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RESEARCH ARTICLE

Reintroduced, but not accepted: Stakeholder perceptions of beavers in Germany

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Abstract

1. While reintroductions of regionally extinct native species usually benefit ecosystems, reintroduced animals often struggle to locate appropriate habitats where they can establish themselves without conflict with humans. European beavers (*Castor fiber*) were successfully reintroduced to Germany almost 60 years ago and have reached high abundances again. As beavers can damage trees and change landscapes, they are increasingly in conflict with humans.
2. We investigated human perceptions of beavers in Germany using an online survey, as they are an example of a reintroduced species with an expanding population and potential conflicts with humans. We asked participants about their emotions (anger, fear, interest, joy) towards beavers and what they consider to be acceptable beaver habitats.
3. Of nearly 1500 survey participants, 803 (53%) were from the general public, 475 (32%) from the agricultural sector and 219 (15%) from forestry. People in these sectors had very different perspectives: beavers were positively perceived by the general public, but negatively by stakeholders working in agriculture and forestry. Independently of stakeholder groups, we also found regional differences, as participants from Bavaria—the German state with the highest beaver densities—viewed beavers more negatively than those from the rest of Germany.
4. Zoos and wildlife parks, as well as urban and nature conservation areas, were considered to be the most acceptable habitats for beavers, whereas survey participants did not accept private gardens and cultivated areas as beaver habitats.
5. We discuss the sources of negative emotions towards beavers and how ecologically suitable habitats differ from those that appear acceptable by humans. Even 60 years after their reintroduction, beavers in Germany are still being recognized as both a novelty and a nuisance. Our findings highlight the need for active beaver

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management and increased public engagement to enable positive coexistence between beavers and humans in Germany.

KEYWORDS
Castor fiber, human–animal interactions, human-wildlife conflicts, keystone species, rewilding, species reintroductions

1 | INTRODUCTION

Restoration and rewilding practices are motivated by the desire to right wrongs wrought on nature by our ancestors—such as the extinction of an animal due to overhunting (Foreman, 2010; Katz, 2009). Human behaviour has altered ecosystems and climate (IPCC, 2014; Malcolm et al., 2006) and led to biodiversity loss, resulting in negative effects on humanity and the planet (Cardinale, 2014). Ecological restoration is a tool used to revert such destruction and relates to the repair of degraded ecosystems by active human intervention (Higgs, 2003). Restoration can be seen as both humans taking control of nature to ease guilt (Katz, 2009), and a process to learn about the consequences of our actions (Hull, 2000). One strategy used within restoration is the reintroduction of former keystone species (Donlan et al., 2006; Nogués-Bravo et al., 2016), for example species that have disproportionately large effects on the ecosystems they inhabit. Examples of such keystone species are wolves (*Canis lupus*) (Laundré et al., 2001; Manning et al., 2009; Ripple & Beschta, 2003) and Eurasian lynx (*Lynx lynx*) (Kramer-Schadt et al., 2005; Linnell et al., 2009) that shape ecosystems via the landscape-of-fear effect, European bison (*Bison bonasus*) that change grasslands by grazing (Cromsigt et al., 2018) or beavers (*Castor* spp.) that alter entire landscapes through their dam-building activities (Hobbs et al., 2024; Law et al., 2017; Wright et al., 2002). The general aim of species reintroductions is to increase ecosystem resilience (Carroll & Noss, 2021) and create self-sustaining ecosystems (Brown et al., 2011) that oppose invasive human interference (Prior & Brady, 2017). The effects of rewilding are still not comprehensively understood, however, and ongoing investigations seek to ascertain if they yield the expected benefits (Hobbs et al., 2024). Attempts to 'rewild' landscapes are often justified by pointing to habitat destruction due to colonization, industrialization and urbanization (Brown et al., 2011; Foreman, 2010). Rewilding can target multiple effects, including the reinstatement of natural 'wild' processes (Corlett, 2016; Jørgensen, 2015), reestablishment of functioning ecosystems and recovery of degraded areas (Jørgensen, 2015; Soulé & Noss, 1998) or public engagement with biodiversity topics (Nogués-Bravo et al., 2016). However, the reintroduction of a species is a Pandora's box: reintroduced animals can cause unintended conflicts, as humans have not experienced living with these animals for decades (Nogués-Bravo et al., 2016).

The successful establishment of a keystone species depends on the consideration of human perceptions in reintroduction plans (Durant et al., 2019; IUCN, 2023). If human attitudes towards reintroduced species turn more negative, calls for lethal control measures could increase (e.g. Siemer et al., 2013; Ulicsni et al., 2020), potentially leading to a repetition of history where the reintroduced animal faces extinction once again (Anderson, 2021; Auster et al., 2021b). Generally, humans want reintroduced animals to be 'wild, but not too wild', so that they restore natural areas, but do not negatively influence working lands (Von Essen & Allen, 2016). Reintroduced wildlife naturally migrate and disperse, and do not contain themselves within boundaries perceived by humans, which can cause conflicts (König et al., 2020). Due to the high potential for human-wildlife conflicts accompanying the reintroduction of keystone species, understanding human dimensions is key for the success of reintroduction efforts (Delibes-Mateos et al., 2022; Riley & Sandström, 2016). Williams et al. (2002) show that the acceptance or support for wildlife reintroductions is lower when risk perceptions are higher. To achieve coexistence or cohabitation between humans and wildlife, adaptation is essential from both parties (Carter & Linnell, 2016). Coexistence hinges on understanding resilience factors in human-wildlife systems, obtaining predictive insights into the effectiveness of conservation policies and heeding early warning signs if positive attitudes are declining (Carter & Linnell, 2023). Considering the ecosystem services and disservices associated with wildlife, as well as social participation of stakeholders can be instrumental in addressing interactions and find solutions for challenges (Ceauşu et al., 2019). Most research on human attitudes towards reintroductions has focused on carnivorous keystone species such as wolves, brown bears (*Ursus arctos*, including grizzlies) or Eurasian lynx (e.g. Arbieu et al., 2019; Delibes-Mateos et al., 2022; Heberlein & Ericsson, 2005; Karlsson & Sjöström, 2007). In contrast, studies focusing on perceptions of herbivorous keystone species (e.g. Auster et al., 2020, 2021a; Balčiauskas & Kazlauskas, 2014) as well as the inclusion of stakeholder perceptions (e.g. Ghasemi et al., 2021) are rare. Coexistence hinges on equitable stakeholder participation and ongoing negotiations, demanding a holistic perspective to address the multifaceted challenges of human-wildlife-conflicts (König et al., 2020, 2021). For our study, we assessed the perceptions of different stakeholder groups towards reintroduced Eurasian beavers (*Castor fiber*) (Table 1) in Germany. Studies on the public perception of beavers exist in the US (Jonker et al., 2006; Siemer et al., 2004), Great Britain (Auster et al., 2020, 2021a; Oliveira et al., 2023), Italy (Viviano et al., 2023) and Hungary (Ulicsni et al., 2020). However, stakeholder attitudes towards beavers have only been included in studies in the US (McKinstry & Anderson, 1999) and Sweden (Hartman, 2003).

The total number of Eurasian beavers across Europe was reduced to 1200 animals at the beginning of the 20th century

(Nolet & Rosell, 1998; Yalden, 1999) because of overexploitation for fur, meat and castoreum (Djoshkin & Safonov, 2004; Halley & Rosell, 2002). Beavers survived extinction in small areas of France, Germany and Norway (Yalden, 1999). Under protection status, they have been reintroduced to various European countries, for example Scotland, Poland and Hungary (see Halley et al., 2021), also due to their beneficial impact on biodiversity as ecosystem engineers (Nummi & Poysa, 1997; Wright et al., 2002).

TABLE 1 Information about the focal keystone species, the Eurasian beaver (based on: Rosell & Campbell-Palmer, 2022; Zahner et al., 2021).

Eurasian beaver (*Castor fiber*)	
Phenotype	Biggest northern-hemisphere rodent, brown fur, tail covered in scales (26.3–35.0 cm), orange teeth, 17.8–25.0 kg weight and 106.8–135.0 cm length
Diet	Herbivorous, forage woody broad-leaved plants and crops
Habitat	Water reliability and food availability important factors for establishing
Behaviour	Nocturnal, semi-aquatic

Due to these strong protections accompanied by reintroductions, recent estimates indicate that there are approximately 1.5 million beavers distributed across Eurasia (Halley et al., 2021; Wróbel, 2020).

The beaver is a prime example of a keystone species that can cause substantial conflicts with humans upon reintroduction (Zahner et al., 2021). Its presence brings both benefits and constraints (Figure 1; see also Table A1 in Appendix S1). Beavers enhance biodiversity (e.g. higher diversity of fish species or insects) through their impacts on water and trees, benefitting various species (Zahner et al., 2021). Their dams increase water purification (Puttock et al., 2017), and ponds created by beavers capture carbon (Wohl, 2013). However, beavers creating burrows close to land used for farming or forestry can result in bank collapse, dead crops in flooded areas (Graf, 2009; Müller-Schwarze, 2011), economic losses due to flooded forests (Boczoń et al., 2009) or cut trees (Parker et al., 1999). While there are monetary impacts associated with damage caused by beavers, social conflicts also arise, especially when people differ in their preferred wildlife management options from impact adaption to lethal control (Jonker et al., 2006; Yarmey & Hood, 2020).

Halley and Rosell (2002) list three stages of human perception of reintroduced beavers: (1) curiosity and pride in the reintroduction of beavers at the time of introduction; (2) complaints and negative

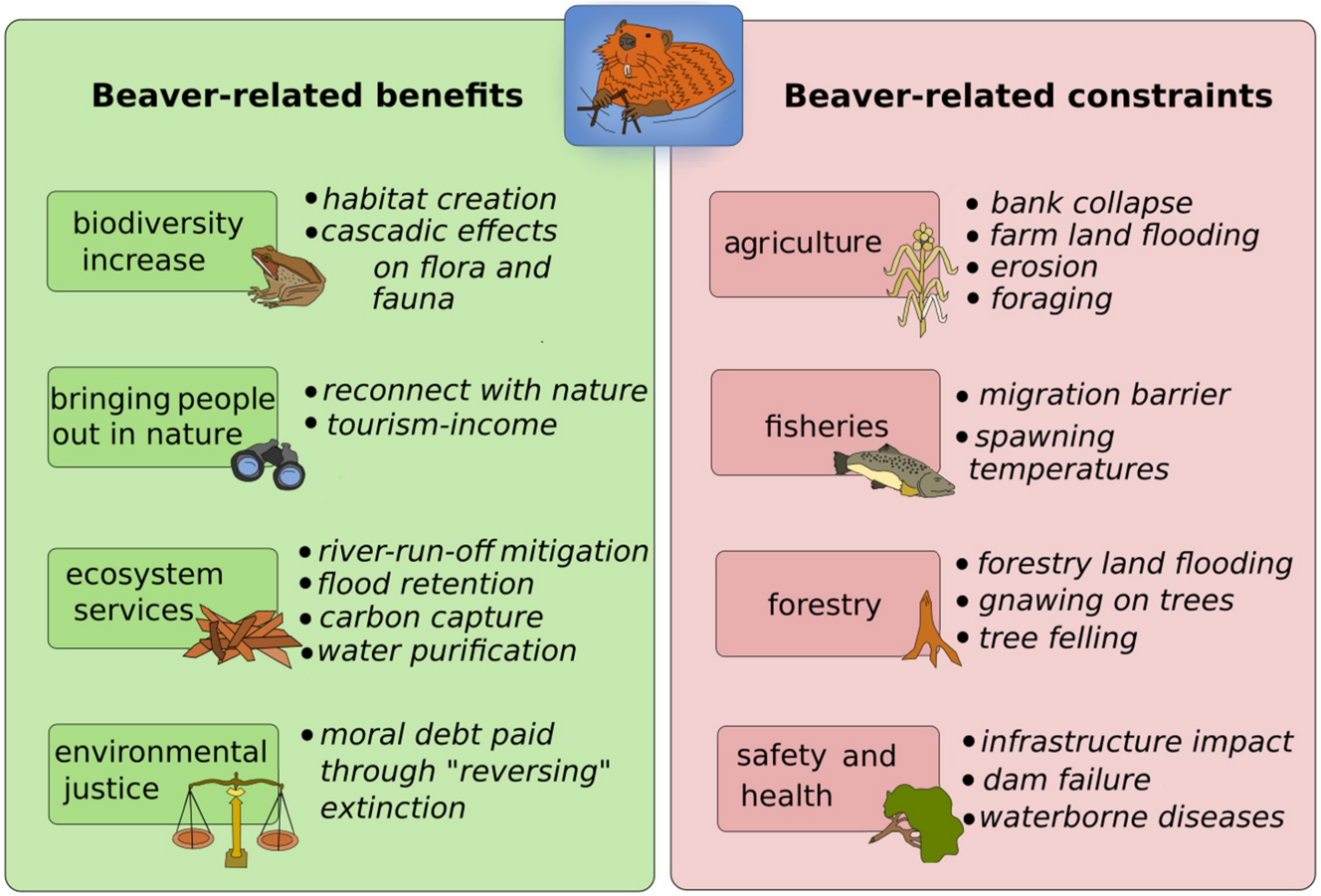

FIGURE 1 Beaver-related positive (green) and negative (red) impacts on the surrounding landscape.

attitudes towards beavers with increasing beaver populations and occupation of marginal habitats, ca. 20 years after reintroductions; and (3) a 'neutral' stage of tolerance and acceptance of beavers, as they are no longer a novelty. In this final stage, local conflicts persist, but stakeholders are content due to beaver management that mitigates or compensates conflicts.

Our study aims to gain insight into attitudes towards beavers by the general public as well as different stakeholder groups in Germany, where beavers have been reintroduced since the 1960s. Germany represents an excellent case study, as beavers in this country exemplify a reintroduced species showing an expanding population and potential conflicts with humans and their activities, such as farming and forestry. Using data obtained via a German-wide questionnaire directed at the general public and land managers working in agriculture or forestry, we addressed two specific questions: (1) Which emotions are felt towards beavers by stakeholders in Germany? (2) Which habitats are seen as acceptable for beavers? In our analysis, we also investigated differences between regions and among stakeholder groups. We addressed two hypotheses:

H1. Despite the considerable time elapsed since beaver reintroductions, Germany has not reached a stage of neutral tolerance and acceptance, as described by Halley and Rosell (2002), as beaver-human conflicts are increasing (Zahner et al., 2021).

H2. Individuals engaged in cultivating lands may exhibit more negative attitudes towards beavers compared to the general public, which might not experience negative impacts in a similar manner.

2 | MATERIALS AND METHODS

2.1 | Study area

Our study took place across Germany. Similar to other Western European countries, Germany has a high human population density (239 per km^2, Food and Agriculture Organization and World Bank population estimates 2023). Of its total area, 50.5% is agricultural land, 29.8% is forested and 14.5% is urban (Statistisches Bundesamt, 2023a). Agricultural and forested areas are highly fragmented, as there are many small forests and farmlands in direct contact with urban areas (Potschin & Bastian, 2004). Forests and farmlands are also highly managed for economic profits and hence covered by highly productive plants like maize on farmlands (Statistisches Bundesamt, 2023b) and coniferous trees in forests (Bundesministerium für Ernährung und Landwirtschaft, 2014). Relatively few places in Germany are strictly protected for nature conservation: 6.5% of the land are protected areas (Bundesamt für Naturschutz, 2023) and only 0.6% considered wilderness areas (Schumacher et al., 2018).

2.2 | Beaver reintroduction history

After the large-scale extirpation of Eurasian beavers at the beginning of the 20th century, Germany was home to one of the eight isolated remaining populations of beavers in Europe (Figure 2; Table A1 in Appendix S1). At that time, an estimated number of 200 individuals were living at the Elbe River. From this isolated population, beavers have been reintroduced to other parts of Germany (Dalbeck, 2012; Heidecke et al., 2003), with first unsuccessful reintroductions taking place in the 1930s (Dolch et al., 2002; Heidecke et al., 2003). Successful reintroductions started in the 1960s in the states of Bavaria (Halley & Rosell, 2002) and Brandenburg. Since

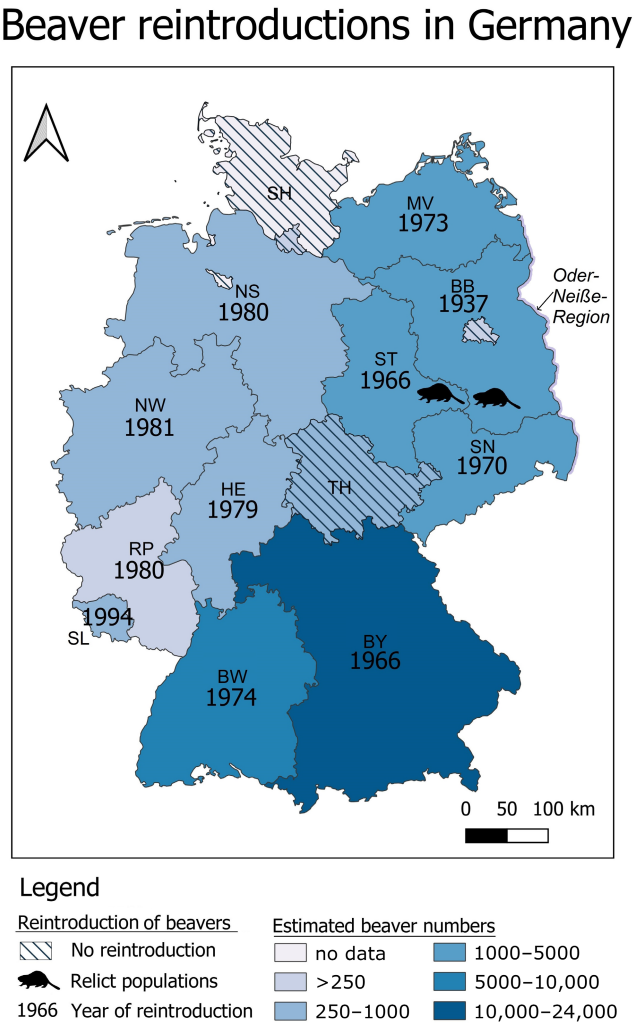

FIGURE 2 Estimated abundance of beavers and year of their reintroduction (successful and unsuccessful) in federal states in Germany based on data from Zahner et al. (2021). Colours indicate estimated beaver numbers to date, with the year of first introduction for each state: BB = Brandenburg, BY = Bavaria, BW = Baden-Württemberg, HE = Hessian, NS = Lower Saxony, NW = North Rhine-Westphalia, MV = Mecklenburg Western Pomerania, RP = Rhineland Palatinate, SH = Schleswig-Holstein, SN = Saxony, ST = Saxony-Anhalt, SL = Saarland, TH = Thuringia. City states (Berlin, Bremen and Hamburg) are not specifically shown on the map, as there were no official reintroductions in urban areas.

then, reintroductions of beavers have repeatedly occurred in most federal states (Figure 2). Due to this history of beaver reintroductions in Germany, the distribution of beavers is not homogeneous across the country (Figure 2): most beavers are concentrated in the southern states, especially Bavaria (Zahner et al., 2021), whereas some areas in northern Germany are still uninhabited by beavers. Currently, there are about 40,000 beavers in Germany, and, while the population is still growing, some regions have reached a point of reduced density-dependent population growth (Zahner et al., 2021). Today, beavers inhabit urban areas as well (Hędrzak et al., 2011; Pachinger & Hulik, 1999; Romanowski & Winczek, 2018).

2.3 | Survey structure

We used a web-based survey (https://www.soscisurvey.de/) to determine perceptions of different stakeholders from (1) the farming sector, (2) the forestry sector and (3) the general public. In the following, we refer to these three groups as *sectors*. The survey ran from 10 June to 30 October 2021 and was only available in German. The link for the survey was distributed through mailings lists and social media, such as Facebook, Instagram and Twitter. For the questions, we used visual analogue scales (VAS), which rely on a bar to be moved between two opposites (Rosas et al., 2017) and five-step Likert scales ranging from 'strongly agree' to 'strongly disagree' (Joshi et al., 2015; Likert, 1932).

The survey included 27 questions in three parts: (P1) general questions on beaver sightings, emotions and acceptable habitats; (P2) detailed questions only for participants working in agriculture or forestry; and (P3) socio-demographic backgrounds (see full questionnaire in Appendix S2). In P1, we asked participants to indicate their (dis)agreement to four emotions towards beavers (fear, joy, interest and anger) on a Likert Scale—inspired by Ghasemi et al.'s (2021) study on large carnivore acceptance. Further, we asked participants about their acceptability of human-beaver cohabitation areas in different habitats: (1) farming areas, (2) own gardens, (3) forest areas, (4) nature protection areas, (5) urban areas and (6) zoos with visual analogue scales (VAS). In the evaluation, a value of 0 indicates a high level of acceptance, while a value of 100 indicates rejection, so a neutral attitude can be located at a value around 50. In P2, participants from agriculture and forestry were asked to provide information about main crops or tree species, if they experienced negative beaver impacts and what kind of measures they knew to prevent such beaver impacts. In P3, participants were asked about their socio-demographic background, for example their postal code, year of birth, gender, highest level of education, if they held a hunting licence and where they heard about the survey. From the postal code, we identified the federal state in which the participant was living.

2.4 | Research ethics

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

2.5 | Data analysis

The survey data were processed using the statistical software R as well as graphically using QGIS. First, we analysed all available complete datasets descriptively by comparing responses among the three sectors and the different regional affiliations. For our statistical analyses, we focused on (A) emotions towards beavers and (B) the acceptability of possible beaver habitats.

Since we measured emotions towards beavers on a five-step Likert scale, we used ordinal logistic models to determine the factors influencing the attitudes of our survey participants. Specifically, we tested the effects of four socio-demographic factors, that is, working sector, region, gender and possession of a hunting licence. Since our survey revealed substantial differences in the number of survey participants in the state of Bavaria, where beavers are most abundant, compared to the rest of Germany (see Section 3), we grouped these two regions into a binomial factor ('Bavaria' and 'Rest of Germany'). We also grouped hunting licence into a binomial factor ('Yes' and 'No'), and sector and gender into three different levels: sector represents 'Forestry', 'Agriculture' and the 'General public', while gender has the levels 'Male', 'Female' and 'Diverse'. The models for the emotions were built with the R-function polr (package MASS, Venables & Ripley, 2007).

We considered the same socio-demographic factors for our question about acceptance of possible beaver habitats. However, since we used a continuous VAS for this question, we were able to use a generalized-linear model (glm) for the analysis of attitudes towards possible beaver habitats.

For both ordinal logistic and generalized linear models, we used a stepwise model selection procedure based on AIC values using stepAIC from the MASS package (Venables & Ripley, 2007). We tested a total of 13 models each (Appendix/Supplement) and based our inferences on the best model, that is the model with the lowest AIC.

3 | RESULTS

The survey resulted in 1902 answers of which 1497 were completed and used for further analysis. Our participants were mostly male (70.2% male, 24.0% female, 1.0% diverse and 4.8% unanswered) and on average about 50 years old (ranging from 16 to 90 years). A quarter (25.3%) of the participants owned a hunting licence (Figure A1 in Appendix S1).

Most participants were reached by the survey via Email (34.5%), followed by associations (28.8%), which can be divided into farming (12.5%), nature protection (8.9%), hunting (6.5%) and forestry associations (2.9%). This is followed by friends and colleagues (19.5%), social media (5.9%) and others (3.8%); 5.3% of the survey participants did not answer this question. Sixteen per cent of participants were contacted by organizations based in Bavaria, divided into 9.4% BBV (Bavarian farming association), 4.4% BJV (Bavarian hunting association) and 2.2% through local church organizations. Hence, about 75.2% of the participants were from Bavaria.

In total, the answered questionnaires were divided among three major sectors; of these, the general public represented the largest group, with 803 completed questionnaires, followed by agriculture with 475 and forestry with 219 completed questionnaires.

3.1 | Emotions

Our four targeted emotions—joy, anger, fear and interest—showed a diverse picture: Considering *joy*, the relative majority of participants (43.7%) disagreed that they did feel *joy* seeing beavers (14.2% disagreed and 29.5% strongly disagreed), but 35.8% agreed to feel *joy* towards beavers (15.5% agreed and 20.3% strongly agreed). Asking about *anger*, 34.9% of the participants strongly disagreed, 6.9% disagreed, 11.1% were neutral, 16.5% agreed and 27.4% strongly agreed. For *fear*, most participants answered that they did not feel this emotion towards beavers (56.8%), while 14.8% agreed that they felt fear (6.68% strongly agreed and 8.15% agreed). Concerning *interest*, most participants either agreed (27.8%) or strongly agreed (28.5%).

Large differences can be seen among the three sectors. While *joy* and *anger* show the greatest agreement among the three groups, participants from agriculture and the general public responded very differently (Figure 3): In the case of *joy*, over 50% of the respondents from agriculture disagreed to feel *joy*, while over 50% of the general public agreed to feel *joy* (Figure 3a). *Anger* about beavers was indicated to be felt by just under 25% of respondents from the general public, while 47% of forestry and 75% of agriculture respondents agreed or strongly agreed to feel *anger* (Figure 3b). *Interest* received the highest level of agreement from the general public, as 86.7% indicated a positive to neutral interest. Agriculture and forestry also had the most positive agreement with *interest* (73% for forestry and 54.9% for agriculture). While *fear* received strong disagreement from the majority of the general public (68%) and forestry (56%), only 38% of the participants from agriculture disagreed. Overall, participants from agriculture had negative emotions towards beavers, whereas those from the general public agreed with positive emotions; participants from the forestry sector had an intermediate position with the highest variation within the sector.

We also found geographic differences: Regardless of their sector, many participants in the federal state of Bavaria agreed to feel *anger* and disagreed to feel *joy* regarding beaver presence, similar to participants located in the Oder-Neiße-Region on the eastern German border at Brandenburg and Mecklenburg-Western Pomerania (Figure 2). In the rest of Germany, at least the general public viewed beavers predominantly positively. *Interest* and *fear*, on the other hand, hardly differ regionally; *fear* is least represented in all regions (Figure A2 in Appendix S1).

We tested the impacts of socio-demographic factors on *joy*, *anger*, *fear* and *interest*. Model selection ultimately led us to a best model that included all four socio-demographic factors (sector, region, gender, hunting licence), with interactions among sector, region and hunting licence (Table A3 in Appendix S1). Overall, we found the biggest influencing factors on the emotions in those interactions. Next to these, the sector and regional differences between groups had the biggest impact. Hunting licence had a much stronger impact than gender. Participants with a hunting licence showed higher probabilities for positive emotions overall (Table A4 in Appendix S1). Except for *fear*, females showed a more positive emotion towards beavers than males.

The statistical comparison showed that especially the answers with high agreement or high disagreement with the emotions varied greatly, and the probability of belonging to one of these choices was highest (Figure 4). The intermediate choices showed less variance and lower choice probabilities.

In the case of *joy*, participants from the rest of Germany showed a higher probability of agreement than participants from Bavaria; this was the case across all sectors (Figure 4a). Among the sectors, forestry and agriculture differed from each other for the rest of Germany, while there were no significant differences within Bavaria.

For *anger*, similar to the descriptive analysis, the best model showed reversed results between agreement and disagreement compared to *joy* (Figure 4b). The highest probability to reflect *anger* was found by the general public from the rest of Germany. Further, we found that participants from Bavaria would rather agree to feeling *anger*, while participants from the rest of Germany would rather disagree with *anger*. Agriculture showed a significantly higher agreement to *anger* than the general public.

For *interest*, the best model showed that there is a high level of agreement overall (Figure A3C in Appendix S1). Again, there is strong discrepancy between Bavaria and the rest of Germany for strong agreement or strong disagreement. In the intermediate categories, hardly any differences were discernible.

For *fear* (Figure A3D in Appendix S1), we found a low probability for all participants to strongly agree with feeling *fear*. Participants from the rest of Germany showed an even lower probability to agree with feeling *fear*. We found differences between sectors: participants in the forestry sector from the rest of Germany showed a very high probability for strong disagreement to *fear*.

3.2 | Habitats

The survey participants also had diverse opinions about potential beaver habitats (*forests*, *agriculture areas*, *gardens*, *urban green spaces*, *nature conservation areas* and *zoo and wildlife parks*). While most participants did not accept forests, agricultural areas and own gardens

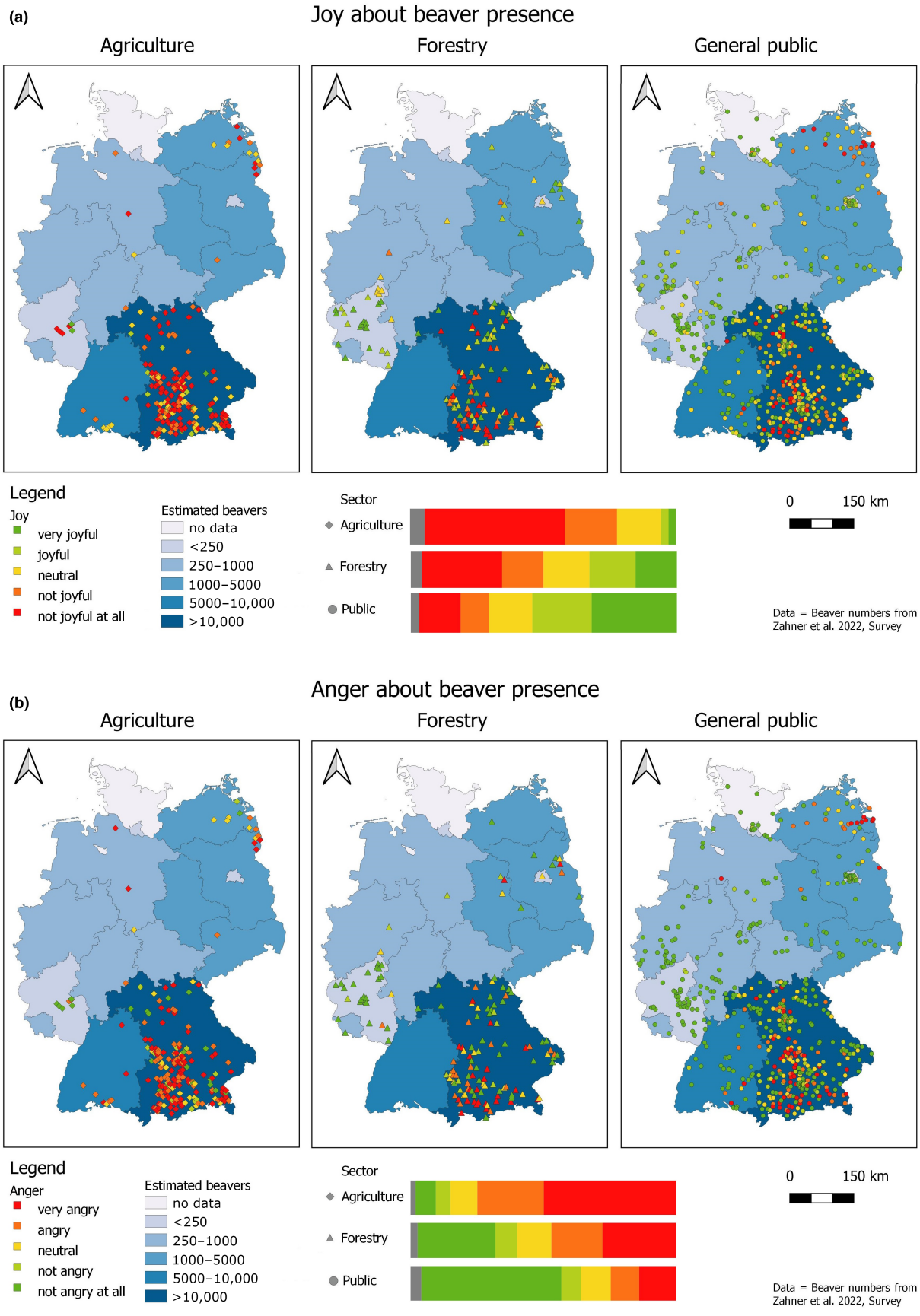

FIGURE 3 Feelings of participants about beavers; a = Joy, b = Anger. Background colours indicate the estimated number of beavers per federal state (from Zahner et al., 2021). Point shapes indicate the sector (diamond = agriculture, triangle = forestry, circle = public), and the colour coding of the shapes indicates the degree of agreement.

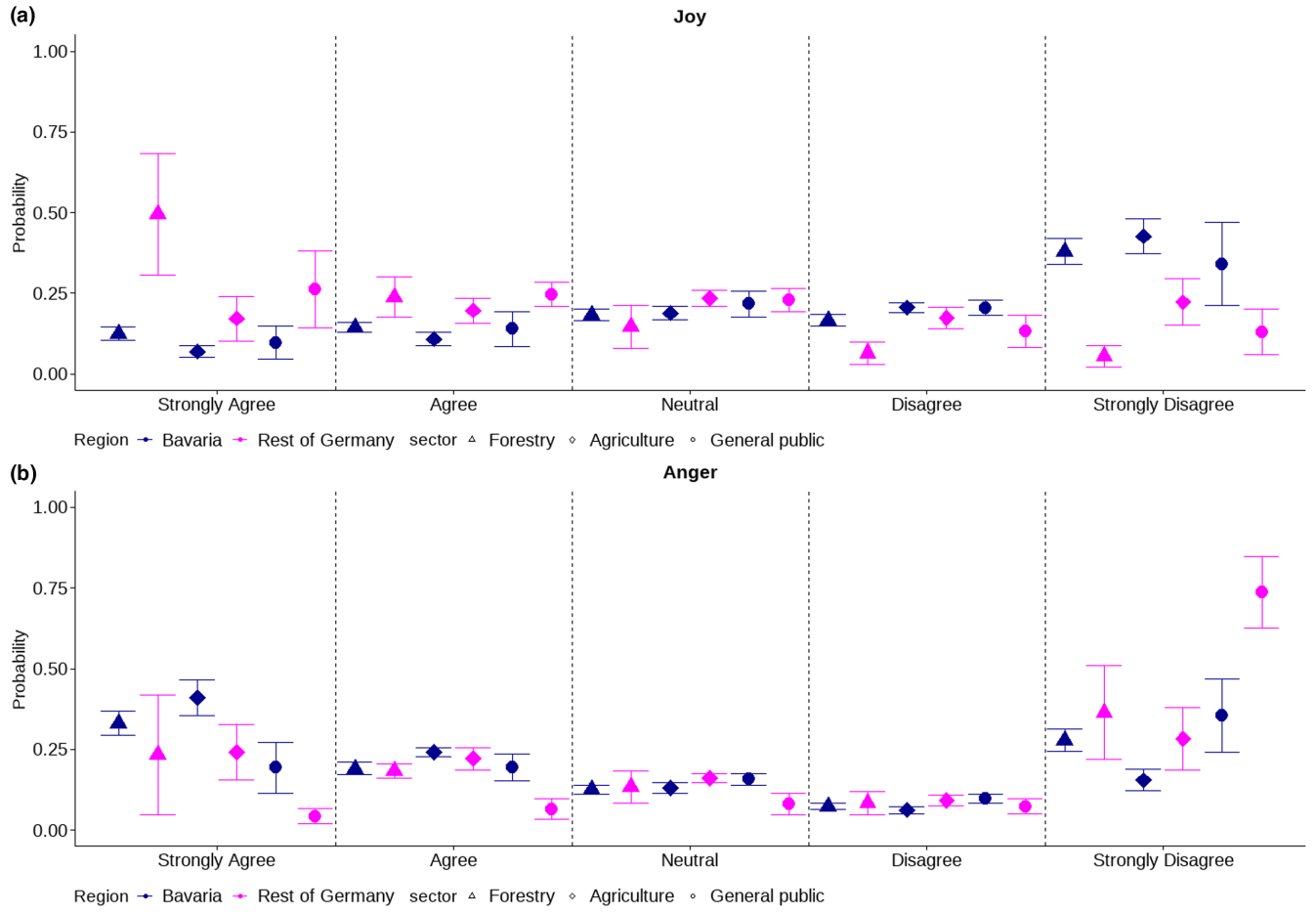

FIGURE 4 Probabilities of decision from ordinal logistic regression analysis. a = Joy, b = Anger; different symbols show the sectors (triangle = forestry, diamond = agriculture, circle = general public), with the colours representing the regional groups (blue = Bavaria, pink = Rest of Germany). Symbols indicate mean probabilities, with whiskers representing standard errors. Note that the socio-demographic factors gender and hunting licence have been omitted due to the two-dimensional representation.

as beaver habitat, most did accept beavers in nature conservation areas, zoos and wildlife parks. Urban green spaces showed a mixed picture (Figure 5).

Own gardens were unaccepted as beaver habitats by participants across all sectors; the highest level of unacceptance was found for the participants in the agricultural sector. Similarly, *agricultural areas* were seen as unacceptable beaver habitat by participants in all sectors. *Nature conservation areas*, *zoos and wildlife parks* were largely accepted by participants across sectors. However, participants from the general public showed the lowest level of acceptance for *zoos and wildlife parks* compared to the other two sectors. While participants from agriculture very strongly rejected *agricultural areas* as beaver habitats, a similarly strong rejection for *forest areas* was not observed for the forestry sector. For *forest areas*, participants in the agricultural sector also showed the highest level of disapproval, while the general public indicated an overall acceptance of this habitat for beavers.

Acceptance as beaver habitats also differed strongly between participants from Bavaria compared to the rest of Germany, particularly for *forest areas*, *agricultural areas*, and *own gardens* (Figure A4 in Appendix S1): While Bavarian participants mostly rejected *forest areas* as beaver habitats, these were largely acceptable for participants from the rest of Germany. *Own gardens* and *agricultural areas were* regarded indifferently by participants from the rest of Germany, but strongly rejected by participants from Bavaria.

Overall, we found congruent results to our descriptive analysis also in the models. All differences between sectors and regional differences were seen here as well (Figure 6). Acceptance was found for *nature conservation areas* (Figure A4 in Appendix S1) as well as *zoos and wildparks*, and unacceptance for *agricultural areas*.

The best model for all six habitats included all four socio-demographic factors, suggesting that these factors are all relevant for accepting, or not, a habitat for beavers. For two habitats, the best model was without interactions (*nature conservation areas* and *own garden*, Table A4 in Appendix S1), and for the other four habitats the best model included interactions between all socio-demographic factors except gender. Regionality and sector affiliation were crucial, and gender and possession of a hunting licence were also significantly related to (un-)acceptance of individual habitats (Table A5 in Appendix S1). For the habitat models, we found no clear trend for gender or hunting licence in the emotion models. For *agricultural areas*, *own gardens* and *nature conservation areas*,

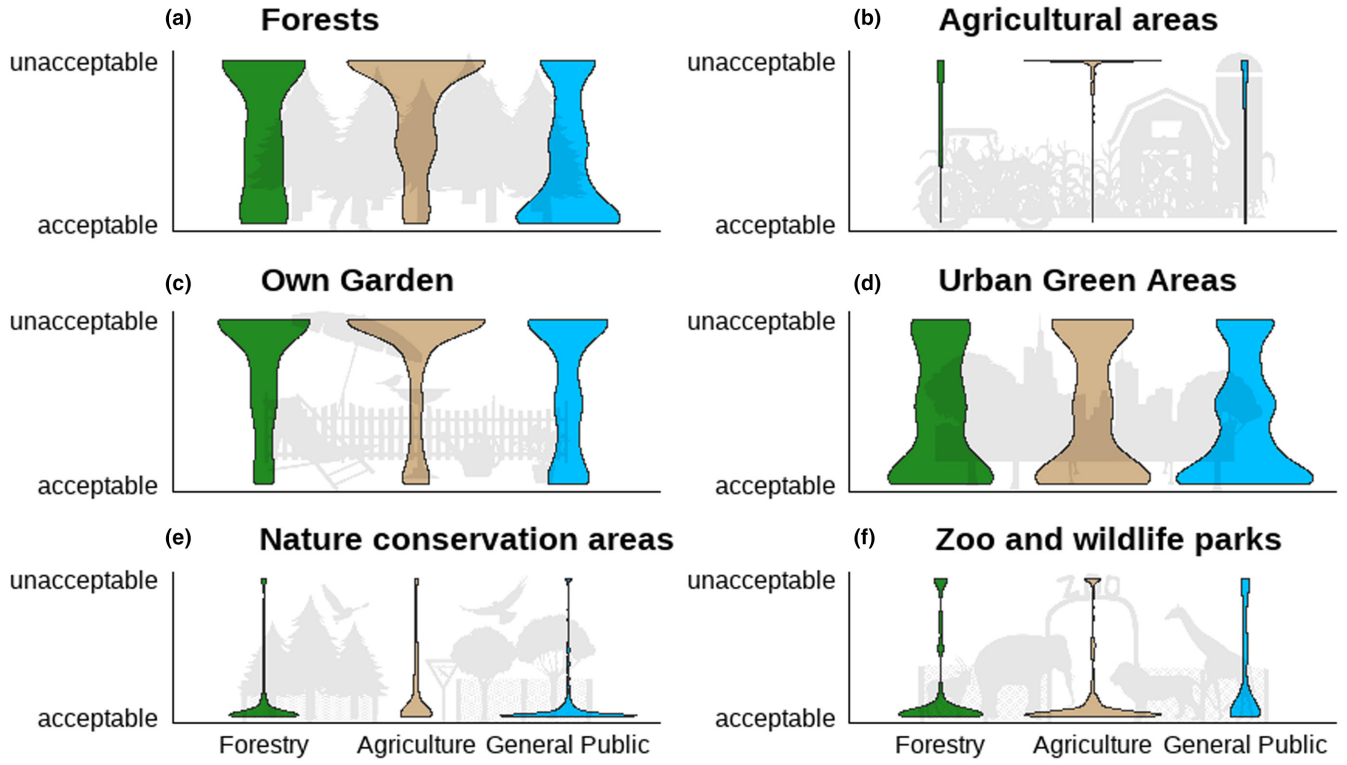

FIGURE 5 Acceptance towards different possible beaver habitats by sectors. Green = Forestry, tan = Agriculture, blue = General public. a = Forests, b = Agricultural areas, c = Own Garden, d = Urban green areas, e = Nature conservation areas, f = Zoos and wildlife parks.

participants from the rest of Germany showed more acceptance than those from Bavaria. The biggest impacts can also be found in the interaction terms followed by the sector separately. Compared to the other factors, gender showed the lowest impact on the probability for acceptance of a possible beaver habitat. Especially for *agricultural areas*, we found vast differences between sectors. *Agricultural areas* and *zoos and wildlife parks* are the only habitats where the possession of a hunting licence had a significant impact on beaver acceptance. People with a hunting licence accepted *zoos and wildparks* less as potential habitat than people without hunting licence, and *agricultural areas* were more accepted by people without a hunting licence (Table A5 in Appendix S1).

4 | DISCUSSION

In our survey, we were able to motivate a large number of participants to give us their personal opinion on beavers in Germany. Especially for feelings towards beavers, there are big differences between the general public and the people who come into contact with beavers more often due to land management. It seems that people from forestry and especially agriculture have a much more negative attitude towards beavers than the general public. The survey also showed that of potential beaver habitats, only nature conservation reserves as well as zoos and wildlife parks are accepted by all groups.

4.1 | Regional and gender biases and differences

Due to a large number of respondents from Bavaria, the survey might have a regional bias (e.g. Deming, 1944). This should be considered in the interpretation of the results. Besides the uneven distribution of our participants across Germany, beavers are not evenly distributed in Germany, either. There are two areas where the majority of German beavers are found: the north-east (e.g. Oder-Neiße) and the south-east (Bavaria). Keeping in mind that in Bavaria an estimated 2/3 of the total German beaver population occurs (Zahner et al., 2021), the higher number of participants from Bavaria becomes reasonable. The geographical evaluation of feelings towards beavers shows that especially in areas with a higher beaver occurrence (e.g. Bavaria), anger towards beavers is higher. Thus, anger and a high number of beavers are closely correlated (Maciej et al., 2020). This phenomenon is reflected in other perception studies showing that communities in Italy with minor beaver populations (Wróbel, 2020) are supportive of their reintroduction (Viviano et al., 2023), whereas those in regions like Hungary where beavers are comparatively abundant (Wróbel, 2020) exhibit a predominantly negative attitude towards them (Ulicsni et al., 2020). In our survey, we had more male participants. This contradicts Herzog (2007) who found that wildlife surveys generally attract more females. Our finding that females are more positive towards beavers mirrors other studies (e.g. Zinn & Pierce, 2002).

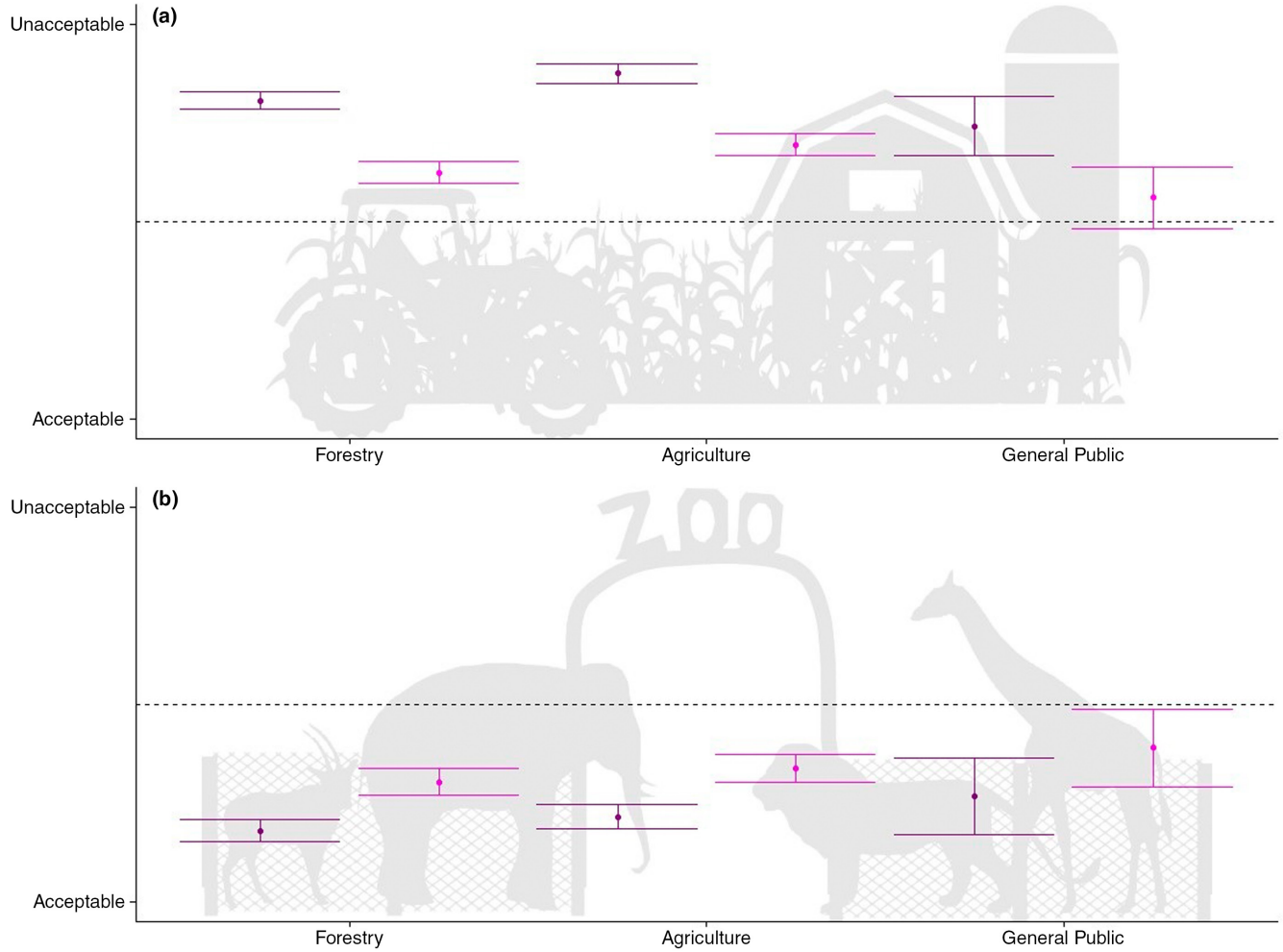

FIGURE 6 Modell-output from glm for a = Agricultural Areas and b = Zoos and Wildlife parks; points indicate mean probabilities and error bars represent standard errors; dark purple = Bavaria, pink = Rest of Germany; the dashed line indicates a neutral attitude of the potential beaver habitat.

Another bias that can influence the observed emotion towards beavers is the high percentage of hunting licence owners in our sample. On average in Germany, 0.5% of the population is holding a hunting licence (Deutscher Jagdverband, 2023). In our survey, the average percentage of hunting licence owners was higher across stakeholder groups (10% in agriculture, 75% in forestry and 30% in the general public). We did not actively aim for such a high portion of hunting licence owners in our sample and did not spread the survey in such direction. Hunting licence owners probably had a high interest in our topic and thus participated in high numbers. Because of this bias, we added the hunting licence to our model as a factor.

4.2 | What can we learn from emotions towards beavers?

Our survey participants generally disagreed with feeling *joy*, but did not agree to feel *anger*, either. While participants from agriculture and forestry indicated rather negative emotions towards beavers, those from the general public were more positive. Schwab and Schmidbauer (2003) see the media to be partly responsible for negative beaver images, presenting impacts on agriculture more dramatically for good headlines. This could result in a general negative feeling towards beavers in Germany. While answers of a general wildlife survey in Germany showed that the majority of participants (51%) thought that beavers should be protected but controlled in their spread (Deutsche Wildtier Stiftung, 2020), our results highlight the importance of considering different sectors.

4.3 | At which of Halley and Rosell's (2002) acceptance stages are we?

Beaver reintroductions have mostly occurred as 'hard releases' without much planning (Halley & Rosell, 2002), but have nevertheless been successful because beavers in Europe are in contact with each other and gene flow is assured (Frosch et al., 2014). In terms of acceptance and as outlined in the Introduction, Halley and Rosell (2002) list three stages of beaver reintroduction. Regarding

hypothesis H1, the survey shows that the acceptance of beavers in Germany, even after about 60 years of human cohabitation with beavers, remains in stage 2, at least when looking at people from the sectors agriculture and forestry. Perceptions and coexistence can also be viewed as dynamic states requiring regular evaluation to ensure that the initial goal of coexistence is not threatened (König et al., 2020; Niemiec et al., 2022). Hence, considerations of removing beavers again and thus interfering with the population do not seem to be a long-term solution on the way to a more conflict-free coexistence (Sjöberg et al., 2020). In contrast to removal, much more thought must be given to the need to achieve a neutral attitude over a wide area, or whether there are habitats where cohabitation with wildlife cannot be achieved. After many years of reintroduction, ongoing conflicts persist, similar to the conflicts encountered with native wildlife. As we established that the resurgence of beavers is often framed within a narrative of conflicts, future research could investigate the current conflict level, ranging from issues like crop loss and safety concerns to conflicts deeply entrenched and intertwined with community identities (Zimmermann et al., 2020).

4.4 | Where are optimal beaver habitats?

Optimal habitats for beavers are riparian forests with a high occurrence of softwoods close to the water (Deinet et al., 2013). Unfortunately, these riparian forests are an endangered habitat in Europe (Reid et al., 2019) because humans have drained most of such areas for cultivation purposes (Hook, 1993). Consequently, beavers moved into cultivated landscapes (Zahner et al., 2021) and even urban areas (John et al., 2010; Romanowski & Winczek, 2018). In our survey, urban areas were more accepted as beaver habitats than forest or agricultural areas. While urban beaver populations are thriving in Berlin, Hamburg and Munich (Behörde für Umwelt, Klima, Energie und Agrarwirtschaft, 2022; BUND Naturschutz Kreisgruppe München, 2021; NABU—Naturschutzbund Deutschland e.V., 2022), and their presence might increase interest for nature conservation (Perry et al., 2020; Soga & Gaston, 2016), mortality in urban areas is relatively high, and settled areas are limited in potential space (Zahner et al., 2021).

While zoos and nature protected areas were among the most accepted beaver habitats in our survey, there are obvious issues with those as potential habitats. Accepting species only in zoos clearly goes against the idea of rewilding ecosystems via reintroductions. While the argument of zoos as modern arks can be used for wildlife where suitable habitat is scarce or populations are close to extinction (Croke, 1997; Lees & Wilcken, 2009), this is not relevant for beavers whose numbers have recovered in the last decades and which experience a range of stresses in captivity (Campbell-Palmer et al., 2016). Further, while positive examples of beavers in protected areas exist (e.g. Orazi et al., 2022), only 6.5% of Germany's total land area is currently protected (Bundesamt für Naturschutz, 2023). Moreover, not every protected area is suitable for beavers, and 60% of these areas in Germany are smaller than 0.5 km^2 (Bundesamt für Naturschutz, 2023), whereas beaver territory sizes are between ca. 1.5 and 7.5 km bank length (Graf et al., 2016).

Our results show that the survey participants do not like wild beavers in habitats that are managed or used by people (forests, agricultural areas, gardens). This highlights the validity of hypothesis H2, suggesting that individuals involved in cultivated lands tend to hold more negative attitudes towards beavers. Since alternative habitats are limited, there are options for people to mitigate negative beaver impacts, particularly in the high-conflict habitats (agriculture and forest areas, private gardens). Permitted measures range from beaver deceiver, which provide protection from overflood areas, to fencing and protection of areas or individual plants to limit damage (Zahner et al., 2021). Even though a large pool of management measures exist (e.g. financial compensation and beaver managers since the 1980s in Bavaria; Bayerisches Landesamt für Umwelt, 2014), this does not translate into a higher acceptance for the animals. Such measures should be combined with long-term management (Sjöberg et al., 2020) including human dimensions (Zahner et al., 2021). Hunting is also a possible management measure (Parker & Rosell, 2003), but its effects are limited, as territories are reoccupied by young beavers (Gable et al., 2020; Zahner et al., 2005). Aside, intensive and large-scale hunting of beavers is currently not feasible for Germany, due to the protected status of the species (§7 BNatschG). Nevertheless, even today permits to lethally remove beavers are being issued locally to mitigate conflicts. The observed positive perception of beavers among individuals possessing hunting licences could potentially be attributed to their self-reliant capacity in addressing issues related to beavers and their enhanced affinity with the natural environment (Joel, 2018). Also evidence shows, that a better knowledge about a species, could help to generate a more positive emotion towards such species (Ostermann-Miyashita et al., 2023).

4.5 | Beavers and other species

There are many places and conflicted species where cohabitation between humans and wildlife already works, and little intervention is needed (e.g. Clark et al., 2010; Pate et al., 1996). Compared to native animals in Germany like foxes (Kimmig et al., 2020) or other returned keystone species like wolves (Arbieu et al., 2019), feelings towards beavers are not too different. Permanently present native species like wild boar (Keuling et al., 2016) and fox (Kimmig et al., 2020) also bring negative and positive impacts to humans. Animals that have long disappeared from our landscape have low acceptance to roam free (Deutsche Wildtier Stiftung, 2020). Large carnivores like wolves are often perceived negatively and associated with fear instead of rewilded herbivores (e.g. Arbieu et al., 2019; Ericsson & Heberlein, 2003; Ostermann-Miyashita et al., 2023). Our results do not show fear of beavers, but they indicate anger towards beavers by land managers from regions with high beaver abundances. While public outreach may take away people's fear of returned wolves,

anger towards beavers may be reduced with a thought-through management strategy. Such a strategy should include proactive engagement, effective communication, shared decision-making and a sense of an acknowledgment of human responsibility for conflicts with reintroduced species (Auster et al., 2021b).

5 | OUTLOOK

From a human perspective, rewilding has both positive and negative consequences. Ecosystems are usually positively affected by reintroduced eradicated animals, while humans might be affected very differently, depending on where they live and what their profession is. If humans have not lived alongside the reintroduced animals for decades, it can sometimes be difficult for them to accept the new arrivals in their neighbourhood. Beavers, in particular, 'engineer' and rewild ecosystems and landscapes, which can also strongly affect people. Given our results and the current situation in Germany, we suggest that instead of reaching a final neutral stage of acceptance and tolerance (Halley & Rosell, 2002), we are more likely to remain in a stage that requires constant active management to balance the needs of beavers with those of humans.

Our findings show that the acceptance of beavers in forestry and agricultural areas is very limited, and that potential habitat is rather seen in urban areas, zoos and nature reserves. However, these habitats have limited capacities to provide sufficient space to wildlife. Cohabitation in other landscapes is thus central to give rewilded keystone species such as beavers the room to rewild ecosystems. While measures exist to deal with negative beaver impacts, further research targeted at land managers is needed to fully understand the anger towards the animals including why currently practiced cohabitation measures (beaver advisor, financial compensations) are not sufficient to reduce anger. We should bear in mind that reintroducing previously native species brings both challenges and benefits. Cohabitation is an ongoing process that needs to be accompanied with active measures such as public engagement.

AUTHOR CONTRIBUTIONS

Maximilian Hohm and Simon S. Mösch conceived the study under the supervision of Niko Balkenhol, Dagmar Haase and Jonathan M. Jeschke. The survey was designed and distributed by Simon S. Mösch, Maximilian Hohm and Jennifer Bahm. Modelling was performed by Maximilian Hohm. Maps were created by Simon S. Mösch. All authors provided valuable input to the development of the final manuscript and have given approval for publication.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data are not publicly available as it may compromise participant confidentiality. Requests about the data and dataset may be made to the corresponding author.

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SUPPORTING INFORMATION

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

Appendix S1. Additional Tables and Figures with descriptions.

Appendix S2. Survey.

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