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RESEARCH ARTICLE

Beyond values: How emotions, anthropomorphism, beliefs and knowledge relate to the acceptability of native and non-native species management in cities

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Abstract

1. Managing non-native species in cities is often controversial because these species can support both ecosystem services and disservices. Yet, how the acceptability of non-native species management by the general public differs in relation to native species, to distance (i.e. close to residence and elsewhere) and among plants and animals is understudied. Furthermore, while values, beliefs and knowledge are often considered in this context, psychometric factors such as emotions and anthropomorphic views have received little attention.
2. We surveyed 658 residents in Berlin, Germany, to assess (i) the acceptability of management actions differing in their severity for non-native plants and animals compared to native species with similar traits, (ii) the influence of perceived distance of species (i.e. close to residence and elsewhere) and (iii) the predictive potential of psychometric (i.e. values, beliefs, self-assessed knowledge, emotions and anthropomorphism) and socio-demographic factors for this acceptability.
3. Eradication (i.e. lethal control/removal) was generally the least accepted management action, but more accepted for non-native than native species. Distance mattered for the acceptability of non-native plant management with unspecified control action the most accepted management action close to residence.
4. While values (self-transcendence and conservation) mostly explained the acceptability of doing nothing and eradication, emotions related strongly to all management actions. Beliefs were more important than self-assessed knowledge in relation to non-native species management and beliefs about non-native plants and animals were rated almost similar. Anthropomorphic views had predictive potential for plants and animals; that is, the stronger people held anthropomorphic views, the less they accepted eradication. Participants with a garden supported doing nothing with plants (native and non-native) more than without.
5. Results highlight the complexity of factors underlying the acceptability of management actions on species in cities. While values, beliefs and self-assessed

knowledge are important in the context of species management, other psychometric factors add to our understanding of acceptability. We conclude that awareness about different acceptability patterns related to species management can support environmental policies on biological invasions in cities. Tailoring and implementing adequate management actions can benefit from incorporating cognitive but also affective factors of the public.

KEYWORDS
Alien species, invasion biology, native species, NIMBY, urban ecosystems, urban wildlife management, values

1 | INTRODUCTION

The majority of people live in cities today (UN, 2018) and are exposed to biological invasions (Aronson et al., 2014; Gaertner, Wilson, et al., 2017; Kowarik, 2008). Cities are hotspots for non-native species that are often associated with an array of both ecosystem services and ecosystem disservices in urban contexts (Potgieter et al., 2017; Schlaepfer et al., 2020). This can result in conflicts about adequate management approaches among stakeholders including among the general public (Crowley et al., 2017; Dickie et al., 2014; Gaertner, Wilson, et al., 2017; Williams et al., 2019). Understanding the different relationships that people have with non-native animal and plant species is key to develop strategies in managing biological invasions (Novoa et al., 2017; Potgieter et al., 2019; Shackleton et al., 2019). The public can support or oppose certain management actions, which can hinder at the worst management efforts (McNeely, 2011). Thus, the different views and concerns of people in non-native management processes should be acknowledged and integrated to support collaboration and foster trust among stakeholders (Shackleton et al., 2019; Young et al., 2016).

Shackleton et al. (2019) developed a framework to understand people's perception towards non-native species. This framework includes a wide range of factors that interact with one other ranging from the context (e.g. landscape, socio-cultural or institutional, governance and policy), to the species (e.g. taxonomic group, species traits) and to the individual level of people (e.g. demographic variables, knowledge and value systems of people; Shackleton et al., 2019). Yet, despite the potential of this framework to link perceptions to downstream management actions, it has still received little attention in empirical work.

Conflicts around non-native species management are context dependent for several reasons. First, the impact of non-native species depends on species identity. Only a small proportion of introduced species are classified as invasive and thereby conflicts with biodiversity conservation or interests of people. In Germany, for example, only about 4% of 864 introduced plant species are classified as invasive (Nehring et al., 2013). Second, the biogeographical and landscape contexts matter. Biological invasions in South African cities, for example, are a major threat to biodiversity and are associated with severe economic problems (Gaertner, Novoa, et al., 2017), different from Central European cities such as Geneva where non-native and native trees provide similarly both ecosystem services and disservices (Schlaepfer et al., 2020). Non-native species can be also perceived as more problematic in rural farmlands compared to highly transformed and urban landscapes (e.g. *Prosopis* [mesquite] in South Africa; Shackleton et al., 2015). Furthermore, non-native species can also be perceived differently among different urban contexts. In Berlin, the non-native tree of heaven (*Ailanthus altissima*) is more preferred in designed green spaces such as parks compared to other urban spaces such as streetscapes (Kowarik et al., 2021).

Species traits such as body size, feeding type and size of flowers can influence how people perceive a species (Shackleton et al., 2019). People often like 'beautiful' plants (Lindemann-Matthies, 2016) or 'cute or charismatic' animals, for example, with neotenic features (big eyes and large heads), that are colourful, small and fluffy or that are large and majestic (Estévez et al., 2015; Jarić et al., 2020; Shackleton et al., 2019; Verbrugge et al., 2013). Moreover, people's socio-demographic background (e.g. age, gender, urban or rural residence) and psychometric factors (e.g. values and beliefs) can relate to the perception and management of non-native plants and animals (Estévez et al., 2015; Fischer et al., 2014, Kapitza et al., 2019, Shackleton et al., 2019).

In particular, values are guiding principles in people's lives (Rokeach, 1973) that influence people's thought processes and their beliefs, attitudes, norms and behaviour (Fulton et al., 1996). Thus, values are central to the practice and science of conservation (Ives & Kendal, 2014; Latombe et al., 2022). While values are more stable and slower to change, they are also more abstract compared to beliefs, which are object focused and situation focused (Fulton et al., 1996). Aside from prior knowledge, beliefs are key factors when it comes to the individual's perception of non-native species (Bremner & Park, 2007; Fischer et al., 2014; Shackleton et al., 2019; Verbrugge et al., 2013). For instance, beliefs about the negative consequences of non-native species to the economy or the environment were found to be stronger compared to beliefs about the negative consequences of native species and influenced attitudes towards their

management (Fischer et al., 2014). Evidentially, considering people's existing values, beliefs or knowledge can increase the effectiveness of approaches towards non-native species (Estévez et al., 2015; Novoa et al., 2017; Potgieter et al., 2019) or even conservation outcomes in general (Manfredo et al., 2017).

Yet, we do not know whether the acceptance of species management in urban areas is spatially contingent, for example, lower or higher species acceptance in one's own backyard compared to a park further away. Usually, people tolerate unwanted objects or organisms when they are further away (i.e. outside of one's residence), but not necessarily close to or within one's residence or property—the NIMBY phenomenon ('not in my backyard'; Scott et al., 2016). The influence of distance has been investigated in relation to wanted and unwanted wildlife in the UK (Baker et al., 2020) but not yet in relation to non-native plants and animals in urban areas, despite the negative connotation of non-native compared to native species (Höbart et al., 2020). Furthermore, it is unclear whether acceptance of species management differs between animal and plant species and whether respondent characteristics predict acceptance of management in the same way for both groups of organisms. It is also uncertain whether values, beliefs (specific, object-focused) or other psychometric factors have a better predictive potential on the perception of non-native species.

Emotions and anthropomorphic views of people can also strongly predict species management action acceptance (Jacobs et al., 2014; Jacobs & Vaske, 2019; Manfredo et al., 2020; Straka et al., 2020), but are largely understudied in relation to non-native species management. Anthropomorphism is the tendency of people to attribute intentionality and mental states to non-human entities, particularly animals (Urquiza-Haas & Kotrschal, 2015). People tend to attribute higher cognitive abilities to non-human species that are perceived as more human-like, likely as a derivate of our ability to infer the mental states of conspecies—an ability that evolved as a consequence of the need to consider the experience and intentions of others (Eddy et al., 1993).

We developed our theoretical framework around this background. Yet, while Shackleton et al. (2019) referred to 'perception' as an interdisciplinary umbrella for other, more specific constructs, we were particularly interested in the construct 'acceptability of management actions'. Management actions can range from unspecified control actions and prevention to eradication including manual removal or herbicide use for invasive plants in a person's own backyard to methods such as insecticide-treated prey or trap-neuter-release methods for, for example, domestic cats (Potgieter et al., 2022). Management actions can also simply imply leaving species at their location without doing anything. In any case, people can support or oppose such management actions; information that is crucial and often at the centre of discussions in the case of non-native species since public opposition can cause delay of or hinder management efforts (McNeely, 2011; Selge et al., 2011).

In this study, we investigate factors driving the acceptability of management actions of non-native species that are linked to people's socio-demographic and psychometric factors (e.g. values, beliefs, anthropomorphism and emotions), including the spatial distance of the perceived animal or plant (Figure 1). Here we use comparative analyses including pairs of non-native and native animal and plant species to test how species' origin matters for species perception (Höbart et al., 2020). In doing so, we use a control component (i.e. native species with similar traits) to determine whether factors relate only to non-native species. Specifically, we ask the following questions:

1. How does the acceptability of management actions that vary in severity differ between native and non-native plants and animals?
2. How do patterns of the acceptability of management actions for native and non-native animals and plants differ with regard to the 'NIMBY' phenomenon (i.e. species either close to residence or elsewhere)?
3. What is the predictive potential of psychometric factors, specifically values, beliefs, self-assessed knowledge, emotions, anthropomorphism, for the acceptability of different management actions for native and non-native animals and plants?

First, we predicted that people would accept more severe management actions (e.g. eradication) for non-native compared to native species, irrespective of whether it is a plant or animal given the negative connotation of non-native species (Höbart et al., 2020). Second, we predicted that the acceptability of severe management actions (e.g. eradication) for non-native species is more accepted close to residence assuming that they are less wanted close-by according to the NIMBY phenomenon. Lastly, we predicted that values are important given their anticipated role in the management of ecological systems, but that more situation- and object-specific antecedents at higher-order cognitive levels in the cognitive hierarchy (e.g. beliefs, Fulton et al., 1996) would show stronger predictive potential. We also predicted that beliefs about the negative effects of non-native species would be stronger predictors for both animals and plants than self-assessed knowledge and that people would hold higher anthropomorphic views in relation to animals than to plants given they would consider them as more human-like. An improved understanding about the acceptability of non-native urban species management of citizens can translate to adjusted decision-making and dialogue between stakeholders (e.g. in nature conservation, urban planning, research) and the public, and contributes to our understanding of what drives acceptability in non-native species management in cities.

2 | METHODS

2.1 | Sample

An online questionnaire was distributed in German using Lamapoll (https://app.lamapoll.de) to people living in Berlin, Germany (Table S1). The survey was separated in two sub-surveys, one for

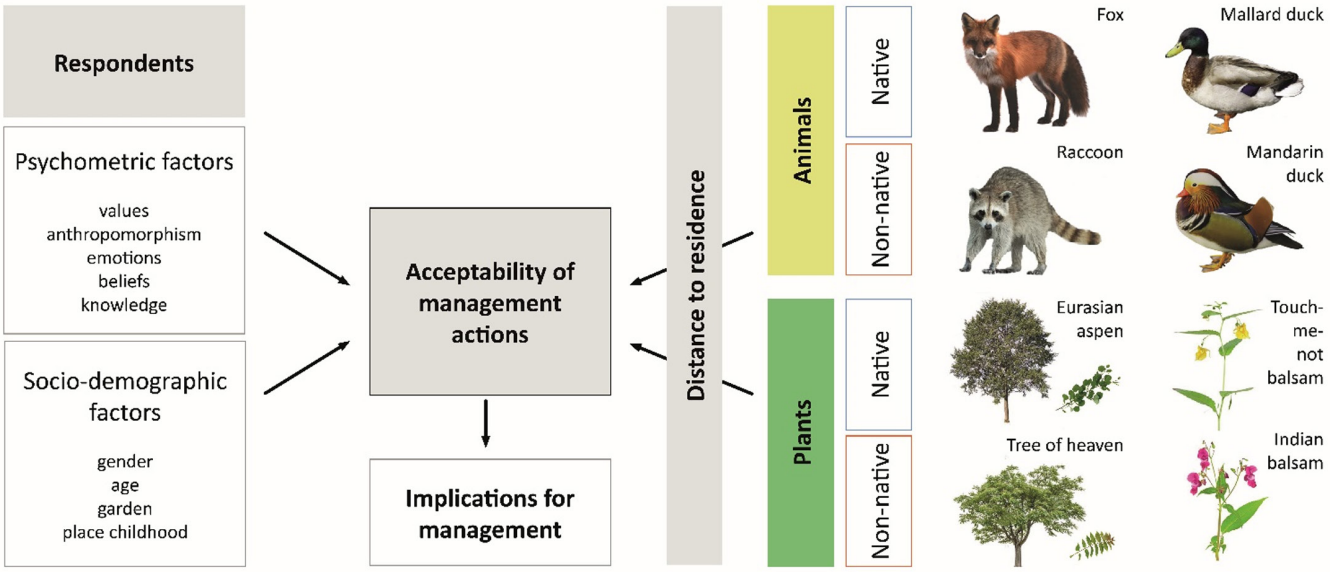

FIGURE 1 Conceptual framework showing the underlying key factors (respondents' psychometric and socio-demographic factors, distance 'NIMBY') for the acceptability of management actions of native species vs. non-native species in cities. On the species level, paired animal and plant species with native and non-native origin were used as stimuli in the questionnaire to assess people's thoughts and emotions towards non-native species in urban areas. Paired species were selected based on similar species traits. The origin of the species was introduced as whether 'native' or the specific geographical origin was given in the questionnaire text.

plants and one for animals to guarantee a shorter time to fill in a survey; however, items to measure the different concepts (e.g. values, emotions) and socio-demographic questions were similar in each survey to enable a comparison between taxa. Participants could decide to fill in either a survey on plants or on animals. While this survey approach (i.e. participants filled out either a plant or animal survey) limits a direct and statistical comparison between animals and plants, it allows us to discuss patterns that are shared or differ between animals and plants. Socio-demographic factors were similar between participants from the plant and animal survey (see 3.1. Survey respondents). The survey was open for 2 months from 24th May 2020 to 24th July 2020. We used a snowball sampling approach, a non-random sampling method that uses a few cases (in our case contact persons of different institutions) to distribute the survey and to increase the sample size (Taherdoost, 2016). The invitation was sent to 925 email addresses of different institutions in Berlin to reach the broad public from differing socioeconomic backgrounds. Institutions ranged from sports, retirement villages, kindergardens, etc. (adapted from Fischer et al., 2018). In an invitation letter, we introduced the survey and asked whether recipients could distribute the survey in their professional and private circles. In addition, social media channels such as Facebook (posting in groups focusing on online research, e.g. 'Umfragen für Studienarbeiten', 'Umfragen & Online- Experimente'), Twitter and SurveyCircle (a platform for online research and to find study participants: www.surveycircle.com) were used to distribute the survey with an emphasis that only Berlin residents should participate. Reminders were sent out via email to the institutions and posted on social media channels 2 weeks after the first call. Respondents who did not live in Berlin (based on their postal code) were excluded from further analyses. Participants were asked for the migration background as a socio-demographic factors since we assumed that responses will differ among cultures (Buijs et al., 2009 and see Fischer et al., 2018 for measures that we used; Table S1). Yet, data on migration background were too small to be included in the analyses.

There were no institutional requirements for ethical clearance. However, the survey was undertaken in accordance with the General Data Protection Regulation of the European Union. A written consent form was provided on the online platform to participants ensuring their anonymity, information about the general aim of the study, data that will be collected, contact and that there would be no disadvantages for participants if they resign from the study at any stage of their participation. Participants had to agree to this consent form before they could start the survey on Lamapoll.

2.2 | Development of survey instrument and measured concepts

In each of the two sub-surveys, we had the same parts that were adjusted for animals or plants, respectively. These parts included items to assess the psychometric factors: (a) values, (b) beliefs and self-assessed knowledge, (c) emotions, (d) anthropomorphism and (e) acceptability of management actions differing in their severity. Lastly, we also asked questions related to (g) socio-demographic factors (including age, gender, owning a garden and whether people grew up in urban or rural areas). Photo stimuli were prepared

to present the different species supplemented with information about their origin.

2.3 | Pre-test of survey instrument

We conducted a pre-test for the questionnaires in semi-structured interviews ($n = 12$ participants for survey on animals; $n = 12$ participants for survey on plants). Wording was adjusted where necessary (i.e. meaning of words not directly clear to participants).

2.3.1 | Values

Value statements included a subset of the *Short Schwartz'sche values* (SSV; Lindeman & Verkasalo, 2005; Schwartz, 1992). *Conservation* values are focusing on preserving the status quo and the certainty that conformity to norms provide and include scales measuring tradition (respect for tradition, humbleness, accepting one's portion in life, devotion, modesty), conformity (obedience, honouring parents and elders, self-discipline, politeness) and security (national security, family security, social order, cleanliness, reciprocation of favours). *Self-Transcendence* values are focusing on the welfare of others and include scales measuring universalism (broad-mindedness, beauty of nature and arts, social justice, a world at peace, equality, wisdom, unity with nature and environmental protection) and benevolence (helpfulness, honesty, forgiveness, loyalty and responsibility). While *Openness to Change* (including values hedonism, self-direction and stimulation) and *Self-Enhancement* (including values achievement and power) are also part of the original SSV framework, we did not include these values since we considered them to be less relevant in this context. Respondents could rate on a 5-point scale how important they considered *Conservation* and *Self-Transcendence* values in their life (ranging from 1 = not important at all to 5 = very important) including an explanation of what each value dimension involves (Table S1).

2.3.2 | Beliefs and self-assessed knowledge about non-native species

Six belief items were selected based on semantic differentials adapted from Fischer et al. (2014). People could rate on 5-point bipolar scales that included the opposite ends of a spectrum: (a) detrimental–beneficial to humans, (b) detrimental–beneficial to the economy, (c) detrimental–beneficial to nature, (d) uncontrollable–controllable, (e) overabundant–rare and (f) problematic–unproblematic. People could rate on a 5-point scale their level of agreement/disagreement with each belief. We reversed that scale ranging from positive to negative, with higher values indicating more negative beliefs about the consequences of non-native species. Cronbach's alpha to measure the internal consistency of items was acceptable for beliefs (animals $\alpha = 0.70$; plants $\alpha = 0.84$); hence, their mean scores used as latent construct for further analyses. For knowledge, people were asked to rate on a 5-point scale (from 1 = not at all to 5 = completely) their self-assessed knowledge with the item 'I think that I know a lot about non-native [...] in Germany with the 'animals' in the animal and 'plants' in the plant survey, respectively.

2.3.3 | Emotions (valence)

To measure participants' emotions towards each species, we used four items to measure valence which is a frequently used dimension to classify emotions on bipolar scales (do not like–like, unpleasant–pleasant, negative–positive, not enjoyable–enjoyable; Jacobs et al., 2014). Respondents were asked to rate on a 5-point scale (−2 ('not at all') to +2 ('very strong')) how they felt about each species in relation to the specific item. Cronbach's alpha was acceptable for valence (native animals $\alpha = 0.90$, non-native animals $\alpha = 0.92$, native plants $\alpha = 0.89$, non-native plants $\alpha = 0.94$) and hence, mean scores were also used in further analyses.

2.3.4 | Anthropomorphism

Items to assess the extent to which participants agreed that animals or plants in general possess mental state attributes associated with humans (having intentions, experiencing emotions, having consciousness) were drawn from the study by Manfredo et al. (2020). In addition, we added 'sensory experiences' which came up to be important in our pre-test. Respondents could rate the extent to which they agreed on a 5-point scale (from 1 = not at all to 5 = completely) to the question: 'Do you think that [animals, in the animal sub-survey or plants, in the plant sub-survey] have (i) consciousness, (ii) intentions, (iii) experience emotions and (iv) have sensory experiences. Cronbach's alpha was acceptable for anthropomorphic views in both groups (animals $\alpha = 0.80$; plants $\alpha = 0.84$) and hence, items were averaged over the total number of items to create a mean index score that was used to assess anthropomorphism to animals and plants, with high values indicating high anthropomorphic views to animals or plants, respectively.

2.3.5 | Acceptability of management actions

For each animal and plant species, we presented three different management actions that differed in their severity, that is, doing nothing, population control through 'unspecified control action' and population control through eradication such as lethal control for animals or complete removal for plants. Participants could rate on a 5-point scale (from 1 = not at all to 5 = completely) how much they agreed with each management action in regard to distance to residence,

that is, whether it would take place in 'close to residence' (i.e. own backyard as hypothetical question) or further away and 'elsewhere' (i.e. next urban park). We based wording and presentation of items on Kowarik et al. (2021).

2.4 | Photo stimuli and information about the origin of the species

A core part of the questionnaire was a photo stimuli supplemented with the origin of the species (Figure 1). Photo stimuli showed for animal or plant species a pair of mammals, birds, trees or herbs, respectively, that were selected on similar characteristics focusing on more or less similar size, feeding or growth types. We did not select our species based on their charisma, but that they frequently occur throughout the study area and that we were able to set up pairs of non-native and native species sharing similar traits for comparability. In relation to animals, we decided for mammals and birds (pairs: fox [*Vulpes vulpes*] and raccoon [*Procyon lotor*], mallard [*Anas platyrhynchos*] and mandarin duck [*Aix galericulata*]). As for plants, we decided for deciduous trees and smaller herbaceous plants (pairs: tree of heaven [*Ailanthus altissima*] and Eurasian aspen [*Populus tremula*], Indian [*Impatiens glandulifera*] and Touch-me-not balsam [*Impatiens noli-tangere*]). Our aim was to keep these photos as neutral as possible, that is, showing each animal or plant from a similar angle on a white background. Each native and non-native animal and plant species was introduced with 'This native [mammal/bird/tree/herb] is… 'or' This from [geographical origin] originated [mammal/bird/tree/herb] is …' to inform participants about the origin of the animal or plant even they would not be familiar with the origin of the species.

2.5 | Data analyses

Of the 443 people who started the animal survey, 342 people (77.2%) and of the 538 people who started that plant survey, 316 (58.7%) fully completed it. Only fully completed surveys were included in the analysis, leading into a total number of $n = 658$ participants. All analyses were undertaken in R (4.0.2) with the package 'psych' (Revelle, 2021) to calculate the internal reliability (Cronbach's alpha) of the items measuring emotions (four items), anthropomorphism (four items) and beliefs (six items). Since Cronbach's alpha was acceptably for emotions, anthropomorphism and beliefs, we calculated average scores for each latent construct. Since our main focus was on the acceptability of native versus non-native species control, we combined responses in relation to the acceptability management actions of raccoons and mandarin ducks; *hereafter* as non-native animals as well as tree of heaven and Indian balsam, *hereafter* as non-native plants. Similarly, we combined responses to the acceptability of management actions of foxes and mallard ducks; *hereafter* as native animals as well as Eurasian aspen and Touch-me-not balsam; *hereafter* as native plants.

To compare how origin (native/non-native) interacts with acceptability of management actions, we first applied a two-way ANOVA with an interaction effect between the acceptability of management action and origin. We applied this separately for animals and plants because although the socio-demographic backgrounds of participants were generally similar, we considered responses from the animal and plant sub-survey as two different surveys. Consequently, we decided to analyse animals and plant separately and to compare patterns. Furthermore, we applied the two-way ANOVA on responses 'close to residence' and similarly on responses 'elsewhere' since we were mainly interested in whether patterns were similar or different rather than a direct comparison between both distances.

To calculate the predictive potential of psychometric and socio-demographic factors on the acceptability of the three management actions (doing nothing, unspecified control action and lethal control/removal) for native and non-native animals and plants, we ran different model sets using ordinal logistic regression using the package 'MASS' (Venables & Ripley, 2002). In the first set of models, we focused on the psychometric factors as explanatory variables, that is, values, emotions and anthropomorphism for native and non-native species and beliefs and self-assessed knowledge in addition for non-native species (since only assessed for non-native species). We used the acceptability of the three different management actions 'close to residence' as response variables. We ran these models only for the scenario 'close to residence' since patterns of acceptance (except for control of non-native plants) were largely similar and we considered this scenario as more relevant in this context. To compare between models focusing only on values and models focusing on values and other psychometric factors, we used log-likelihood values to measure the goodness of fit between models using the package 'pscl' (Jackman, 2020). We decided for this approach to validate whether models with values as only explanatory variables performed better compared to models with values and other psychometric factors. In the last set of models, we assessed only socio-demographic factors (gender, age, owning a garden and place of childhood, i.e. whether urban or rural) as explanatory variables.

Lastly, we applied Wilcoxon tests to test for significant differences in relation to emotions between native and non-native animals as well as between native and non-native plants to account for the different affective responses towards native and non-native species. Effect sizes were based on Cohen (1988) with weak (≤0.1), moderate (≤0.3) and strong (≤0.5).

3 | RESULTS

3.1 | Survey respondents

The socio-demographic background of respondents from both surveys ($n = 342$ participants animal and $n = 316$ plant survey) was mostly comparable. Individuals in the animal survey sample were

equal in age (mean = 40.7 years ±15.0) as in the plant survey sample (mean = 40.0 years ±15.1). Similarly, more females participated in both, the animal (60%) and plant (64.6%) survey compared to male participants (animal survey = 36.0%; plant survey = 30.4%; with remaining participants identified as diverse or no information given).

3.2 | Severity of management

Overall, lethal control was the least accepted management action for native and non-native animals, irrespective of distance (Figure 2; Table S2). Nevertheless, lethal and unspecified control actions were more accepted for non-native than for native animals, whereas the opposite was true for the management action doing nothing. Doing nothing was more accepted for native than for non-native animals. For plants, we found that patterns were generally similar to animals and that removal was the least accepted management action for native and non-native species, irrespective of distance (Figure 2; Table S2). We similarly found that removal and unspecified control actions were more accepted for non-native than for native plants. However, the acceptability of doing nothing and unspecified control actions of non-native plants differed with perceived distance.

3.3 | NIMBY

A NIMBY effect was found for the acceptability of non-native plant management (Figure 2). Unspecified control actions were most accepted for non-native plants when described as 'close to residence'. This was not found for the scenario 'elsewhere' nor for native plants. In the scenario 'elsewhere', here, unspecified control actions were similarly accepted as doing nothing. As for native and non-native animals, patterns were similar; irrespective of distance. Hence, no NIMBY effect could be identified in relation to animals.

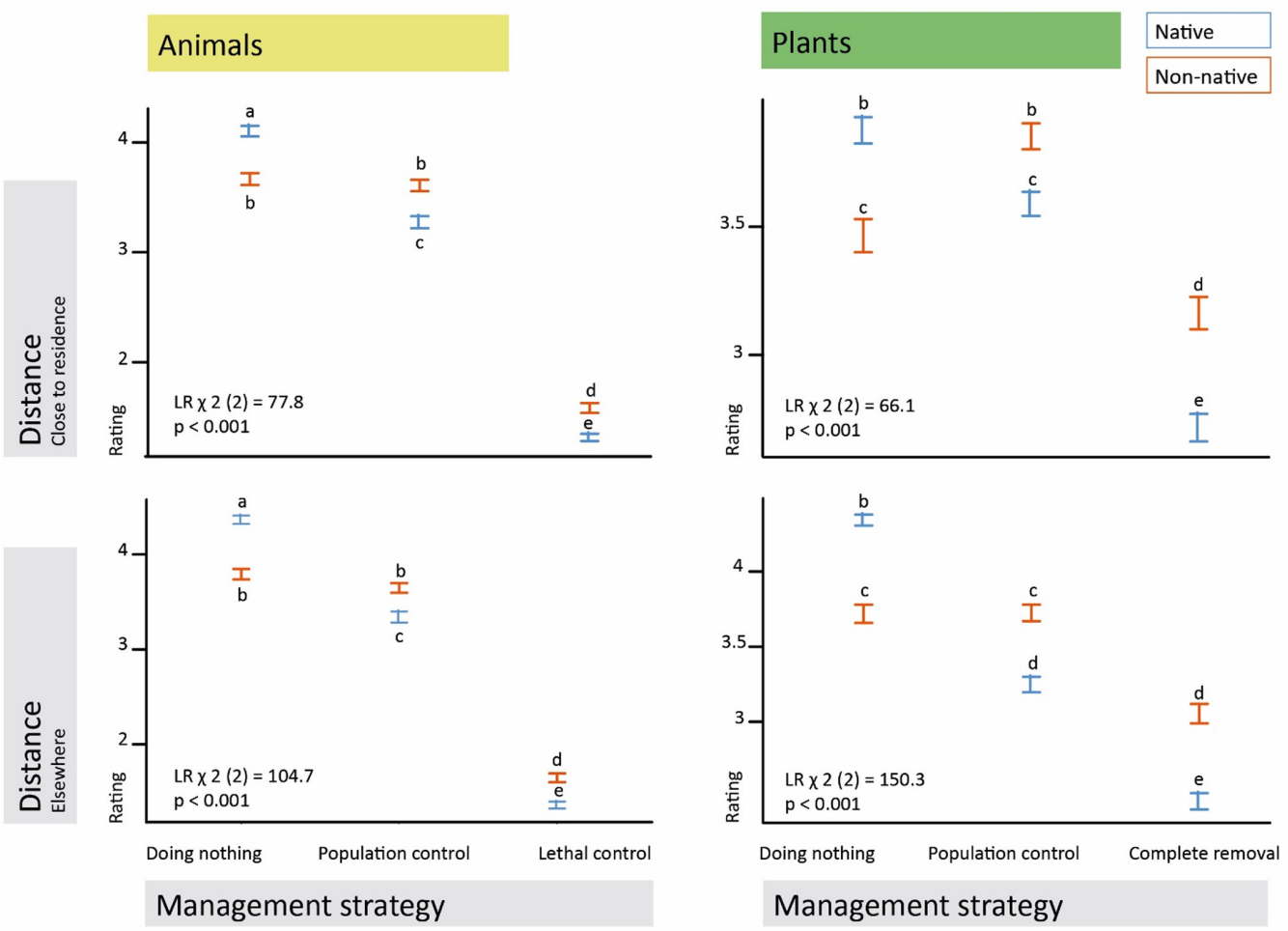

FIGURE 2 Mean and standard deviation of ratings for the acceptability of the three different management actions differing in their severity for native (blue) and non-native (red) animals (left) and plants (right) in relation to distance (close to residence; top and 'elsewhere', bottom) to assess an indication of the NIMBY phenomenon as indicated on a 5-point scale (1 = not at all to 5 = completely).

3.4 | Predictive potential of psychometric and socio-demographic factors

Overall, all models improved when the variables emotions, beliefs, anthropomorphism and self-assessed knowledge were included besides the variable on values in the models (Table 1). This is indicating that factors beyond values are crucial for the acceptability of species management in urban areas.

3.5 | Values

Self-transcendence (mean = 4.54, SD = 0.49) and conservation values (mean = 3.45, SD = 0.71) of respondents were similar in the animal and plant survey (self-transcendence: mean = 4.55, SD = 0.50, conservation: mean = 3.49, SD = 0.73), with self-transcendence values overall predicting higher conservation values. Both self-transcendence and conservation had predictive potential for the acceptability of management actions on either of the extremes: doing nothing and lethal control/removal of animals and plants. High self-transcendence values were a positive predictor ('support') on doing nothing with native and non-native animals and plants, whereas high conservation values showed negative predictive potential ('opposition'; Table 1). In relation to lethal control/removal, values showed only predictive potential for native species. Here, high self-transcendence values were a negative predictor ('opposition') for the eradication of native animals and plants whereas high conservation values showed positive potential ('support') on the eradication of native plants.

3.6 | Anthropomorphism

Overall, average anthropomorphic views for animals were high (mean across all four items = 4.30, SD = 0.64) and for plants moderate (mean across all four items = 2.81, SD = 0.96). For animals, people rated highest that animals have sensory experiences and lowest that animals have consciousness (Figure 3). As for plants, people rated highest that plants have sensory experiences and intentions and lowest that plants experience emotions. Anthropomorphism was a significant negative predictor ('opposition') for lethal control of native and non-native animals and removal and unspecified control actions of native plants (Table 1).

3.7 | Self-assessed knowledge and beliefs

Self-assessed knowledge and beliefs were only assessed for non-native animals and plants. Overall, participants in the animal survey rated their self-assessed knowledge about non-native animals (mean = 3.21, SD = 1.10) higher compared to participants in the plant survey and their self-assessed knowledge about non-native plants (mean = 2.76, SD = 1.29). In contrast, beliefs about the negative consequences of animals (mean across all six items = 3.18, SD = 0.70) were similar as for plants (mean across all six items = 3.18, SD = 0.73). Comparing between single items, problematic in general and detrimental to nature were the two items that were rated highest for non-native animals and plants, whereas detrimental to humans lowest (Figure 4).

Self-assessed knowledge and beliefs showed predictive potential for all management actions in relation to non-native plants and partially for non-native animals. Highly held beliefs about the negative effects of non-native plants was a positive predictor ('support') for complete removal and unspecified control actions; whereas a negative predictor ('opposition') of doing nothing. While similar effects were found for self-assessed knowledge about non-native plants, beliefs had higher effect sizes on the acceptability of management actions than self-assessed knowledge (Table 1). For animals, beliefs were only predictors for both extreme management actions (doing nothing and lethal control) and self-assessed knowledge only for lethal control. However, patterns were similar and highly held beliefs about the negative effects of non-native animals was a positive predictor ('support') for lethal control and a negative predictor ('opposition') for doing nothing and beliefs had higher effect sizes than self-assessed knowledge.

3.8 | Emotions

Emotions towards native animals and plants were significantly higher (mean = 4.5, SD = 0.6 and mean = 4.3, SD = 0.7, respectively) compared to non-native animals and plants (mean = 4.1, SD = 0.8 and mean = 3.9, SD = 0.9, respectively; $z = -5.72$, $r = 0.31$, $p < 0.001$ and $z = -4.70$, $r = 0.27$, $p < 0.001$, respectively). Emotions showed predictive potential for all management actions (except for removal of native plants). Generally, positively held emotions (valence) towards species supported doing nothing but less unspecified control actions and eradication of species, irrespective of taxa and origin of species.

3.9 | Socio-demographic factors

Socio-demographic factors showed less predictive potential on the acceptability of management actions compared to the psychometric factors (Table 1). Owning a garden had only predictive potential in the case of plants. Here, owning a garden predicted the acceptability of doing nothing with native and non-native plants in the own backyard. Owning a garden was also a negative predictor ('opposition') for unspecified control actions and complete removal of non-native plants in the own backyard. Gender was only a predictor in the case of animals, with men were more supportive of lethal control of native and non-native animals than women. As for age, older people were less supportive ('opposition') of doing nothing with non-native animals and plants, but also native plants. Furthermore, older people were more in support of the complete removal of non-native plants. Whether people grew up in urban or rural areas did not have any predictive potential on the acceptability of any management action.

TABLE 1 Predictive potential of underlying psychometric and socio-demographic factors on the acceptability of native and non-native animals and plants close to residence

	Animals			Plants		
Native	**Doing nothing mean ± SE (*p*-value)**	**Pop. control mean ± SE (*p*-value)**	**Lethal control mean ± SE (*p*-value)**	**Doing nothing mean ± SE (*p*-value)**	**Pop. control mean ± SE (*p*-value)**	**Removal mean ± SE (*p*-value)**
Psychometric factors						
Pseudo R^2; logLIK (df)	0.03; −584.55 (10)	0.003, −690.47 (10)	0.03, −343.55 (8)	0.03, −577.71 (10)	0.007, −588.85 (10)	0.01, −630.30 (10)
Value: Self-Transcendence	**0.52 ± 0.21* (0.02)**	−0.12 ± 0.21 (0.55)	**−0.59 ± 0.26* (0.02)**	**0.54 ± 0.21** (<0.009)**	−0.05 ± 0.21 (0.84)	**−0.45 ± 0.21* (0.03)**
Value: Conservation	**−0.64 ± 0.14*** (<0.001)**	0.17 ± 0.13 (0.21)	0.27 ± 0.18 (0.12)	**−0.64 ± 0.15*** (<0.001)**	0.09 ± 0.15 (0.54)	**0.29 ± 0.15* (0.04)**
Pseudo R^2; logLIK (df)	0.07; −559.92 (12)	0.01, −683.25 (12)	0.06, −330.23 (10)	0.08, −549.29 (12)	0.02, −580.16 (12)	0.03, −614.35 (12)
Anthropomorphism	0.16 ± 0.16 (0.32)	−0.10 ± 0.15 (0.51)	**−0.59 ± 0.19** (0.002)**	−0.05 ± 0.11 (0.71)	**−0.38 ± 0.11** (0.0003)**	**−0.31 ± 0.11** (0.003)**
Emotions	**1.23 ± 0.18*** (<0.001)**	**−0.59 ± 0.17*** (<0.001)**	**−0.68 ± 0.20*** (<0.001)**	**1.22 ± 0.17*** (<0.001)**	−0.28 ± 0.16 (0.08)	**−0.73 ± 0.16*** (<0.001)**
Socio-demographic factors						
Gender (men compared to women)	0.18 ± 0.17 (0.29)	0.22 ± 0.16 (0.16)	**0.59 ± 0.19** (0.002)**	0.15 ± 0.15 (0.34)	−0.19 ± 0.15 (0.21)	0.17 ± 0.15 (0.26)
Age	−0.01 ± 0.007 (0.10)	−0.001 ± 0.01 (0.14)	0.02 ± 0.01 (0.07)	**−1.51 ± 0.51* (0.003)**	0.76 ± 0.48 (0.11)	0.45 ± 0.51 (0.38)
Garden (no = 0, yes = 1)	0.02 ± 0.21 (0.91)	−0.002 ± 0.21 (0.99)	−0.36 ± 0.26 (0.16)	**0.52 ± 0.19** (0.006)**	−0.29 ± 0.19 (0.13)	−0.32 ± 0.19 (0.09)
Place childhood	0.01 ± 0.19 (0.96)	0.07 ± 0.19 (0.71)	−0.17 ± 0.23 (0.46)	0.15 ± 0.21 (0.45)	−0.05 ± 0.21 (0.80)	−0.24 ± 0.21 (0.25)
	Animals			**Plants**		
Non-native	**Doing nothing mean ± SE (*p*-value)**	**Pop. control mean ± SE (*p*-value)**	**Lethal control mean ± SE (*p*-value)**	**Doing nothing mean ± SE (*p*-value)**	**Pop. control mean ± SE (*p*-value)**	**Removal mean ± SE (*p*-value)**
Psychometric factors						
Pseudo R^2, logLIK (df)	0.02; −663.47 (10)	0.0001; −661.87 (10)	0.008; −471.17 (9)	0.008; −648.15 (10)	0.003; −635.48 (10)	0.001; −664.75 (10)
Value: Self-Transcendence	**0.51 ± 0.21* (0.01)**	0.16 ± 0.21 (0.40)	−0.07 ± 0.25 (0.79)	**0.47 ± 0.21* (0.03)**	−0.29 ± 0.21 (0.16)	−0.25 ± 0.21 (0.23)
Value: Conservation	**−0.40 ± 0.14** (0.005)**	0.03 ± 0.14 (0.81)	0.04 ± 0.16 (0.82)	**−0.39 ± 0.15** (0.008)**	−0.0003 ± 0.14 (1.00)	0.04 ± 0.15 (0.79)
Pseudo R^2, logLIK (df)	0.09; −615.49 (14)	0.01; −653.65 (14)	0.15; −401.63 (13)	0.16; −545.41 (14)	0.11; −569.61 (14)	0.11; −592.15 (14)
Anthropomorphism	0.15 ± 0.16 (0.35)	−0.003 ± 0.15 (0.98)	**−0.61 ± 0.17*** (<0.001)**	−0.03 ± 0.11 (0.80)	−0.18 ± 0.11 (0.09)	−0.16 ± 0.11 (0.15)
Emotions	**0.95 ± 0.14*** (<0.001)**	**−0.39 ± 0.13** (0.004)**	**−1.02 ± 0.16*** (<0.001)**	**1.35 ± 0.14*** (<0.001)**	**−0.54 ± 0.12*** (<0.001)**	**−0.70 ± 0.13*** (<0.001)**
Beliefs	**−0.65 ± 0.17*** (<0.001)**	0.21 ± 0.16 (0.19)	**1.06 ± 0.21*** (<0.001)**	**−0.81 ± 0.17*** (<0.001)**	**1.06 ± 0.17*** (<0.001)**	**1.09 ± 0.17*** (<0.001)**
Self-assessed knowledge	0.05 ± 0.09 (0.59)	−0.15 ± 0.09 (0.11)	**0.40 ± 0.11*** (0.0004)**	**−0.23 ± 0.09** (0.009)**	**0.31 ± 0.09*** (<0.001)**	**0.23 ± 0.09** (<0.001)**
Socio-demographic factors						
Gender (men compared to women)	0.06 ± 0.16 (0.71)	−0.22 ± 0.16 (0.17)	**0.54 ± 0.17** (0.002)**	−0.19 ± 0.15 (0.19)	0.19 ± 0.15 (0.21)	0.17 ± 0.15 (0.27)
Age	**−0.02 ± 0.01* (0.02)**	−0.01 ± 0.01 (0.22)	**−0.02 ± 0.01* (0.02)**	**−1.33 ± 0.52* (0.01)**	0.92 ± 0.49 (0.06)	**1.09 ± 0.48* (0.03)**
Garden (no = 0, yes = 1)	−0.07 ± 0.21 (0.75)	0.19 ± 0.21 (0.37)	−0.28 ± 0.23 (0.23)	**0.67 ± 0.19*** (0.0005)**	**−0.40 ± 0.19* (0.04)**	**−0.42 ± 0.19* (0.03)**
Place childhood	0.05 ± 0.18 (0.80)	0.05 ± 0.19 (0.81)	−0.30 ± 0.21 (0.15)	0.07 ± 0.21 (0.75)	0.11 ± 0.20 (0.59)	−0.21 ± 0.21 (0.30)

Mean and standard error (SE). Significant results (in bold) are shown by $^*p < 0.05$, $^{**}p < 0.01$ and $^{***}p < 0.001$.

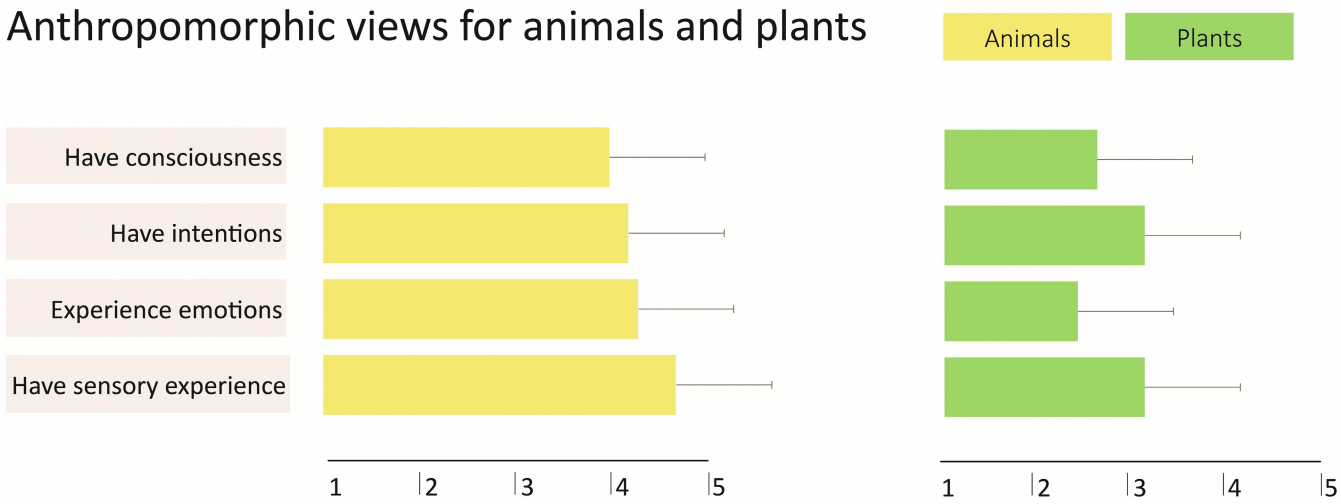

FIGURE 3 Mean rating and standard deviation for each of the four anthropomorphism items. Responses to the questions 'Do you think that [animals (animal survey)/plants (plant survey)] have … ?', are depicted on a 5-point Likert scale ranging from 1 = 'not at all' to 5 = 'completely'.

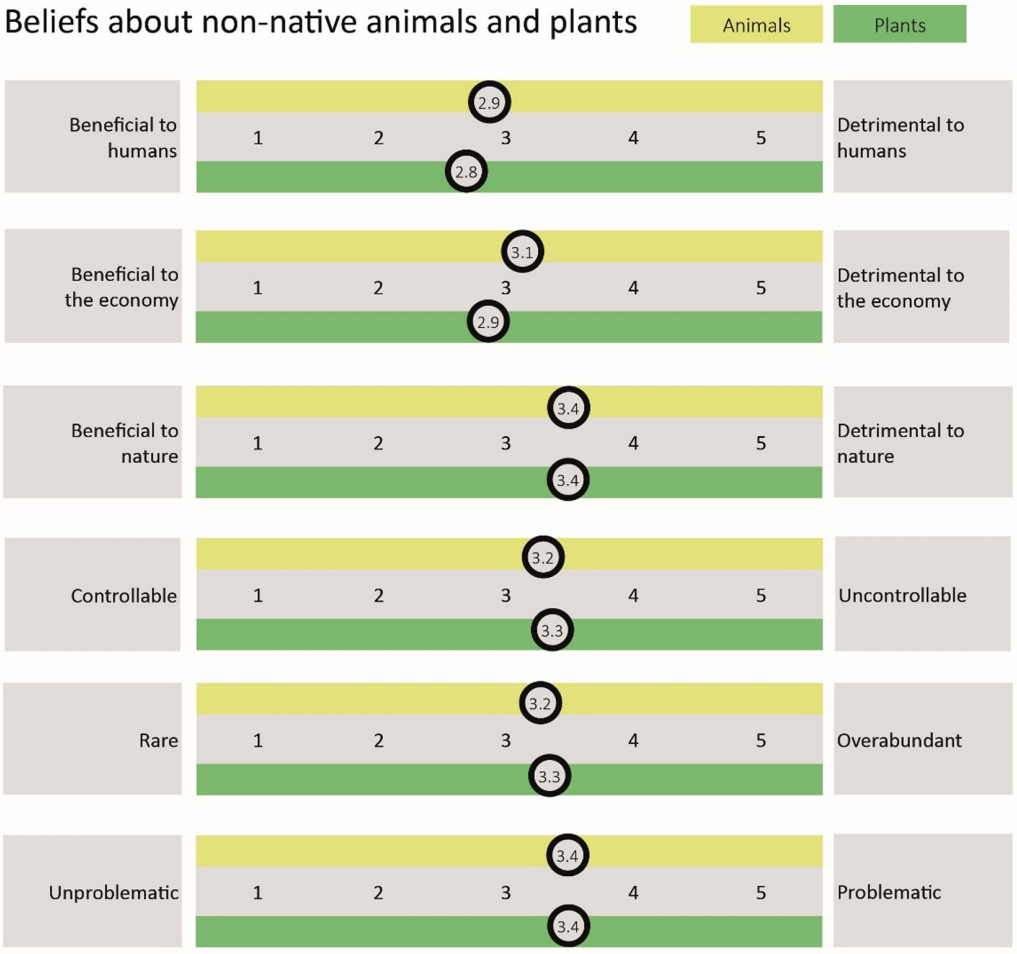

FIGURE 4 Mean rating for each of the six belief items. Responses to question 'Do you believe that [non-native animals (animal survey)/non-native plants (plant survey) are […]? While semantic differentials were used, scales ranged here from 1 to 5 to measure either extreme.

4 | DISCUSSION

The acceptability of non-native species management in urban environments often produces conflicts between decision-makers and the public (Dickie et al., 2014, Crowley et al., 2017; Gaertner, Wilson, et al., 2017; Williams et al., 2019). Here, we contribute to our understanding of factors that underlie the acceptability of native and non-native species management actions among residents in Berlin, Germany. Previous studies have investigated different factors in this context (e.g. context of species, values, knowledge and beliefs, Bremner & Park, 2007; Estevez et al., 2015; Fisher et al., 2014). This study simultaneously investigated the role of distance to the species, that is, the NIMBY phenomenon, and psychometric factors of respondents (values, emotions, beliefs, self-assessed knowledge and anthropomorphism) in species management in urban areas. The choice of these variables was based on the framework of Shackleton et al. (2019) and on acceptance research with animals and plants (Kowarik et al., 2021; Straka et al., 2020). The major insights of our work are as follows: (1) eradication (i.e. lethal control/removal), the most severe management action, was the least accepted management action; irrespective of taxa or origin of species; (2) the acceptability for management actions differed significantly between native and non-native species; (3) patterns were similar for the distance scenario 'close to residence' and 'elsewhere' with the exception for non-native plants; and (4) psychometric and socio-demographic factors showed predictive potential and demonstrate the complexity in which species management in urban areas is embedded.

4.1 | Severe management actions are more accepted for non-native than native species

The acceptability of management actions within the public can inform how people support or oppose non-native species management (Selge et al., 2011), relevant because public opposition can hinder management efforts (McNeely, 2011). Overall, we found that eradication was the least accepted management action for animals (lethal control) and plants (removal) in the urban context, irrespective of the species' origin (native or non-native). The low acceptance for eradication compared to less severe management actions such as unspecified control actions or doing nothing adds evidence to previous studies on animals (Dheer et al., 2021; Jacobs et al., 2014) and plants (Kowarik et al., 2021). However, we show that eradication and unspecified control actions were more accepted for non-native compared to native species, irrespective of whether they are plants or animals. Thus, compared to native species, people prefer active management actions for non-native species in urban areas. The preference for active management actions of non-native species such as eradication and unspecified control actions may be due to the negative connotation of non-native compared to native species (Höbart et al., 2020). Indeed, we also found in our study that people expressed lower emotions (valence) towards non-native compared to native species.

4.2 | Indication of Nimby?

We used the 'NIMBY' concept to assess whether the acceptability of management actions differed with perceived distance. In the case of non-native plants, we found that unspecified control actions were the most accepted management action compared to doing nothing 'close to residence' but not 'elsewhere'—a potential indication of NIMBY for non-native species. Home gardens are places where dichotomies between native or non-native are generally blurred, and conservation recommendations around ecologically 'good' versus 'bad' controversial (Head & Muir, 2006; Kendal et al., 2010). Most plants in backyards are already non-native cultivated and ornamental plants that result from gardening activity (Kendal et al., 2012; Loram et al., 2008; van Heezik et al., 2013), which is related to people's demographics, experience and motivations (Philpott et al., 2020). However, in the case of non-native plants, we showed participants the two species tree of heaven (*Ailanthus altissima*) and the Indian balsam (*Impatiens glandulifera*), which have a rapid growth and spread that may not be desired by gardeners. Rather, garden plant species are often selected based on aesthetic (e.g. flower size, leaf width, foliage cover), but also non-visual traits such as nativeness (Kendal et al., 2012). As our native and non-native plant pairs shared similar traits, the origin of the plant likely explains the acceptance of management actions in our study. While this adds to our knowledge that the acceptance of non-native plants is context specific (differing for example between different urban situations; Kowarik et al., 2021), we did not find this pattern for non-native animals. In both scenarios of 'close to residence' and 'elsewhere', unspecified control actions of non-native animals were similarly accepted as doing nothing. There are two possible explanations for this. First, given that animals are more anthropomorphized than plants (as our study shows), participants did not consider it as ethical to control for populations of non-native animals close to their residence, whereas this is more acceptable for plants. Second, plants are possibly considered easier to control compared to animals.

Xenophobia (i.e. hostility towards anything that is foreign such as non-native species) is controversially discussed in invasion studies (Richardson & Ricciardi, 2013; Simberloff, 2003), including the role of people for the spread of non-native species (Selge et al., 2011). While we cannot clearly state that people held xenophobic views in relation to non-native plants because we did not compare them in our survey to native species, it is noteworthy that beliefs about the consequences of non-native species did not largely differ between plants and animals. Both beliefs about the consequences of non-native animals and non-native plants were moderate in our study, that is, they were not considered as extensively detrimental nor beneficial (Figure 4). While this contrasts to a study in South Africa in which participants considered non-native plants as problematic (Potgieter et al., 2019), it also confirms the biogeographical context that needs to be considered in studies on non-native species management.

4.3 | Values matter, but other psychometric factors add to our understanding of acceptability

Throughout the literature, people's values largely determine non-native species management (Bartz & Kowarik, 2019; Estévez et al., 2015; Shackleton et al., 2019). In our urban study, values had predictive potential for both extremes of management—doing nothing and eradication—but not for the moderate management (unspecified control actions). People with high self-transcendence values (i.e. the welfare of others is important) were in support of doing nothing, that is, leaving animals and plants alone, irrespective of their origin. People with high self-transcendence values were also more in opposition of lethal management of animals or removal of plants. However, only in the case for native and not for non-native species. The influence of self-transcendence values on harming other species was also shown in a study by Hrubes et al. (2001). Here, researchers showed how self-transcendence values were negatively correlated to hunting behaviour among outdoor recreationists (Hrubes et al., 2001). The second value system in our survey, 'conservation' (i.e. preserving the status quo is important) predicted the opposite to self-transcendence values. People with high conservation values were more in opposition of doing nothing, that is, to not manage animals and plants, irrespective of their origin. Hence, understanding whether people are more on a 'self-transcendence' or 'conservation' value spectrum might be useful for urban planners and managers if they want acceptance for not managing animals and plants, also native species.

Our models improved when including other psychometric factors (emotions, anthropomorphism, self-assessed knowledge and beliefs). Particularly, emotions had predictive potential on all management actions, underpinning their important role in relation to the acceptability of management actions (Jacobs et al., 2014; Straka et al., 2020). We used in our survey emotions based on valence that was measured as the 'positive' and 'negative' character of an emotion or of its aspects (Colombetti, 2005), in our case whether people felt for instance more positive or negative when they were thinking about native or non-native species (see Table S1). While emotions towards non-native species was lower compared to native species, they were generally high towards plants and animals, and also for non-native ones. Thus, the more positive people felt about a species, the more they supported doing nothing, but the less they supported unspecified control actions and eradication.

In support of our predictions, people held higher anthropomorphic views in relation to animals than plants, aligning with the theory that people attribute higher cognitive abilities to other species that are perceived as more human-like (Eddy et al., 1993). In the case of animals, anthropomorphism, that is, the ability to attribute cognitive and emotional abilities to others, had only predictive potential for the opposition of lethal control to animals as also shown in a study on wolf management (Manfredo et al., 2020). We show in addition that anthropomorphism does not reflect species' origin. If people held high anthropomorphic views towards animals, they did not differentiate whether it is a native or non-native animal in the urban context. Interestingly, anthropomorphism was also a negative predictor for control management actions (unspecified control actions and removal) of native plants. One possible explanation could be the attachment that people form with plants in their backyards. Owning a garden had only predictive potential when it came to plants, suggesting ties of garden owners to their plants (Hands et al., 2018; Head & Muir, 2006). For example, through gardening activity, people interact with and care for plants in their backyards, ultimately forming emotional bonds to their plants (Cerda et al., 2022; Freeman et al., 2012).

In relation to knowledge and beliefs, earlier studies found that better knowledge of non-native species increases the acceptance of control measures (Bremner & Park, 2007; Lewis et al., 2019). In our study, self-assessed knowledge was important for the acceptance of control measures (unspecified control actions and eradication). Yet, beliefs were even more important in relation to non-native species than self-assessed knowledge, confirming again the importance to consider beliefs in non-native species management (Fischer et al., 2014). In detail, the more people believed that non-native species have negative consequences, the more they supported their eradication and control and the less of doing nothing. Beliefs are fundamental parts of cognitive processes (Fulton et al., 1996) and similar as suggested for values (Manfredo et al., 2017), they need to be understood to work effectively with people involved in conservation issues.

Older people were less supportive of doing nothing and more supportive of eradication of non-native plants. Previous studies showed that older people tended to perceive invasive plants more negatively than younger respondents (Nguyen et al., 2020; Potgieter et al., 2019). According to the 'shifting baseline syndrome' theory, environmental changes are more noticed and questioned by the older generations, whereas they are less so by younger people, who have experienced different states of nature (Soga & Gaston, 2016). Yet, contrasting results for the acceptance of eradication of tree of heaven in another study (Kowarik et al., 2021) suggest that attitudes of respondents towards non-native species may depend on the addressed species.

We did not find an effect of where people grew up on the acceptability of the different management actions. However, males were more supportive of eradication than females. This is also supported by other studies, particularly on animals. For instance, women were found to show more empathy towards animals than men and were more opposed to killing and more supportive of wildlife conservation as shown for instance in the case of whales among U.S. college students (Hamazaki & Tanno, 2002; Kellert, 1984). In relation to plants, women were more likely to enjoy aesthetically pleasing plants than men in a study investigating attractiveness of plant species in Zurich, Geneva and Lugano (Lindemann-Matthies, 2016).

Limitations of this study are that many participants may not be landholders and not be confronted with these management decisions, as a large proportion of people in cities in Germany are renters of apartments without garden access. Hence, many people may not have their own backyard or garden but rather use that of a property-owner. We did not account for these factors and while non-landholders can also be opposed to management actions,

scenarios are more assumptive in this context. Furthermore, since we only surveyed self-assessed knowledge, how much people really knew about non-native species remains a question.

5 | CONCLUSION

Our study contributes to a better understanding of people's views on management options towards non-native and native plants and animals in an urban context. Such insights can enhance management feasibility and the effectiveness of management activities because controlling native animals or plants can similarly conflict with people's views as non-native species. This comparative study on pairs of native and non-native plants and animals shows that management acceptability differs between species' origin with active management actions as eradication and unspecified control actions more accepted for non-native compared to native species. Furthermore, socio-demographic factors, but more importantly psychometric factors of respondents strongly predict acceptability of management actions. While values are important, emotions and anthropomorphism can play equally or even more important roles. The latter is particularly true for severe management actions for animals and native plants.

Our results indicate opportunities for managers to work and communicate with the public on several levels, ranging from values (e.g. value-congruent information, Boomsma & Steg, 2014) to anthropomorphic views and emotions. In relation to non-native species, beliefs about the negative consequences of a species is more important than self-assessed knowledge of non-native species. Thus, education programmes should openly address beliefs related to non-native species; particularly because evidence about the detrimental effect of non-native species is not always clear and benefits of these species may be strongly underestimated. People's values but also other psychometric factors can, however, also help to adjust environmental policies on introduced species that are usually based on both, scientific information about invasion impacts and related societal values. There is no one-size fits all action for management acceptability; transdisciplinary approaches should be implemented to address the complexity of native and non-native species management in urban areas.

Future research should test other concepts from the Shackleton et al. (2019) framework such as species' introduction status or participants' sense of place. Comparative studies in different cultural contexts would be a decisive step forward since both invasion patterns and people's views on these likely differ in cities around the globe.

AUTHOR CONTRIBUTIONS

All authors were involved in the idea development; Tanja M. Straka, Luise Bach, Ulrike Klisch and Ingo Kowarik designed the survey instrument; Luise Bach and Ulrike Klisch collected the data; Tanja M. Straka, Luise Bach and Ulrike Klisch analysed the data; Leonie K. Fischer created the figures; Tanja M. Straka and Ingo Kowarik led the writing of the manuscript. All authors contributed critically to the drafts and gave final approval for publication.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data are available in Dryad (https://doi.org/10.5061/dryad.p8cz8w9t7).

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SUPPORTING INFORMATION

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

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