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RESEARCH ARTICLE

Interests, beliefs, experience and perceptions shape tolerance towards impacts of recovering predators

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Abstract

1. The modification of landscapes is increasing the interface between humans and wildlife, while conflicts concerning predator impacts on human activities persist. Some previously persecuted but now protected predator species are experiencing recovery and range expansion.
2. Tolerance is considered essential for achieving coexistence between humans and wildlife; however, its conceptualisation remains unresolved. Little is known about tolerance in the context of recovering predators, particularly which drivers are relevant to all or specific species and human interests.
3. Using an online questionnaire survey shared with members of organisations with interests in rural land-based activities, we collected data on interests and beliefs, and attitudes, perceptions, experience and management preferences for six recovering vertebrate predators in the United Kingdom ($n = 819$). We created a species tolerance score representing the management choices of the respondents in different conflict scenarios, which differed in the degree of impact on the predator population.
4. Our species tolerance score was characterised by a complex combination of the interests and beliefs of the respondents about wildlife management, perceptions and experience of that species (perceived benefits, population trend, positive and negative experience, indirect negative experience) and negative experience of other recovering predators.
5. We found a tolerance gradient between interest groups with notable overlap between groups with primary interests in wildlife conservation, shooting, farming and fishing. Although higher perceived benefits consistently corresponded to higher tolerance, having a negative experience of the species dampened the effect of perceived benefits on tolerance. When both negative personal and indirect experiences were reported, tolerance was dramatically reduced. The classification of species from least to most tolerated was consistent between interest groups.

6. The application of our species tolerance score as the normative dimension (i.e. acceptability) in Brenner and Metcalf's (2020) Social Tolerance of Wildlife Framework highlights that tolerance (negative attitude—high acceptability) is potentially rare and more positive attitudes must be achieved before acceptance of the impacts of species can increase.
7. Our findings highlight that considering only primary interests may hinder debates concerning recovering predators. Strategies to reduce negative experiences or change how they are perceived could significantly increase tolerance in combination with increasing positive experiences.

KEYWORDS
acceptability, attitude, experience, impacts, interests, perceptions, predator, recovering predators, tolerance

1 | INTRODUCTION

There is a growing need to promote and support coexistence between humans and wildlife, and tolerance and acceptance are identified as fundamental in achieving this (Frank, 2016; Glikman et al., 2021). However, a deeper understanding of these concepts and their relationships is needed as definitions, conceptual framing and measurement, in particular, of tolerance are still a work in progress (Brenner & Metcalf, 2020; Bruskotter et al., 2015; Carlson et al., 2023; Glikman et al., 2021; Hjerm et al., 2020). Many studies address the concept of tolerance towards a single species (Carter et al., 2012; Kansky et al., 2016; Lehnen et al., 2022; Struebig et al., 2018). Fewer strive for generality by focussing on and sharing information across multiple predator species (although see Kansky et al., 2021; Romañach et al., 2007), particularly those recently recovered or undergoing recovery.

In this paper, using multiple species and simultaneously exploring sociopsychological and experiential factors, we provide insight from an online questionnaire survey focused on recovering predators in the United Kingdom. Specifically, we demonstrate the importance of people's interactions with a given species, the influence of 'wider experience' of other recovering species and factors that may drive tolerance towards the impacts of recovering predators in general (e.g. beliefs about wildlife management).

1.1 | Historic persecution and predator recovery

Many avian and mammalian predator species were historically subjected to strong population control due to perceptions of the impacts and threats the species posed to societal interests, and were often termed 'pests' and 'vermin' (Roemer et al., 2009). This resulted in dramatic population declines and regional extirpations during the 19th and 20th centuries of many predator species in the United Kingdom, and across Europe (Langley & Yalden, 1977; Lovegrove, 2007).

Several of these persecuted predator species were assigned protected status in the mid-late 20th century (Chapron et al., 2014; Linnell et al., 2009) and are now recovering naturally or because they are supported by conservation actions within highly anthropogenically modified landscapes throughout Europe (Chapron et al., 2014; Linnell et al., 2009; Sainsbury et al., 2019). Some species once regarded as pests are now conservation flagship species, with substantial investment targeting population recovery (e.g. Iberian lynx *Lynx pardinus*, Delibes-Mateos et al., 2022; Simón et al., 2012). Although the return of previously heavily depleted predator populations follows enacted legislation, significant time may have elapsed between stronger protective legislation being enacted and population recovery becoming evident. Differences in recovery rate could potentially influence people's perceptions or be a consequence of attitudes towards a predator (Mykrä et al., 2017). Indeed, the spatial extent of recovering predator populations and the exposure of people to a species can influence their experience and perceptions (Eriksson et al., 2015; Kansky et al., 2016); however, this may not always be the case (Arbieu et al., 2019).

1.2 | Predator impacts and conflicts

When forming views on the recovery of predators, it is known that predation of livestock and game species, as well as impact on other species, is important to stakeholders (Dickman, 2010; Marshall et al., 2016). Debates concerning predator management often unfold, and in extreme cases, larger conservation conflicts arise or are reignited between human interest groups, causing societal divides (Blossey & Hare, 2022; Cusack et al., 2021; Redpath et al., 2013). Although impacts such as livestock predation are frequently emphasised in conflicts surrounding predators, the intensity of conflict can exceed that of impacts, and efforts to mitigate impacts may not cease the conflict (Dickman, 2010; Suryawanshi et al., 2013; Thirgood & Redpath, 2008). Therefore, if conflicts were exclusively the result of impacts incurred by stakeholders,

negative impacts would be a key driver of attitudes and high levels of negative impacts would indicate the predator population exceeding a threshold beyond which the species negatively affects a valued resource. However, people's views can also be influenced by their interests, social groups with which they identify and information and opinions heard from others (hereafter referred to as 'hearsay') (Heeren et al., 2017; Lute et al., 2014). When a person's interests and social group are key drivers, the influence of personal interactions with species on attitudes and acceptance could depend on whether it reinforces or contradicts the hearsay exposed to about the recovering predator.

1.3 | Valuing nature and species

However, societies are neither homogeneous nor unified in how nature is valued (Pascual et al., 2017). Several sociopsychological frameworks represent theories on how human mental processes, including values, influence each other to identify the progression from human thoughts to action. The cognitive hierarchy states values and value orientations (groups of related values, e.g. concerning wildlife) influence attitudes and norms that underpin behavioural intentions and behaviour (Fulton et al., 1996). The Values–Beliefs–Norms (VBN) theory, when simplified, links values to beliefs, personal norms and lastly behaviour, in a causal chain (Stern et al., 1995). Seymour et al. (2010) extended the VBN theory to include 'assigned values', values that concern specific features of nature, such as a place or species (Lockwood, 1999). They proposed that these are influenced by held values, beliefs about environmental conditions and personal norms, as well as by knowledge, perceptions, characteristics of the specific natural feature and external factors (e.g. economic conditions or regulations, Seymour et al., 2010). For example, perceptions about species abundance, native versus non-native origins, attractiveness and harmfulness influenced both public and professional views on whether a species needed management (Fischer et al., 2014), reflecting how variation in assigned values and perceptions of a species can alter views. In turn, exposure to a species, including positive and negative experiences, both personal and indirect, can be important in determining attitudes towards species and their management (Arbieu et al., 2020; Eriksson et al., 2015; Karlsson & Sjöström, 2007). Aesthetic and behavioural traits such as charisma and attractiveness, which promote positive emotions, strongly influence people's preference for species conservation (Castillo-Huitrón et al., 2020; Colléony et al., 2017; Knight, 2008). However, perceptions of species traits are highly subjective, as people's perceptions are influenced by numerous factors, including cultural factors (e.g. media), history and their social identity (Kellert et al., 1996).

1.4 | Research on tolerance

Tolerance is defined as 'accepting wildlife and/or wildlife behaviours that one dislikes' by Brenner and Metcalf (2020) who propose a tolerance framework interrelating two cognitive dimensions; attitudes and acceptability (normative dimension) to identify five distinct typologies within the tolerance realm (Figure 1). Using this definition, research on people's attitudes towards wildlife, preference for wildlife population levels, acceptability of management actions and impacts is important for understanding tolerance to wildlife (Decker & Purdy, 1988; Fulton et al., 1996; Jacobs et al., 2014; Sijtsma et al., 2012; Struebig et al., 2018). The cognitive hierarchy and the extension of VBN theory, where species are potentially valued differently, provide appropriate frameworks to ground research on tolerance to recovering predators in current socio-psychological theories (Fulton et al., 1996; Seymour et al., 2010; Stern et al., 1995).

To progress our conceptualisation and understanding of tolerance, further application of measures such as Brenner and Metcalf's (2020) tolerance framework are required (Glikman et al., 2021). Furthermore, investigating the tolerance of individual stakeholders to the impacts of different predator species would allow for the identification of drivers of inter-individual variation (Lehnen et al., 2022).

1.5 | This study

Our study was carried out in the United Kingdom, which has a small proportion of the population who own a large proportion of land (Home, 2009; Land Reform Review Group, 2014), and around two-thirds of the rural land that are said to be influenced by management for shooting (PACEC, 2014). Legal predator control is

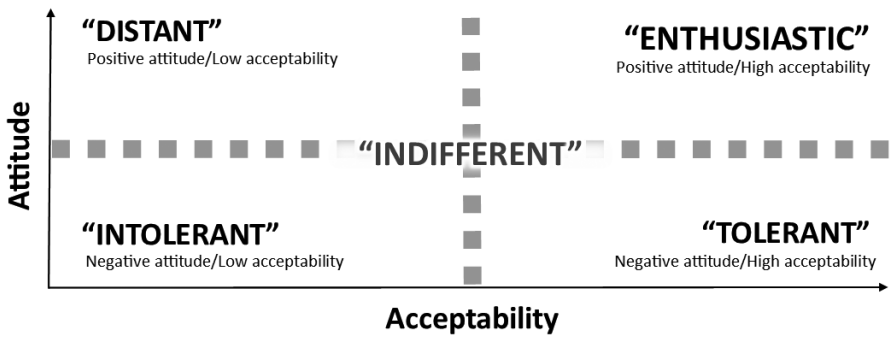

FIGURE 1 Proposed typology groups in the social tolerance of wildlife framework (attitudes/acceptability) (reproduced from Brenner & Metcalf, 2020).

implemented to protect game birds, with an estimated 31.5 million pheasants and 9.1 million red-legged partridges released annually (Madden, 2021). Debates about recovering predator management occur and conservation conflicts are present (Hodgson et al., 2018).

Our study focuses on six predators in the United Kingdom, three mammals (European otter *Lutra lutra*, European pine marten *Martes martes*, European polecat *Mustela putorius*) and three birds (common buzzard *Buteo buteo*, golden eagle *Aquila chrysaetos*, red kite *Milvus milvus*), which have recovered or are in the process of recovery with increases in population sizes and ranges (S1; Evans et al., 1999; Hayhow et al., 2017; Sainsbury et al., 2019; Stevens et al., 2019). The focal species have varied distributions across the United Kingdom, and all are protected under the Wildlife and Countryside Act (1981), with four having been subjected to reintroductions (red kite, otter, pine marten and polecat), one recently assisted through reinforcement (golden eagle) and one that has recovered unaided (buzzard) (S1).

Using an online questionnaire, we solicited views of members from organisations with stated interests in land-based activities likely to interact or conflict with recovering predators (i.e. shooting, fishing, farming, forestry and wildlife conservation). Organisations, rather than ourselves, made their members aware of our survey. Our specific aims were as follows:

1. Explore the consistency of our tolerance measure with other measures of tolerance.
2. Assess the role of different drivers of tolerance towards recovering predators to identify variables that increase and decrease tolerance.
3. Characterise any differences in tolerance between species and between interest groups.

Identifying factors that drive the normative dimension of tolerance is highly relevant for land managers to better understand the opinions of stakeholders on wildlife management and to identify points where consensus or disagreements can arise.

2 | METHODS

2.1 | Online questionnaire survey

We designed an online questionnaire survey (Data S1) consisting of multiple choice, 5-point Likert-type items and open-ended questions, with the majority adapted from previous studies and distributed using the SNAP 11 Professional software (www.snapsurveys.com). We collected data within the following broad categories (further explanation below, S5 and S6): respondent-level information including where the respondent's childhood was spent (i.e. their *upbringing*) (Heberlein & Ericsson, 2005), basic beliefs often used to define Wildlife Value Orientations using Fulton et al.'s (1996) definition ('*Equality between people and wildlife*', '*Wildlife management*' and '*Shooting*') (Table S6, St. John et al., 2019; Whittaker et al., 2006), and *interests*, and species-specific information including perceptions (e.g. *beneficial rating*, *attractiveness rating*), self-reported *attitude* score (Fischer et al., 2011, 2014), direct (Kansky et al., 2016) and indirect experience, whether respondent *live in an area with* the focal species (Karlsson & Sjöström, 2007), their *perceived* and *desired national population trends* (Riley & Decker, 2000) and perceived knowledge of species (*how well informed a respondent feels*) (Arbieu et al., 2019). Respondents selected those of the six species included in the survey that they recognised or knew of (photos with common names of the predator were displayed in the questionnaire), and all further questions related to those selected species only.

2.2 | Data collection

We identified 11 UK-based organisations based on their stated interests in rural land-based activities (i.e. forestry, fishing, farming, shooting, wildlife conservation, Table S1) and large number of members, staff or volunteers based throughout the United Kingdom that are likely to interact or be impacted by recovering predators. We sent the online questionnaire web link to these organisations and received confirmation that it was shared as part of their regular online communication or dedicated emails with members. The survey was open from June 2019 to February 2020. Our study was approved by the Ethics Review Committee of the School of Psychology of the University of Aberdeen (Application No. PEC/4220/2019/5). Informed consent to participate in the study was obtained from all respondents.

2.3 | Data analysis

2.3.1 | Synthetic tolerance response variable and indicators

We tasked respondents with answering multiple choice questions and selecting the management strategy they deemed most acceptable (under the stated assumption all would be legal i.e. licensed under UK law) under eight hypothetical conflict scenarios for each species (Figure 2). This created a set of strategies chosen by each respondent about each species to use as tolerance indicators. For analysis, we coded the strategies from most (1) to least severe (5) for the predator population: (1) control population, (2) trap and kill individual, (3) trap and move individual, (4) mitigation measures (e.g. fences, deterrents) or financial compensation and (5) do nothing (Figure 2).

These tolerance indicators were checked for multicollinearity, and an exploratory factor analysis (EFA) and a confirmatory factor analysis (CFA) were used to create a unique tolerance score for each respondent for each species (synthetic tolerance variable: mean 0, range: −1.65 to 1.73, Figure 2, for more details on the method, see S2).

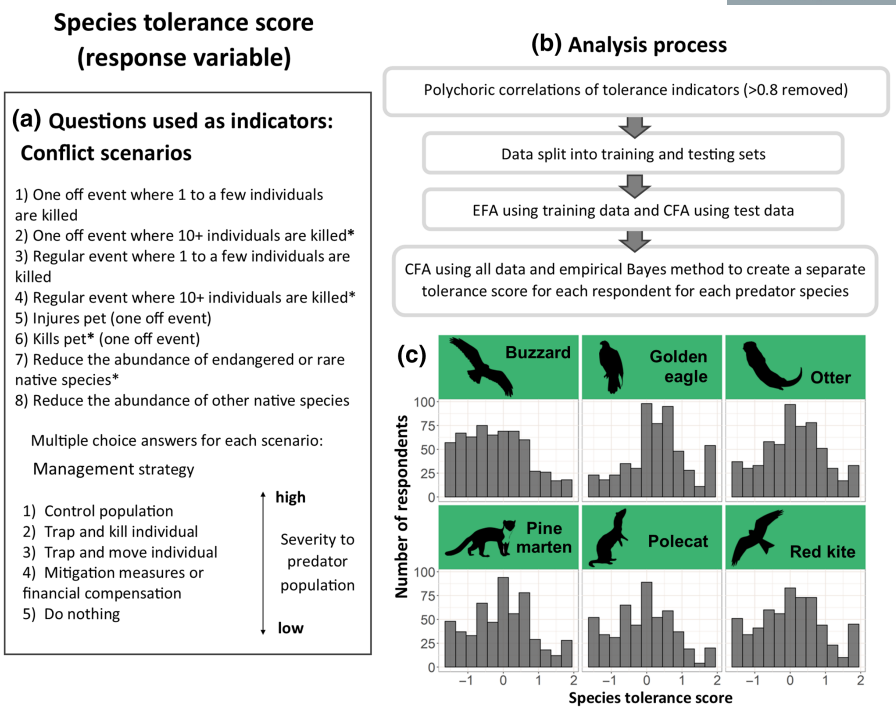

FIGURE 2 Process used to create the species tolerance score (response variable). (a) Respondents' choice of management strategy under the hypothetical conflict scenarios involving the predation of livestock and game species (including pheasants), pets and native species were used as indicators for the tolerance response variable. Respondents were asked to choose the management strategy deemed most acceptable to mitigate negative impacts of each species under each scenario. Management strategies were ranked from 1 (most severe) to 5 (least severe). The conflict scenarios used to define the synthetic tolerance response variable are marked with*. The scenarios concerning pets were regarding one-off events. (b) Steps taken to create tolerance response variable using the indicators (S2). (c) Histograms of the synthetic tolerance response for each species (standardised: mean = 0; scaled: standard deviation 1). All species silhouettes were obtained from http://phylopic.org/, see Table S14 for full list of credits.

Analyses were performed using R (v.4.0.2, R Development Core Team, 2020) and packages *psych* for EFA and *lavaan* for CFA.

2.3.2 | Predictor variables

In total, we created 23 predictor variables as potential drivers of tolerance to wildlife (Figure 3, Tables 1 and S5). To group the respondents into *interest groups* of approximately the same size, we used a rule-based approach applied to the top three self-ranked interests of the respondents in rural activities (selected among farming, fishing, forestry, shooting, tourism, wildlife conservation and red squirrel conservation, Table S4). Although interests such as shooting and wildlife conservation may not always be mutually exclusive, allowing respondents to rank their multiple interests enabled us to capture the interests of respondents with only one of these interests, while allowing for the multidimensionality of other respondents' interests. Respondents with primary and secondary interests not represented in these main groups i.e. a combination of forestry, tourism, red squirrel conservation) and no other interests ($n = 9$) or interests were not selected by the respondent ($n = 48$) were removed from the analysis (Table S4).

We created three basic belief predictor variables using the level of agreement of the respondent with nine statements representing three belief dimensions: *equality between people and wildlife*, *wildlife management* and *shooting* (Table S6). These basic beliefs were used as separate predictors to identify whether certain beliefs were particularly influential on tolerance. Using fit indices, we checked the validity of the a priori groupings of statements into three belief dimensions (see St. John et al., 2019, Tables S3 and S6). We removed the *equality between people and wildlife* belief from the analysis due to a low Cronbach alpha (0.57). Although the *wildlife management* belief had a Cronbach alpha value of 0.65, less than the common 0.7 cut-off, we retained it as a predictor variable, as the same basic belief statements for *wildlife management* achieved a value of 0.7 for a study on red grouse and hen harrier management in England that engaged similar stakeholders (St. John et al., 2019). We used average scores across each dimension as predictors that represent the two beliefs: *wildlife management* and *shooting*.

2.3.3 | Mixed model and model selection

We modelled tolerance using linear mixed models with Gaussian distributions and a random effect of the respondent to account for those who had answered about multiple species. We defined and checked a global model using 19 predictor variables as fixed effects (Tables S5 and S6). We created an a priori candidate list of

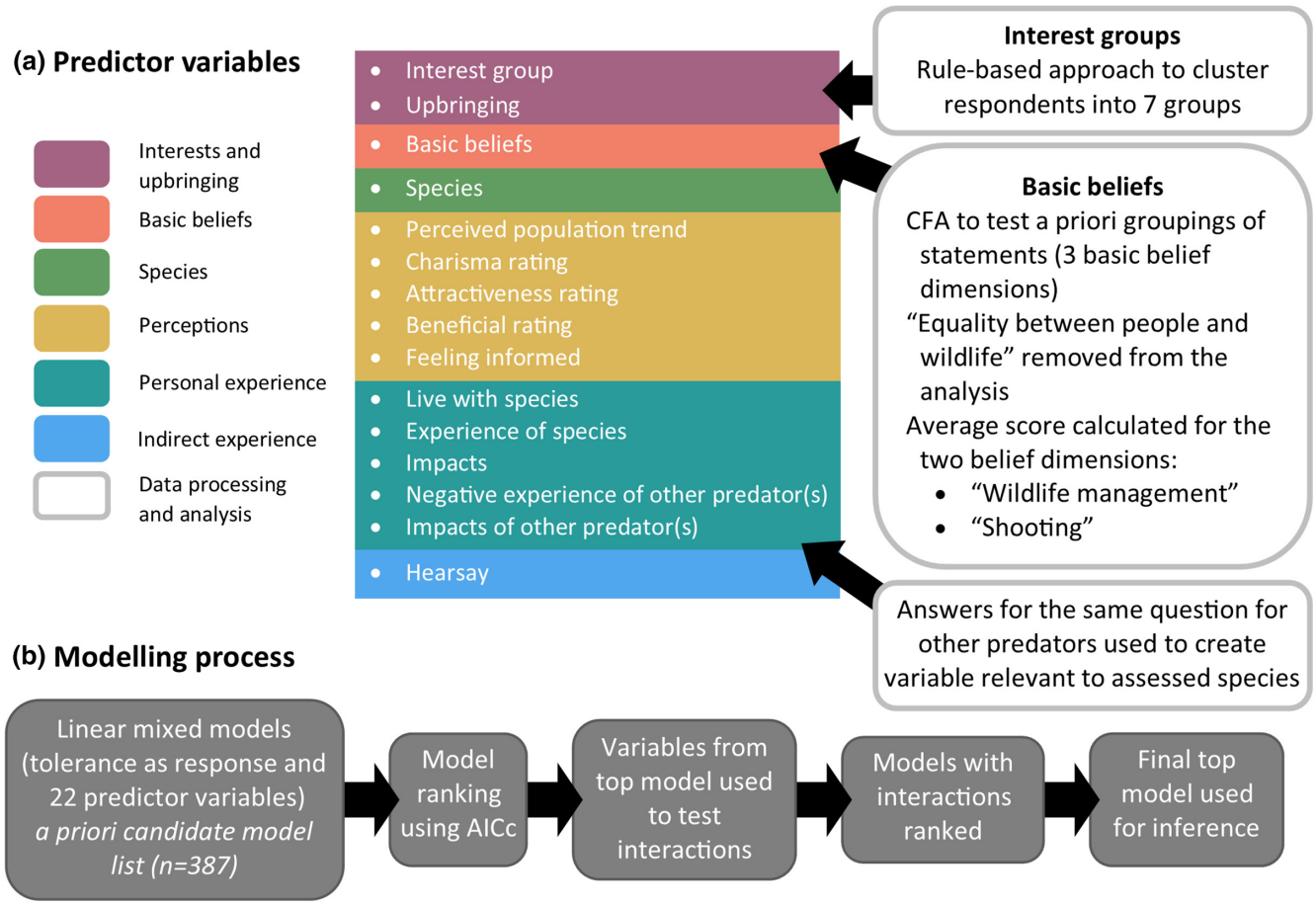

FIGURE 3 Overview of (a) categories of predictor variables used to model tolerance towards the impacts of recovering predators, and key data processing and analysis steps (for more information about data manipulation undertaken to create each predictor variable, see Tables S2 and S5 for details, and Figure S4 for summaries). (b) Flowchart of key steps taken in modelling process. AIC_c, corrected akaike information criterion; CFA, confirmatory factor analysis; EFA, exploratory factor analysis.

387 models based on previous studies and plausible hypotheses and ranked the models in order of parsimony using AIC_c (Table S9). We examined all models within 10 Delta AIC_c of the top model for redundant variables. Analyses were performed using R packages linear mixed model *lme4*, R^2 and multicollinearity using the r2_nakagawa() and check_collinearity() functions in *performance*, and aictab() function in *AICcmodavg* for ranking models using AIC_c.

Using the top additive model, we tested all plausible two-way interactions between predictor variables by including each in turn in the top model and ranked them using AIC_c (Table S10). We restricted the model evaluation to two-way interaction terms due to the large number of predictor variables and plausible interactions. Using interactions from models with lower AIC_c than the top additive model, we tested all possible combinations of the predictors and interactions to identify the best overall model based on AIC_c (using the dredge() function in the *MuMIn* R package, Table S11). We extracted coefficients from the final model and made predictions to examine the effect of predictors on tolerance and calculated 95% confidence intervals using normal nonparametric bootstrapping (10,000 replicates). The R package *boot* was used for bootstrapping and plots were created using *ggplot2*.

2.4 | Additional variables from the questionnaire

We used additional variables about experiences and impacts from the questionnaire to enrich the interpretation of the final model coefficients. We plotted the relationship between the *desired population trend* (levels—Decrease, Remain the same, Increase, No opinion) and our species tolerance score to understand how our measure of tolerance relates to another measure of tolerance; people's capacity to accept wildlife (Decker & Purdy, 1988, Figure S3). Following Brenner and Metcalf's (2020) Social Tolerance of Wildlife Framework, we assessed the relationship between our species tolerance score and the self-reported *attitude* score (negative (1) to positive (5)).

3 | RESULTS

A total of 819 respondents completed the questionnaire. Of these, 180 respondents were removed due to missing data: 57 respondents could not be assigned to an *interest group*, 84 did not select any species and were relatively evenly distributed across the *interest groups* (Table S7) and 39 respondents had missing data for

TABLE 1 Predictor variables used in linear mixed models to model tolerance towards the impacts of recovering predators. *Variable name*—those used in the models, *Type*—describes the data type, *Levels*—describes the number of levels in each variable and *S.C*—predictor variables standardised (mean = 0) and scaled (standard deviation 1). *Upbringing—location of childhood.

Predictor variable	Variable name	Type	Levels	S.C
Upbringing*	upb.rural	Binary	Levels: rural, suburban/urban	
Basic beliefs—wildlife management	BB.W.mgt.avg.SC	Numeric	1 (more utilitarian) to 5 (more mutualist)	✓
Basic beliefs—shooting	BB.Shoot.avg.SC	Numeric	1 (more utilitarian) to 5 (more mutualist)	✓
Species	Species	Categorical	Levels: Buzzard, Golden eagle, Pine marten, Otter, Red kite, Polecat	
Beneficial rating	harm_ben.num.SC	Numeric (interval)	Levels: 1 (harmful) to 5 (beneficial)	✓
Attractiveness rating	unatt.att.num.SC	Numeric (interval)	Levels: 1 (unattractive) to 5 (attractive)	✓
Charismatic rating	charisma.num.SC	Numeric (interval)	Levels: 1 (dull) to 5 (charismatic)	✓
Personal experience frequency (how often) (i.e. Exposure to species)	per.exp.freq.4lev	Categorical	Levels: no experience, very rarely/rarely, occasionally, frequently/very frequently	
Positive experience with a species	pos.exp.overall	Binary	Levels: no experience/no positive experience (0), yes (1)	
Negative experience with a species	neg.exp.overall	Binary	Levels: no experience/no negative experience (0), yes (1)	
Impacted by predation	predation.binary	Binary	Levels: no (0), yes (1)	
Impacted by damage	damage.binary	Binary	Levels: no (0), yes (1)	
Impacted by inconvenience	incon.binary	Binary	Levels: no (0), yes (1)	
Impacted (all types)	impact.overall	Binary	Levels: no (0), yes (1)	
Positive hearsay	hearsay.all.pos	Binary	Levels: no (0), yes (1)	
Negative hearsay	hearsay.all.neg	Binary	Levels: no (0), yes (1)	
Wider negative experience (i.e. negative experience with other predators included in survey)	Neg.exp.oth.pred	Binary	Levels: no (0), yes (1)	
Impacted by other predators (included in the survey)	Impact.oth.pred	Binary	Levels: No (0), Yes (1)	
Live with species	live.with.fac	Binary	Levels: No (0), Yes (1)	
Perceived national population change	nat.pop.st.fac	Categorical	Levels: Do not know, decreasing, stable, increasing	
Feeling informed about the species	informed.fac_3lev	Categorical	Levels: Not.at.all/slightly, moderately, very/extremely	
Interest group	Cluster	Categorical	Shoot-Cons-low, Shoot-Cons-mid, Shoot-Cons-high, Fishing, Farming, Cons-Shoot.Fish, Conservation	

predictor variables or tolerance response variable. The final data set included 639 respondents from all over the United Kingdom and was grouped into seven *interest groups* named predominantly by their primary interest (Tables S4 and S7). Most of the respondents were men (83.7%) (women 14.7%, other/not given <2%) and older than 45 years old (>81%) (Table S7). A total of 3009 tolerance scores were created (buzzard 523; pine marten 496; polecat 451; red kite 524; otter 520, golden eagle 495, Table S7). The highest proportions of respondents stated that they lived in an area with buzzard (95%), and the lowest living with golden eagle (12%) (pine marten 24%, polecat 29%, red kite 59%, otter 63%, Figure S7).

3.1 | Tolerance response variable

The '*Mitigation measures or financial compensation*' management strategy was the most common management option chosen for the hypothetical one-off predation scenario (40%) and the regular predation scenario (28%). For the conflict scenario in which a pet is killed, the most common option was '*Do nothing*' (30%). '*Control predator population*' (38%) was the most popular option for the hypothetical scenario in which the abundance of a rare or endangered native species is reduced. The proportion of respondents who selected each strategy varied between *species* and *interest group* (Figure S2).

Training and test data sets for tolerance indicators were considered suitable for factor analysis, with high internal reliability (Table S2). The EFA had a one-factor solution (Figure S1) and the CFA showed an acceptable fit, except for a statistically significant chi squared $p < 0.05$, which is expected given the large sample size (Table S3). All indicators had high factor loadings (range 0.73–0.94) (Table S2).

3.2 | Predictor variables

The loadings of the CFA factor (Table S6) and the fit indices (Table S3), for the basic belief predictor variables supported the grouping of the statements into two dimensions (*wildlife management* and *shooting*). For further summaries of all predictor variables, see Figure S4.

3.3 | Mixed model and model selection

The global model showed an acceptable fit to the data (Figure S5, R^2 marginal 0.35, R^2 conditional 0.81) with minimal multicollinearity issues (Table S8). Four of the top models were within 10 delta AIC_c, and these included a redundant variable (*impact.overall*) in the third and fourth models (Table S9). As the second model was simpler than the top model (one fewer predictors) (k 20, delta AIC_c 0.91), the top model was determined the most informative due to the additional variable resulting in a lower AIC_c (k 23, AIC_c 4472.72) and was used to test interactions.

A total of 21 two-way interactions were tested in separate models and ranked (Table S10). Six models had lower AIC_c than the top model. After testing all combinations of these interactions with additive effects, the final top model included nine predictors of tolerance with five two-way interactions (Figure 4, Tables S11 and S12).

3.4 | Final model

3.4.1 | Main effects (predictors not involved in interactions)

For the predictors that were main effects, basic beliefs about *wildlife management* increased tolerance for all *interest groups* and *species* with an effect size of 0.17 (95% CI 0.15–0.19). *Positive experience* with a species increased tolerance (0.12, 95% CI 0.08–0.18) (Figures 4 and 5a). *Perceived national population trend* was a main effect; however, the relative effect sizes compared to other predictors were minimal (Figure 4).

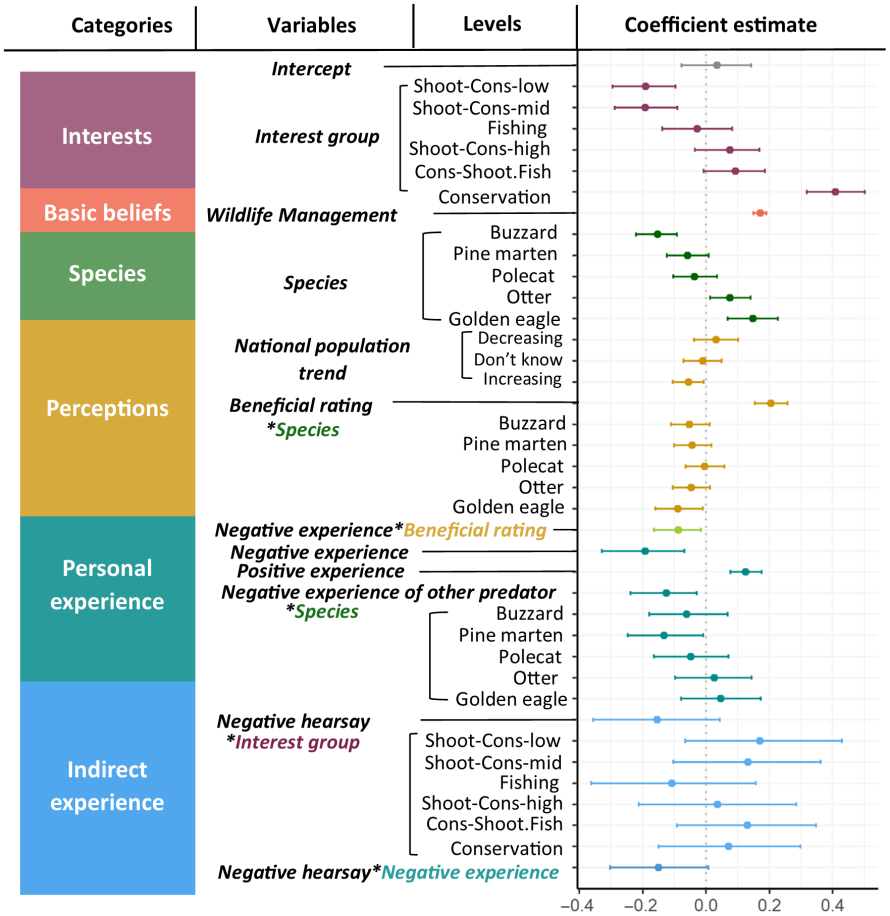

FIGURE 4 Final tolerance model coefficients and 95% confidence intervals using normal non-parametric bootstrapping (10,000 replicates) showing the effect of each predictor on tolerance towards the impacts of recovering predators. The model included nine predictors of tolerance (interest group, basic beliefs about wildlife management, species, national population trend, beneficial rating, negative experience, positive experience, negative experience of other recovering predators and negative hearsay), with five two-way interactions (species × beneficial rating, negative experience × beneficial rating, negative experience of other recovering predators × species, negative hearsay × interest group, negative hearsay × negative experience). Reference levels: Species—Red kite; Interest—Farming; National population trend—Stable; 'no' option for all dichotomous variables and mean for continuous. Variables are grouped in categories and indicated with different colours (Interests, Basic Beliefs, Species, Perceptions, Personal experience, Indirect experience), and levels of each categorical variable given. *represents an interaction between predictor variables. Coefficients with +/− standard errors, and 95% confidence intervals using non-parametric bootstrapping in Table S12.

3.4.2 | Interaction effects

The influence of *negative hearsay* (i.e. negative information and opinions heard through affiliations and peers) depended on the *interest group* (and not on *species*); however, there was much uncertainty and low precision for the *negative hearsay* coefficient estimates and their effect on each *interest group* (Figures 4 and 5d). An exception was the Fishing group that showed no overlap with zero in the bootstrapped confidence intervals for the predicted effect of *negative hearsay* and reduced tolerance by −0.26 (−0.11, 95% CI −0.36 to 0.16). The effect of *negative hearsay* was also dependent on whether the respondent had a *negative experience* with a species, causing tolerance to decrease for all those with *negative experience*, but decreased further when *negative hearsay* about the species was reported (Figures 4 and 5b).

The effect of *wider negative experience of recovering predators* depended on the *species* assessed (Figures 4 and 5e). When respondents had not experienced any *negative experience of another predator*, the buzzard was the least tolerated, followed by the pine marten, polecat and red kite, and the golden eagle was the most tolerated, followed by the otter. For respondents who reported a *negative experience of another predator*, the most pronounced effect was for pine marten, and this reduced tolerance by 0.26 (−0.13, 95% CI −0.25 to −0.01), followed by buzzard (−0.06, 95% CI −0.18 to 0.07) and polecat (−0.05, 95% CI −0.16 to 0.07), reducing tolerance by 0.19 and 0.18 respectively. Compared to pine marten, the effect of *negative experience of another predator* was two to three times less influential in reducing tolerance for otter (0.03, 95% CI −0.10 to 0.14) and golden eagle (0.05, 95% CI −0.08 to 0.17), reducing tolerance by only 0.1 and 0.08 respectively.

From the predictors that captured perceptions about each species, the effect of the *beneficial rating* depended on two other predictor variables: *species* and *negative experience*. An increase in the *beneficial rating* (i.e. a species is perceived as more beneficial) increased tolerance the most for red kite and polecat, and the least for golden eagle. However, there was considerable overlap in confidence intervals between species. The effect of the *beneficial rating* on tolerance was also dependent on whether the respondent had a *negative experience* of the species, by which tolerance decreased for almost all those with a *negative experience*, but mainly for those who rated the species more beneficial, with almost no effect on those who rated the species harmful (−0.07, 95% CI −0.15 to 0.01) (Figure 5c).

3.5 | Additional data

As expected, the respondents who wanted future populations to increase had a higher tolerance, the respondents who wanted populations to decrease had a lower tolerance and those who wanted the populations to remain the same tended to have tolerance scores between (Figure S3).

The plot of our tolerance score with self-reported *attitude* scores for all *interest groups* and *species* showed that very few respondents fell within the 'Tolerant' typology proposed by Brenner and Metcalf (2020) (Figures 1 and 6a). Most of the respondents were within the 'Distant', 'Enthusiastic' and 'Indifferent' typologies. Separate plots for *species* showed that most invoked neutral to positive attitudes, but the more tolerated species had a higher proportion of respondents with positive attitudes (Figure 6b). Separate plots for *interest groups* showed that the Conservation group had generally positive attitudes and high acceptability (Figure 6c). For all other *interest groups*, most respondents had neutral to positive attitudes; however, acceptability varied from low to high. A slightly higher proportion of respondents in the Shoot-Cons low, Shoot-Cons mid and Fishing and Farming interest groups were within the 'Intolerant' and 'Distant' typologies compared to Shoot-Cons high and Cons-Shoot-Fish.

4 | DISCUSSION

Our findings show that tolerance towards the impacts of recovering predators is characterised by a tractable but complex combination of factors determined at the level of an individual person and species, and variability between respondents not accounted for in our predictor variables. While accounting for the heterogeneity of the respondents, we found that the combination of interests a person holds, their beliefs regarding wildlife management, their perceptions about population trends and species benefits, their positive and negative personal experience and negative hearsay best described tolerance to recovering predators.

4.1 | Gradient of tolerance across multidimensional interest groups

Our large sample size allowed the grouping of respondents into interest groups. We found a tolerance gradient with notable overlaps between several groups with primary interests in different land-based activities (wildlife conservation, shooting, farming and fishing). The groups with the highest tolerance had strong interests in wildlife conservation, and those with the lowest tolerance had strong interests in shooting and were comparatively less interested in wildlife conservation. Tolerance is often assumed to be homogenous within groups of similar interests or affiliations (Grossmann et al., 2020), yet by classifying groups by multiple-ranked interests, we have highlighted an important gradient within and across groups.

The formation of groups with divergent interests and opposing views is a common and recurring characteristic of conservation conflicts concerning predators around the world, for example, those surrounding raptor and grouse moor management (Hodgson et al., 2018), and wolf recovery, livestock production and hunting (Hamilton et al., 2020; von Essen et al., 2015). Often, polarised views can overshadow the large middle ground where agreement and potential for compromise exist (Cusack et al., 2021). Our results are a clear reminder that, despite the presence of strongly opposing

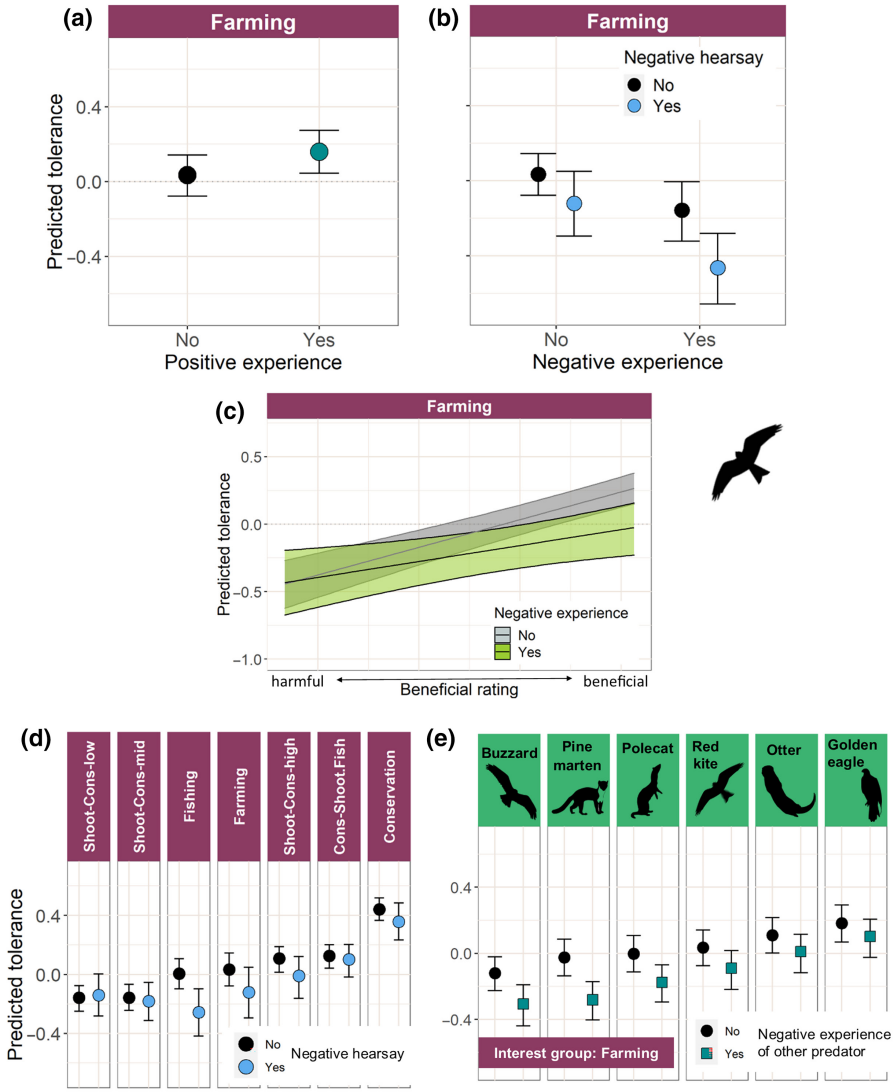

FIGURE 5 Predicted effects of predictor variables on tolerance towards the impacts of recovering predators with 95% confidence intervals using non-parametric bootstrapping (10,000 repetitions). Reference levels: Interest group—Farming; Species—Red kite; National population trend—Stable; 'no' option for all dichotomous variables and mean for continuous variables. (a) Positive experience. (b) Negative experience and negative hearsay (two-way interaction). (c) Negative experience and beneficial rating (two-way interaction). (d) Negative hearsay and interest group (two-way interaction). (e) Negative experience of other predator and species (two-way interaction). All species silhouettes were obtained from http://phylopic.org/, see Table S14 for full list of credits.

views, there is significant overlap in views for those with different primary interests. Recognising and acknowledging the existence of a gradient of interests can provide opportunities to identify synergies and leverage points for negotiations and conflict resolution. This highlights the importance of well-balanced stakeholder representation in wildlife management and ensuring that all stakeholders are permitted to contribute to decision-making surrounding predator recovery and management (Grossmann et al., 2020).

4.2 | Beliefs about wildlife management

As our tolerance score was constructed using the management strategies deemed most appropriate under conflict scenarios, the importance of beliefs about wildlife management was anticipated. Wildlife value orientations, which are determined by patterns in multiple basic beliefs (Table S6), have been shown to strongly predict the acceptability of wildlife management interventions, particularly the most and least extreme (Jacobs et al., 2014). Divergent beliefs about wildlife management are potentially linked to deep-rooted values and, therefore, challenging to alter or influence through short-term stakeholder engagement activities. However, acknowledging these different viewpoints and framing communication towards different value orientations can help improve the effectiveness of stakeholder engagement efforts (Hermann et al., 2013; Miller et al., 2018). In particular, understanding the motivations behind stakeholders' views on management, such as past experience and perceptions of the species, may help identify shared or conflicting motivations among stakeholders, and therefore identify compromises (Swan et al., 2020).

4.3 | Experience and perceived benefits of a species are key to tolerance

Our results build on previous findings that higher perceived benefits of a species increase tolerance (Carter et al., 2012; Inskip et al., 2016; Kansky et al., 2016; Slagle et al., 2013). However, we also found that negative experience strongly dampened the effect of perceived benefits on tolerance when perceived benefits were high. Previous studies have found an association between experience and beliefs. For

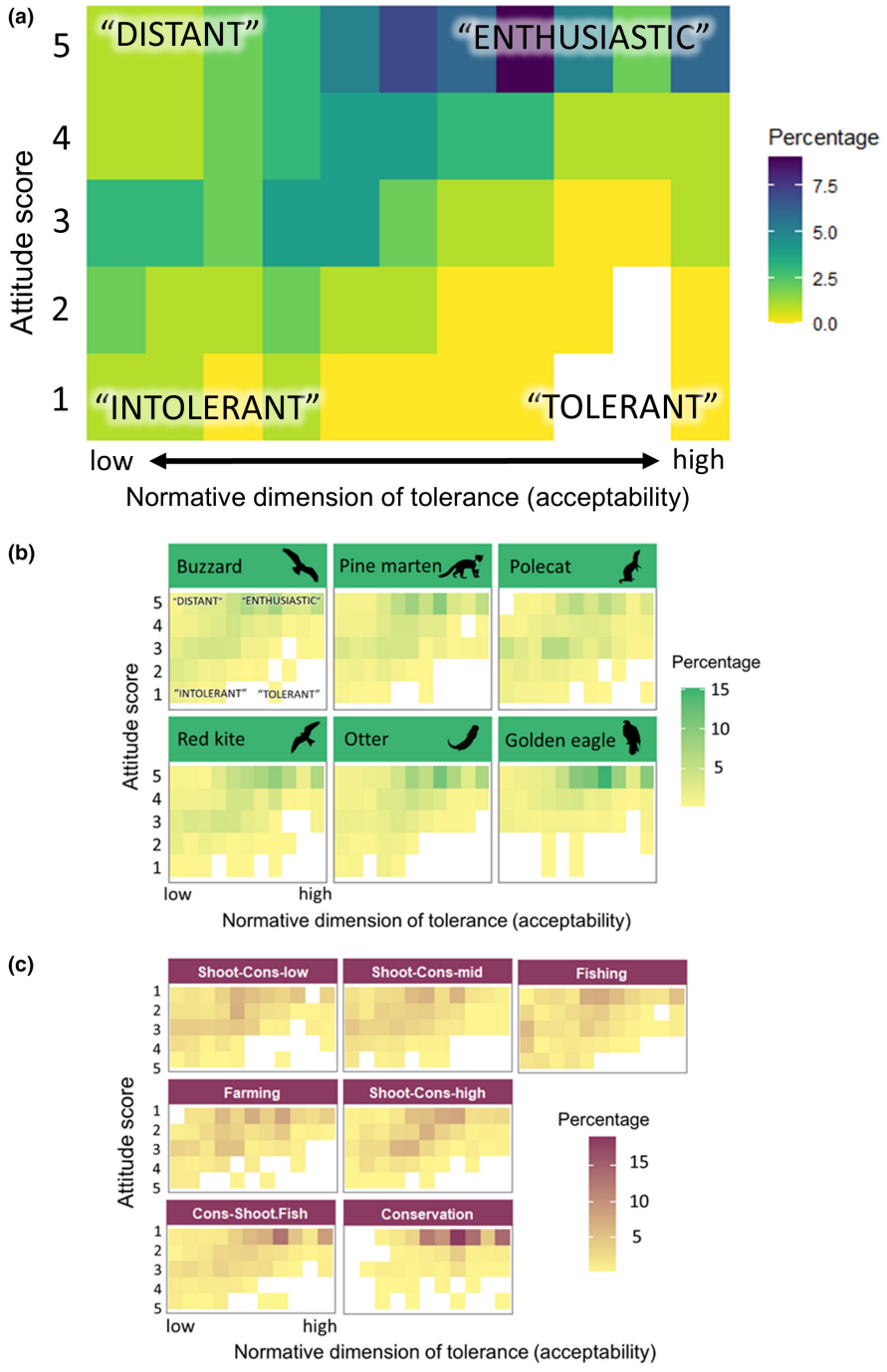

FIGURE 6 Self-reported attitude and tolerance response variable with the proposed typology groups in the social tolerance of wildlife framework (attitudes/acceptability) (Brenner & Metcalf, 2020). (a) Data include attitude and tolerance score for all six recovering predators (buzzard, golden eagle, otter, pine marten, polecat, red kite) and seven interest groups. As the number of respondents differed in each interest group, the percentage is calculated from the proportions within each interest group (total number of respondents: Shoot-Cons-low 93, Shoot-Cons-mid 91, Fishing 70, Farming 55, Shoot-Cons-high 94, Cons-Shoot. Fish 112, Conservation 124). (b) Data grouped by species. (c) Data grouped by interest group. The normative dimension of tolerance variable is divided into 11 equal segments for visualisation purposes. All species silhouettes were obtained from http://phylopic.org/, see Table S14 for full list of credits.

example, experience mediated the effect of beliefs and perceived risks on tolerance for tigers (Inskip et al., 2016), and experiences with baboons influenced perceived costs and benefits, in turn influencing tolerance (Kansky et al., 2016). These studies applied structural equation modelling that helps to determine significant causal pathways between factors. Although our study did not aim to identify casual pathways, our modelling approach allowed us to identify this association between experience and perceptions that influence tolerance.

Positive experience plays a role in determining tolerance (Arbieu et al., 2020; Lischka et al., 2019). People's tolerance to living in close proximity to wolves in Germany was higher for those who had positive experiences, and interestingly, there was a higher frequency of positive experience reported by all respondents living inside and outside the wolf region (Arbieu et al., 2020). We found a similar trend for several medium-sized predators: There was a higher frequency of positive experiences reported by respondents. A novel insight is that details of positive experiences given by respondents highlight that these experiences need not occur within the area they live in or with wild individuals; reported positive interactions also occurred on excursions to other parts of the country or with captive or domesticated species.

4.4 | Negative experiences can be more important than impacts

For our sample population, negative experience was important in describing the tolerance levels of the respondents, while impacts were not (see Limitations for more details). This has previously been identified for black bears in Colorado, United States, where safety and nuisance-related conflicts did not strongly influence tolerance, even when the frequency of conflict events was reduced (Lischka et al., 2019). In our study and across all species, the number of respondents who reported any of the impacts (or only predation impacts) was higher than those who reported negative experiences. Many of the impacts reported were associated with negative experiences; however, not all the respondents who reported the impacts reported a negative experience. This suggests that the respondents interpreted impact events differently. The information provided by these respondents suggests an appreciation or acceptance of predator behaviour, including killing prey, while others indicate that impacts were infrequent or manageable (Table S13).

Our findings demonstrate how human–wildlife interactions vary along different continuums (Frank, 2016) including intensity and frequency, and that there are thresholds that must be surpassed to classify an interaction with a predator as negative (Nyhus, 2016; Soulsbury & White, 2015). Different people may perceive the same interaction in different ways, as thresholds are likely to depend on a range of socioeconomic, cultural and psychological factors (Nyhus, 2016). Emotions are likely to play an important role in how an interaction is internalised and can influence views on management actions (Larson et al., 2016).

4.5 | The influence of indirect experience on tolerance

A novel finding was that negative hearsay was particularly influential on tolerance when negative experience was reported. This suggests that indirect negative experience shared through a person's social network may exacerbate the influence of personal negative experience on tolerance towards a species. Hearing others' negative experience may highlight that the issue is not isolated and elevates concerns about a species. For tolerance to tigers, indirect experience was found to influence the perceived risk of livestock depredation; however, no interaction was found between direct and indirect experience (Inskip et al., 2016). Most respondents who reported a negative experience also reported hearing negative information about the species (negative hearsay: yes 85%; no 15%), compared to far fewer respondents who did not report a negative experience (negative hearsay: yes 17%, no 83%). A plausible inference would be that there are hotspots (either within geographical areas or social networks) where negative experience with a species is frequent, and subsequently negative hearsay about a species common. Furthermore, having a negative experience with a species may make a person more alert to and able to recall information about other people's similar experiences more easily (potentially a product of 'confirmation bias', Colman, 2008).

4.6 | Strategies focusing on experience

Efforts should be made to prevent or reduce the negative impacts of predators on stakeholder interests. Furthermore, understanding why people interpret an experience with a predator as negative, positive or neutral may help identify strategies to increase tolerance. Situational factors make emotions relatively unstable (Muhar et al., 2018) compared to values, which are reasonably stable throughout a person's life (Dietz et al., 2005). Controlled exposure to brown bears was found to strongly reduce people's fear of the species (Johansson et al., 2019). Although fear related to human safety concerns is not as relevant to our focal species, providing opportunities for people to experience and learn about predator behaviour and predator–prey dynamics so that predation on wild and to some extent game and livestock species is accepted as natural behaviour has the potential to increase tolerance. Although a higher level of education can correspond to lower perceptions of risk and more positive attitudes towards predators (Kimmig et al., 2020), the effectiveness of education as a conflict resolution strategy is contested (Gore et al., 2008). However, using environmental education or awareness campaigns as a preventative measure before a conflict ensues may be more productive (Skupien et al., 2016).

4.7 | Drivers of tolerance for people without experience of a species

The familiarity and awareness of golden eagle, polecat and pine marten was disproportionate to the area occupied by the species. A large proportion of respondents formed their perceptions of the costs and benefits of a species without personal experience or living alongside a species. Our findings suggest that people are likely to draw on their experience with other predators and can be influenced by information shared by peers and acquaintances. However, none of our predictors explained the overall trend in tolerance towards the six recovering species for all interest groups.

The portrayal of recovering predators and framing of costs and benefits in the media or specialised interest publications may be highly influential in shaping tolerance. Studies on wolves have highlighted differences in how regional and national newspapers represented human–wolf interactions and management issues in France (Chandelier et al., 2018), and an increase in negative discourse in print news media in states with new wolf populations in the United States (Houston et al., 2010). The influence of social media, in particular online videos, is a relatively new phenomenon that has the potential to influence the tolerance and attitudes to wildlife across a broad-spectrum of society (Ballejo et al., 2021; Casola et al., 2020).

4.8 | Very few people are truly tolerant

The application of our tolerance score within the Brenner and Metcalf (2020) tolerance framework provides an interesting insight into the challenges of conceptualising tolerance towards wildlife. A clear pattern emerges showing that very few respondents fall within the 'Tolerant' (negative attitude, high acceptability) typology (Figure 6). Although limited inference can be deduced due to the lack of a robust attitude measurement, our findings provide quantitative support for the observation by Brenner and Metcalf (2020) of sociological studies that true tolerance is relatively uncommon (Peffley et al., 2015; Sullivan et al., 1979; van Doorn, 2014). This is likely due to it being a cognitively dissonant position, as being highly acceptive of something strongly disliked (i.e. negative attitude) is rather inconsistent. However, holding the opposite position of positive attitude and low acceptability was more common (Figure 6), and conceptually more intuitive to understand.

Furthermore, we show how the psychological concepts of attitude and acceptance regarding several recovering predator species differ, which was previously demonstrated for the grey wolf (Carlson et al., 2023). The relationship between attitude and acceptability highlights that before higher levels of impact are accepted, attitudes must be neutral or positive. Therefore, to foster coexistence between people and predators, tolerance to impacts (i.e. acceptability of impacts), which is reliant on more positive attitudes, must be achieved instead of true 'tolerance' as defined in Brenner and Metcalf's (2020) tolerance framework.

The aggregated data for all interest groups and species show that the highest proportion of respondents fall within the 'Enthusiastic' and 'Distant' typologies. However, a considerable proportion of respondents potentially lie on the boundary between typologies, called 'Indifference' in the framework. The boundaries between typologies are arbitrary and depend on the response scale and the questions used to define attitude and acceptability and should be interpreted with caution. The recent development of a framework that focuses on 'individual relationships with entities of nature' (IREN) (Lehnen et al., 2022) is a promising avenue to overcome the challenge of these arbitrary boundaries when applying Brenner and Metcalf's (2020) tolerance framework. The IREN framework incorporates attitude, behavioural preference and behaviour to identify a rich set of 17 typologies (Lehnen et al., 2022), yet this complexity may present challenges to its application and interpretation.

4.9 | Limitations of the study

Asking respondents to answer questions about hypothetical conflict scenarios may be considered unrealistic and may therefore be a limitation (Slagle & Bruskotter, 2019). However, this approach allowed us to investigate the tolerance of respondents with and without personal experience of these species, which is highly relevant to ongoing efforts to support predator recovery and coexistence. Our sample population included respondents with association or membership to organisations with relevant interests related to or potentially affected by predator recovery in the United Kingdom. Therefore, the respondents were self-selected and therefore not formally stratified a priori. Stratification of the respondents to only those living alongside the species, those with only experience or only professional interests would be of interest for future research.

Our assignment to interest groups was based on self-declared interests and therefore presents the potential for confounding factors to specific interests, such as gender. A very high proportion of the respondents were men (>80%), yet the Conservation group had the highest proportion of women (54%). Several studies have found that women tend to hold more mutualist values in comparison to men (Gamborg & Jensen, 2016; Kellert & Berry, 1987; Teel & Manfredo, 2010), and therefore, the very high levels of tolerance predicted for this group may be shaped by the higher proportion of women within this group. As the number of non-male respondents was low within our sample, extrapolation of our findings should be done with caution. Generally, field-based sports such as shooting and fishing have a high proportion of male participants, and therefore, the high number of male respondents for these interest groups is likely representational (e.g. 6.2% of shotgun and/or firearm certificates in England and Wales are held by women, Home Office, UK Government, 2021).

5 | CONCLUSIONS

Recognising that people's interests are multidimensional allowed us to highlight a tolerance gradient between groups with interests in farming, fishing, shooting and wildlife conservation. This gradient and the similarities between groups with different primary interests suggest that there are points of consensus and cooperation that can often be overshadowed by polarised groups or hidden if interests are defined solely on primary interests. Discussions surrounding predator management and conservation will inevitably involve challenges due to differences in deeply rooted value and belief systems concerning the way people interact with nature and wildlife. Higher levels of perceived benefits of a species consistently increased tolerance. The experience of a species is highly influential on tolerance, with negative experiences diminishing the influence of perceived benefits of a species and a combination of negative experience and negative hearsay strongly reducing tolerance. On the contrary, positive experience had the universal effect of increasing tolerance for all species and interest groups. Our study highlighted that negative experiences were more important than impacts to describe tolerance, with additional information suggesting that acceptance of predator behaviour and frequency and severity of impacts influenced whether people interpreted an experience as negative. The ranking of species from least to most tolerated was the same for all interest groups, suggesting that factors not measured in this study that transcend all interest groups play an important role in shaping tolerance to specific species. Our application of the Brenner and Metcalf tolerance framework (Brenner & Metcalf, 2020) highlighted

that pure tolerance (negative attitude—high acceptability) is potentially rare, and to avoid issues related to terminology and conceptualisation of tolerance, it is likely more advantageous to focus on improving attitudes and increasing acceptance of impacts or costs.

AUTHOR CONTRIBUTIONS

Keziah J. Hobson and Xavier Lambin conceived the study; Keziah J. Hobson designed the questionnaire with input from Xavier Lambin, Andrew Stringer and Robin Gill; Keziah J. Hobson collected and analysed the data and drafted the manuscript with inputs from Xavier Lambin. All authors provided critical reviews and revisions.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data supporting this study are openly available from Dryad at https://doi.org/10.5061/dryad.k6djh9wd6.

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SUPPORTING INFORMATION

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

Figure S1. Scree plot and parallel analysis for exploratory factor analysis (EFA) using tolerance indicators.

Figure S2. Conflict scenarios used as indicators for the tolerance response variable.

Figure S3. Relationship between desired population trend and tolerance score for all six recovering predator species grouped by species and interest group.

Figure S4. Plots summarising predictor variables.

Figure S5. Diagnostic plots for global model fit.

Table S1. UK-based organisations that shared the questionnaire survey.

Table S2. Descriptive statistics and test results for the tolerance indicators used for factor analysis.

Table S3. Confirmatory factor analysis fit indices and results (adapted from Hooper et al., 2008).

Table S4. Rules used to create interest groups.

Table S5. Data manipulation to create predictor variables.

Table S6. Basic belief dimensions, statements, and confirmatory factor analysis results.

Table S7. Summary data and interest group and species predictor variables with information on missing data.

Table S8. Variance inflation factors for parameters in global model.

Table S9. Candidate model list to identify predictors that best describe tolerance to recovering predators (387 models in total) ranked by AICc.

Table S10. Ranking table of models for tolerance to recovering predators with single interactions using AICc.

Table S11. Output from dredging the top additive model of tolerance to recovering predators from step 1 with six 2-way interactions.

Table S12. Final tolerance model coefficients.

Table S13. Noteworthy quotes from respondents that reported impacts but did not report a negative experience with the species.

Table S14. List of credits for silhouettes of species.

Data S1. Native protected predators in the UK - Questionnaire.

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