

# Public acceptance of Eurasian lynx (*Lynx lynx*) in Germany

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## ABSTRACT

In a geological epoch, referred to as the Anthropocene, where large carnivores are increasing and expanding across Europe simultaneously to human activity impacting wildlife population numbers, an understanding of how to manage conservation success is required. Eurasian lynx (*Lynx lynx*) populations have expanded back into some of their former ranges within Germany through natural re-establishment and reintroductions. Several proven illegal killings of Eurasian lynx (hereafter lynx) in Germany question the acceptance of lynx within one of its former ranges. An online self-administered questionnaire ( $n = 1195$ ) was distributed across Germany collecting data on demographic factors, knowledge of lynx ecology, feelings on the presence of lynx, and future management of lynx populations. The questionnaire data was analysed through non-parametric tests. The results suggested that acceptance of lynx was similarly high across German states. No significant differences were found in acceptance scores between lynx absence or presence, nor within areas of different lynx re-establishment processes. Age, education, profession, and awareness or experience of lynx attacks were significantly associated with acceptance scores. Longitudinal monitoring would prove beneficial in assessing acceptance levels of this large carnivore amongst the public in Germany. Acceptance of lynx assists in creating a balanced ecosystem where large carnivores and humans can co-exist and share the same landscape.

## 1. Introduction

In a geological epoch, referred to as the Anthropocene, where large carnivores are increasing and expanding across Europe simultaneously to human activity impacting wildlife population numbers, an understanding of how to manage conservation success is required (Boitani, 2022). Large carnivores were extirpated across Europe up until the early 20th century due to persecution, and a reduction of habitat and prey (Port et al., 2021). The last decades have seen an increase in legal protection, prey, and habitat for carnivore populations, such as the European brown bear (*Ursus arctos arctos*), the Eurasian wolf (*Canis lupus lupus*), wolverine (*Gulo gulo*), and Eurasian lynx (*Lynx lynx*), which are re-establishing their former ranges within Europe (Trouwborst, 2010). Eurasian lynx (hereafter lynx) is a protected species across many European countries because of international and national law enforcement. Lynx are listed in the Annex II (habitat protection) and Annex IV (strictly protected species) of the European Directive 92/43/EEC on the Habitat and Species Directive (Červený et al., 2019). High human population densities and urbanization characterize Europe, therefore a requirement for research on coexistence of large carnivores, such as lynx, and human presence and needs has emerged.

Large carnivores, such as bears and wolves, are feared more strongly than lynx and are more controversial (Červený et al., 2019). This controversy explains the imbalance within current literature with its focus on bears and wolves and less attention on lynx (Bath et al., 2008). Lynx become environmental stressors when conflict stems from livestock predation, competition for game animals, and safety concerns for pets (Lescureux and Linnell, 2010). Depending on the levels of interactions experienced with large carnivores, further conflict can develop between interest groups, who hold opposing views on lynx population management (Lüchtrath and Schraml, 2015). Conflict contributes to forming negative attitudes. Attitudes and perceptions are one of the main drivers for human-wildlife conflict, for example illegal killings of wildlife (Klenke et al., 2013). Illegal killings have major detrimental effects on lynx numbers and are responsible for up to 30 % of the annual European lynx population mortality, threatening the conservation of this species (Andrén et al., 2006).

Over the last few decades lynx numbers have increased in Germany, however, populations tend to be small and isolated, and the removal of individuals can result in stagnation or decline in numbers leading to local extinctions of the species. In Germany, resident lynx populations are found in the Harz Mountains, the Palatinate Forest, and the Bavarian

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Forest National Park. Port et al. (2021) report that the subpopulation of lynx southwest of the Harz Mountain population is isolated with a low chance of migration of new females into the area. This finding suggests that the subpopulation has heightened vulnerability to natural fluctuations in the population size, with demographic stochasticity increasing the probability of its extinction. Further threatening large carnivores are an increase in human population densities (Woodroffe, 2000). To overcome this challenge, species are successfully reintroduced into protected areas, for example, African wild dogs (*Lycaon pictus*) in Kruger National park, South Africa (Davies-Mostert et al., 2009; Gusset, 2009). Large carnivores have large area requirements for survival and have a higher chance of existence in strictly protected areas (Palmero et al., 2021). For example, Hebblewhite and Whittington (2020) indicate that wolves have an increased chance of survival within Banff National park, Canada, compared with areas outside the park. Most European protected areas are too small to host viable large carnivore populations (Woodroffe and Ginsberg, 1998) and therefore, conservation of the species would benefit from expanded or new protected areas, as suggested in the controversial idea of half-Europe (Wilson, 2016). The lynx population in the Bavarian Forest National Park has stagnated for several years as expansion of the population is hindered by illegal killings (Heurich et al., 2018). Several illegal killings of lynx in Germany are proven and may reflect negative perceptions. This finding highlights the importance of human dimension research in large carnivore conservation.

In this paper we demonstrate that it is important to assess acceptance of lynx to identify and evaluate negative perceptions of the species across different regions. Addressing these issues may decrease negative emotions, minimize illegal killings of the species, and promote the long-term conservation of lynx (Bath et al., 2008). Ultimately, public acceptance of lynx in Germany is an indication as to whether the species can exist in a human-dominated landscape.

Whilst the term *acceptance* is applied within previous wildlife conservation literature, the term is seldomly defined. A measure of acceptance by Decker and Purdy (1988, p.53) was ‘the maximum wildlife population level in an area that is acceptable.’ This definition is based on a perception that when wildlife population numbers exceed an acceptable amount, stakeholders may feel motivated to reduce population numbers. However, this definition does not account for retaliatory killings where, regardless of population numbers, wildlife is removed when a negative interaction is experienced (Zajac et al., 2012). Therefore, the definition used in this study for acceptance is an extension of the meaning of the term, ‘the presence of a species in an area without protest or negative reactions’ (‘accept’, Merriam-Webster\*). Previous literature has investigated perceptions and acceptance of lynx across areas such as eastern Europe, Scandinavia, and the Netherlands (Bath et al., 2008; Balčiauskas et al., 2010; Červený et al., 2019). These studies highlight that several factors are associated with attitudes towards lynx, such as people’s fear of and knowledge about lynx, impacts or perceived impacts of lynx predation, demographics, geographical region, and level of relationship with nature (Chapron et al., 2014). Bath et al. (2008) report that significant differences in acceptance of lynx across Poland indicate that attitudes are associated with the presence or absence of the species. Lücktrath and Schraml (2015) provide invaluable insight into perceptions of hunters of large carnivores in southwest Germany, for example, natural re-establishment of lynx is more accepted than artificial reintroductions. However, public acceptance of lynx in Germany at a national level has not yet been investigated. Our paper explored acceptance of lynx through quantitative analysis with further insight collected from open-ended questions.

Our objectives of this study were:

- (1) to investigate the acceptance of lynx in Germany
- (2) to investigate whether the acceptance of lynx differs among areas with and without lynx presence

- (3) to investigate whether the acceptance of lynx differs in areas where lynx have naturally recolonized and in areas where lynx were artificially reintroduced
- (4) and to explore what future conservation projects should consider for public acceptance of lynx.

**Notes.** \* <https://www.merriamwebster.com/dictionary/accept>.

## 2. Methods

### 2.1. Study area

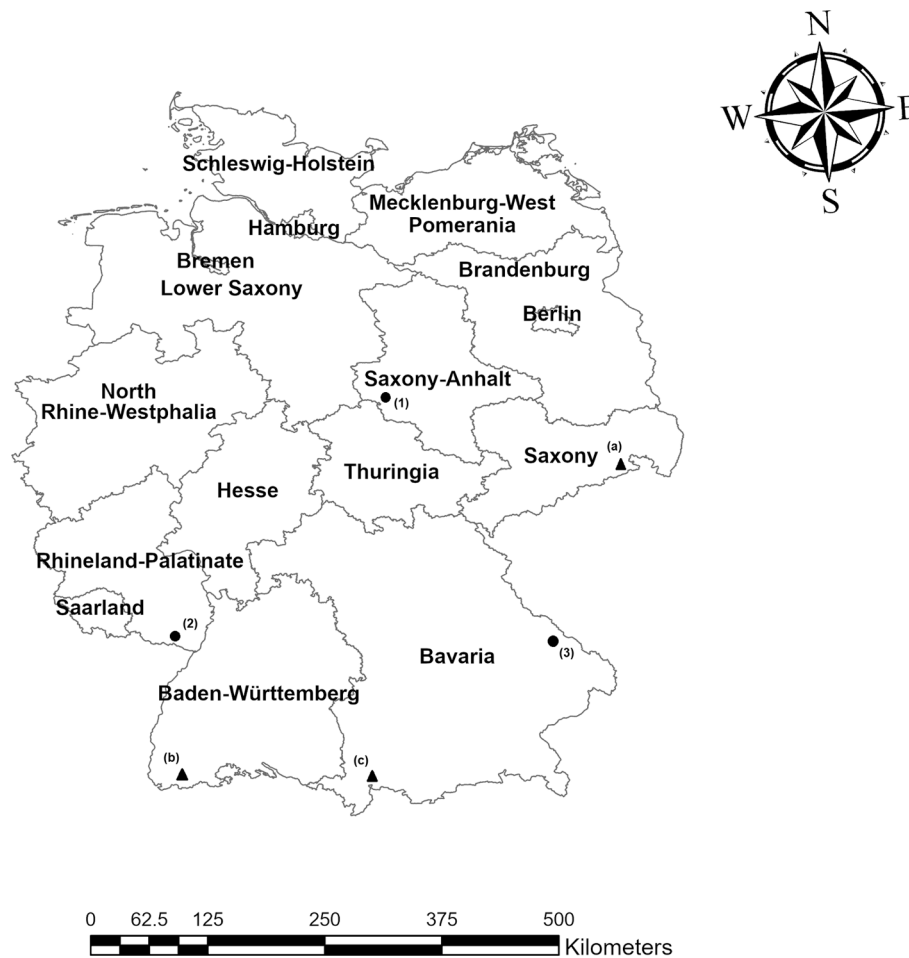
Germany consists of 16 states (Fig. 1) and has an average of 240 people / km<sup>2</sup> (Worldometer, 2021). The research was implemented across all German states. Three resident lynx populations (approximately 140 individuals) exist in Germany (Fig. 1); a reintroduced population in the Harz Mountains; a second in the Palatinate Forest National Park; and a population in the Bavarian Forest National Park, which have naturally re-established from a lynx reintroduction in the Bohemian Forest ecosystem (Austrian German-Czech border). Occasional sightings of lynx in the Saxony state, the Black Forest (southwest Germany), and in the Alps are reported (Port et al., 2021).

### 2.2. Data collection

Large carnivores are a sensitive topic by those that have experienced negative interactions with the species. Therefore, to explore the objectives of our study, we used online self-administered questionnaires. Studies report that respondents are more likely to complete self-administered questionnaires, compared to interviews, where anonymity is provided (Tourangeau and Yan, 2007; Murdoch et al., 2014). The questionnaire was mainly quantitative, as the aim was to attain data from a large sample of the public in Germany. However, open-ended questions allowed for the collection of further in-depth detail and allowed respondents to elaborate on their answers (Foddy, 1993). The questionnaire consisted of 19 closed and eight open-ended questions (see supplementary file 1) and designed to be completed within 10 minutes to avoid response fatigue.

Research conducted in other countries report that demographic information is associated with attitudes towards and acceptance of large carnivores (Kleiven et al., 2004; Bath et al., 2008), therefore the first section of the questionnaire focused on collecting demographic information on the public in Germany. Furthermore, a study by Lescureux et al. (2011) report that knowledge of mammal ecology plays a vital role in the acceptance of large carnivores. Therefore, the second section of the questionnaire focused on the existing knowledge of lynx ecology amongst the public in Germany. The third section of the questionnaire focused on the feelings of respondents on the presence of lynx. To explore what future projects should consider for public acceptance of lynx, we collected data on lynx population management, similarly to Wechselberger et al. (2005), in the last section of the questionnaire.

A pilot study was carried out over a 2-week period ( $n = 25$ ) and based on the findings; questions were amended accordingly. The questionnaire was translated into German and corrected by native speakers (see supplementary file 1). The questionnaire was distributed in the German language by email over a 6-week period between May and June 2021, and email reminders were distributed 3 weeks after the original email. As an incentive to complete the questionnaire respondents were able to enter a prize draw for a financial voucher. The questionnaire was administered, and answers were recorded using Qualtrics software (Qualtrics, 2021). We obtained prior, informed consent from participants and anonymized the questionnaire responses. This research was approved by the Research and Ethics committee at the University of Kent.



**Fig. 1.** Eurasian lynx (*Lynx lynx*) populations in Germany: the map shows the three resident lynx populations in Germany: (1) Harz Mountains, (2) Palatinate Forest National Park, and (3) Bavarian Forest National Park. Occasional lynx sightings in (a) Saxony, (b) the Black Forest and (c) the Alps.

Target respondents were German residents who were both familiar and unfamiliar with lynx. We used a non-probability convenience-based sampling and snowball sampling method to search and collect email addresses. To acquire a large sample size and minimize response bias (White et al., 2005), email addresses from a wide range of professions in each German state were collected from online resources. Personal contacts were used to reach those in rural areas, who are not as active on the internet.

### 2.3. Statistical analysis

Data was imported from Qualtrics into Microsoft excel (version 16.0.1, 2022). Descriptive and inferential statistics of the quantitative questionnaire data were obtained through Rcmdr: Rcommander package, within R Studio (version.1.3.1093, R core Team, 2016). Respondents had the option to not answer questions, therefore  $n$  values differ between statistical tests. We used ArcGIS Pro (version 2.6.0, 2020) to create maps showing acceptance scores across Germany. For the statistical tests, the confidence level was set at 95 % ( $p < 0.05$ ). We applied the Shapiro-Wilk to test quantitative data for normality which revealed that the data did not follow a normal distribution ( $p < 0.05$ ). After a Log transformation, the data did not follow a normal distribution, therefore we used non-parametric tests.

To address the main objective of this study and investigate the acceptance of lynx (1), we developed acceptance scores for each respondent. We assigned a one to five score for responses to eight statements with 5-point Likert Scale answers (Questions 16c, d, e, f; 20 a, b, c, d: see supplementary file 2) and added the scores from each

statement. Forty was the maximum acceptance score for each respondent. Acceptance scores were examined using Cronbach's alpha scale (Taber, 2018). For example, a high Cronbach's alpha score is 73 and above (out of 100) and equates to 29 and above (out of 40) for high acceptance scores within our study. Similarly, we developed knowledge scores to explore whether knowledge on lynx ecology affected acceptance. Respondents chose the correct answer (score of 1), or an incorrect answer (score of 0) to each of the four knowledge questions, and the scores were added together. Four was the maximum knowledge score for each respondent (see supplementary file 3). Scores of two (50 % of answers were correct) were assumed adequate, and scores of three (75 % of answers were correct) and above were considered high (Taber, 2018). The statements and questions to create the acceptance and knowledge scores were assumed to be equally weighted.

We applied these acceptance scores to explore differences in gender (Mann-Whitney  $U$  test), in age (Spearman's rank correlation test), education, profession and level of rurality (Kruskal-Wallis test). For significant results from the Kruskal-Wallis tests, the Dunn's test was used to identify which specific means were significant from the others. Additionally, we applied chi-square tests and data collected from open-ended questions in the third and final sections of the questionnaire to further explore acceptance of lynx by hunters. We used NVivo software (release version 1.3 (535), March 2020) to analyse the answers to develop a qualitative coding framework (see supplementary file 4).

When investigating objectives two and three, we characterized acceptance and knowledge scores for each German state similarly to Cronbach's alpha scale (Taber, 2018): scores above 73 were considered high. As respondents per state were not equal, we calculated an

acceptance and knowledge score as a percentage for the overall total score per state. We applied chi-square tests to investigate associations between acceptance scores and German states, and to investigate associations between knowledge scores and German states.

To investigate objective four of what future conservation projects should consider for public acceptance, we explored differences in how respondents trusted information sources to deliver reliable information about lynx and preferences on lynx population management. We analysed data collected from open-ended questions and applied chi-square tests to investigate associations between acceptance scores and statements asked in the third and final sections of the questionnaire.

### 3. Results

The questionnaire was administered to 3416 email addresses and generated a total of 1195 responses (cooperation rate of 35 %). The age ranges of respondents were between 18 and 88 years old (mean [SD] = 42 years old [15]). Half of the respondents lived in cities, while 28 % lived in villages, and 22 % in rural areas.

To explore the acceptance of lynx in Germany, the Spearman's rank correlation test suggested a significant but weak positive correlation between age and acceptance scores (Table 1). The Kruskal-Wallis test suggested that acceptance scores were significantly different between education levels (Table 1). The Dunn's test indicated that respondents educated at a vocational training (or apprenticeship) level had significantly higher acceptance scores ( $p = .02$ ) than respondents educated at high school level. Acceptance scores were significantly different between professions (Table 1). The Dunn's test revealed that respondents working in the agricultural sector had significantly lower acceptance scores than respondents working in the environmental sector ( $p = .04$ ) and those who were retired ( $p = .01$ ), with no significant differences amongst other professions. Acceptance scores did not significantly differ between respondents living in cities, villages, and rural areas (Table 1). The Mann-Whitney *U* test suggested that acceptance scores between females (mean [SD] = 30.92 [3.35]) and males (mean [SD] = 30.75 [3.99]) did not significantly differ. A chi-square test suggested that respondents who were not aware of any attacks by lynx on humans, pets, or domestic animals were significantly associated with higher acceptance scores (Table 1). Those who were aware of attacks by lynx (12.30 %) reported that attacks were on livestock, particularly sheep, goats, and game animals.

Most respondents who were professional hunters, or those who hunt in spare time, thought lynx would impact their hunting experience (55.71 %). However there was no significant association between acceptance scores and whether hunters thought lynx would impact their hunting experience ( $\chi^2 = 3.97$ , [4,  $n = 289$ ],  $p = .41$ ). Few respondents suggested that lynx would cause negative impacts on the hunting experience, however, other respondents were neutral or positive. For example, a respondent stated that:

*"I find it very positive (prefer stalking and need a challenge where the*

**Table 1**  
Eurasian lynx (*Lynx lynx*) acceptance scores and variables: statistical tests and results of acceptance scores of Eurasian lynx and variables.

Variable	Non-parametric test	Statistical Result	P value
Age	Spearman's rank correlation	$r_s = 0.19$ , $n = 1188$	0.001
Education levels	Kruskal-Wallis	$\chi^2 = 10.62$ , $df = 3$	0.01
Attacks by lynx on humans, pets, or domestic animals	Chi-Square	$\chi^2 = 9.04$ , [3, $n = 1195$ ]	0.03
Professions	Kruskal-Wallis	$\chi^2 = 29.59$ , $df = 10$	0.001
Rurality	Kruskal-Wallis	$\chi^2 = 2.35$ , $df = 2$	0.31
Gender	Mann-Whitney U	$U_{517,664} = 166643$	0.38

*game has an honest chance)."*

Behavioural changes of prey were reported in the open-ended question on how lynx would impact the hunting experience of the respondent. Respondents reported that game animals would become "secretive," "cautious," and the game would "change its hours of activity." Many comments suggested that hunting roe deer would become "difficult" and "demanding" with the presence of lynx. Conversely, "seeing a lynx enriches the hunting experience" and "to observe a lynx in the wild makes the hunt even more interesting!" were reported. As one respondent stated:

*"The interaction with the lynx must be learned and thus affects the hunting experience. And it is certainly interesting not to be the only hunter in the forest."*

However, some respondents reported that there may be negligible impact on the individual hunter.

To explore whether the acceptance of lynx differed among areas with and without lynx presence, the chi-square test suggested that acceptance scores did not significantly differ between the 16 German states ( $\chi^2 = 15$ ,  $df = 15$ ,  $p = .45$ ,  $n = 1191$ ). This finding suggested that acceptance scores in areas with and without lynx presence, or in areas where lynx have naturally recolonized compared with areas where lynx were artificially reintroduced did not significantly differ. Bremen had the highest acceptance score (80,  $n = 3$ , Fig. 2), followed by Bavaria (79.22,  $n = 231$ ), and Schleswig-Holstein had the lowest acceptance score (74.06,  $n = 109$ ). Knowledge scores did not significantly differ between the 16 German states ( $\chi^2 = 15$ ,  $df = 15$ ,  $p = .45$ ). Bremen had the highest knowledge score (83.33,  $n = 3$ ), followed by Lower Saxony (82.61,  $n = 69$ ), and Schleswig-Holstein had the lowest knowledge score (58.49,  $n = 109$ ).

To explore what future conservation projects should consider for public acceptance of lynx, respondents were asked whom they trusted to supply reliable information about the impacts of lynx in Germany. The most trusted information source were scientists (78.49 %) and the least trusted were social media (40.59 %). There were significant differences between each information source ( $\chi^2 = 3440$ ,  $df = 7$ ,  $p < 0.001$ ,  $n = 1195$ , Dunn's tests all at  $p < 0.001$ ). In the open-ended question about which other sources were trusted to deliver reliable information about lynx, foresters, lynx working groups, and national park administrations were reported. Also, certain documentation was reported as trusted sources of information, for example, one respondent stated,

*"I would trust a systematic review in a peer-reviewed journal...otherwise, it all depends on which television station, which newspaper, which social media channel, and which scientist expresses himself and to which aspect. The interests and biases of the respective communicators should be recognizable."*

In the questionnaire, respondents were asked about management of lynx in Germany (Fig. 3). Most respondents chose protection of lynx (76.65 %), and the lowest number of respondents chose extermination of lynx (0.08 %).

The 'Other' option was an open-ended question about lynx population management (Fig. 3). Active reintroduction and an increase in lynx population numbers were reported numerous times:

*"Protection and development of the population, however, only to an extent that is acceptable to all interest groups."*

Some respondents were in favour of a combined population management strategy, for example, protection of lynx, but control of lynx in some circumstances.

### 4. Discussion

Our study revealed that the overall acceptance of lynx in Germany from the respondents was high (Fig. 2). Our results were from a large sample size of respondents collected from the 16 German states. Lynx population numbers are gradually increasing in Germany, but experiences with these species remain infrequent. Acceptance scores may change when the public gain familiarity or experience negative

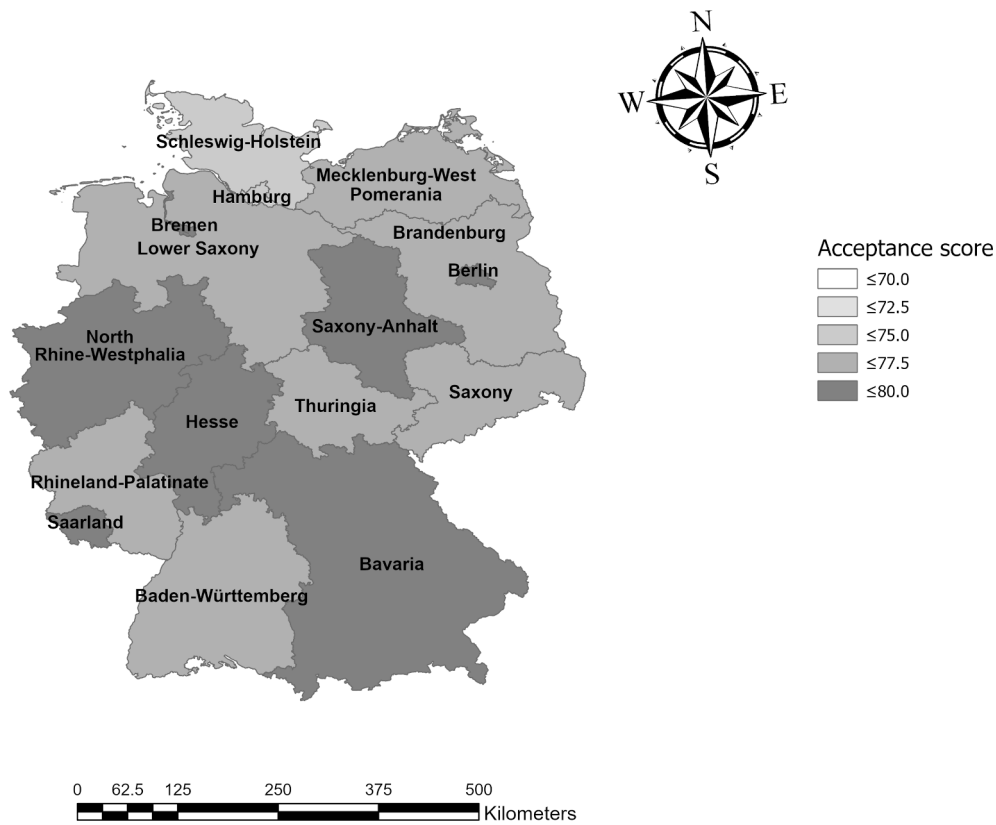


Fig. 2. Eurasian lynx (*Lynx lynx*) acceptance scores across the German states: the acceptance scores of Eurasian lynx by respondents in each German state. Dark grey represents a higher percentage or score.

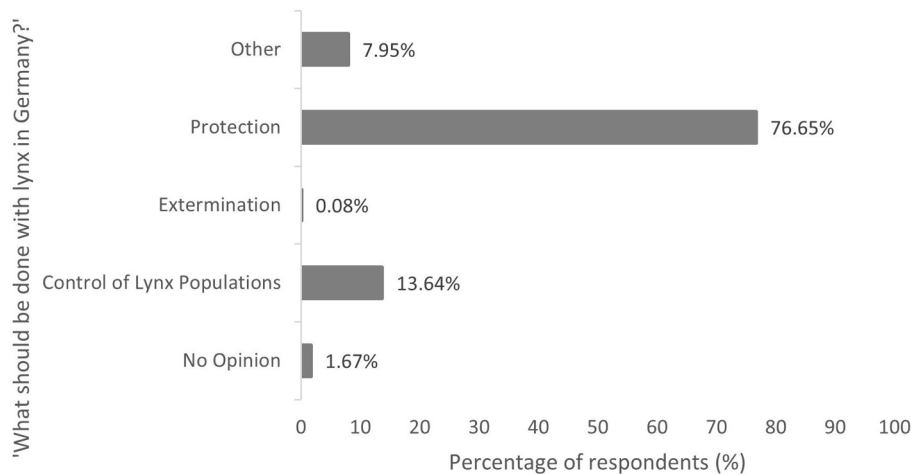


Fig. 3. Eurasian lynx (*Lynx lynx*) management in Germany: the answers of respondents (%) when asked about Eurasian lynx management in Germany.

interactions, with these species. Previous research by Lescureux et al. (2011) report that despite the lack of interactions with lynx in western Macedonia, respondents were in favour to protect and ensure survival of the species. However, acceptance of large carnivores are dynamic and are influenced by a diverse range of political, cultural, and economic factors (Lescureux and Linnell, 2013). Ongoing monitoring of acceptance levels of lynx may prove beneficial in large carnivore conservation.

Further findings from our study suggested that there is a weak relationship between age and acceptance scores ( $r_s = 0.19, p < 0.001$ ), with higher acceptance scores associated with increased age. This finding is unexpected and contrasts with previous findings, such as those

reported in Poland and Norway, where negative perceptions tend to increase with the age of the respondent (Bath et al., 2008; Kleiven et al., 2004). An explanation for the increased negative perception with age is provided by Røskoft et al. (2007) who suggest that a longer life provided greater opportunity for negative interactions to occur, or due to the elderly feeling less physically able to defend themselves in a potential attack. Our results suggested that an increased age associated with higher acceptance scores and therefore, more positive perceptions. This is in line with other findings in our study where acceptance scores significantly differed between those educated with a high school diploma and those with vocational training; those with vocational training had higher acceptance scores. Those with vocational training

are generally older and may have a more developed understanding of the environment.

Our study explored the relationship between acceptance scores and the profession of respondents. Respondents working in the agricultural sector had significantly lower acceptance scores than respondents who were retired or working in the environmental sector, with no significant differences amongst other professions. Respondents working in the agricultural sector may have higher levels of perceived impacts or have experienced negative impacts of co-existing with lynx, such as livestock predation. It is livestock predation that negatively affects livelihoods by causing huge emotional and economic losses, especially to those who solely rely on livestock for income (Røskoft et al., 2003). Previous studies in Poland and the Netherlands support our findings and report that the profession of a person influences their perception of and attitude towards lynx (Bath et al., 2008; Van Heel et al., 2017). For example, livestock farmers are more likely to have interactive relationships with lynx in rural locations, and experience loss of livestock. These experiences result in low acceptance levels and the development of negative attitudes (Červený et al., 2019). Those working in the environmental sector have a general interest in wildlife and the environment, which explain the significantly higher acceptance scores than those working in the agricultural sector. Retired respondents tend to spend more recreational time outdoors (Pennington-Gray and Kerstetter, 2002) which may increase their intrinsic appreciation of nature. Therefore, the significantly higher acceptance scores amongst retirees, compared with those working in the agricultural sector, was to be expected. This may also explain our findings of higher acceptance scores associated with an increase in age.

Our results suggested that respondents with higher acceptance scores were not aware of any attacks by lynx on humans, pets, or domestic animals. An explanation for these results is that negative interactions between humans and lynx, such as livestock predation, are low, and therefore, shared experiences between humans are uncommon. Wild prey populations in Germany can support such low lynx numbers, and sheep are less common in Germany (1.4 million) compared with other countries where lynx are present, such as Norway (up to 2.5 million) (Odden et al., 2008). Additionally, there is small overlap of areas in Germany where lynx and sheep herding occur.

One interesting finding within our study was that although most hunters thought lynx would impact their hunting experience, this perception did not significantly affect acceptance scores. This finding suggested that the impact of lynx was not necessarily perceived negatively. This contrasts with previous research from across Europe, which report that hunters have mainly negative perceptions of lynx due to competition with game animals (Lüchtrath and Schraml, 2015; Červený et al., 2019). A wide range of reasons may explain our finding, from changing perceptions of lynx to differences in perceptions between hunting districts. This remains to be explored in further research.

Our findings suggested that the German state of Bremen and Bavaria had the highest acceptance score whilst Schleswig-Holstein had the lowest (Fig. 2). However, these acceptance scores did not significantly differ. Bremen is a city state and therefore, the public have fewer negative interactions with large carnivores. In Germany, the Bavarian Forest National Park has a resident lynx population, but no lynx are present in Schleswig-Holstein (Heurich et al., 2018). Wolves are present in Schleswig-Holstein, and illegal killings are thought to explain the wolf population sink (Sunde et al., 2021). This finding from Sunde et al. (2021) suggests that due to the current interactions with wolves, there is an overall negative perception of large carnivores in this German state. As lynx are not currently present in Schleswig-Holstein, there is a lack of knowledge and experience of living alongside this species. In such situations, it is common for the public to assume lynx have similar behaviour and ecology to other large carnivores, such as the wolf (Lüchtrath and Schraml, 2015). Therefore, it is important to ensure the public is aware of the differences in large carnivore ecology and behaviour.

Despite the different re-establishment processes of lynx populations in Germany (Fig. 1), our study suggested acceptance scores in states where lynx had been artificially reintroduced or naturally re-established were not significantly different. However, previous qualitative analysis of the perceptions of hunters on lynx reported by Lüchtrath and Schraml (2015) suggest that hunters in southwest Germany are more accepting of natural re-establishing lynx populations. This finding by Lüchtrath and Schraml (2015) suggest that it is the specific interest group undertaking the artificial reintroductions that is the problem and not the presence of lynx. It would be interesting to explore acceptance of lynx by different interest groups across regions.

Our study set out to explore what future conservation projects should consider for public acceptance of lynx. Foresters, lynx working groups, and National Park administrations were reported by respondents in the open-ended question to be a high trustworthy information source. Additionally, our results suggested that scientists were significantly more trusted than other information sources. The findings from our study are supported by previous research by Arbieu et al. (2019) who found that in Germany, science-based information is the most trusted to deliver information on large carnivore ecology and management rather than information released by the press or TV news. Scientists have a deep understanding of their topic area; however, they are reported to hold mostly positive views towards large carnivores because, in general, they do not live alongside the species and do not experience negative interactions (Van Heel et al., 2017). Therefore, science-based information needs to be communicated in an empathetic way that is understood and appreciated by a wide range of people (Arbieu et al., 2019). Collaboration of trusted information sources may prove beneficial in promoting co-existence and improving acceptance of lynx in Germany.

Within our study most respondents chose protection of the species when asked how lynx should be managed in Germany (Fig. 3). Feelings towards large carnivores are projected through the desired population management strategy, for example, those who are fearful of large carnivores accept lethal control of population numbers (Johansson et al., 2016). Lynx is a protected species in Germany, and this is supported by most respondents and therefore could explain the high acceptance scores. Similarly, previous research by Glikman et al. (2012) report that the protection of naturally recolonized bears and wolves in the Abruzzo Lazio and Molise National Park, Italy, were consistent with the feelings of most residents. Feelings were concluded to be strong indicators of wildlife management preferences. Despite the overall positive attitudes towards large carnivores, illegal killings of both species were present in the park (Glikman et al., 2012). Within our study a small number of respondents favour the extermination of lynx (Fig. 3), and such negative perceptions need to be addressed to prevent these perceptions from being expressed through human behaviour, for example, through illegal killings. Active dialogue with individuals who hold negative perceptions could lead to effective compromises on large carnivore management, positive relationships between interest groups and acceptance of the species (Liukkonen et al., 2009).

Although there is a high public acceptance of lynx in Germany, there are two important considerations. Firstly, there is not a high acceptance of lynx across all interest groups, for example, respondents working in the agricultural sector had significantly lower acceptance scores. Those working in agriculture represent a substantial proportion of people working on the land. Any expansion of large carnivores would bring them closer to agricultural and urban areas. The resistance to, and conflict with, large carnivores may increase further.

Secondly, lynx are not feared and do not cause as much financial damage as other large mammals, such as wolves and bears (Bautista et al., 2019). As lynx populations expand into higher human density areas, it is likely that high levels of acceptance indicated in the results of our study may decrease as some humans may become fearful through increased human-wildlife interactions. Even reintroduction of these species within protected areas cannot ensure that these large mammals, requiring extensive territorial space, will remain exclusively within the

boundaries. Previous research suggests that protected areas can be beneficial for large mammals, for example, lower mortality rates for lynx as reported by Kramer-Schadt et al. (2005). Since, in Germany and across Europe, the majority of protected areas do not belong to the International Union for Conservation of Nature Category I (strict nature reserves or wilderness areas), or Category II (national parks) (Dudley and Stolton, 2008) where human-wildlife interaction is supposed to be limited, any expansion of protected areas with populations of reintroduced mammals, will increase considerably the interactions of people and reintroduced wildlife. It is highly likely that public acceptance may thus change substantially as a result of any negative human-wildlife interaction within these areas.

## 5. Conclusions

Our study suggested that the acceptance of lynx in Germany is high amongst our respondents. Age, education, profession, and awareness or experience of attacks by lynx were associated with acceptance scores. Acceptance levels did not differ between areas of lynx presence or absence, nor between re-establishment processes. However, acceptance requires ongoing monitoring due to the complex and dynamic nature of the topic. Although the results cannot be generalized, the method is beneficial in assessing the current acceptance level of this large carnivore amongst the public.

Our study has shown that there is variation in acceptance of lynx between professions and further human dimensions research with interest groups on a local level would prove beneficial, such as with hunters. As indicated by previous research, future reintroductions of lynx in protected areas within Germany may increase the chances of survival of the released individuals (Palmero et al., 2021). However, a reintroduction should not be undertaken without assessing perceptions and attitudes at a local level and management plans should be adapted accordingly. As lynx populations in Germany expand, the likelihood of interactions between the species and people increase. These interactions have the potential for increased cases of human-wildlife conflict. Monitoring acceptance of large carnivores assists in mitigating human-wildlife conflicts and achieving the species' conservation success in the geological epoch of the Anthropocene.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

Data will be made available on request.

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## Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jnc.2023.126535>.

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