RESEARCH ARTICLE

A path to human-raccoon dog harmony: Identifying factors influencing the tolerance of urban residents in Shanghai towards a neglected species

Qianqian Zhao[1] | Yihan Wang[1] | Lejie Wu[1] | Yidi Feng[2] | Yuhan Li[2] | Zhuojin Zhang[1] | Qing Zhao[3] | Fang Wang[1]

[1]School of Life Sciences, Fudan University, Shanghai, China

[2]Shan Shui Conservation Center, Beijing, China

[3]Bird Conservancy of the Rockies, Fort Collins, Colorado, USA

Correspondence
Fang Wang
Email: wfang@fudan.edu.cn

Abstract

1. Human-wildlife interactions become increasingly common in urban areas across all continents and ecosystem types. Depending on the context, human-wildlife interactions can be categorized as harmonious, neutrality, or in conflict and raises cultural, economic and ecological challenges in maintaining urban biodiversity. Understanding the mechanism behind the tolerance of residents to the presence of wildlife is vital to promoting a harmonious coexistence between humans and wildlife in urban environments.

2. To advance our knowledge of this mechanism, we developed a questionnaire to survey residents in Shanghai, China about their knowledge of and attitude towards raccoon dogs (*Nyctereutes procyonoides*), a species whose population is increasing in urban areas. Using 281 questionnaires, we conducted structural equation modelling to examine how relational values, including familiarity with raccoon dogs, perceived benefits and risks, together with residents' trust in wildlife management authorities, interactively influence the tolerance for this species.

3. We found that the residents' familiarity with raccoon dogs positively influenced their tolerance, both directly and indirectly through increased perceived benefits and reduced perceived risks. Furthermore, trust in wildlife management authorities contributed to higher tolerance through perceived benefits. Our results suggested that education about the relational values of raccoon dogs to the public can reduce the traditional negative connotation for this species and promote the coexistence of people and raccoon dogs in Shanghai urban environment.

4. Based on our understanding about how raccoon dogs were culturally constructed and the willingness of residents to share landscapes with the species, we advocate that relational values play an important role in future urban biodiversity conservation planning. We also advocate for education programs that familiarize the public with raccoon dogs as well as other species, which can turn urban human-wildlife conflicts into harmonious relationships in Shanghai and other urban areas.

1 | INTRODUCTION

> Boy: Hey, raccoons!
> Girl: Aw! They're so cute!
> Boy: Are those raccoons?
> Mom: Mm-hmm. I wonder what they're doing here. They don't usually come so close to the city.
> [Raccoons screeching and running away]
> Girl: Hey, wait, raccoons! Don't go!
> Boy: Aw. They're gone.
> Girl: I wish we could have fed them something.
> Boy: I wonder if they can change their form, like in fairy tales.
>
> Pom Poko

The title of the Japanese animated fantasy film, Pom Poko, refers to the sound of raccoon dogs (*Nyctereutes procyonoides*) drumming their bellies. Even though this puffy species is a symbol of fertility in Japan and therefore has a relatively positive image traditionally, in the film they desperately struggle to save their natural habitat from excessive human development. One important message that many similar cases demonstrated is that natural environment is essential for both human and wildlife through its intrinsic, instrumental and relational values (Chan et al., 2016, 2018). The effectiveness of international agreements, policies and regulations that aims to manage biodiversity therefore varies, when people hold different opinions but all view natural resources as affecting their well-being (Whitehead et al., 2016). People perceive and appreciate biodiversity in different ways because of their distinct heritage and experience, during such processes the value of biodiversity is recognized as a product of different worldviews and perceptions on the relationship of humans and nature (Bridgewater & Rotherham, 2019). Using British woodlands as a study system, Austen et al. (2021) demonstrated that people referenced perceptions and experiences external to this habitat, and the relational value was more associated with their everyday lives. Cultural influences and memories linked to particular people and places were also prominent. Furthermore, how people perceive benefits from nature also change over time, regardless the fact that nature's value is often considered independent of human uses (Chan et al., 2018; Chapman & Deplazes-Zemp, 2022; Klain et al., 2017). Consequently, biodiversity management in densely populated residential areas needs more sophisticated design because many such practices can lead to conflicts between differently opinioned groups (Ostermann-Miyashita et al., 2021; van Eeden et al., 2019).

Framing human–wildlife relationships predominantly through the lens of conflict can lead to strong negative attitudes on peoples' psyche and influence perceptions of risk from wildlife (Gore & Kahler, 2012). Relational values, defined as preferences, principles, and virtues of human-nature relations, have therefore attracted great attention because of their potential to promote human-wildlife harmony under such circumstances (Chan et al., 2018; Chapman & Deplazes-Zemp, 2022; Stalhammar & Thoren, 2019). As described in Pom Poko, residents could intuitively consider wildlife cute, mysterious and even amazing, an evident representation of relational values that may lead to harmony efforts (Bridgewater & Rotherham, 2019). Furthermore, the dynamic nature of relational values, which are closely related to culture, customary and human feelings, indicates that there is great potential to promote relational values through environmental education programs (Klain et al., 2017; Santos & Gould, 2018). Efforts on promoting relational values, which aim to build desirable relationships between people and nature, have succeeded in cases such as Asiatic black bears (*Ursus thibetanus*), red fox (*Vulpes vulpes*), jaguars (*Panthera onca*) and brown bears (*Ursus arctos*) conservation (Delie et al., 2023; Kimmig et al., 2020; Marchini & Macdonald, 2020; Orazem et al., 2021). In promoting residents' tolerance to black bear, for example, modifying existing educational materials to improve people's perceived benefits from wild animals lowered the intensity of human-bear conflict (Delie et al., 2023). The more participants knew about foxes in Germany, the more positive their attitude was towards them and the less they perceived them as a risk. (Kimmig et al., 2020). Such efforts also improve the cooperation between groups of city residents with different interests (García-Antúnez, 2023), and have promoted human-wildlife harmony and guided management practices (Ghijselinck, 2023).

Among most situations where human-wildlife conflict happens, urbanization presents both challenges and opportunities. Besides negative interactions, the numerous natural areas also enable city residents to positively interact with and learn about nature, which is lacking in modern life (Chawla, 2020). Humans and wildlife have shared landscapes in urban areas for as long as records have been kept (Bateman & Fleming, 2012; Dagtekin et al., 2020; Soulsbury & White, 2015). Depending on the context of the perceived human-animal interaction, the relationship is categorized as being harmonious, neutral, or in conflict (Chawla, 2020). Human-wildlife conflict often leads to deterrence, relocation, or removal of certain animal individuals or groups (Proctor et al., 2018; Soulsbury & White, 2015). However, only a small portion of reported conflicts in urban areas actually reflect severe situations, such as loss of property or injury, while the majority of conflicts are simply perceived threats due to lack of knowledge (Peterson et al., 2010). For wildlife that has successfully adapted to urban habitats, relocation or removal have been shown to have a negligible long-term effect and are considered unacceptable to resident groups due to animal welfare, ethical, religious, or cultural reasons (Honda et al., 2018). In addition, arbitrary and temporary solutions to eliminate urban

animals often resulted in negative symbolism of the species, which jeopardizes future opportunities to rebuild relational values and promote human-wildlife harmony (Elliot et al., 2016). Considering the long-lasting nature of human-wildlife interactions, researchers and decision-makers are increasingly interested in finding alternative ways to promote human-wildlife harmony in human-dominated landscapes (Frank, 2016). Positive experiences with wildlife can improve health, foster spiritual and inspirational experiences, and support social relationships, which are comparable to the perceived benefits of increased income and better education (Capaldi et al., 2014). City residents' experiences, beliefs, and values frame their perceptions about urban wildlife, which further translate into different levels of willingness to tolerate or accept these wildlife, and often initiate bottom-up conservation efforts (Lewicki et al., 2003; Mascia, 2003). While the relationships between relational values and human-wildlife harmony have been demonstrated, the specific actions and practices to achieve healthy relationships between human and wildlife are still unclear, warranting a comprehensive investigation (Lumber et al., 2017).

Understanding the driving factor of human behaviours (e.g. awareness, knowledge and attitudes) is shown to be a key element underpinning peaceful harmony between human and wildlife (Elliot et al., 2016; Lukasik & Alexander, 2011). Environmentally informed citizens are more likely to participate in actions to preserve biodiversity, and often have greater awareness of anthropogenic impacts on local ecosystems (Cooper et al., 2007; Haywood et al., 2016). To promote such change, research on human-wildlife interactions has evolved from focusing on conflict to the inclusion of harmony, acceptance and tolerance (Frank et al., 2019; Pooley et al., 2017). Several specific drivers of tolerance for wildlife by residents, such as knowledge on broader social issues, have been identified in recent studies that target at issues including trust in government's ability to manage conflicts and temporal patterns of people's attitude change (Lischka et al., 2020). Here, we used the case of human-raccoon dog interactions in Shanghai, one of China's largest cities, to demonstrate how relational values, represented by familiarity with urban wildlife, trust in wildlife management authorities, and perceived benefits and risks, interactively influenced the tolerance for wildlife by residents (Figure S1). Recently, raccoon dogs have recolonized Shanghai and experienced rapid population growth (Diao et al., 2022; Zhao et al., 2022). The number of complaints has increased 32-fold in the past 5 years, generating millions of heated social media debates about whether specific urban animals should be eliminated from residential districts (Shanghai Forestry Bureau, 2021). However, only one among hundreds of complaints was verified to be an actual raccoon dog attack on a person, while the majority were merely a perceived threat after raccoon dog sightings (Shanghai Forestry Bureau, unpublished data). The Chinese idiom gives the species a bad connotation as a scoundrel or unjust villain, which possibly fosters negative feelings of danger, annoyance and disrespect.

We aimed to identify key factors that influence the tolerance for raccoon dogs by residents and suggest future management plans to promote human-wildlife harmony. This approach has substantial implications for wildlife management in Shanghai and other regions where urban species are undergoing rapid expansion but effective strategies for human-wildlife harmony remains unclear.

2 | METHODS

2.1 | Study area

The rapid urbanization over the past half-century in Shanghai, one of China's most densely populated cities, has led to highly human-dominated landscapes and significant change in urban biodiversity (Figure S1). Many native species were locally extirpated (e.g. Leopard Cat *Prionailurus bengalensis*, Eurasian River Otter *Lutra lutra*), and the significant decrease in natural vegetation and the increase of anthropogenic activities has led to a significant reduction in the number of other small and medium-sized mammals that depend on more rural landscapes (Shanghai Municipal Bureau of Agriculture and Forestry, 2004). On the contrary, raccoon dogs are growing in number and are rapidly reoccupying their urban territory after decades of population decline (Shanghai Forestry Bureau, 2021).

2.2 | Residents survey

We developed a questionnaire and conducted a survey during April–June 2021 to investigate people's knowledge, attitude and tolerance towards raccoon dogs. Because the wildlife tolerance model (WTM) described by Kansky et al. (2016) provided a theoretical framework for identifying the key drivers (e.g. cost, benefits) of people's tolerance for wildlife, we followed and revised Kansky et al. (2016) to develop our questionnaire. We considered demographic variables including gender, age, and education as external variables because we hypothesized that these factors potentially influence residents' familiarity with raccoon dogs and their trust in the ability of wildlife management authorities (Table 1). We also included four variables of human dimensions, including familiarity with raccoon dogs, trust in the ability of wildlife management authorities, and perceived benefits and risks of raccoon dogs, to explain tolerance of residents towards raccoon dogs (Table 1). We designed multiple corresponding questions for each dimension to quantitatively score participant responses (Tables S1 and S2).

During the survey, the questionnaires were collected from a convenience sampling due to respondents' geographical proximity, availability and willingness to participate (Farrokhi & Mahmoudi-Hamidabad, 2012). All questionnaire surveys were conducted in 10 residential districts which had the most human-raccoon dog conflict cases according to the Shanghai Forestry Bureau database (Shanghai Forestry Bureau, unpublished data). We started our surveys at the residential district at 6 PM and spent the next 2–3 h interviewing passers-by at the roadside. We chose to survey people at this time because residents walk after dinner and the nocturnal raccoon dogs start to come out. In each residential district, we randomly stopped passers-by

TABLE 1 Descriptions of the external variables in the wildlife tolerance model and related hypotheses.

External variables	Generalized description	Hypothesized relationships
Gender	Biological sex of respondent: female, male	Females have a higher familiarity with raccoon dogs Females have a higher trust in management authorities
Age	The age of the respondent, categorized into four ranges: 18–30, 31–50, 51–70, 70+	Older respondents have a lower familiarity with raccoon dogs Older respondents have a higher trust in management authorities
Education	Respondent's level of education, categorized into five levels: high school and below, college, bachelor, master, doctor and above	People with higher educational level have higher familiarity with raccoon dogs People with higher educational level have higher trust in management authorities
Familiarity	The (positive or negative) experience of interacting with raccoon dogs and the level of knowledge about them	Higher familiarity leads to lower perceived risk Higher familiarity leads to higher perceived benefit Higher familiarity leads to higher tolerance
Trust	The level to which the respondent trusts the officials responsible for wildlife management	Higher trust leads to higher perceived benefit
Risk	Respondent's perceived level of risks that raccoon dogs may pose such as zoonotic diseases and attacks	Higher perceived risk leads to lower tolerance
Benefit	Respondent's perceived benefits of raccoon dogs to individuals, communities, humans, and nature	Higher perceived benefit leads to higher tolerance
Tolerance	Level of tolerance for killing raccoon dogs, acceptable population size of raccoon dogs	

to ask about their willingness to participate in the survey. Each participant was informed that the questionnaire survey was anonymous. We received written informed consent from all participants to participate in this research, and the questionnaire was approved by the Ethics Reviewing Committee of Fudan University (FDU220901a). We generated a QR code so that participants could open the questionnaires on their mobile devices and submit their responses anonymously. When interviewing the residents, we distributed stickers with the QR code of the questionnaire and invited participants to share the QR code with their neighbours on social network platforms.

We also conducted a second survey during October–December 2021, after Shanghai wildlife management authorities and environmental organizations initiated educational activities that aimed to inform the public about urban wildlife in their areas. During these educational activities, staff distributed science brochures (Figure 1a) and placed urban species bulletins in residential districts that had raccoon dog distribution, with specific guidance on how to keep safe distance and coexist with raccoon dogs. Four educational talks were organized for the communities (Figure 1b), and volunteers from these communities were invited to participate in raccoon dog surveys. Because the Chinese pronunciation of raccoon dog "貉" sounds exactly the same with "和", which means peace and harmony, we utilized the homophonic stem and designed raccoon dog emoji (Figure 1c), and distributed raccoon dog window decoration paper-cut (Figure 1d). Because the goal of the second survey was to evaluate the effect of these educational activities on tolerance, we conducted the survey in the same districts as the first survey by the same surveyors to achieve compatibility.

2.3 | Data analysis

Using the responses to our questionnaire during the first survey, we constructed a WTM that consisted of two meta-analysis components: large-scale evaluations of residents' attitudes, and the drivers of human-wildlife conflict (Kansky et al., 2014; Saif et al., 2020). The adaptability of WTM to different environments allows for its implementation at various spatio-temporal scales and for different species (Marino et al., 2021). In the outer model, tolerance depends on the net perceived costs and benefits of living with a species, which depends on the extent to which a person experiences a species. Other than a one-time application of WTM, we investigated whether the familiarity with the species influenced residents' perceptions of benefits and risks by constructing WTM for our second survey and compared it with previous runs (Table 1; Table S1; for the complete questionnaire see Table S2).

As a specific form of the structural equation modelling (SEM) approach, partial least squares-SEM (PLS-SEM) is preferred when conducting exploratory studies using the WTM framework with various potential explanatory variables (Hair et al., 2019; Lowry & Gaskin, 2014). The PLS-SEM model consists of two sub-models: structural and measurement models. The measurement model specifies the relationships between the latent variables and their observed indicators, while the structural model refers to the relationship among latent variables (Hair et al., 2019). We constructed PLS-SEM in the SmartPLS program (Ringle et al., 2015) to assess the relationship between people's tolerance and their other attitude dimensions to raccoon dogs
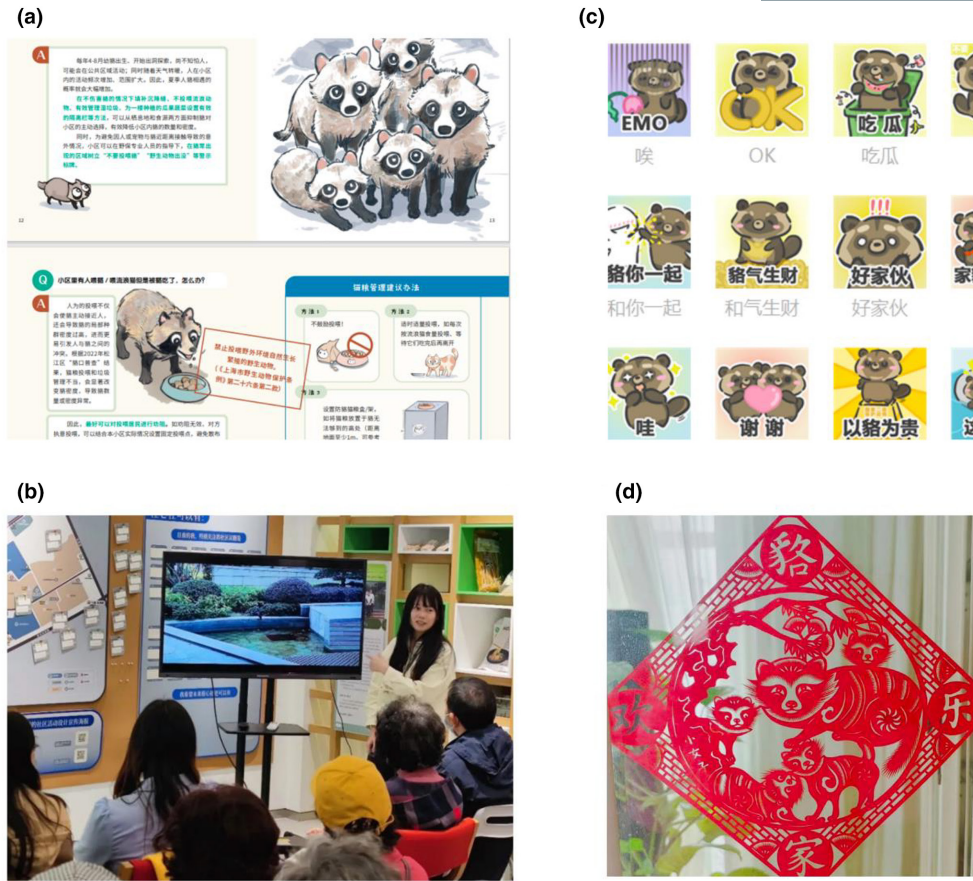
FIGURE 1 Educational activities including (a) science brochures distributed in residential districts that had raccoon dog presence, (b) four educational talks given to the communities*, (c) raccoon dog emoji and (d) raccoon dog window decoration paper-cut distributed to residents. *People who can be identified have given consent for the photo to be used.
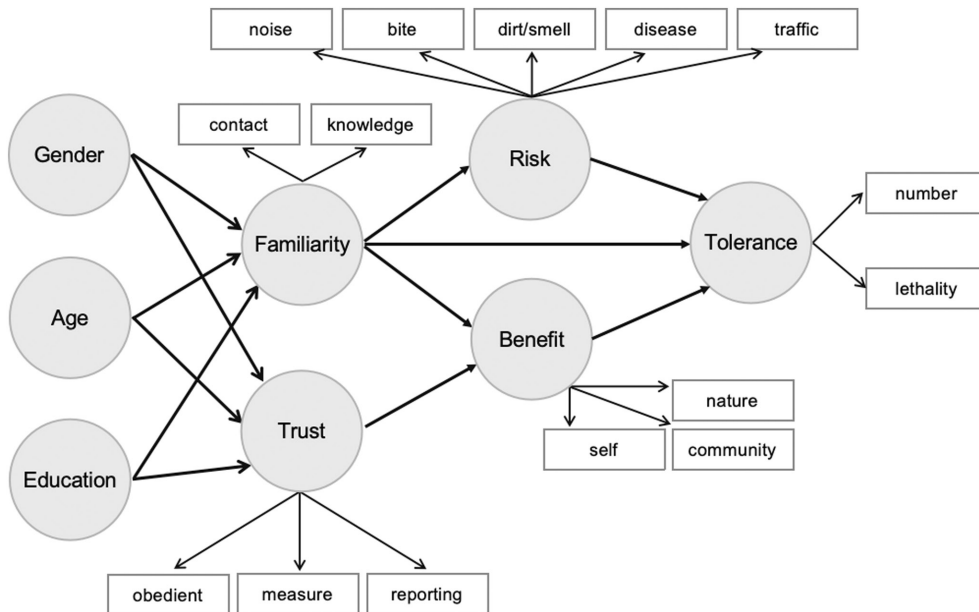

FIGURE 2 A predefined framework for our raccoon dog tolerance model. Circles represent latent variables, and rectangles represent indicator variables used to measure the latent variable. Thick black arrows represent the interactions between latent variables, and thin grey arrows represent how the latent variables lead to the corresponding indicator variables.

using β-path coefficients (Brearley et al., 2012; Kansky et al., 2016; Lowry et al., 2013; Wong, 2013). An iterative sequence based on ordinary least squares regression was fit to maximize the variance of the dependent variable to estimate the association between people's tolerance and other attitude dimensions (Ringle & Sarstedt, 2016).

We followed Hair et al. (2021) in setting PLS-SEM algorithm parameters. When constructing PLS-SEM, path model diagrams were used to visualize the hypothesis and latent variable relationships (Figure 2). We assessed the reliability of the measurement model using four metrics: indicator reliability, internal consistency, convergent validity and discriminant validity (Tables S3–S5). We used covariance tests to evaluate structural models (Hair et al., 2019; Wong, 2013), and the coefficient of determination (R^2) to test the model's predictive power and measured the amount of explained variance of the structure in the structural model. A higher R^2 value indicates a higher degree of explanation of the construct by the latent variables that point to it through the structural path (Hair et al., 2019, 2021; Wong, 2013). The significant coefficients of the paths were calculated using bootstrap confidence intervals and the significance of the path coefficients.

3 | RESULTS

3.1 | Factors that affect tolerance

During the first questionnaire survey, we collected a total of 281 valid questionnaires, with 76.5% of respondents being female and 23.5% male (Table S3). The majority of respondents were between 31 and 50 (76.9%), followed by 18–30 (19.2%). Most respondents received a bachelor's or higher degree (84%), and their employment situation were mainly working (74%) followed by self-employed (15%). We collected 375 valid questionnaires during the second survey (63.2% female, Table S3).

3.1.1 | Evaluation of the structural equation model

All four measurements, indicator reliability, internal consistency, convergent validity and discriminant validity, were within the recommended range, which indicated that our model was reliable (see Appendix S5; Data Sources). For indicator reliability, all items had significant path loadings at the 0.01 level, and all five formative items in the model have weights more significant than 0.2, indicating a substantial contribution to their corresponding structure. For internal consistency, Cronbach's alpha is above or close to the acceptable threshold for all variables (>0.7), and all composite reliability values were higher than the acceptable threshold of 0.7. All of our reflective measures fulfilled the recommended composite reliability and average variance levels. As shown in Table 1, all items were above 0.50. We found that each indicator variable had sufficient variance explanation and contributed substantially to their corresponding structure (Table 2; Appendix S5; Data Sources). The results of the Bootstrap confidence intervals and the path coefficients were significant ($p < 0.05$), which

confirmed that each path was valid and that there were direct impacts among latent variables (Table S6).

3.1.2 | Tolerance for raccoon dogs

The model had three significant direct pathways and three significant indirect pathways to explain the level of tolerance (Figure 3; Table 2). For direct pathways, familiarity with raccoon dogs (+0.320), perceived benefits (+0.351), and perceived risks (−0.442) together explained 50.4% of the variance in the tolerance of residents for raccoon dogs. For indirect pathways, familiarity promoted tolerance through a negative effect (−0.219) on perceived risks (25.8% variance explained). Familiarity and trust in wildlife management authorities explained 14.8% of the variance of perceived benefits with positive effects (familiarity: +0.332, trust: +0.195), which also led to increased tolerance. Among the external variables, age was the only factor that negatively affected familiarity (familiarity: −0.192).

3.2 | Effect of education on tolerance

We collected 375 valid questionnaires during the second survey. After 3 months of educational and relational value-related initiatives, the mean tolerance in the second survey (3.110 ± 1.118) was significantly higher than that in the first survey (2.690 ± 1.287; t-statistic = −4.53, df = 694.160, $p < 0.001$).

4 | DISCUSSION

In our search for answers about why and how people would care about urban species and their natural environment, we applied PLS-SEM and found that familiarity with wildlife positively influenced the tolerance for raccoon dogs, both directly and indirectly through increased perceived benefits and reduced perceived risks to residents. We also found that trust in wildlife management authorities positively influenced tolerance through increased perceived benefits. These results suggested that the knowledge about relational values play an important role in the coupled human-nature systems by promoting human-wildlife, representing a promising direction for wildlife management agencies, environmental NGOs and other related organizations in Shanghai and other places that face similar challenges (Parsons et al., 2018).

4.1 | Factors that affect residents' tolerance for raccoon dogs

4.1.1 | Familiarity

As a native species that was extirpated from Shanghai but has recently recolonized urban landscapes, many residents believed raccoon dogs are an exotic or invasive species, ignoring the fact that the species

TABLE 2 Evaluation criteria of structural equation model measurement model. Latent variables, their indicators and the survey questions are described in Appendix S3.

Latent variable	Indicators	Indicator reliability	Internal consistency		Convergent validity (average variance extracted)
		Outer loadings	Cronbach's α	Composite reliability	
Gender		1.000			
Age		1.000			
Education		1.000			
Familiarity	Contact	0.730	0.674	0.840	0.727
	Knowledge	0.958			
Trust	Reporting	0.777	0.809	0.885	0.720
	Obedient	0.885			
	Measure	0.860			
Risk	Dirt/smell	0.384			0.307
	Zoonotic disease	0.623			
	Traffic accident	0.373			
	Bite	0.837			
	Noise	0.362			
Benefit	Self	0.812	0.826	0.896	0.742
	Community	0.923			
	Nature	0.844			
Tolerance	Number	0.890	0.562	0.816	0.691
	Lethality	0.766			

perform various ecological functions and benefit urban ecosystems such as dispersing seeds and controlling pests (Vilà et al., 2010). The COVID-19 pandemic further increased people's generic fear for zoonotic diseases, but a recent city-wide zoonotic disease test in Shanghai has proved that raccoon dogs were free from zoonotic infectious disease pathogens (Shanghai Forestry Bureau, unpublished data). The perceived risks of having raccoon dogs in urban environments also include physical attacks, noise and obstructing traffic, all were extremely rare in the past decades. With all these backgrounds, we are confident that increases in people's familiarity with raccoon dogs through knowledge can significantly increase their perceived benefits and decrease perceived risks of this species.

Humans classify animals in a sociozoologic scale, which is an arbitrary, constantly changing category system based on the roles animals play in human lives and people's culture and worldview (Arluke & Sanders, 1996). While how raccoon dogs are socially constructed and negatively symbolized in Chinese culture may have enhanced people's perceived risks, we anticipate that residents' tolerance for raccoon dogs will gradually increase as educational efforts introduce positive cultural aspects of the species. Studies have also shown that the capability of perceiving and appreciating the benefits of nature, which often needs to be established at an early stage of life, is essential for the success of biodiversity management (Chawla, 2020). Results from a sample population of recreational trail users indicated that direct experience, self-assessed knowledge and perceived risk were either directly or indirectly related to each of the

four antecedent dimensions of tolerance for Asiatic black bears (Delie et al., 2023). In our case, we advocate environmental education activities, with a specific focus on enhancing relational values in pre-school and primary education by submitting a legislation amendment proposal to Shanghai Municipal Government, which has been preliminarily approved.

4.1.2 | Trust

We found that the trust in wildlife management authorities increased residents' perceived benefits, which further increased their tolerance for urban wildlife. This finding matches the results of studies of brown bears (*Ursus arctos*; Cleary et al., 2021) and wolves (*Canis lupus*; Marino et al., 2021). Increases in social trust leads to greater perceptions of advantages and demonstrates how official policies and actions affect locals' tolerance for animals (Marino et al., 2021). Our findings imply that improving the public's trust in the authorities may favour the receptivity of raccoon dogs. Contrary cases exists where researchers found that social trust had a negative relationship to human-bear relationship, because residents who reported higher trust in the agency to address interactions with black bears (*Ursus americanus*) were less tolerant (Lischka et al., 2020).

Given the complex nature of residents' trust in wildlife management authorities, we advocate that wildlife management authorities
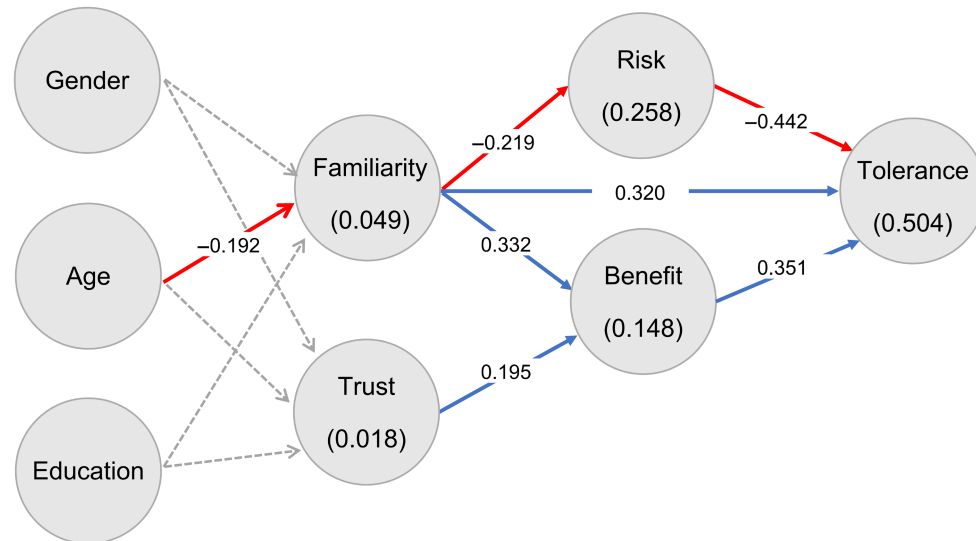
FIGURE 3 Partial least squares structural equation modelling of the latent variables constitutes the raccoon dog tolerance model. Grey circles represent latent variables with the corresponding R^2 value (i.e. variance explained) shown in the parentheses. Solid red lines represent significant negative effects and solid blue lines represent significant positive effects with the corresponding coefficients shown on the lines. Non-significant relationships are represented by dashed lines.

should take every opportunity to demonstrate that they can successfully conserve and manage raccoon dog populations, while approaching residents for their real-time feedback. Administrators should facilitate comprehensive public participation in wildlife decision-making processes (Bruskotter et al., 2010). Based on our findings, we encourage environmental NGOs to participate and increase their effort in wildlife management as enhanced societal trust could amplify the public's tolerance for raccoon dogs.

4.1.3 | Risk and benefit

There was a significant association between residents' perceived risks and benefits and their tolerance for urban wildlife. This finding involves several deep-rooted factors and implications.

First, the negative impact of risk perception may reflect human natural instincts of avoiding threats (van Eeden et al., 2019). To avoid direct attacks or disease transmission, empathetic risk perception helps people to gain a sense of security (Whitehead et al., 2016). However, significant differences exist between danger perception and actual threats. False perceptions of danger may lead to the unnecessary exclusion of wildlife, thus there is a need to help residents better understand wildlife behaviour and their actual threats.

Second, differences in cultural backgrounds and social groups affected how benefit is perceived towards wildlife. In our experimental education initiatives, part of our effort was focused on how to refine the cultural symbols of raccoon dogs in targeting residential districts. We used the homophonic stem and designed window decorations and posters to increase species' relational value in their densely distributed areas. We also participated in making nature documentaries, in which we thoroughly introduced raccoon dog ecology and discussed its coexistence with people in Shanghai residential districts. Through

these measures, we anticipate an increase in residents' perceived benefit and decrease in perceived risk, which could further translate into residents' tolerance increase.

4.2 | Caveats and future directions

We identify two caveats of our study due to the convenient nature of our sampling (Mackey & Gass, 2015). First, our respondents may not represent the sex, age and educational structure of the population. Sociodemographic variables are widely recognized to affect individuals' attitudes towards wildlife (Arbieu et al., 2019; Bencin et al., 2016) and their willingness to participate in questionnaire surveys (Boulet et al., 2021; Koziarski et al., 2016). For example, numerous studies have reported that females or higher educated people tended to be more sympathetic towards animals and pay more attention to animal cruelty and welfare (Lutz, 2016). Females are also more willing to take the time to answer questionnaires, which was also true for our study. Such unbalanced sampling may lead to bias in modelling results. Second, convenient sampling also made it challenging to control the sex, age, and educational structure of the respondents between the two surveys. Due to large sample size and the fact that our survey did not include any leading questions and rewards, we believe that our results provide valuable information for understanding tolerance of residents for raccoon dogs. Meanwhile, we acknowledge the importance of considering rigorous sampling design such as stratified random sampling in future studies.

4.3 | Management implications

Human-wildlife conflicts can be turned into positive interactions by promoting relational values of nature, especially when such conflicts

tend to represent perceived risks rather than actual injury or property loss (Chapman et al., 2019; Treves et al., 2009). Among the numerous causes that potentially lead to human-raccoon dog conflict (e.g. noise, road kill), the fear of disease transmission and physical attacks are the top two reasons, despite the fact that there is no evidence for raccoon dog transmitted disease and only three raccoon dog attack in the past 10 years (Zhao et al., 2022). Interesting to us was that there are also human-human conflicts due to people having opposing opinions about a specific wildlife species (Linnell & Carter, 2016). The actual level of such conflicts varies greatly depending on the social, economic, and geographical contexts. For example, in our study, significant differences in opinions occur among people with different knowledge, while the actual threat of raccoon dogs is negligible.

To promote harmony between urban residents and nature and foster their affection for urban species, educational campaigns and citizen science, which refers to the participation of non-professional citizens in scientific research (Sullivan et al., 2014), can be used to address conflicts both between humans and wild animals and between people with different opinions. We have organized citizen science activities, such as sign transect raccoon dog surveys and pop-science carnivals. Citizen volunteers can gain more knowledge about wildlife management and establish positive experiences while coexisting with urban species. Ongoing experimental collaborations among universities, environmental NGOs and wildlife authorities also have the potential to improve residents' trust in wildlife management authorities.

A school-based experiment was conducted in the Brazilian Amazon to compare the influence between school education and passively received information on the conservation of jaguars (*Panthera onca*), and the results indicated that books distributed via school had much higher impact in lowing social acceptance of jaguar killing (Marchini & Macdonald, 2020). To institutionalize nature education in the school system, one of our proposed revisions was added to the newly announced Shanghai's Wildlife Protection Law, requesting the primary and secondary education system to add more biodiversity and natural history education to their current curriculum. We believe such change not only provides a more promising future to enhance residents' relational value with nature but also encourages a broader range of organizations to participate in the process. Tasks include designing curriculum systems, training teachers, producing natural history documentaries, connecting wildlife management authorities with residents, and initiate citizen science activities as well as other bottom-up efforts.

Given the interdisciplinary nature of human-wildlife interactions, many different research fields have the potential to promote people's relational values using such educational activities (Echeverri et al., 2018). For example, while studies of animal symbolism evaluate how a species becomes a symbol and how these symbolic meanings get renegotiated over time (Arluke, 2002), studies in environmental economics aim to understand how much economic benefit could be generated from a healthy urban ecosystem. We strongly advocate social, ecological and psychological disciplines to interact and collaborate so that diverse social sciences and humanities theories can be translated to conservation contexts and contribute to our understanding of people's willingness to harmonize with nature.

ORCID

Qianqian Zhao https://orcid.org/0000-0001-8546-8689
Yihan Wang https://orcid.org/0000-0002-0225-4915
Lejie Wu https://orcid.org/0009-0009-7754-3381
Yidi Feng https://orcid.org/0000-0002-9879-670X
Yuhan Li https://orcid.org/0000-0002-6620-9654
Zhuojin Zhang https://orcid.org/0000-0002-6481-8624
Qing Zhao https://orcid.org/0000-0003-2759-1114
Fang Wang https://orcid.org/0000-0002-3922-5851

REFERENCES

Arbieu, U., Mehring, M., Bunnefeld, N., Kaczensky, P., Reinhardt, I., Ansorge, H., Böhning-Gaese, K., Glikman, J. A., Kluth, G., Nowak, C., & Müller, T. (2019). Attitudes towards returning wolves (*Canis lupus*) in Germany: Exposure, information sources and trust matter. *Biological Conservation*, *234*, 202–210.

Arluke, A. (2002). A sociology of sociological animal studies. *Society and Animals*, *10*, 369–374.

Arluke, A., & Sanders, C. (1996). *Regarding animals* (Vol. 39). Temple University Press.

Austen, G. E., Dallimer, M., Irvine, K. N., Maund, P. R., Fish, R. D., & Davies, Z. G. (2021). Exploring shared public perspectives on biodiversity attributes. *People and Nature*, *3*(4), 901–913.

Bateman, P. W., & Fleming, P. A. (2012). Big city life: Carnivores in urban environments. *Journal of Zoology*, *287*, 1–23.

Bencin, H., Kioko, J., & Kiffner, C. (2016). Local people's perceptions of wildlife species in two distinct landscapes of Northern Tanzania. *Journal for Nature Conservation*, *34*, 82–92.

Boulet, M., Borg, K., Faulkner, N., & Smith, L. (2021). Evenly split: Exploring the highly polarized public response to the use of lethal methods to manage overabundant native wildlife in Australia. *Journal for Nature Conservation*, 61, 125995.

Brearley, G., McAlpine, C., Bell, S., & Bradley, A. (2012). Influence of urban edges on stress in an arboreal mammal: A case study of squirrel gliders in southeast Queensland, Australia. *Landscape Ecology*, 27, 1407–1419.

Bridgewater, P., & Rotherham, I. D. (2019). A critical perspective on the concept of biocultural diversity and its emerging role in nature and heritage conservation. *People and Nature*, 1(3), 291–304.

Bruskotter, J. T., Toman, E., Enzler, S. A., & Schmidt, R. H. (2010). Gray wolves not out of the woods yet. *Science*, 327(5961), 30–31.

Capaldi, C. A., Dopko, R. L., & Zelenski, J. M. (2014). The relationship between nature connectedness and happiness: A meta-analysis. *Frontiers in Psychology*, 5, 976.

Chan, K., Balvanera, P., Benessaiah, K., Chapman, M., & Turner, N. J. (2016). Why protect nature? Rethinking values and the environment. *Proceedings of the National Academy of Sciences of the United States of America*, 113, 1462–1465.

Chan, K. M. A., Gould, R. K., & Pascual, U. (2018). Editorial overview: Relational values: What are they, and what's the fuss about? *Current Opinion in Environmental Sustainability*, 35, A1–A7.

Chapman, M., & Deplazes-Zemp, A. (2022). 'I owe it to the animals': The bidirectionality of Swiss alpine farmers' relational values. *People and Nature*, 5, 147–161.

Chapman, M., Satterfield, T., & Chan, K. M. A. (2019). When value conflicts are barriers: Can relational values help explain farmer participation in conservation incentive programs? *Land Use Policy*, 82, 464–475.

Chawla, L. (2020). Childhood nature connection and constructive hope: A review of research on connecting with nature and coping with environmental loss. *People and Nature*, 2, 619–642.

Cleary, M., Joshi, O., & Fairbanks, W. S. (2021). Mapping and modeling the components of human tolerance for black bears in eastern Oklahoma. *Journal of Environmental Management*, 288, 112378. https://doi.org/10.1016/j.jenvman.2021.112378

Cooper, C. B., Dickinson, J., Phillips, T., & Bonney, R. (2007). Citizen science as a tool for conservation in residential ecosystems. *Ecology and Society*, 12, 375–386.

Dagtekin, D., Şahan, E. A., Denk, T., Köse, N., & Dalfes, H. N. (2020). Past, present and future distributions of Oriental beech (*Fagus orientalis*) under climate change projections. *Biological Conservation*, 3, 1–9. https://doi.org/10.1016/j.healthplace.2020.102399

Delie, J., Needham, M. D., & Biedenweg, K. (2023). Modeling cognitive antecedents of tolerance for black bears: The roles of direct experience, knowledge, and risk perceptions. *Human Dimensions of Wildlife*, 28, 564–584.

Diao, Y. X., Zhao, Q. Q., Weng, Y., Huang, Z. X., Wu, Y. Q., Gu, B. J., Zhao, Q., & Wang, F. (2022). Predicting current and future species distribution of the raccoon dog (*Nyctereutes procyonoides*) in Shanghai. *China. Landscape and Urban Planning*, 228, 104581.

Echeverri, A., Karp, D. S., Naidoo, R., Zhao, J., & Chan, K. M. A. (2018). Approaching human-animal relationships from multiple angles: A synthetic perspective. *Biological Conservation*, 224, 50–62. https://doi.org/10.1016/j.biocon.2018.05.015

Elliot, E. E., Vallance, S., & Molles, L. E. (2016). Coexisting with coyotes (*Canis latrans*) in an urban environment. *Urban Ecosystems*, 19, 1335–1350. https://doi.org/10.1007/s11252-016-0544-2

Farrokhi, F., & Mahmoudi-Hamidabad, A. (2012). Rethinking convenience sampling: Defining quality criteria. *Theory & Practice in Language Studies*, 2(4), 784–792.

Frank, B. (2016). Human–wildlife conflicts and the need to include tolerance and coexistence: An introductory comment. *Society and Natural Resources*, 29, 738–743. https://doi.org/10.1080/08941920.2015.1103388

Frank, B., Glikman, J. A., & Marchini, S. (Eds.). (2019). *Human–wildlife interactions: Turning conflict into coexistence* (Vol. 23). Cambridge University Press.

García-Antúnez, O., Lindgaard, J., Lampinen, J., & Stahl Olafsson, A. (2023). Gardening for wildlife: A mixed-methods exploration of the factors underlying engagement in wildlife-friendly gardening. *People and Nature*, 5(2), 808–825.

Ghijselinck, D. (2023). Relational values of nature: Outgrowing anthropocentrism by enriching human-nature relationships? *Journal for Nature Conservation*, 73, 126386.

Gore, M., & Kahler, J. (2012). Gendered risk perceptions associated with human-wildlife conflict: Implications for participatory conservation. *PLoS One*, 7(3), e32901.

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, 31, 2–24.

Hair, J. F., Jr., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2021). *A primer on partial least squares structural equation modeling (PLS-SEM)*. Sage Publications.

Haywood, B. K., Parrish, J. K., & Dolliver, J. (2016). Place-based and data-rich citizen science as a precursor for conservation action. *Conservation Biology*, 30, 476–486.

Honda, T., Iijima, H., Tsuboi, J., & Uchida, K. (2018). A review of urban wildlife management from the animal personality perspective: The case of urban deer. *Science of the Total Environment*, 644, 576–582. https://doi.org/10.1016/j.scitotenv.2018.06.335

Kansky, R., Kidd, M., & Knight, A. T. (2014). Meta-analysis of attitudes toward damage-causing mammalian wildlife. *Conservation Biology*, 28, 924–938.

Kansky, R., Kidd, M., & Knight, A. T. (2016). A wildlife tolerance model and case study for understanding human wildlife conflicts. *Biological Conservation*, 201, 137–145. https://doi.org/10.1016/j.biocon.2016.07.002

Kimmig, S. E., Flemming, D., Kimmerle, J., Cress, U., & Brandt, M. (2020). Elucidating the socio-demographics of wildlife tolerance using the example of the red fox (*Vulpes vulpes*) in Germany. *Conservation Science and Practice*, 2(7), e212.

Klain, S. C., Olmsted, P., Chan, K. M., & Satterfield, T. (2017). Relational values resonate broadly and differently than intrinsic or instrumental values, or the new ecological paradigm. *PLoS One*, 12(8), e0183962.

Koziarski, A., Kissui, B., & Kiffner, C. (2016). Patterns and correlates of perceived conflict between humans and large carnivores in Northern Tanzania. *Biological Conservation*, 199, 41–50.

Lewicki, R., Gray, B., & Elliott, M. (Eds.). (2003). *Making sense of intractable environmental conflicts: Concepts and cases*. Island Press.

Linnell, J. D. C., & Carter, N. H. (2016). Co-adaptation is key to coexisting with large carnivores. *Trends in Ecology & Evolution*, 31(8), 575–578.

Lischka, S. A., Teel, T. L., Johnson, H. E., Larson, C., Breck, S., & Crooks, K. (2020). Psychological drivers of risk-reducing behaviors to limit human–wildlife conflict. *Conservation Biology*, 34(6), 1383–1392.

Lowry, H., Lill, A., & Wong, B. B. M. (2013). Behavioural responses of wildlife to urban environments. *Biological Reviews*, 88, 537–549.

Lowry, P. B., & Gaskin, J. (2014). Partial least squares (PLS) structural equation modeling (SEM) for building and testing behavioral causal theory: When to choose it and how to use it. *IEEE Transactions on Professional Communication*, 57, 123–146.

Lukasik, V. M., & Alexander, S. M. (2011). Human coyote interactions in Calgary, Alberta. *Human Dimensions of Wildlife*, 16, 114–127.

Lumber, R., Richardson, M., & Sheffield, D. (2017). Beyond knowing nature: Contact, emotion, compassion, meaning, and beauty are pathways to nature connection. *PLoS One*, 12, e0177186.

Lutz, B. (2016). Sympathy, empathy, and the plight of animals on factory farms. *Society and Animals*, 24, 250–268.

Mackey, A., & Gass, S. M. (2015). *Second language research: Methodology and design*. Routledge.

Marchini, S., & Macdonald, D. W. (2020). Can school children influence adults' behavior toward jaguars? Evidence of intergenerational learning in education for conservation. *Ambio*, 49, 912–925.

Marino, F., Kansky, R., Shivji, I., Di Croce, A., Ciucci, P., & Knight, A. T. (2021). Understanding drivers of human tolerance to gray wolves

and brown bears as a strategy to improve landholder–carnivore co-existence. *Conservation Science and Practice*, 3, 1–14.

Mascia, M. B. (2003). The human dimension of coral reef marine protected areas: Recent social science research and its policy implications. *Conservation Biology, 17*, 630–632.

Orazem, V., Smolej, T., & Tomazic, I. (2021). Students' attitudes to and knowledge of brown bears (*Ursus arctos* L.): Can more knowledge reduce fear and assist in conservation efforts? *Animals, 11*, 1958–1975.

Ostermann-Miyashita, E. F., Pernat, N., & Knig, H. J. (2021). Citizen science as a bottom-up approach to address human-wildlife conflicts: From theories and methods to practical implications. *Conservation Science and Practice, 3*(3), e385.

Parsons, A. W., Goforth, C., Costello, R., & Kays, R. (2018). The value of citizen science for ecological monitoring of mammals. *PeerJ, 6*, e4536.

Peterson, M. N., Birckhead, J. L., Leong, K., Peterson, M. J., & Peterson, T. R. (2010). Rearticulating the myth of human-wildlife conflict. *Conservation Letters, 3*, 74–82.

Pooley, S., Barua, M., Beinart, W., Dickman, A., Holmes, G., Lorimer, J., Loveridge, A. J., Macdonald, D. W., Marvin, G., Redpath, S., & Sillero-Zubiri, C. (2017). An interdisciplinary review of current and future approaches to improving human-predator relations. *Conservation Biology, 31*, 513–523.

Proctor, M. F., Kasworm, W. F., Annis, K. M., MacHutchon, A. G., Teisberg, J. E., Radandt, T. G., & Servheen, C. (2018). Conservation of threatened Canada-USA trans-border grizzly bears linked to comprehensive conflict reduction. *Human-Wildlife Interactions, 12*, 348–372.

Ringle, C. M., & Sarstedt, M. (2016). Gain more insight from your PLS-SEM results the importance-performance map analysis. *Industrial Management & Data Systems, 116*, 1865–1886.

Ringle, C. M., Wende, S., & Becker, J. M. (2015). SmartPLS 3. SmartPLS GmbH, Boenningstedt. *Journal of Service Science and Management, 10*(3), 32–49.

Saif, O., Kansky, R., Palash, A., Kidd, M., & Knight, A. T. (2020). Costs of coexistence: Understanding the drivers of tolerance towards Asian elephants (*Elephas maximus*) in rural Bangladesh. *Oryx, 54*, 605–611.

Santos, N. B., & Gould, R. K. (2018). Can relational values be developed and changed? Investigating relational values in the environmental education literature. *Current Opinion in Environmental Sustainability, 35*, 124–131.

Shanghai Forestry Bureau. (2021). *Shanghai Forestry Station went to Jiading to solve the public's panic about the raccoon dog*. https://doi.org/10.1038/s41559-018-0769-y

Shanghai Municipal Bureau of Agriculture and Forestry. (2004). *Shanghai terrestrial wildlife resources*. Shanghai Science and Technology Press.

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

Stalhammar, S., & Thoren, H. (2019). Three perspectives on relational values of nature. *Sustainability Science, 14*, 1201–1212.

Sullivan, B. L., Aycrigg, J. L., Barry, J. H., Bonney, R. E., Bruns, N., Cooper, C. B., Damoulas, T., Dhondt, A. A., Dietterich, T., Farnsworth, A., & Fink, D. (2014). The eBird enterprise: An integrated approach to development and application of citizen science. *Biological Conservation, 169*, 31–40.

Treves, A., Wallace, R. B., & White, S. (2009). Participatory planning of interventions to mitigate human-wildlife conflicts. *Conservation Biology, 23*, 1577–1587.

van Eeden, L. M., Smith, B. P., Crowther, M. S., Dickman, C. R., & Newsome, T. M. (2019). "The dingo menace": An historic survey on graziers' management of an Australian carnivore. *Pacific Conservation Biologogy, 25*, 245–256.

Vilà, M., Basnou, C., Pyšek, P., Josefsson, M., Genovesi, P., Gollasch, S., Nentwig, W., Olenin, S., Roques, A., Roy, D., Hulme, P. E., & DAISIE Partners. (2010). How well do we understand the impacts of alien species on ecosystem services? A pan-European, cross-taxa assessment. *Frontiers in Ecology and the Environment, 8*, 135–144.

Whitehead, A. L., Kujala, H., & Wintle, B. A. (2016). Dealing with cumulative biodiversity impacts in strategic environmental assessment: A new frontier for conservation planning. *Conservation Letters, 10*(2), 195–204.

Wong, K. K.-K. (2013). Partial least squares structural equation modeling (PLS-SEM) techniques using SmartPLS. *Marketing Bulletin, 24*, 1–32.

Zhao, Q. Q., Diao, Y. X., Weng, Y., Huang, Z. X., Gu, B. J., Wu, Y. Q., Wang, Y. H., Zhao, Q., & Wang, F. (2022). Predicting future distributions and dispersal pathways for precautionary management of human-raccoon dog conflicts in metropolitan landscapes. *Environmental Research Letters, 17*(10), 104036.

DATA SOURCES

The following reference pertains to the methods of structural equation models as described in the methods and appendix.

Hair, J. F., Sarstedt, M., Ringle, C. M., & Mena, J. A. (2012). An assessment of the use of partial least squares structural equation modeling in marketing research. *Journal of the Academy of Marketing Science, 40*, 414–433.

Hair, J. F., Jr., Sarstedt, M., Hopkins, L., & Kuppelwieser, V. G. (2014). Partial least squares structural equation modeling (PLS-SEM) an emerging tool in business research. *European Business Review, 26*(2), 106–121.

Henseler, J. F., Kolk, A., van der Zwaal, P., Nagels, J., Vlieland, T. P. V., & Nelissen, R. G. (2015). The minimal detectable change of the constant score in impingement, full-thickness tears, and massive rotator cuff tears. *Journal of Shoulder and Elbow Surgery, 24*(3), 376–381.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Appendix S1. Description of the study area.

Appendix S2. The raccoon dog tolerance model—explanations of latent variables.

Appendix S3. Questions and variables used in the questionnaires for testing the model of the wildlife tolerance model.

Appendix S4. Descriptive statistics for the sample.

Appendix S5. Partial least square structural equation models-additional information and results of evaluation of measurement and structural models.

Appendix S6. Correlation between structures with reflection metrics.

Appendix S7. Collinearity statistics of outer model.

Appendix S8. Collinearity statistics of inner model.

Appendix S9. Path coefficients of all variables.