or lethal control methods. The cognitive and demographic factors that were tested in that study included wildlife value orientations, attitude towards the species, gender, and average level of urbanization in respondent residency. In this study we used the same dataset to determine if these cognitive and demographic factors could predict the likelihood of specific combinations of predator control preferences (i.e., how individuals responded across multiple scenarios). We expected these variables to be significant in the prediction of predator control preference combinations because past research has found wildlife value orientations (Glas et al., 2019; Manfredo et al., 2009; Zinn et al., 1998), affective reaction towards the scenario's subject carnivore (Slagle et al., 2012; Sponarski et al., 2015), and the respondent's gender (Agee and Miller, 2009) can impact predator control preferences.

This study also sought to characterize the predator control preference combinations of respondents based on average residential experience. We expected to see an association between a respondent's residential experience and predator control preference combination because a combined measure of both childhood and current residency might be able to better capture the effect of one's social networks and experiences connected with their living environment.

3. Methods

3.1 Data Collection

During 2016, we conducted an online survey of adult United States residents and adult Ohio residents using samples obtained from an online panel of respondents designed to be representative of the United States (i.e., GfK's Knowledge Panel). Emails were delivered to 645 Ohio residents for the bobcat survey and 651 United States residents for the coyote survey during July of 2016. These emails included an invitation for respondents to take the survey and an internet link to the survey on the Qualtrics 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 day 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%.

3.2 Measuring Cognitive Variables

Wildlife value orientations were measured by asking respondents on a 7-point bipolar response scale if they agreed or disagreed with a block of 19 statements designed to measure two orientations: mutualism and domination (see Manfredo et al., 2009). We calculated separate mean scores for domination and mutualism for each respondent which were treated as independent variables in subsequent analyses. We computed the McDonald's omega reliability coefficients for the items averaged to calculate mutualism (ω=0.81) and for the items averaged to calculate domination (ω=0.84) to determine that the reliability was acceptable (Hayes and Coutts, 2020).

We captured the affective component of a respondent's attitude towards either bobcats or coyotes before they were presented with any carnivore scenarios. Affect is the initial positive or negative association one has in response to a stimulus (Slovic et al., 2007). We first asked respondents to record in a few words the "first thought or image that comes to mind" when they think about bobcats or coyotes. This simple exercise served to help respondents identify their affective reaction towards the species. Then we asked respondents how negative or positive they feel about that thought or image on a 5-point bipolar response scale. The standardized elicitation measure of affect was constructed by Slovic et al. (1991).

3.3 Measuring Average Residential Experience

We used data from three different measures of residency to create a robust ordinal measure that categorizes respondents as having either an urban, moderately populated, or rural average residential experience. The new average "residential experience" variable accounts for the respondent's current residency (Metropolitan Statistical Area status, hereafter MSA), current self-reported current residency, and their self-reported childhood residency (see appendix A). In the self-reported residency questions, we asked the respondent to categorize their current or childhood residence with 8 possible choices each based on an ordered description of population size (e.g., "Small city with 25,000 to 49,999 people"). The MSA variable was included in the calculation of residential experience because MSA distinction does not rely on perceptions of residency, and MSA distinction measures a different aspect of residential experience by including urban economic connectivity. The United States Census Bureau determines the area of an MSA through both population size and urban economic connectivity (e.g., commuting patterns; United States Census Bureau). The resulting residential experience variable was split into three categories: "urban", "moderately populated / mixed", and "rural". More information on creation of the residential experience variable and the location of the categorical splits can be found in appendix A.

This measure for residential experience has two major limitations. The first is that residency was only measured from two points in time. Taking an average of residential experience by using more than two points in time would have produced a more accurate depiction of the respondent's residential experience over their lifetime. Since only two points in time were measured, our variable does little for capturing the average residential experience for individuals who have moved to many different places throughout their life (e.g., military families), and individuals who very recently moved to their current place of residence without enough time to gather experiences from the area. The second limitation of average residential experience is that the average gives an inaccurate representation for individuals who reported living in urban areas and rural areas, but not moderately populated areas (9.7% of respondents; n=53). For this reason, labeled the middle residential experience category “moderately populated / mixed”. However, our residential experience variable is likely a theoretically acceptable average for most of our respondents despite these limitations because most respondents either reported the same level of urbanization for both their childhood residency and their current residency (43.6%; n=238) or reported their childhood residency being only slightly more or less urbanized than their current residency (28.9%; i.e., 1- or 2-degree difference in urbanization level with 8 possible levels of urbanization). Past research shows that adults often choose to return to the community where they grew up (Blaauboer, 2011; Feijten et al., 2008), and rural residents who do not return to the community where they grew up are more likely to choose another rural area to live in rather than an urban or suburban area (Feijten et al., 2008).

The average residential experience variable is meant to capture the collective effects from experiences around the area that the respondent reported living in rather than the exact location. For this reason, we found it acceptable to average the residential experience for respondents who reported living in both urban and moderately populated areas, or both moderately populated and rural areas, because a person who has reported two different levels of urbanization in residency, has likely experienced visiting the surrounding areas which are in between the different levels of urbanization they reported. Individuals for whom we had to average urban and moderately populated residency together or moderately populated and rural residency together, received an averaged result that gives way to the most extreme urbanization level they reported experiencing.

3.4 Carnivore scenarios

We prepared a set of 4 hypothetical scenarios depicting probable indirect human-mesocarnivore interactions for the scenario section of the survey. Respondents were randomly assigned to 2 of 4 possible human-carnivore interaction scenarios (Figure 3.1). These interaction scenarios 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 4 scenarios were randomly used in each survey (for U.S. residents and Ohio residents), but with the subject mesocarnivore question context switched to either coyotes or bobcats, respectively.

Locational Context	Carnivore Observed	Killed A Domestic Animal
Agricultural	"Over the past several weeks a ['rancher'/ 'farmer'] has seen a ['coyote' / 'bobcat'] near his sheep on his property, however the ['coyote' / 'bobcat'] has ***not attacked any of the ['sheep'/lambs']***."	"Over the past several weeks a ['rancher'/ 'farmer'] has seen a ['coyote' / 'bobcat'] near his sheep on his property, last night the ['coyote' / 'bobcat'] ***killed one of the ['ranchers' sheep'/ 'farmer's lambs']***."
Residential	"Over the past several weeks a ['coyote'/ 'bobcat'] has been ***seen several times*** in a residential area."	"Over the past several weeks a ['coyote' / 'bobcat'] has been seen several times in a residential area; the ['coyote' / 'bobcat'] ***kills a resident's pet dog***. (The dog was allowed to 'roam' the neighborhood unsupervised.)"

Severity Context

Figure 3.1 Carnivore scenarios that respondents could receive

3.5 Carnivore scenario response options

Respondents were asked which predator control method they thought to be the "most appropriate" for each scenario using a multiple-choice question with four possible choices. The three main predator control answer choices included two non-lethal choices and one lethal choice (Figure 3.2). A fourth option stating "none of these actions are appropriate" was included in recognition that some respondents may reject any type of management, while others may consider options not investigated here that are generally considered infeasible for management agencies (e.g., surgical sterilization, translocation).

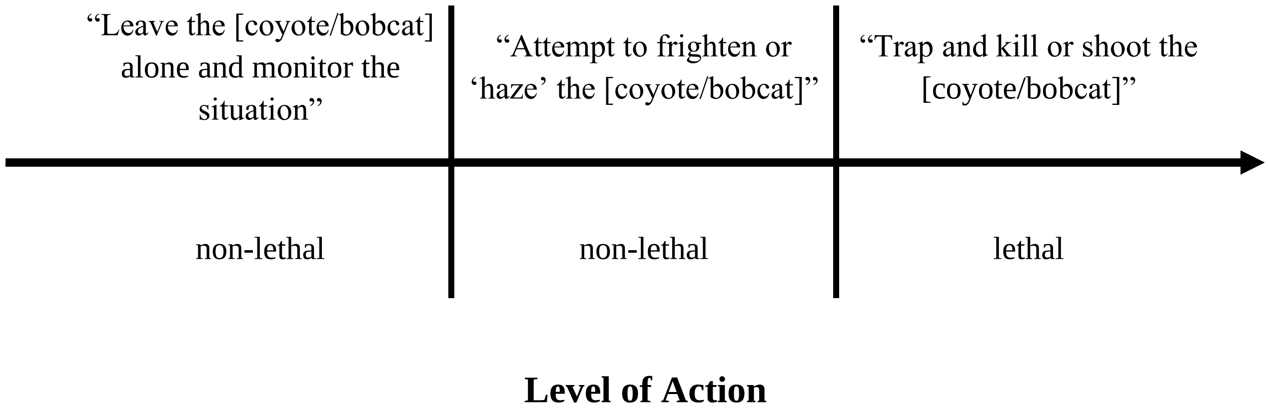

Figure 3.2 Lethal or non-lethal status for carnivore-scenario management options

3.6 Data Exclusion Criteria

Because our study was primarily 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, so as not to 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 also 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.

3.7 Data grouping

We define "preference combination" as a combination of predator control preferences in response to a set of hypothetical scenarios with respect to order for the purposes of this manuscript. All of the analyses in this manuscript investigate each respondent's preference combination in response to both scenarios, rather than the isolated preference for each scenario.

For some of the analyses, we divided preference combinations into two groups based on rigidity in pattern: *flexible* preference combinations and *rigid* preference combinations. The *flexible* pattern is defined by a change in preference between the first and second scenario presented. The *rigid* pattern is defined by no change in preference between the first and second scenario presented.

The responses from the United States sample (coyote scenarios given) and from the Ohio sample (bobcat scenarios given) were combined for parts of 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. We found a moderate association (Cohen, 1988) between the respondent's preference combination and the dichotomous variable depicting if respondents were from the United States sample (coyote scenarios given) or from the Ohio sample (bobcat scenarios given) (Pearson chi-square =15.92; df=6; p=0.014; Cramer's V=0.171; We referred to Cohen (1988) to judge effect size of Cramer's V in a way that takes degrees of freedom into consideration.) Due to this association, a dichotomous variable depicting which sample the respondent was from was included in the multinomial logistic regression as a control variable.

Predator control preference combinations containing a lethal method and a non-lethal method were partially collapsed for part of the analyses in this manuscript (Figure 3.3). Preferences for hazing the carnivore or monitoring the carnivore in the scenario, were given the same coding (i.e., "non-lethal") just for these select response combinations. We discuss the appropriateness of this data collapse in Appendix B. The order of the responses given was preserved for all the predator control preference combinations.

Monitor / Lethal
Haze / Lethal
Non-lethal / Lethal

Lethal / Monitor
Lethal / Haze
Lethal / Non-lethal

Key: Answer to first scenario / Answer to second scenario

Monitor - "Leave the [Coyote/Bobcat] alone and monitor the situation"

Haze - "Attempt to frighten or 'haze' the [Coyote/Bobcat]"

Lethal - "Trap and kill or shoot the [Coyote/Bobcat]"

Non-lethal – Monitor or Haze

Figure 3.3 Collapse of preference combinations for analyses

3.8 Regression Analysis

We used a multinomial logistic regression model to determine cognitive and demographic variables that were significant in the likelihood estimate of predator control preference combinations. As our independent variables, we included residential experience (urban, moderately populated / mixed, 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), and variables that have been found in previous literature to be significant in explaining variance in preferred or accepted predator control. These independent variables from the literature included wildlife value orientations (Manfredo et al., 2009), affect for the carnivore involved in the scenario (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 strict overall sample size recommendation of adhering to a minimum sample size of 500 in logistic regression to be able to create reliable parameter estimates for large populations in observational studies (Bujang et al., 2018; Peduzzi et al., 1996). We confirmed that there were no multicollinearity issues between the independent variables (VIF<1.3 for all independent 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 independent variables and the logit of the response variable was tested using a Box-Tidwell transformation test.

4. Results

4.1 Predator Control Preference Combinations

Table 3.1 displays all the possible response combinations in order of popularity. Results showed that about 1 in 4 respondents preferred to haze the bobcat or coyote in response to both scenarios (27%; Table 3.1, row a). About half (51%) of the respondents preferred the same management method in both scenarios (Table 3.1, rows a, c, d, j). Among these respondents with rigid predator control preferences, there were almost five times as many respondents who chose a non-lethal method (39%, Table 3.1, rows a, c), than respondents who chose lethal control (8%, Table 3.1, row d). About half (49%) of respondents were flexible in their preferred predator control (49%; Table 3.1, rows b, e, f, g, h, i, k, l, m, n, o, p). Among those respondents who changed their preferred method of control, there were almost twice as many respondents who escalated their preference to a more intensive method of predator control (25%; Table 3.1, rows b, f, h), than respondents who de-escalated to a less intensive method (12%; Table 3.1, rows e, g, i). Only 4% (Table 3.1, rows h, p) of respondents situationally preferred the least intensive predator control option (monitor the carnivore) and the most intensive predator control option (lethal control).

Table 3.1 Responses to the randomized scenarios in order of popularity

Predator Control Preference Combinations		**# of Respondents**	**% of Total Respondents**
a. Scenario 1.) Haze	**Scenario 2.) Haze**	173	26.7%
b. Scenario 1.) Monitor	**Scenario 2.) Haze**	96	14.8%
c. Scenario 1.) Monitor	**Scenario 2.) Monitor**	80	12.4%
d. Scenario 1.) Lethal	**Scenario 2.) Lethal**	53	8.2%
e. Scenario 1.) Haze	**Scenario 2.) Monitor**	43	6.6%
f. Scenario 1.) Haze	**Scenario 2.) Lethal**	42	6.5%
g. Scenario 1.) Lethal	**Scenario 2.) Haze**	31	4.8%
h. Scenario 1.) Monitor	**Scenario 2.) Lethal**	25	3.9%
i. Scenario 1.) Monitor	**Scenario 2.) Other**	24	3.7%
j. Scenario 1.) Other	**Scenario 2.) Other**	23	3.6%
k.Scenario 1.) Haze	**Scenario 2.) Other**	16	2.5%
l. Scenario 1.) Other	**Scenario 2.) Haze**	14	2.2%
m.Scenario 1.) Other	**Scenario 2.) Monitor**	12	1.9%
n. Scenario 1.) Other	**Scenario 2.) Lethal**	8	1.2%
o. Scenario 1.) Lethal	**Scenario 2.) Other**	4	0.6%
p. Scenario 1.) Lethal	**Scenario 2.) Monitor**	3	0.5%

Predator control preference combinations containing a lethal method and a non-lethal method were partially collapsed by giving the same coding (i.e., "non-lethal") to preferences for hazing or monitoring for the purposes of the rest of the analyses in this manuscript (Figure 3.3). Additionally, respondents who chose "none of these actions are appropriate" in response to either of the carnivore scenarios given (16%; n=101, Table 3.1, rows i, j, k, l, m, n, o) were excluded from the rest of the analyses due to the wide range of possible reasons a respondent may choose this option.

4.2 Residential Experience

We found that predator control preference combinations were moderately associated (Cohen, 1988) with urban, moderately populated / mixed, and rural residential experience (Pearson chi-square =31.35; df=12; p=0.002; Cramer's V=0.17). Differences in predator control preference combinations given by respondents with urban residential experience, moderately populated / mixed residential experience, or rural residential experience became clearer when *flexible* response combinations were separated from *rigid* response combinations (Figure 3.4 and 3.5).

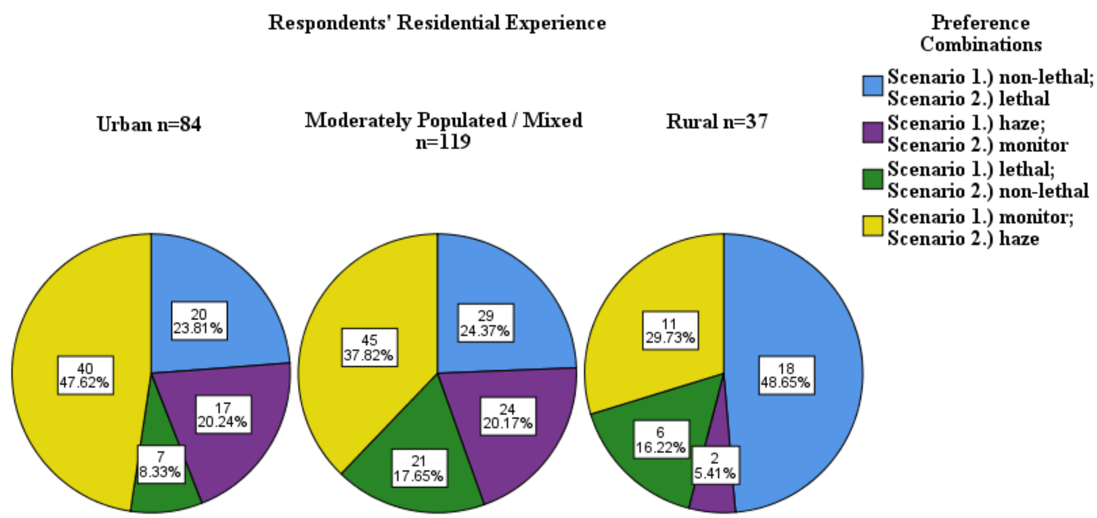

Figure 3.4 *Flexible* predator control preference combinations split by residential experience

Flexible response combinations (Figure 3.4) were moderately associated (Cohen, 1988) with residential experience (Pearson chi-square =16.04; df=6; p=0.014; Cramer's V=0.18) such that respondents with urban residential experience were least likely to choose lethal control methods. We found that among respondents with *flexible* response combinations, urban vs. rural residential experience had a large effect (Cohen, 1988) on the predator control preference combination (Pearson chi-square=12.08, df=3, p=0.007, Cramer's V = 0.32), and moderately populated / mixed vs. rural residential experience had a medium effect (Cohen, 1988) on the predator control preference combination (Pearson chi-square=9.76, df=3, p=0.021, Cramer's V = 0.25). *Flexible* predator control preference combinations were also statistically independent of whether the respondent was from the Ohio sample (i.e., received the bobcat scenarios) or from the United States sample (i.e., received the coyote scenarios) (Pearson chi-square =1.42; df=4; p=0.703).

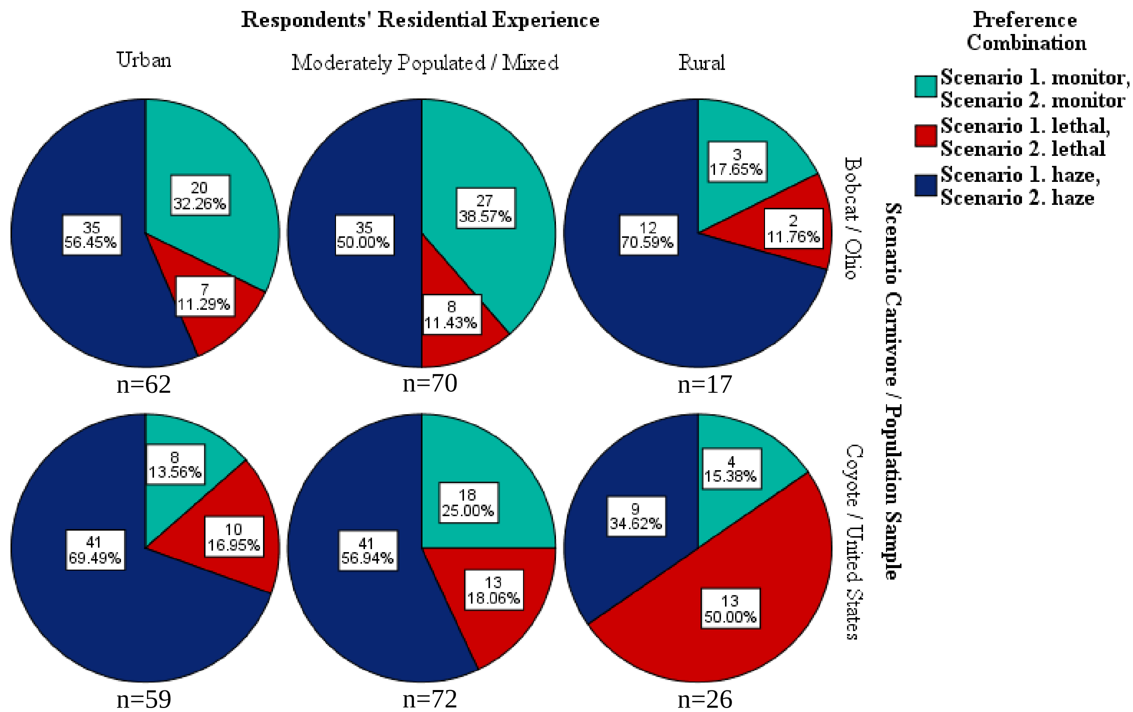

Figure 3.5 *Rigid* predator control preference combinations split by residential experience and survey sample

Rigid response combinations (Figure 3.5) were also moderately associated (Cohen, 1988) with residential experience (Pearson chi-square =14.14; df=4; p=0.007; Cramer's V=0.15), but weakly associated (Cohen, 1988) with whether the respondent was from the Ohio sample (i.e., received the bobcat scenarios) or from the United States sample (i.e., received the coyote scenarios) (Pearson chi-square =12.08; df=2; p=0.002; Cramer's V=0.20). Among rural respondents, there was a strong association (Cohen,

1988) between *rigid* preference combinations and whether the respondent was from the Ohio sample (i.e., received the bobcat scenarios) or from the United States sample (i.e., received the coyote scenarios) (Pearson chi-square =7.06; df=2; p=0.029; LR=0.021; Cramer's V=0.41).

4.3 Multinomial Logistic Regression

The multinomial logistic regression (hereafter MLR) model outperformed the null model (likelihood ratio p=0.00). We included a summary of the results from this multinomial logistic regression model in Table 3.2. The significant results from the multinomial logistic regression model were divided into 4 tables (Tables 3.3-3.6), each with their own interpretive paragraph. These tables report the parameter estimates for each significant predator control preference combination compared to the reference category. Note that all 4 tables (Tables 3.3-3.6) are part of the same multinomial logistic regression model that is displayed in the Table 3.2 summary. The reference category used throughout the entirety of this analysis was the flexible preference combination of non-lethal in the first scenario and lethal in the second scenario.

Table 3.2 Significant odds ratios from MLR predicting predator control preference combinations

*p≤0.05

Reference category: Scenario 1.) Non-Lethal, Scenario 2.) Lethal	**Rigid Responses**				**Flexible Responses**	
	S1.) Monitor, S2.) Monitor	***S1.) Haze, S2.) Haze***	***S1.) Lethal, S2.) Lethal***	***S1.) Lethal, S2.) Non-Lethal***	***S1.) Monitor, S2.) Haze***	***S1.) Haze, S2.) Monitor***
Mutualism	1.603*					
Domination	0.631*	0.700*				
Ohio or United States population sample						
Affect for Bobcats or Coyotes						1.494*
Gender (2=Female; 1=Male)		2.073*			3.199*	
Urban Residential Experience	3.384*	3.281*			3.538*	8.939*
Moderately Populated / Mixed Residential Experience	3.999*				2.565*	8.180*
Rural Residential Experience (subcategory reference)	-	-	-	-	-	-

Results showed that mutualism and/or domination wildlife value orientations were significant predictors of rigid non-lethal preference combinations (Table 3.2) compared to the reference category (i.e., a non-lethal method in the first scenario and escalating to a lethal method for the second scenario). Four non-lethal preferences combinations showed that respondents with an urban residential experience were more likely than respondents with a rural residential experience to prefer only non-lethal predator control methods in response to both randomized scenarios they were given, rather than the reference category (Table 3.2). Three non-lethal preferences combinations showed that respondents with a moderately populated / mixed residential experience were more likely than respondents with a rural residential experience to prefer only non-lethal predator control methods in response to both randomized scenarios they were given, rather than the reference category (Table 3.2). None of the variables were significant for predicting the odds of respondents choosing lethal in both scenarios or choosing lethal in the first scenario and non-lethal in the second scenario, rather than choosing the reference category (Table 3.2).

Table 3.3 Results of Multivariate Logistic Regression Explaining Responses to Two Randomized Carnivore Scenarios

Reference category: Scenario 1.) Non-Lethal Scenario 2.) Lethal	B	Std. Error	df	P-value	Exp(B)	95% Confidence Interval for Exp(B) **Lower Bound**	**Upper Bound**
Scenario 1.) <u>Monitor</u> Scenario 2.) <u>Monitor</u>							
Intercept	-1.391	0.961	1	0.148			
Mutualism	0.472	0.155	1	0.002	1.603*	1.183	2.170
Domination	-0.461	0.189	1	0.015	0.631*	0.436	0.913
Ohio or United States population sample	-0.091	0.370	1	0.805	0.913	0.442	1.885
Affect for Bobcats or Coyotes	0.245	0.153	1	0.110	1.277	0.946	1.725
Gender (2=Female; 1=Male)	0.416	0.372	1	0.264	1.516	0.731	3.146
Urban Residential Experience	1.219	0.564	1	0.031	3.384*	1.121	10.215
Moderately Populated / Mixed Residential Experience	1.386	0.534	1	0.009	3.999*	1.405	11.382
Rural Residential Experience (subcategory reference)	0		0				

The odds of a respondent preferring to monitor the carnivore in both scenarios, instead of preferring the reference category (i.e., a non-lethal method in the first scenario and a lethal method for the second scenario), increases by 60% for every one-unit in increase in the mutualism score (mutualism range=6; Table 3.3). This means that respondents with a higher mutualist orientation were more likely to prefer consistently monitoring carnivores (the response with the least impact on the animal involved) in response to these randomized human-mesocarnivore scenarios than they were to prefer the reference category (p=0.002; Exp(B)=1.603; std. error=0.155). The odds of a respondent preferring to monitor the carnivore in both scenarios instead of preferring the reference category decreases by 37% for every one-unit in increase in the domination score (domination range=6). This means that respondents with a higher domination orientation were less likely to consistently prefer monitoring carnivores in response to these randomized human-mesocarnivore scenarios than they were to prefer the reference category (p=0.015; Exp(B)=0.631; std. error=0.189). In comparison to the odds for respondents with rural residential experience, respondents with urban residential experience were 238% more likely and respondents with a moderately populated / mixed residential experience were 300% more likely to consistently prefer monitoring carnivores in response to these randomized human-mesocarnivore scenarios than they were to prefer the reference category (Urban: p=0.031, Exp(B)=3.384, std. error=0.564; Moderately populated / mixed: p=0.009, Exp(B)=3.999, std. error=0.534).

Table 3.4 Results of Multivariate Logistic Regression Explaining Responses to Two Randomized Carnivore Scenarios

Reference category: Scenario 1.) Non-Lethal Scenario 2.) Lethal	B	Std. Error	df	P-value	Exp(B)	95% Confidence Interval for Exp(B) **Lower Bound**	 **Upper Bound**
Scenario 1.) <u>Haze</u> Scenario 2.) <u>Haze</u>							
Intercept	-1.474	0.810	1	0.069			
Mutualism	0.101	0.129	1	0.432	1.107	0.859	1.425
Domination	-0.357	0.163	1	0.028	0.700*	0.509	0.963
Ohio or United States population sample	0.538	0.316	1	0.088	1.712	0.922	3.178
Affect for Bobcats or Coyotes	0.220	0.130	1	0.091	1.246	0.965	1.609
Gender (2=Female; 1=Male)	0.729	0.325	1	0.025	2.073*	1.097	3.915
Urban Residential Experience	1.188	0.428	1	0.005	3.281*	1.418	7.588
Moderately Populated / Mixed Residential Experience	0.765	0.406	1	0.060	2.149	0.969	4.766
Rural Residential Experience (subcategory reference)	0		0				

The odds of a respondent preferring to haze the carnivore in both scenarios, instead of preferring the reference category (i.e., a non-lethal method in the first scenario and a lethal method for the second scenario), decreases by 30% for every one-unit increase in the domination score (domination range=6; Table 3.4). This means that respondents with a higher domination orientation were less likely to prefer consistently hazing carnivores in response to these randomized human-mesocarnivore scenarios than they were to prefer a flexible (non-lethal to lethal) response (p=0.028; Exp(B)=0.70; std. error=0.163). In comparison to the odds for male respondents, female respondents were

107% more likely to prefer consistently hazing carnivores in response to these randomized human-mesocarnivore scenarios than they were to prefer the reference category (p=0.025; Exp(B)=2.073; std. error=0.325). In comparison to the odds for respondents with rural residential experience, respondents with urban residential experience were 228% more likely to prefer consistently hazing carnivores in response to these randomized human-mesocarnivore scenarios than they were to prefer the reference category (p=0.005; Exp(B)=3.281; std. error=0.428).

Table 3.5 Results of Multivariate Logistic Regression Explaining Responses to Two Randomized Carnivore Scenarios

Reference category: Scenario 1.) Non-Lethal Scenario 2.) Lethal	**B**	**Std. Error**	**df**	**P-value**	**Exp(B)**	**95% Confidence Interval for Exp(B) Lower Bound**	**Upper Bound**
Scenario 1.) <u>Monitor</u> Scenario 2.) <u>Haze</u>							
Intercept	-2.557	0.923	1	0.006			
Mutualism	0.255	0.145	1	0.079	1.290	0.971	1.713
Domination	-0.326	0.181	1	0.071	0.722	0.507	1.028
Ohio or United States population sample	0.278	0.350	1	0.428	1.320	0.664	2.623
Affect for Bobcats or Coyotes	0.230	0.145	1	0.111	1.259	0.948	1.671
Gender (2=Female; 1=Male)	1.163	0.359	1	0.001	3.199*	1.583	6.465
Urban Residential Experience	1.264	0.498	1	0.011	3.538*	1.334	9.388
Moderately Populated / Mixed Residential Experience	0.942	0.475	1	0.047	2.565*	1.011	6.507
Rural Residential Experience (subcategory reference)	0		0				

In comparison to the odds for male respondents, female respondents were 220% more likely to prefer monitor in the first scenario and haze in the second scenario than they were to prefer the reference category ($p=0.001$; Exp(B)=3.199; std. error=0.359; Table 3.7; reference category: a non-lethal method in the first scenario and escalating to a lethal method for the second scenario). In comparison to the odds for respondents with rural residential experience, respondents with urban residential experience were 254% more likely and respondents with a moderately populated / mixed residential experience were 157% more likely to prefer monitor in the first scenario and haze in the second scenario than they were to prefer the reference category (Urban: $p=0.011$, Exp(B)=3.538, std. error=0.498; Moderately populated / mixed: $p=0.047$, Exp(B)=2.565, std. error=0.475). This means that when respondents with urban residential experience and respondents with a moderately populated / mixed residential experience decided to escalate the method of predator control, they were more likely than respondents with rural residential experience to stay within the use of non-lethal methods only. However, the likelihood of staying within the use of non-lethal methods compared to respondents with rural residential experience when escalating to a more intensive form of predator control was greater for respondents with urban residential experience than it was for respondents with a moderately populated / mixed residential experience.

Table 3.6 Results of Multivariate Logistic Regression Explaining Responses to Two Randomized Carnivore Scenarios

Reference category: Scenario 1.) Non-Lethal Scenario 2.) Lethal	B	Std. Error	df	P-value	Exp(B)	95% Confidence Interval for Exp(B) **Lower Bound**	 **Upper Bound**
Scenario 1.) Haze Scenario 2.) Monitor							
Intercept	-3.667	1.259	1	0.004			
Mutualism	0.317	0.178	1	0.075	1.373	0.969	1.944
Domination	-0.079	0.219	1	0.718	0.924	0.602	1.419
Ohio or United States population sample	0.024	0.430	1	0.955	1.025	0.441	2.383
Affect for Bobcats or Coyotes	0.402	0.181	1	0.027	1.494*	1.047	2.132
Gender (2=Female; 1=Male)	0.780	0.430	1	0.070	2.182	0.939	5.072
Urban Residential Experience	2.190	0.834	1	0.009	8.939*	1.744	45.820
Moderately Populated / Mixed Residential Experience	2.102	0.811	1	0.010	8.180*	1.669	40.093
Rural Residential Experience (subcategory reference)	0		0				

The odds of a respondent preferring to haze in the first scenario and monitor in the second scenario instead of preferring the reference category (i.e., a non-lethal method in the first scenario and a lethal method for the second scenario) increases by 49% for every one-unit in increase in the respondent’s affect towards the mesocarnivore species (affect range=4; Table 3.8). This means that respondents with a higher positive affect towards the species (bobcat or coyote depending on the sample) were more likely to prefer hazing the carnivore in the first scenario and monitoring the carnivore in the second scenario (i.e., stay with preferences for non-lethal methods) than they were to prefer the reference category (p=0.027; Exp(B)=1.494; std. error=0.181). In comparison to the odds for respondents with rural residential experience, respondents with urban residential experience were 793% more likely and respondents with a moderately populated / mixed residential experience were 718% more likely to prefer haze in the first scenario and monitor in the second scenario than they were to prefer the reference category (Urban: p=0.009, Exp(B)=8.939, std. error=0.834; Moderately populated / mixed: p=0.010, Exp(B)=8.180, std. error=0.811). However, the wide 95% confidence intervals (Urban: lower bound=1.744, upper bound= 45.820; Moderately populated / mixed: lower bound=1.669, upper bound= 40.093) indicate that the accuracy of these parameter estimates could have been improved by an increased sample size in the "Scenario 1.) Haze, Scenario 2.) Monitor" dependent variable category (n=43).

5. Discussion

This study investigated how individuals responded across multiple scenarios each portraying a probable human-mesocarnivore interaction. We found that residential experience has a substantial impact on an individual's collective predator control preferences. Additionally, we found that residential experience, wildlife value orientations (mutualism and domination), affect, and gender were all significant in predicting the odds of an individual's predator control preference combination.

Our research shows that respondents with urban residential experience were especially reluctant to endorse lethal methods of carnivore control in any of the scenarios they were given compared to respondents with rural residential experience. Respondents with urban residential experience were 228%-793% more likely than respondents with rural residential experience to respond with an exclusively non-lethal predator control combination rather than the non-lethal to lethal preference combination (i.e., the reference category of the MLR). Respondents with a moderately populated / mixed residential experience were 157%-718% more likely than respondents with rural residential experience to respond with an exclusively non-lethal predator control combination rather than the non-lethal to lethal preference combination (i.e., the reference category of the MLR).

Our findings are consistent with the existing literature, which demonstrates resistance to lethal carnivore control among urban residents compared to rural residents (Manfredo et al., 1998; Zinn et al., 1998). However, lethal control is not always avoidable once problem animal behavior manifests. These circumstances suggest that the best management actions will be those that prevent conflicts from occurring in the first place. Because conflicts often result from human behavior (e.g., feeding wildlife), one means of preventing conflicts is to employ programs designed to limit these types of behaviors (e.g., through education). Because agencies are often unknown and may be untrusted in urban settings, outreach to these communities might be more effective when the message is delivered via partner organizations. Past research suggests that education in human-carnivore conflict mitigation should be delivered in conjunction with education on the benefits of sharing land with carnivores to be most effective (Slagle et al., 2013).

The moderate association between respondent residential experience and predator control preference combinations existed among both respondents with *flexible* and *rigid* preference combinations. In our MLR, the residential experience variable predicted respondents' predator control preference combination in 4 out of 6 predator control combination groups (Tables 3.2).

Our measure of average residential experience (i.e., both childhood and current residency taken into account) serves to capture some of the unmeasured effects resulting from the differences in experiences, opportunities, and social influences provided by different levels of urbanization. We surmise that it is these effects (i.e., the collective experiences afforded by one's living environment)—not any aspect of the physical location, that caused the observed differences in preferred predator control. Put another way, we do not anticipate that moving to a different location would have an immediate effect on an individual's preferred method of predator control; rather, we anticipate that such judgments result from the totality of social and ecological experiences one has over time. Our findings highlight the importance of understanding the public's predator control preferences separately for different types of residential areas, and perhaps, justify handling human-carnivore conflict differently in these areas.

In our MLR, we also found mutualism and domination wildlife value orientations predict the likelihood of predator control combinations that were rigid (i.e., preference was the same for both scenarios), when compared to the reference category (i.e., a non-lethal method in the first scenario and escalating to a lethal method for the second scenario). Our results agree with past literature on the importance of wildlife value orientations in their ability to impact predator control preferences (Glas et al., 2019; Manfredo et al., 2009; Zinn et al., 1998).

One drawback of this type of study is that the scenarios are hypothetical. It is not clear whether subjects' responses to such hypothetical scenarios would be similar in actual conflict situations. Having to live with the consequences in a ‘real-life’ scenario with a mesocarnivore might give individuals cause for deeper reflection and consideration of the potential consequences of using different types of control. Moreover, ‘real-life’ conflict situations include a wealth of contextual information (e.g., how is the animal behaving, is this animal familiar) that cannot be conveyed in the type of hypothetical scenarios presented in our survey. Will the desire not to harm an animal (expressed in a hypothetical situation) give way to ‘pragmatism’ when individuals face an actual conflict? Psychological research on self-interest may provide some insight. This research suggests that self-interest can bias judgments in favor of that interest, but this occurs primarily when personal consequences are salient (Darke & Chaiken 2005). This finding implies that individuals who are directly affected (salient self-interest) may be more sensitive to the risks and benefits associated both with carnivores and actions used to manage them.

6. Conclusion

The randomized urban scenarios we presented to respondents in this study are possible representations of some of the most common human-mesocarnivore urban interactions according to Butaeu et al. (2022) and Poessel et al. (2013). The three predator control preference options we analyzed in this study philosophically represent either tolerance or intolerance for carnivores. A preference for monitoring suggests the carnivore’s behavior in the scenario is likely interpreted by the respondent as an acceptable or appropriate behavior (not as conflict). A preference for hazing the carnivore suggests the carnivore's behavior is seen as needing correction and discouragement, but may indicate that an individual wishes to avoid removal of the carnivore (thereby expressing tolerance for the animal and its behavior). In contrast, a preference for lethal control suggests an unwillingness to coexist under the circumstances of the scenario given. In our study ~79% of respondents with urban residential experience and ~73% of respondents with a moderately populated / mixed residential experience had exclusively non-lethal preferences (i.e., monitor or haze the carnivore) in the randomized scenarios they were given (not including respondents who chose "none of these actions are appropriate" in response to either of the carnivore scenarios given). This sign of tolerance towards bobcats and coyotes may mean that residents of urban and moderately populated areas are willing to coexist with mesocarnivores. However, achieving coexistence will require more than tolerance; it will require respect towards carnivores by taking measures to prevent conflict seriously (e.g., remain a safe distance from carnivores when viewing, don't feed wildlife), because a desire to coexist will never reify sustainable coexistence without actions of human behavioral adaptation (Carter and Linnell, 2016; Lute and Cater, 2020).

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Chapter 4. Conclusions

1. Summary of Key Findings

The primary purpose of this research was to understand which factors are useful for explaining individuals' predator control preferences. Our first study (chapter 2) examined predator control preferences by looking at the consistency of responses across scenarios; that is, we sought to understand what factors led people to respond to different predator control scenarios in the same way (rigidity). We determined that the likelihood of flexibility in an individual's predator control preferences between two probable human-mesocarnivore scenarios was predicted best by the location in which the scenarios occurred (i.e., residential or agricultural) and second by an increase in severity between the two scenarios' context. Cognitive and demographic factors had no impact on the odds of a respondent preferring the same form of predator control in response to different scenarios.

In our second study (chapter 3) we sought to determine the significance of various cognitive and demographic factors in explaining the odds of an individual's preferences for monitoring, hazing, or lethal control across multiple scenarios. We found that an individual's predator control preference combination was moderately associated with the respondent's average residential experience (i.e., urban, moderately populated / mixed, or rural). Additionally, wildlife value orientations were not as predictive as average residential experience when predicting an individual's predator control preferences across multiple scenarios.

2. Order Effect Bias in Predator Control Preference Survey Research

The analyses presented in our first study were the first in the literature to focus on the flexible or rigid nature of the response pattern as a dependent variable in regression analysis without including preference characterization (e.g., monitor, haze, lethal control). Our examination of respondents' preference patterns also exposed potential question order bias (i.e., order effect bias) as a phenomenon that may be present as well in other survey research that used hypothetical scenarios to gauge the public's preferred predator control.

Order effect bias is a type of response bias that occurs when the context of a survey's question or response impacts the response to a following question (Perreault, 1975). Our first study found that scenario order did have an impact on the individual's collective responses. An *increase* in scenario severity (i.e., "carnivore observed" to "carnivore killed a domestic animal") increased the likelihood of *flexible* predator control preferences. However, a *decrease* in scenario severity (i.e., "carnivore killed a domestic animal" to "carnivore observed") resulted in proportionally more *rigid* responses than *flexible* responses. If scenario order can partially explain the odds of a *rigid* or *flexible* response pattern, then scenario order likely has an impact on odds of certain lethal or non-lethal preferences chosen by the individual as well because the 'pattern' is a broader categorization of the individual's preference combination. These findings could mean that the first scenario, or the response to the first scenario, has likely impacted the reported preference in the second scenario. Thus, a collapse in the order of the scenarios or predator control preferences for analysis, would have been in effect comparable to collapsing two significantly different scenario treatments. Additionally, there were twice as many respondents who *increased* the intensity of their preferred predator control (~30%), compared to the number of respondents who *decreased* in the intensity of their preferred predator control (~14%). If there was no order effect bias, then I would have expected these proportions to not be as divergent because the scenarios were randomized in both context and order. Thau et al. (2021:192) showed that preceding questions can "have the unintended effect of priming certain beliefs about a subject that spill over to answers to subsequent questions". It seems that in our dataset, high severity scenarios might have primed certain perceptions about the subject mesocarnivore (e.g., that they are risky). This finding on order effect bias might mean that the results from some past carnivore scenario survey research may be muddled to a degree by the method of analyzing responses to one scenario at a time, especially if the order of the scenarios was not randomized in the survey.

3. The Preference for Hazing Carnivores Among Respondents

Sixty-four percent of respondents preferred to haze carnivores in at least one of the two randomized scenarios they received, and a third (27%) of all respondents preferred to haze carnivores in both of the randomized scenarios. This strong preference we found for hazing carnivores may indicate that management may find success in prompting urban and moderately populated communities to participate in community-level hazing efforts before conflict becomes an issue of human safety because this method is in congruence with the public's own preferences (Siegrist et al., 2000). It is helpful to know that the United States public is open to this method of control regardless of living inside or outside of areas currently experiencing considerable conflict because community hazing of coyotes is most effective before extreme conflict has developed (Bonnell and Breck, 2017). Research has shown that community hazing may not alter the behavior of coyotes that have already developed extreme problematic behavior (e.g., attacks on humans; Breck et al., 2016). However, by providing a concrete action that can be taken, community hazing may still increase a person's sense of security regardless of the stage of when it is implemented (Breck et al., 2016).

4. Future Research

There are two questions I would like to address that this research surfaces. The first question is to what degree does this research apply to real-life scenarios, and to what degree are these responses to hypothetical scenarios a product of survey biases? Testing the impact of hypothetical bias involves comparing actions in real-life scenarios to the responses given for the hypothetical scenarios (FeldmanHall et al., 2012; Fifer et al., 2014; Gonzalez-Gadea et al., 2018). Testing the effect of hypothetical bias in this manner would also catch the impact from any other survey-derived biases present. However, due to the tricky nature of this testing (i.e., obtaining reactions to real-life scenarios to compare to the survey's scenarios) this research might be unfeasible for scenarios with carnivores.

The second and possibly more important question is why in cities can it be difficult to get strong participation in community hazing and other non-lethal preventative measures (e.g., prohibiting feeding wildlife, avoiding leaving pets outside unattended at night or during breeding season, keeping a safe distance from wildlife when viewing) when our results from respondents with urban or moderately populated / mixed residential experience show high preferences for hazing and monitoring and an exceptionally low preference for lethal control? One possible research direction for this is exploring the impact of phrasing and approach to education materials that encourage the public to participate in community hazing and other non-lethal preventative measures (e.g., prohibiting feeding wildlife, avoiding leaving pets outside unattended at night or during breeding season, keeping a safe distance from wildlife when viewing).

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Appendices

Appendix A. Creation of the residential experience variable

The variable representing the respondent's residential experience was calculated using a combination of three different measures of residency, two of which were self-reported by the respondents as part of the survey's questions and thus are perceptions of residency. In the survey we asked respondents to describe their current residence or community and the residence or community that they grew up in using a multiple-choice question format with 8 different possible levels of population density to choose from. These two questions can be found after this paragraph. The third measure of residency was a dichotomous variable depicting if the respondent resides inside or outside of a metropolitan statistical area. The data company that we purchased the population samples from tracks whether panel members reside inside or outside of a Metropolitan Statistical Area (hereafter MSA). To create a combined measure of residential experience, we first added 1 as a weight to the perception of current residency for respondents who were marked as residing outside of an MSA. We then took the average of the two residency perception variables (i.e., average residential experience = 2 ÷ ((1 for non-MSA + "self-reported current residency") + "self-reported childhood residency")). This created a continuous variable that was then systematically split into thirds by using the context of the answers in the self-reported residency measures to choose splits that were representative of the definition of urban, and rural areas instead of splitting the variable into equal thirds. The urban / moderately populated split was made after 3 in Figure A.1 (between " City with 50,000 to 99,999 " and " Small city with 25,000 to 49,999 "). This split is supported by the U.S. Census Bureau, which defines an “urbanized area” as an area of continuous development with a population of 50,000 or more (Ratcliffe et al., 2016). The moderately populated / rural split after 6 in Figure A.1 (between " Town with 5,000 to 9,999 people " and " Small town/village with less than 5,000 people "). Splitting the combined residential experience variable into equal thirds would have been inappropriate because urban, moderately populated, and rural residency is not equal in the United States, and that method would be essentially using respondent proportions to define the boundaries between what is urban, moderately populated, and rural.

❍ Large city with 250,000 or more people (1) ❍ City with 100,000 to 249,999 people (2) ❍ City with 50,000 to 99,999 people (3)	urban residential experience
❍ Small city with 25,000 to 49,999 people (4) ❍ Town with 10,000 to 24,999 people (5) ❍ Town with 5,000 to 9,999 people (6)	moderately populated / mixed residential experience
❍ Small town/village with less than 5,000 people (7) ❍ A farm or rural area (8)	rural residential experience

Figure A.1 survey options for self-reported childhood residency and current residency

Appendix B. Description of non-lethal partial collapse

Key for responses in tables below:

M= monitor the carnivore

I= frighten or haze the carnivore

L= lethal control of the carnivore

Key for the scenarios in tables below:

Rk= The scenario took place in a ranch location, and the carnivore killed a domestic animal.

Ro= The scenario took place in a ranch location, and the carnivore was observed only.

Uk= The scenario took place in a residential location, and the carnivore killed a domestic animal.

Uo= The scenario took place in a residential location, and the carnivore was observed only.

Table A.1 Crosstabulation of Scenarios Given in Order and the Respondent's Answers Given in Order

		Response Combination									
		II	IL	IM	LI	LL	LM	MI	ML	MM	Total
Scenario Combination	Rk/Ro	18	0	13	13	2	1	0	0	4	51
	Rk/Uk	17	3	2	9	6	1	3	1	1	43
	Rk/Uo	24	1	3	2	11	0	0	0	3	44
	Ro/Rk	6	13	0	0	2	0	13	8	3	45
	Ro/Uk	18	6	4	0	4	0	12	4	7	55
	Ro/Uo	19	4	3	0	0	0	12	0	15	53
	Uk/Rk	17	4	2	2	11	0	13	4	3	56
	Uk/Ro	11	0	7	2	5	0	7	1	12	45
	Uk/Uo	16	3	6	3	3	1	3	0	6	41
	Uo/Rk	5	6	0	0	4	0	13	3	2	33
	Uo/Ro	11	0	2	0	2	0	10	1	18	44
	Uo/Uk	11	2	1	0	3	0	10	3	6	36
Total		173	42	43	31	53	3	96	25	80	546

Reference to Table A.1: Collapsing the LI and LM response combinations can be supported by the similar responses to the scenarios given in these two columns and by the meaning of these two response combinations (both LI and LM represent a switch from a lethal method preference in the first scenario, to a non-lethal method preference in the second scenario.) We do anticipate that this will make a large difference in the analysis since only 3 respondents selected LM as a response combination.

Table A.2 Crosstabulation of Scenarios Given in Order and the Respondent's Answers Given in Order

		Response Combination					
		IL	IM	LN	MI	ML	Total
Scenario Combination	Rk/Ro		30.2%	41.2%			11.3%
	Rk/Uk	7.1%	4.7%	29.4%	3.1%	4.0%	7.9%
	Rk/Uo	2.4%	7.0%	5.9%			2.5%
	Ro/Rk	31.0%			13.5%	32.0%	14.2%
	Ro/Uk	14.3%	9.3%		12.5%	16.0%	10.8%
	Ro/Uo	9.5%	7.0%		12.5%		7.9%
	Uk/Rk	9.5%	4.7%	5.9%	13.5%	16.0%	10.4%
	Uk/Ro		16.3%	5.9%	7.3%	4.0%	7.1%
	Uk/Uo	7.1%	14.0%	11.8%	3.1%		6.7%
	Uo/Rk	14.3%			13.5%	12.0%	9.2%
	Uo/Ro		4.7%		10.4%	4.0%	5.4%
	Uo/Uk	4.8%	2.3%		10.4%	12.0%	6.7%
Total		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Reference to Table A.2: Collapsing the IL and ML response combinations can be supported by the similar ratios in these two columns and by the meaning of these two response combinations (both represent a non-lethal method in the first scenario and a lethal method for the scenario). Collapsing these the IL and ML response combinations also produced a more stable logistic regression model (before the likelihood ratio tests were disagreeing with the parameter estimates, and now they are not; Pearson goodness-of-fit increased from 0.269 to 0.367 in these preliminary models).