Elucidating the socio-demographics of wildlife tolerance using the example of the red fox (*Vulpes vulpes*) in Germany

Sophia E. Kimmig1 | Danny Flemming2 | Joachim Kimmerle2,3 | Ulrike Cress2,3 | Miriam Brandt1

1Leibniz-Institute for Zoo and Wildlife Research, Berlin, Germany
2Leibniz-Institut fuer Wissensmedien/Knowledge Media Research Center, Tuebingen, Germany
3Department of Psychology, University of Tuebingen, Tuebingen, Germany

Abstract
As a consequence of increasing human-wildlife encounters, the associated potential for human-wildlife conflict rises. The dependency of conservation management actions on the acceptance or even the participation of people requires modern conservation strategies that take the human dimension of wildlife management into account. In the first place, conservationists therefore need to understand how people perceive wildlife. In the present study, we examined how wildlife perception varies with people's socio-demographic backgrounds in terms of age, gender, and education as well as the settlement structure of people's living environment and their general life satisfaction, using the red fox (*Vulpes vulpes*) as a model species. We used an interview-based survey of 2,646 participants, representative for the German population, for investigating their knowledge about, risk perception of, and attitude toward red foxes. We found a negative correlation between age and the risks perceived regarding foxes. Moreover, men held a more positive attitude and perceived less risk than women. Higher education was also associated with lower risk perception and a more positive attitude. The results further indicated that people who live in rural areas perceived higher risks regarding foxes and showed a less positive attitude than people in urban or suburban areas. Finally, people who perceived higher risks and held a less positive attitude supported lethal population management actions more often. However, we also found that perceived risks decreased with participants' general life satisfaction. Hence, wildlife perception is affected by various factors. Understanding the factors affecting wildlife perception is crucial for environmental communication and for fostering acceptance of conservation measures to improve conservation strategies.

Keywords
attitude towards wildlife, human dimension, knowledge, perception of wildlife, risk assessment, wildlife management
1 | INTRODUCTION

Almost all natural habitats worldwide are subject to human encroachment, which increases the level of shared human-wildlife living space and creates potential for human-wildlife conflict. At the same time, human-wildlife encounters also increase in decidedly industrialized regions, where human commensal species actively colonize urban habitats. Human-wildlife conflicts in such industrialized regions may result from wildlife damage and the fear of zoonotic diseases (Mackenstedt, Jenkins, & Romig, 2015). Generally, implications of human-wildlife coexistence may be social, economic, or health-related, and both actual and assumed implications may have a large impact on the acceptance of wildlife by the general public (Decker et al., 2012; Riley et al., 2002). Therefore, many conservationists propose that considering the social, physical, and economic well-being of people is central to a holistic conservation approach (Minteer & Miller, 2011).

Implementing this human dimension in conservation management may include approaches for loss or harm compensation (Naughton-Treves, Grossberg, & Treves, 2003; Nyhus, Ososky, Ferraro, Madden, & Fischer, 2005), but also requires advocacy for conservation activities and of human-wildlife coexistence (Kansky, Kidd, & Knight, 2014). This is particularly true when people are forced to arrange themselves with the co-housing situation, for example, when they compete with threatened species and no alternative habitats are available for potential resettlements, or in urbanized areas, where species reach high densities (e.g., Prange, Gehrt, & Wiggers, 2004) and population reduction via hunting is not a feasible option.

Therefore, wildlife acceptance by humans is a crucial element of modern conservation and wildlife management (Enck et al., 2006; Grevling & Kimmerle, 2020; Mascia et al., 2003). Ultimately, the preservation of nature is a human endeavor that requires getting stakeholders to support conservation aims (Salafsky, 2011). As a consequence, researchers, conservation agents, wildlife managers, and policy makers aim to raise awareness for the inherent value of biodiversity and to increase wildlife tolerance (Decker et al., 2016). Saunders, Brook, and Myers, (2006), thus, stated that we need to use psychology to save biodiversity (and human well-being). So, it is crucial to know which factors shape human perception of wildlife, that is, the knowledge about certain wildlife species, perception of the risks associated with these species, and the attitudes toward them.

Even though some research has been conducted in this field (Dickman, 2010), many studies on wildlife perception face methodological issues: When they are conducted as mail surveys, response rates are often low (e.g., Bjurlin & Cypher, 2005: 28%; or Thornton & Quinn, 2009: 29%). Surveys conducted among specific target groups, for example, members of conservation non-profit organizations (NGOs), may achieve higher response rates but are not representative of the general public. Not being representative, for instance, might be a problem that most surveys face, since people with strong positive or negative opinions may be more likely to participate, leading to the underestimation of moderate positions. To study people’s wildlife perceptions in relation to their socio-demographic backgrounds, we interviewed a large sample representative for the general public of Germany, with long-term data available for all participants. Since participants were interviewed personally, the response rate was virtually 100%. We chose the red fox (Vulpes vulpes) as an example of human-wildlife co-existence in Western Europe, a species abundant in urban as well as rural regions. In addition, humans and foxes have a long, ambiguous relationship. On the one hand, the mid-sized carnivore is described as beautiful, smart, and cute. Characterized as sly, yet charismatic, it appears in many folk tales that people grew up with. In recent years fox images have been used for decorative purposes on many daily life products, for example, as a print in fashion industry. On the other hand, foxes are associated with carrying infectious diseases and parasites, such as rabies and the fox tapeworm (Echinococcus multilocularis), which may harm or even kill people (Combes et al., 2012). Although terrestrial rabies is extinct in Germany, many people still fear this disease, and echinococcosis is still present. Foxes are also potential predators of poultry and a threat to smaller companion animals and they cause damages in public and private gardens. Since attitudes toward foxes therefore vary from very negative to extremely positive, this species is well suited for assessing how these attitudes are influenced by people’s backgrounds.

We related potentially relevant socio-demographic factors like age, gender, education, and place of residence to the outcome variables factual knowledge, risk perception, and attitude. Since a higher formal level of education usually goes along with greater general knowledge (Conway, Cohen, & Stanhope, 1991), which should lead to a more realistic estimation of risks, we hypothesized that a higher level of education would be associated with (a) higher levels of knowledge about foxes, (b) lower levels of risk perception, and (c) a more positive attitude toward foxes (Hypotheses 1a–c). It has been argued that due to urbanization and technification, people in cities have become alienated from nature and tend to romanticize wildlife (Heberlein & Ericsson, 2005). We therefore hypothesized that people who live in urban areas have (a) less knowledge, (b) lower levels of risk perception,
and (c) a more positive attitude toward foxes than people who live in suburban and rural areas (Hypotheses 2a–c).

People who have greater life satisfaction also have generally a more positive attitude toward other beings (Erdogan, Bauer, Truxillo, & Mansfield, 2012). Thus, we hypothesized that people with higher levels of general life satisfaction have more positive attitudes toward foxes (Hypothesis 3a) and perceive lower risks (3b). Finally, we investigated the relationship of the three measures, knowledge, risk perception, and attitude with people’s opinions regarding fox-management strategies.

2 MATERIALS AND METHODS

Participants were recruited via the Socio-Economic Panel (SOEP), located at the German Institute for Economic Research Berlin (DIW) that holds a highly reliable sociodemographic long-term dataset of the population in Germany. It is a private household-based longitudinal study that annually (re-) interviews up to 30,000 adult household members on numerous topics such as biography, employment, health, or satisfaction with political or personal circumstances. We used a slot in the 2016 survey of the SOEP Innovation Sample to conduct our study, with a representative subset of the SOEP sample (N = 2,646; age range: 18–95 years; mean age = 53.8 years; SD = 18.52; gender: N = 1,415 [53.5%] female; N = 1,231 [46.5%] male). The participants attended voluntarily and anonymously. Ethical approval was obtained from the Local Ethics Committee of the Leibniz-Institut fuer Wissensmedien. Due to the large sample size, all of the analyses were conducted using a 99% confidence level to minimize the risk of false-positive results.

Data were available on age (date of birth), gender (male/female), education (various classifications), settlement structure (rural/suburban/urban), and personal life satisfaction for all of the participants. According to their obtained school degree, education levels of participants were categorized as low (N = 894, 33.9%), medium (N = 839, 31.7%), or high (N = 710, 26.8%). Low education indicated that participants either had achieved no school leaving certificate or a degree from a secondary modern school from class level 5–9 (“Hauptschule”). A medium level of education meant that participants held a degree from a secondary modern school from class level 5 to 10 (“Realschule”), and high level of education meant that they got a university-entrance diploma from a secondary modern school from class level 5 to 12 or 13 (“Gymnasium” with degree “Abitur” or “Fachhochschulreife”). Two-hundred and three participants (7.7%) indicated having achieved a different certificate or did not provide information about their school-leaving qualifications. The participants’ settlement structure was categorized pursuant to the criteria for spatial classification of the Federal Institute for Research on Building, Urban Affairs, and Spatial Development (BBSR) (Table A1, Appendix S1). The life satisfaction scale consisted of 10 items (Table A2) asking participants to rate their satisfaction with different aspects of their lives from 0 (not satisfied) to 10 (very satisfied). Internal consistency (Cronbach’s alpha) of this scale was \( \alpha = 0.69 \). All ratings were summed up and divided by the number of items.

We designed a questionnaire that inquired into people’s knowledge about, risk perception regarding, and attitude toward foxes. Earlier versions of the questionnaire were tested in a laboratory setting with a smaller sample before being implemented in the survey presented here (Flemmng, Cress, Kimmig, Brandt, & Kinnerle, 2018). In order to measure people’s factual knowledge, we used 11 statements about foxes—with six statements being correct and five statements being wrong (Table A3). Participants were asked to classify the statements as true or false, and each correct assessment was coded with one point. All points were added, resulting in a scale from 0 to 11 points, with higher values indicating greater knowledge.

The risk perception questionnaire consisted of five items, with each item representing an infectious disease. Participants had to indicate for each disease how they perceived the risk of infection for themselves and for domestic animals on a 5-point Likert scale from 0 (no risk) to 4 (very high risk). They could also choose the option “not able to say” (this choice was treated as missing data in the analysis and replaced by the mean score of all participants on that item). The diseases listed were rabies (a viral disease that causes inflammation of the brain in humans and other mammals), echinococcosis (a parasitic disease caused by the fox tape worm. In the questionnaire referenced as “fox tape worm” because the expression echinococcosis is less known), distemper (a viral disease that affects domestic dogs and wild animals), mange (a skin disease caused by parasitic mites) and foot-and-mouth disease (FMD, a viral disease that affects cloven-hoofed animals). Of these, only echinococcosis, can actually be transmitted from foxes to humans in Germany (the country having been declared free of terrestrial rabies by the World Health Organization [WHO] in 2008) while mange and distemper can be transmitted to companion animals. We also included Morbus metum, which is a fictitious disease that was not included in the further analyses, since less than 50% of the participants provided an answer to this item. The sum total was divided by the number of items, resulting in a risk perception score between 0 and 4, with higher values indicating perception of higher risks. Internal consistency (Cronbach’s alpha) of this scale was \( \alpha = 0.89 \).
The attitude questionnaire consisted of six items, such as “I consider foxes in urban environments a pest,” that participants had to rate on 7-point Likert scales from 1 (completely disagree) to 7 (fully agree). Items 2, 5, and 6 were inverted and recoded before summing up all the items (Table A4). The score was divided by the number of items, resulting in an attitude score between 1 and 7, with higher values indicating a more positive attitude. Internal consistency (Cronbach’s alpha) of this scale was \( \alpha = 0.70 \).

We also asked participants how wild fox populations should be managed. They could opt for protecting and supporting foxes, for area-wide hunting, or for not intervening. They also had the option “no opinion on fox management”. Answers were coded with 0 for hunting, 1 for neutrality, and 2 for a supporting position. No opinion was coded as a missing value.

We present descriptive statistics to provide frequency information on the sample’s education level, settlement structure, and fox population management preferences. We also provide mean scores and standard deviations for life satisfaction, knowledge about foxes, risk perception, and attitude. Moreover, we conducted correlation analyses with the variables knowledge, risk perception, and attitude. To examine the role of age and gender, we conducted a multivariate analysis of variance with gender as a fixed factor and age as a covariate. In order to test the hypotheses, we conducted multivariate analyses of variance and regression analyses. All statistical analyses were conducted using SPSS Statistics 25.

3 | RESULTS

The participants’ knowledge about foxes was on average \( M = 4.77 \) (SD = 1.54) out of 11 possible points. Their average risk perception was \( M = 1.40 \) (SD = 0.93) on a scale from 0 to 4 (Figure 1). Their mean attitude toward foxes was \( M = 4.27 \) (SD = 1.47) on a scale from 1 to 7. Regarding the fox population management 30.8% of the participants indicated a supporting position, 9.6% preferred hunting, 40.6% opted for not intervening, and 19.1% had no opinion on fox management (Figure 2a). A total of 38.6% of the participants lived in urban, 31.6% in suburban, and 29.9% in rural regions. Their average life satisfaction was \( M = 6.70 \) (SD = 1.54) on a 10-point scale.

We found a positive correlation between factual knowledge and attitude (r = .118, p < .001) and a negative correlation between factual knowledge and risk perception (r = −.062, p = .01): The more participants knew about foxes, the more positive their attitude was toward them and the less they perceived them as a risk. There was a negative correlation between attitude and risk perception (r = −.185, p < .001), such that the lower the risk people perceived, the more positive their attitude was toward foxes.

A multivariate covariance analysis controlling for age revealed significant differences between men and women, \( F(3, 2,641) = 8.228, p < .001; \) Wilk’s \( \Lambda = 0.991 \), partial \( \eta^2 = 0.009 \) (Table A5). Women and men did not differ in knowledge, \( F(2, 2,644) = 0.186, p = .666 \), but differed significantly in risk perception, \( F(2, 2,644) = 6.888, p = .009; \) partial \( \eta^2 = 0.003 \), and attitude, \( F(2, 2,644) = 21.375, p < .001; \) partial \( \eta^2 = 0.008 \): Men perceived significantly lower risk (\( M = 1.35, SD = 0.91 \)) than women (\( M = 1.44, SD = 0.94 \)). Men also held a more positive attitude toward foxes (\( M = 4.41, SD = 1.42 \)) than women (\( M = 4.15, SD = 1.50 \)). The covariate age affected neither knowledge, \( F(1, 2,645) = 0.934, p = .334 \) nor risk perception, \( F(1, 2,645) = 0.249, p = .618 \), but had a significant effect on attitude, \( F(1, 2,645) = 41.175, p < .001; \) partial \( \eta^2 = 0.015 \). The younger the participants were, the more positive were their attitudes toward foxes.

In order to test Hypotheses 1a–c, we conducted a multivariate analysis of variance that revealed an overall significant impact of education, \( F(6, 4,820) = 18.829, p < .001, \) Wilk’s \( \Lambda = 0.955, \) partial \( \eta^2 = 0.023 \). However, participants with different educational levels did not differ in their knowledge about foxes, rejecting Hypothesis 1a, \( F(2, 2,412) = 0.051, p = .950 \). Hypotheses 1b and c, in contrast, were supported: Depending on their educational levels, participants differed in their risk perception, \( F(2, 2,412) = 24.155, p < .001, \) partial \( \eta^2 = 0.020 \) as well as in their attitude toward foxes.
F(2, 2,412) = 40.518, p < .001, partial \( \eta^2 = 0.033 \). Post hoc tests with Bonferroni corrections revealed that all of the groups (low, medium, and high educational levels) differed significantly from each other regarding both risk perception and attitude. Higher education levels were associated with more positive attitudes and lower risk perception, and lower education was associated with more negative attitudes and higher risk perception (Table 1).

For testing Hypotheses 2a–c, we conducted a multivariate analysis of variance that revealed an overall significant impact of settlement structure, \( F(6, 2,884) = 4.897, p < .001; \) Wilk’s \( \Lambda = 0.980 \), partial \( \eta^2 = 0.010 \). While knowledge did not vary with settlement structure, \( F(2, 1,444) = 0.915, p = .401 \), the data supported our hypotheses regarding risk perception, \( F(2, 1,444) = 8.553, p < .001, \) partial \( \eta^2 = 0.012 \), and attitude, \( F(2, 1,444) = 7.132, p < .001, \) partial \( \eta^2 = 0.010 \).
Post hoc tests with Bonferroni corrections revealed that people who live in rural areas had a significantly higher risk perception than people who live in urban \((p < .001)\) or suburban \((p = .010)\) areas. People who live in urban areas also had a more positive attitude toward foxes than people who live in suburban \((p = .002)\) or rural areas \((p = .010)\) (Table 1).

We hypothesized that life satisfaction also influences attitude toward foxes (Hypothesis 3a) and risk perception (Hypotheses 3b). There was indeed a slightly positive regression coefficient for attitude, but it was not significant on the 1% level (standardized \(\beta = 0.044; p = .024; R^2 = 0.044\)). We found, however, that the more satisfied people were with their lives, the lower their risk perception was (standardized \(\beta = -0.012; p < .001; R^2 = 0.12\)).

Finally, we compared people who held different views on management options with regard to their knowledge, attitude, and risk perception, and found significant differences, \(F(6, 2,141) = 35.342, p < .001\); Wilk’s \(\Lambda = 0.061\), partial \(\eta^2 = 0.939\). People who had different views on management options did not differ with regard to knowledge, \(F(2, 2,141) = 0.478, p = .620\), but with regard to attitude, \(F(2, 2,141) = 100.602, p < .001\), partial \(\eta^2 = 0.086\), and risk perception, \(F(2, 2,141) = 16.975, p < .001\), partial \(\eta^2 = .016\) (Table 2). Post hoc tests showed that all groups differed significantly in their attitude: Participants who were in favor of supporting fox populations had a more positive attitude toward foxes than those who preferred not to manage them at all (neutral). Supportive and neutral participants both had a more positive attitude than those who preferred hunting. Participants also significantly differed in risk perception: People who favored hunting perceived higher risks than those who were neutral or supportive. People who were neutral did not differ in risk perception from those who wanted to support fox populations (Figure 2b–d).

### 4 | DISCUSSION

In recent years, many researchers have tried to account for the human dimension of wildlife management and conservation (Miller, Minteer, & Malan, 2011). One theory on human responses to wildlife argues that the number of people who value conservation may decline if costs or perceived risks of coexisting with wildlife increase disproportionately to the benefits (Decker et al., 2012). The results of our study show the importance of factoring in sociodemographic background when trying to gauge people’s perception of wildlife.

With less than half of the possible points achieved on average, the participants’ factual knowledge about foxes in this study was rather low. This is probably not due to people not being familiar with foxes, as Hooykaas et al. (2019) showed that in the Netherlands, the red fox was correctly identified by 97.2% of primary school children and 99.2% of participants from the general public. Thus, omnipresence of a species apparently does not necessarily lead to an increase in factual knowledge about it. Risk perception (mean 1.4 out of 4) was lower than randomly expected and the average attitude toward foxes was rather positive (mean 4.27 out of 7). In line with these results, a study on perception of foxes in Munich, Germany found that the majority of inhabitants were “pleased to see a fox in the community and felt the animals have a right to live” (König, 2008, p. 101).

While factual knowledge about foxes was equivalent among gender and age groups, some differences in the perception of risks and in attitude became apparent. In line with other studies, women perceived more risks from foxes and, in contrast to those studies, also held a less positive attitude toward them (Thornton & Quinn, 2009; Zinn & Pierce, 2002). König (2008) found that people are more afraid of fox-borne diseases when they have children in their households. One could thus assume that health- and safety-related concerns are more important to women who are still more often responsible for raising children in our society (see also Dietz, Kalof, & Stern, 2002). Some studies suggest that women generally tend to report stronger environmental attitudes and concerns than men (Luchs & Mooradian, 2012; Scannell & Gifford, 2013; Tikka, Kuitunen, & Tynys, 2000). However, risk perception is complex and other findings suggest that socio-political factors, such as power and status, are also strong determinants of people’s perception of risks (e.g., Flynn, Slovic, & Mertz, 1994).
In the United States, adolescent conservation behaviors have shown a downward trend since the 1970s (Wray-Lake, Flanagan, & Osgood, 2010, see also Thornton & Quinn, 2009). This seems to contrast with our finding that younger people held a more positive attitude toward foxes than older people. However, in a review on pro-environmental concerns and behavior by Gifford and Nilsson (2014) the authors conclude that those two measures do not converge well: Several studies have shown that older people report engaging in more pro-environmental behavior than younger people (e.g., Arcury, Nique, Añaña, & Herter, 2011; Swami, Chamorro-Premuzic, Snelgar, & Furnham, 2011). But research also shows that younger people report being more concerned about the general environment than older people (e.g., Arcury & Christianson, 1993; Klineberg, McKeever, & Rothenbach, 1998). Generally, it is difficult to detect whether apparent age effects are caused by aging itself or may be the result of a cohort effect (e.g., due to a specific experience in a generation) or an era effect (e.g., due to a general trend in society).

We found no effect of settlement structure on fox-related knowledge. However, people living in urban agglomerations showed a more positive attitude toward foxes than people in suburban or rural areas, while people living in rural areas perceived higher risks from foxes than people in urban and suburban areas. This has also been shown for other carnivores, except coyotes (Kansky et al., 2014; Williams, Ericsson, & Heberlein, 2002). According to Manfredo (2008), these differences could be explained by the fact that urban residents are less impacted in their livelihoods by wildlife. On the protection-use scale (Fulton, Manfredo, & Lipscomb, 1996; Manfredo, Teel, & Bright, 2003), wildlife perception is ranging from a utilitarian end with the belief that wildlife should be managed and used for human benefit to a protection end, at which people think wildlife has an intrinsic value and should have rights similar to those of humans. In this context, urbanization and modernization may lead urban residents to be more tolerant of wildlife, because they view wildlife as beings with rights rather than as a food source. This is consistent with literature showing less anthropocentric tendencies in urban residents (e.g., Huddart-Kennedy, Beckley, McFarlane, & Nadeau, 2009) and describing an association between urbanization and increased concern about animal welfare (e.g., Hays, 1987; Mertig, Dunlap, & Morrison, 2002).

We found an effect of educational level on attitude and risk perception but, not on fox-related knowledge. Higher education levels were associated with lower levels of risk perception and a more positive attitude. These findings correspond well with prior research (e.g., Hanisch-Kirkbride, Riley, & Gore, 2013), as well as with the observation that utilitarian wildlife values are associated with lower levels of education and that education shifts these values toward an appreciation of wildlife (Inglehart & Baker, 2000; Manfredo et al., 2003). More generally, they are also in line with findings from Karanci, Aksit, and Dirik (2005) who showed that higher educated individuals tend to worry less about possible future risks but show a higher sense of control and preparedness.

We found that the more satisfied people were with their lives, the lower their risk perception was. This could perhaps be explained by the fact that people with lower levels of emotional stability worry about many aspects of life, among them about environmental issues (Hirsh, 2010). Wildlife perception seems to be multifactorial (McShane et al., 2011) and several personality or self-construal related factors, such as openness, agreeableness, or conscientiousness have been shown to be linked to environmental engagement (Milfont & Sibley, 2012). However, life satisfaction depends on a person’s living circumstances and can be influenced at least to some extent by local management actions. Thus, we may need to include considerations of life satisfaction in conservation management attempts. Social and economic interventions around protected areas in Nepal, for example, led to more favorable attitudes toward conservation (Baral & Heinen, 2007). For some local areas, conflicts, or stakeholder groups, it may therefore be promising to invest in development of infrastructure or other economically or culturally relevant areas, rather than in information campaigning only, to improve the people’s quality of life in general.

Finally, we found that a majority of the participants (who were representative for the German population) preferred either not to intervene in the fox population or did not have an opinion on fox management. Only a small proportion was in favor of lethal population control (less than 10%). This corresponds with König’s (2008) prediction who stated on the basis of his local study that “it is to be expected that radical solutions such as killing the foxes are unlikely to be accepted among the population” (p. 101).

We also found that there was a relationship among attitudes, perceived risks, and preferred management strategies. Generally, the perception of higher risks of getting infected with fox-borne diseases was correlated with a more negative attitude. It is important to note that only three of the diseases listed pose an actual threat to humans or domestic animals, but that more than those three were seen as a threat by the participants, indicating that the true risk level may be quite irrelevant in determining perceived risks (see also Figure 1). This corresponds to the findings of Decker et al. (2012) that perceived risks of wildlife associated diseases are a growing concern. These perceived risks influenced people’s attitudes and their opinion on management options: People with positive attitudes and low-risk perception preferred neutral coexistence with or active support of fox...
populations, while people with higher risk perceptions and more negative attitudes were in favor of hunting.

It seems plausible that better knowledge about foxes would prevent an overestimation of risks that are based on false assumptions. This would, consecutively, result in a more positive attitude and finally in increased tolerance for human coexistence with foxes. We thus expected species-related knowledge to influence wildlife perception. Maybe another set of questions on factual knowledge would have shown a different picture, yet we intended to test the general effect of species-specific knowledge and therefore not only included questions that directly relate to possible threats.

There was an indirect effect of factual knowledge on management preferences, that is, we could find a positive correlation between fox-related knowledge and attitude and a negative one between knowledge and risk perception, which in turn showed significant impact on management attitude. Interestingly, however, fox-specific knowledge did not significantly affect the participants’ management preferences and was not influenced by the socio-demographic factors tested. One possible explanation is that increased knowledge of wildlife might simply be used to support pre-existing opinions (Bjurlin & Cypher, 2005; Kellert, Black, Rush, & Bath, 1996). This could indicate that more knowledge about fox-related diseases, for example, just increases already present fears, an effect that König (2008) reported regarding the small fox tapeworm (*Echinococcus multilocularis*). In a mail survey in Boulder, the United States, Hunter and Rinner (2004) also found that people with more eco-centric perspectives placed greater priority on species preservation, regardless of species-related knowledge. Accordingly, successful conservation management should not only provide species-specific knowledge but also advocate the significance of ecological integrity and biological diversity more broadly (Hunter & Rinner, 2004).

5 | CONCLUSION

Obtaining people’s support is crucial for conservation success. However, as we have shown here, the perception of wildlife is influenced by a complex interplay of factors (see also McShane et al., 2011). Determining how to best promote conservation actions is challenging when wildlife tolerance differs among socio-demographic groups. Since the general level of education and even life satisfaction have an impact on the perception of wildlife, studying the socio-demographics behind wildlife tolerance may not be sufficient. We would need to additionally investigate how to reach out to different target groups and study how different communication styles and formats influence wildlife perception of those groups.

ACKNOWLEDGMENTS

We are indebted to the Socio-Economic Panel (SOEP) of the German Institute for Economic Research for providing us the opportunity to conduct this study within the SOEP Innovation Panel. We further acknowledge the participants of the SOEP survey.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

AUTHOR CONTRIBUTIONS

M.B., S.E.K., J.K., and U.C. designed the research. D.F., J.K., and S.E.K. conducted data analysis and plotting. S.E.K., and D.F. wrote the manuscript. All authors contributed to the development of the questionnaire, contributed to the drafts and gave final approval for publication.

ETHICS STATEMENT

All research was carried out in accordance with standard research practices.

DATA AVAILABILITY STATEMENT

The data used in this study contain sensitive personal information. Due to German data protection regulations they are therefore not publicly available for download but will be made available upon request by the Socio-Economic Panel (SOEP) Research Data Centre: https://www.diw.de/en/diw_02.c.222829.en/access_and_ordering.html#242008.

ORCID

Sophia E. Kimmig https://orcid.org/0000-0002-4140-6002

REFERENCES

Arcury, T. A., & Christianson, E. H. (1993). Rural–urban differences in environmental knowledge and actions. *Journal of Environmental Education*, 25, 19–25.

Baral, N., & Heinen, J. T. (2007). Resources use, conservation attitudes, management intervention and park–people relations in the Western Terai landscape of Nepal. *Environmental Conservation*, 34(1), 64–72.

Bjurlin, C. D., & Cypher, B. L. (2005). Encounter frequency with the urbanized San Joaquin kit fox correlates with public beliefs and attitudes toward the species. *Endangered Species Update*, 22, 107–115.

Combes, B., Comte, S., Raton, V., Raoul, F., Boué, F., Umhang, G., ... Giraudoux, P. (2012). Westward spread of *Echinococcus multilocularis* in foxes, France, 2005–2010. *Emerging Infectious Diseases*, 18(12), 2059–2062. https://doi.org/10.3201/eid1812.120219

Conway, M. A., Cohen, G., & Stanhope, N. (1991). On the very long-term retention of knowledge acquired through formal education: Twelve years of cognitive psychology. *Journal of Experimental Psychology: General*, 120, 395–409. https://doi.org/10.1037/0096-3445.120.4.395
Milfont, T. L., & Sibley, C. G. (2012). The big five personality traits and environmental engagement: Associations at the individual and societal level. *Journal of Environmental Psychology, 32*, 187–195. https://doi.org/10.1016/j.jenvp.2011

Miller, T. R., Minteer, B. A., & Malan, L. C. (2011). The new conservation debate: The view from practical ethics. *Biological Conservation, 144*, 948–957. https://doi.org/10.1016/j.bioc.2010.04.001

Minteer, B. A., & Miller, T. R. (2011). The new conservation debate: Ethical foundations, strategic trade-offs, and policy opportunities. *Biological Conservation, 144*, 945–947. https://doi.org/10.1016/j.bioc.2010.07.027

Naughton-Treves, L., Grossberg, R., & Treves, A. (2003). Paying for tolerance: Rural citizens' attitudes toward wolf depredation and compensation. *Conservation Biology, 17*, 1500–1511. https://doi.org/10.1111/j.1523-1739.2003.00060.x

Nyhus, P. J., Ososky, S. A., Ferraro, P., Madden, F., & Fischer, H. (2005). Bearing the costs of human–wildlife conflict: The challenges of compensation schemes. In R. Woodroffe, S. Thirgood, & A. Rabinowitz (Eds.), *People and wildlife: Conflict or coexistence?* (pp. 107–121). Cambridge, UK: Cambridge University Press.

Pinto, D. C., Nique, W. M., Añaña, E. D. S., & Herter, M. M. (2011). Green consumer values: How do personal values influence environmentally responsible water consumption? *International Journal of Consumer Studies, 35*(2), 122–131. https://doi.org/10.1111/j.1470-6431.2010.00962.x

Prange, S., Gehrt, S. D., & Wiggers, E. P. (2004). Influences of anthropogenic resources on raccoon (Procyon lotor) movements and spatial distribution. *Journal of Mammalogy, 85*(3), 483–490.

Riley, S. J., Decker, D. J., Carpenter, L. H., Organ, J. F., Siemer, W. F., Mattfeld, G. F., & Parsons, G. (2002). The essence of wildlife management. *Wildlife Society Bulletin, 30*, 585–593. https://doi.org/10.2307/3784519

Salafsky, N. (2011). Integrating development with conservation. A means to a conservation end, or a mean end to conservation? *Biological Conservation, 144*, 973–978. https://doi.org/10.1016/j.bioc.2010.06.003

Scannell, L., & Gifford, R. (2013). Personally relevant climate change: The role of place attachment and local versus global message framing in engagement. *Environment and Behavior, 45*(1), 60–85.

Saunders, C., Brook, A., & Myers, O. (2006). Using psychology to save biodiversity and human well-being. *Conservation Biology, 20*(3), 702–705.

Swami, V., Chamorro-Premuzic, T., Snelgar, R., & Furnham, A. (2011). Personality, individual differences, and demographic antecedents of self-reported household waste management behaviours. *Journal of Environmental Psychology, 31*, 21–26. https://doi.org/10.1016/j.jenvp.2010.08.001

Thornton, C., & Quinn, M. S. (2009). Coexisting with cougars: Public perceptions, attitudes, and awareness of cougars on the urban-rural fringe of Calgary, Alberta, Canada. *Human-Wildlife Conflicts, 3*, 282–295.

Tikka, P. M., Kuitunen, M. T., & Tynys, S. M. (2000). Effects of educational background on students' attitudes, activity levels, and knowledge concerning the environment. *The Journal of Environmental Education, 31*(3), 12–19.

Williams, C. K., Ericsson, G., & Heberlein, T. A. (2002). A quantitative summary of attitudes toward wolves and their reintroduction (1972-2000). *Wildlife Society Bulletin, 30*, 575–584.

Wray-Lake, L., Flanagan, C. A., & Osgood, D. W. (2010). Examining trends in adolescent environmental attitudes, beliefs, and behaviors across three decades. *Environment and Behavior, 42*, 61–85. https://doi.org/10.1177/0013916509335163

Zinn, H. C., & Pierce, C. L. (2002). Values, gender, and concern about potentially dangerous wildlife. *Environment and Behavior, 34*, 239–256. https://doi.org/10.1177/0013916502034002005

**SUPPORTING INFORMATION**

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

**How to cite this article:** Kimmig SE, Flemming D, Kimmerle J, Cress U, Brandt M. Elucidating the socio-demographics of wildlife tolerance using the example of the red fox (*Vulpes vulpes*) in Germany. *Conservation Science and Practice*. 2020;2:e212. https://doi.org/10.1111/csp2.212