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Quantifying behavioural impact and plasticity via expert and population surveys to prioritise bird conservation behaviour

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ABSTRACT

Social science interventions serve an important role in bird conservation efforts. Many bird species are endangered, and their conservation requires widespread changes in human behaviour. To optimally distribute resources such as time or money, conservation efforts should be directed at changeable human behaviours with the highest impact on bird conservation. However, quantitative information on the behavioural impact and plasticity (changeability) of bird conservation behaviour remains lacking. To address this gap, we conducted three distinct studies with different samples for the present research. First, we identified 28 relevant bird conservation behaviours via semi-structured interviews with bird conservation experts (Study 1; $n = 21$). Subsequently, these behaviours were ranked according to a prioritisation score based on the behaviours' anticipated impact (Study 2; expert questionnaire; $n = 188$) and plasticity (Study 3; representative population questionnaire; $n = 361$). Ultimately, the results of these studies were combined into a prioritisation score for each behaviour. Our results highlight the potential of activist behaviours, such as *Contributing to NGOs* and *Spreading enthusiasm and interest*, in significantly impacting conservation efforts. However, although general ecological behaviours like *Using bikes or public transport* received lower prioritisation scores, they still play a crucial role. This study provides valuable insights for strategic conservation planning and sets the groundwork for future prioritisation methodologies, thus advancing the interdisciplinary approach to biodiversity conservation and human behaviour.

KEY POLICY HIGHLIGHTS

- This study provides initial evidence for the prioritisation of several human bird conservation behaviours.
- NGOs and policy makers should concentrate on activist behaviours such as *Contributing to an NGO*, *Spreading enthusiasm and interest*, and *Sensitising others* as these are highly impactful and changeable.
- General environmental behaviours have less significance for bird conservation.
- Our methodology is adaptable to other conservation contexts and can be tailored to applied settings.

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1. Introduction

Global biodiversity is declining at a concerning rate (IPBES 2019). Across ecosystems, the state of numerous species is constantly worsening, and many face extinction. This scenario is often labelled as the sixth mass extinction event in Earth's history (Barnosky et al. 2011). Most of this decline can be attributed to anthropogenic causes (Jaureguiberry et al. 2022; Prakash and Verma 2022). Accordingly, behavioural change in the human population is an essential component of successful biodiversity conservation (Balmford et al. 2021; Nielsen et al. 2021). While most individual actions only have small effects, enduring and widely adopted changes can make a meaningful difference (Veríssimo 2013).

Biodiversity is a broad and multidimensional concept that can be defined at the genetic, species and ecosystem levels (Primack 2012). Therefore, to make conservation efforts more effective, it is essential to focus them on one level, such as one specific (group of) species (Reydon 2019). In Germany, birds are particularly suitable for this form of conservation strategy (Eylering et al. 2022). Since many bird species are indicator species, conserving birds can also contribute to the conservation of other species (Gregory et al. 2008; Gregory and Van Strien 2010). Moreover, a large proportion of breeding birds in Germany are endangered, with 43% of all 259 bird species being listed as endangered (Red List Breeding Birds: Bird deaths in Germany continue 2021). Human influences such as agricultural practices, construction projects (e.g. wind farms) and pets (e.g. dogs and cats) are among the greatest threats to bird populations (Gerlach et al. 2019).

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However, birds provide countless ecosystem services, such as seed dispersal and pest control (Whelan et al. 2008), making them indispensable for humans and other species. Additionally, birds are generally well-liked and perceived as charismatic species (Stoudt et al. 2022). As a result, people in Germany are willing to engage in bird conservation, and many non-governmental organisations (NGOs; e.g. the largest nature conservation organisations NABU [Nature and Biodiversity Conservation Union] and BUND [German Federation for the Environment and Nature Conservation]) already focus their efforts on bird conservation (Eylering et al. 2022). In summary, there appears to be a great need – as well as potential – for the adoption of human bird conservation behaviours in Germany.

Comparable to other environmental behaviours (Schultz and Kaiser 2012), bird conservation behaviours encompass all actions that provide benefits for a specific facet of the natural environment, namely bird biodiversity. In this study, 'behaviour' specifically refers to individual human actions aimed at supporting bird conservation. While all bird conservation behaviours have the potential to make a positive impact, the degree of their impact can vary depending on the specific behaviour and conservation context. By prioritising the most impactful behaviours and encouraging their adoption, conservationists could effectively improve the state of birds in Germany (Schultz 2011; Nielsen et al. 2021). However, identifying the most impactful behaviours can be challenging for conservation scientists and practitioners (Selinske et al. 2018). Unfortunately, behavioural impact is difficult to measure – particularly in biodiversity conservation – due to the complexity of ecosystems and the interactions between different species (Cheek et al. 2023). As a result, the selection of behaviours is often not primarily guided by ecological impact considerations, but by factors such as feasibility or ease of study (Nielsen et al. 2021).

In research and practise prioritisation studies are becoming increasingly popular (McKenzie-Mohr 2011; Selinske et al. 2020). To quantify the impact of conservation behaviours, these studies create estimates using various methods (e.g. expert ratings or literature reviews). In this manner, conservation actions can be guided by quantifiable evidence (Downey et al. 2022). Although prioritisation approaches differ, most focus on quantifying the behavioural impact and plasticity of conservation behaviours to rank them. To serve as useful intervention targets, Schultz (2011) suggests that conservation behaviours should not only be effective in improving the status of biodiversity but also be high in behavioural plasticity (in this study, 'plasticity' specifically refers to changes in individual human behaviour).

While previous prioritisation studies on biodiversity conservation behaviour have focused on specific regions (e.g. Australia: Selinske et al. 2020), little research has been performed in the European context (for an exception, see Barbett et al. 2019). Likewise, some prior studies have focused on particular population segments (e.g. dog owners: Please et al. 2018; cat owners: Linklater et al. 2019), yet little remains known about the species-specific impact of conservation behaviours. Notably, Comber and Dayer (2019) analysed shorebird conservation behaviours along the east coast of the United States. However, it can be expected that the effectiveness of conservation behaviours will vary across different species, cultural settings and regions (Maass 2005; Pierce et al. 2021). Therefore, our research aimed to produce the prioritisation evidence for bird conservation behaviour by conducting a prioritisation study in Germany, which will enable us to identify region-specific conservation behaviours and their potential impact on bird populations.

With the present research, we aimed to answer the following research question: Which bird conservation behaviours should be prioritised in Germany according to their estimated ecological impact and plasticity? In line with previous prioritisation studies (for an overview, see Selinske et al. 2020), we first identified bird conservation behaviours in Germany through expert interviews (Study 1). Thereafter, we prioritised these behaviours by estimating their impact using an expert questionnaire (Study 2). We then assessed the plasticity of these behaviours via a population questionnaire (Study 3). Based on these indicators, we calculated final prioritisation scores to rank the identified bird conservation behaviours according to their importance for bird conservation. This allows us to derive concrete recommendations for the conservation of native bird species as well as directions for future research.

2. Study 1 – Identifying bird conservation behaviours in Germany

Previous studies have used various systematic approaches to create comprehensive lists of behaviours that benefit (or harm) biodiversity. Some studies exclusively relied on literature to identify relevant behaviours (e.g. Linklater et al. 2019). However, if the conservation context is relatively broad, this method may lead to systematic biases during literature searches (Drucker et al. 2016). In contrast, most prioritisation studies have relied on reports by experts (Please et al. 2018; Barbett et al. 2019; Selinske et al. 2020), which can include expert interviews or various workshop formats (e.g. focus groups or other techniques). While expert opinions are inherently subjective, their aggregated insights

can provide reliable estimates of the effectiveness of conservation behaviours (Selinske et al. 2020). Furthermore, discrepancies between controlled impact evaluations of conservation measures and expert estimates can reveal how practical implementation may deviate from academic knowledge. By integrating diverse perspectives, expert consultations help to balance viewpoints and mitigate individual biases, which can best be achieved by recruiting a diverse set of experts (Bogner et al. 2014). Thus, for the present study, we conducted semi-structured expert interviews to systematically identify relevant bird conservation behaviours in Germany.

2.1. Method

To identify bird conservation behaviours, we conducted online expert interviews, as significant barriers such as large geographical distances, participant effort, and the COVID-19 pandemic made in-person or workshop formats impractical. These interviews allowed for more goal-oriented exchanges, and participants were not directly influenced by the answers of other participants (Mayring and Fenzl 2000; Bortz and Döring 2009; Flick 2018).

2.1.1. Expert sampling

By definition, an expert is experienced and knowledgeable in a certain field and is often the representative of an organisation or group (Bogner et al. 2014). To qualify for an interview, experts had to be people whose opinions are not guided by traditions or intuition, but by their scientific expertise instead (Bogner et al. 2014). Experts in German nature conservation can be classified as belonging to three groups: (1) NGOs; (2) governmental agencies; (3) scientific institutions (Hupke 2015). We attempted to balance bird conservation experts across these three groups and the 16 federal states in Germany. To ensure sufficient expertise and experience, we primarily contacted the person with the highest rank in an organisation. In some cases, they recommended their colleagues, which were subsequently contacted. For each group, a separate search was conducted. To complement the search, all participants could name other potential interviewees during recruitment and after their interview.

2.1.1.1. NGOs. There are several umbrella NGOs for bird conservation in Germany (for example, see Deutsche Ornithologen-Gesellschaft e.V. n.d. *[German Ornithologists' Society], Kommittee Gegen den Vogelmord*, n.d. [Committee Against Bird Slaughter] or Dachverband Deutscher Avifaunisten, n.d. [Federation of German Avifaunists]). We chose the 'Federation of German Avifaunists' due to its thematic organisational fit (i.e. a stronger focus on conservation when compared to the others) and because it has publicly listed member organisations in every German state. For each state, we selected a member organisation that operates at the state level. If there were multiple organisations, we chose the one with the most explicit focus on bird conservation in their description. Subsequently, we contacted the chairperson or a board member of an organisation in each German state as a potential interview partner.

2.1.1.2. Nature conservation agencies. In Germany, each federal state has a nature conservation agency (Hupke 2015). Moreover, nine states maintain an ornithological station specifically tasked with bird conservation matters (Länderarbeitsgemeinschaft der Vogelschutzwarten n.d.). Where applicable, we contacted the directors of these stations. For the other states, we searched for the best-fitting employee in the organisational chart of the state's nature conservation agency. In this case, the fit was determined by a focus on local bird conservation in their job description.

2.1.1.3. Scientific institutions. For the experts from scientific institutions, we started by systematically searching two databases including all German study programmes (for the databases, see Hochschulrektorenkonferenz n.d.; Studycheck.de n.d.), with several search terms used for each (translated from German; #bird(s), #species protection, #species conservation, #biodiversity, #biology, #marine biology, #nature conservation, #ecology, #ornithology, #environment, #environmental protection, #environmental science). Using our search terms, we found 445 (out of more than 20 000; Studycheck.de n.d.) study programmes from 71 different scientific institutes (out of 422; Destatis [Statistisches Bundesamt; Federal Statistical Office], n.d.). For each fitting study programme, we considered the members of the affiliated research labs. In this manner, we were also directed to the labs of institutes that are not primarily connected to universities. We limited our selection to researchers in Germany who had already obtained their PhD since this qualification is an indicator of their experience and expertise. If there were multiple people in one project or research lab with a comparable research focus, we chose the person with the highest academic position. Authors 1 and 3 rated each candidate's fit according to their publication record and the description of their research on their websites. In addition to this initial search, we considered the colleagues and co-authors of these candidates to find other potential participants. In total, 11 suitable candidates were agreed upon and contacted. Additionally, nine possible substitutes with a slightly weaker fit (e.g. fewer relevant publications or

fewer recent publications) were also identified. Since the number of experts in this area is more limited when compared to the other two groups, we were unable to balance the sample according to the federal state that the experts worked in.

2.1.2. Expert sample

All potential participants were first contacted via mail and then followed up with through phone calls based on the information found online, if necessary. Of the initial 43 people contacted, 18 agreed to a video interview, while one asked to fill out the questions independently in a text document. Two participants were recruited based on the recommendation of their peers. Of the 21 experts ($n_{male} = 17$; $n_{female} = 4$; $M_{Age} = 56.61$; $SD_{Age} = 9.90$) interviewed, 8 came from an NGO, 7 came from a governmental agency and 6 worked for a scientific institution. Importantly, some experts from agencies and scientific institutions were also members of NGOs. Experts came from 12 of the 16 German federal states (see Table A1 for more information). All participants had a university education, almost exclusively in biology or ecology.

2.1.3. Interview guide and procedure

We used a semi-structured guide for the interviews. Next to the questions on bird conservation behaviours, the guide included questions on socio-demographic data, life experiences, and their organisations. The relevant sections of the interview guide can be accessed on the Open Science Framework (OSF; at https://osf.io/yj4gf/?view_only=8e02912d4da3476b99db452afaf2debf.) Participants answered the first question on bird conservation behaviour using the freelisting technique, where they mention anything that comes to mind ('*Please name any bird conservation behaviour that comes to your mind*'; Quinlan 2017). Subsequently, more behaviours were identified and clarified through follow-up questions, such as by asking for a personal recommendation ('*What three things would you recommend for me to start with bird conservation?*'). To get a feeling for potential answers, we performed a non-systematic web search of potential bird conservation behaviours in preparation for the interviews.

Before the actual study, two test interviews were conducted to train the interviewer and clarify possible misunderstandings. The actual interviews were conducted from April to June 2022 using the web-conferencing system Big Blue Button and had a mean length of 34:25 minutes (SD = 08:08; see Table A1). For the one text-based interview, the participant completed a prepared form and was able to ask questions via phone afterwards. All interviews were conducted by the same person (Author 1) and transcribed in MAXQDA (VERBI Software 2021). The (German) transcripts of the interviews can be obtained upon request from the authors. The ethical guidelines of the corresponding author's institution were adhered to in all studies conducted in this research.

2.1.4. Data analysis

The interviews were transcribed according to Dresing and Pehl (2018). The transcripts were coded by Author 3 using MAXQDA. Other Authors (1 and 7) were consulted for unclear and critical codes. Interrater reliability was calculated after a person that had not previously been involved with the project coded five of the interviews. Overall, the analysis produced satisfactory results (Kappa values ranging from .90 to .93; Brennan and Prediger 1981). The coding was at first guided by a deductive code system based on Stern (2000); private sphere behaviours, public sphere behaviours: divided into activist and non-activist behaviours). Below these overarching categories, another level of subcategories was added based on previous prioritisation research (OSF; at https://osf.io/yj4gf/?view_only=8e02912d4da3476b99db452afaf2debf; Smith et al. 2012; Barbett et al. 2019; Selinske et al. 2020; Balmford et al. 2021). During the coding process, these subcategories were further complemented with inductive codes to derive concrete behaviours. The experts often gave broad and abstract answers, which we concretised during the coding process. For example, a statement such as '*Also, in the forest or something, do not walk around haphazardly so that resting areas can also be established there*' was concretised to the behaviour of *Being considerate of birds*. We only coded behaviours that a member of the public can engage in. Several experts reported behaviours that are specifically relevant to members of a certain occupation (e.g. relevant for farmers: *Leaving buffer strips on the sides of fields*); however, these were disregarded from further analyses. Ultimately, only behaviours that were mentioned by at least two experts were further analysed to keep the data pool manageable.

2.2. Results

Overall, we identified 28 different bird conservation behaviours that can be performed by members of the German public. The behaviours are presented and defined in Table 1. On average, each expert named 11 (SD = 4) behaviours.

The experts from NGOs mentioned *Sharing knowledge* (8; the number of experts mentioning this behaviour) and *Contributing to an NGO* (8) most frequently. The experts from governmental agencies reported *Putting pressure on politics and agencies* (6) and *Setting up nest boxes and birdhouses* (6). The experts from

Table 1. Bird conservation behaviours identified by experts and their definitions.

Behaviour	Definition	Mentions
Contributing to an NGO	Actively participate in a bird conservation organisation (e.g. participate in efforts, initiate and maintain conservation projects, public relations, and fundraising).	18
Setting up bird feeders and baths	Feed birds with species-appropriate insect or grain food in winter. In summer, offer water through a bird bath.	15
Sharing knowledge	Pass on knowledge about birds and bird conservation (e.g. in one's environment, via the internet).	15
Spreading enthusiasm and interest	Create enthusiasm and interest for birds as well as motivation for bird conservation in others (e.g. in one's work environment or children).	15
Bird-friendly gardening	Design the garden to assimilate nature, using diverse structures (e.g. native deciduous trees and shrubs, wildflower meadows, ponds, and rocks) and appropriate maintenance (e.g. infrequent mowing and pruning, no poisons).	14
Putting pressure on politics and agencies	Put pressure on authorities and politicians (e.g. contacting them, informing the media).	14
Gaining knowledge	Learn general knowledge about birds or increase knowledge of species (e.g. read books and magazines about birds, attend lectures, or participate in excursions).	13
Setting up nest boxes and birdhouses	Place nesting boxes and birdhouses in suitable places (e.g. garden, balcony, house walls, or nature).	13
Organising teaching events	Organise or conduct bird-related excursions, lectures, or guided tours for different groups.	13
Taking part in bird counting events	Participate in bird counting campaigns and monitoring programs (e.g. "*Stunde der Gartenvögel*" or "*Stunde der Wintervögel*" [Hour of the Garden or the Winter Birds; two relatively well-known citizen science projects in Germany]).	11
Observing birds	Observe birds (e.g. in the garden, forest, or at water bodies).	9
Being considerate of birds	Do not disturb birds while in nature and show consideration (e.g. keep your distance, do not leave paths, do not enter shore areas).	9
Consuming ecologically produced products	Buy products from controlled organic cultivation.	9
Consuming regionally produced products	Buy regionally produced products.	7
Sensitising others	Make others aware of bird conservation issues (e.g. in one's community, via the Internet).	7
Using bikes or public transport	Use bicycles or public transportation instead of cars.	6
Following the law	Adhere to laws on nature and environmental protection.	6
Demonstrating	Participate in demonstrations focusing on environmental, nature, or bird conservation.	5
Responsible dog ownership	Keep dogs on leash in nature.	4
Responsible cat ownership	Keep cats indoors in the spring or keep them on a leash in nature.	4
Avoiding and recycling waste	Produce less trash, separate and dispose of trash properly, and do not leave trash in nature.	4
Donating money	Donate money to a bird conservation organisation.	4
Becoming active in politics	Get involved in politics or hold a political office.	4
Marking windows	Mark windows of living and working spaces to make them visible for birds (e.g. tape them or cover them with curtains).	3
Following a vegetarian diet	Eat a vegetarian diet.	3
Paying NGO membership fees	Pay membership fees for a bird protection organisation.	3
Voting for bird-friendly parties	Elect political decision-makers who are committed to bird conservation.	3
Considerate driving	Drive with care, especially near (flocks of) birds.	2

Behaviours mentioned by less than two experts were not further analysed.

scientific institutions focused on *Contributing to an NGO* (5), *Spreading enthusiasm and interest* (4), *Consuming ecologically produced products* (4), *Bird-friendly gardening* (4) and *Setting up bird feeders and baths* (4). Overall, *Contributing to an NGO* (18), *Setting up bird feeders and baths* (15), *Sharing knowledge* (15) and *Spreading enthusiasm and interest* (15) were the most frequently mentioned bird conservation behaviours by all experts. Less frequently mentioned behaviours included *Considerate driving* (2), *Marking windows* (3), *Following a vegetarian diet* (3), *Paying NGO membership fees* (3) and *Voting for bird-friendly parties* (3).

2.3. Discussion study 1

Study 1 provided 28 specific bird conservation behaviours that were identified by at least two independent bird conservation experts in Germany. Many of the mentioned behaviours can also be found in other literature (e.g. the Conservation Evidence Project: Williams et al. 2012). According to our experts, changing any of these behaviours in the desired direction positively impacts bird conservation. However, since resources are limited in conservation (Waldron et al. 2013), it is not possible to focus on all of these behaviours simultaneously. For instance, investing in changing cat owner behaviour to be more bird-friendly may leave fewer resources for changing dog owner behaviour. Therefore, more information is required to guide the selection of behaviours that will have the greatest ecological impact (Nielsen et al. 2021). One possible indicator of the relevance of a behaviour is the frequency with which it has been mentioned during our expert interviews. However, this may simply reflect the strength of mental associations with the fuzzy concept of bird conservation behaviour (Eylering et al. 2023) rather than the actual impact of the behaviour. The specificity of a single behaviour impact may also be an important factor to consider in this respect. This is because a behaviour may have a large impact on bird conservation, but if it also has a large impact on other related (less specific) environmental issues, the association with bird

conservation might be weaker and experts might be less likely to list the behaviour when asked to list bird conservation behaviours (e.g. driving a car and climate change). Hence, more explicit information on the impact and plasticity of bird conservation behaviours is needed. In Studies 2 and 3, we aimed to generate this information and prioritise the identified bird conservation behaviours.

3. Study 2 – Quantifying the ecological impact of bird conservation behaviours via an expert questionnaire

With our second study, we aimed to estimate the ecological impact of the behaviours identified in Study 1 based on expert opinions. As previously mentioned, it is difficult to disentangle the impact of a single behaviour. There is no standard unit of measurement for impact in bird conservation, which stands in contrast to other fields (e.g. limiting greenhouse gas emissions for climate change mitigation). To estimate the impact of conservation behaviours, previous prioritisation studies have typically used expert ratings (Selinske et al. 2020). Experts are the most qualified segment of the population to estimate the impact of conservation behaviours since the general population is often not knowledgeable about biological or ecological matters (Gosler and Tilling 2022). To have a more locally and culturally diverse set of experts, we surveyed a much larger sample (compared to Study 1) to estimate the impact of the previously identified bird conservation behaviours in Study 2. This step in the research can contribute valuable insights into which behaviours conserve birds most effectively.

3.1. Method

To conduct the questionnaire, we used SoSci Survey, an online questionnaire provider (Leiner 2023). In addition to the materials listed below, the questionnaire included scales on life experiences and values that are not part of this research project. Data collection was performed during July and August of 2022. The impact section of the survey used the 28 bird conservation behaviours identified from Study 1 (Table 1).

3.1.1. Expert sample

The expert sample included participants from Study 1. Furthermore, we extended this selection by contacting additional experts from all three groups who fit the expert criteria of Study 1. Crucially, we did not use filters for knowledge or experience to ensure expertise; instead, we asked the participants to identify themselves as bird or nature conservation experts (Hsu and Sandford 2007). To sample additional experts from NGOs, we contacted several umbrella organisations and their members (the Federation of German Avifaunists, the German Ornithologists' Society, and the Committee Against Bird Slaughter), the authors and editors of bird (conservation) magazines, and large nature conservation organisations (e.g. NABU, BUND and the German chapter of Greenpeace). Additionally, the directors of all ornithological stations and employees of nature conservation agencies operating at the federal state level who had a focus on bird conservation were contacted as bird conservation experts from agencies. Experts with a scientific background could only be extended by the backup options of Study 1. Finally, we asked all contacted organisations and experts to share our questionnaire in their networks, which resulted in the publication of the questionnaire on several websites such as that of the Federal Association of Professional Conservationists (Bundesverband Beruflicher Naturschutz e.V., n.d.). To encourage participation, we donated 150 € to bird conservation and gave participants the opportunity to vote on how the funds would be allocated (Gendall and Healey 2010).

In total, 309 pageviews were recorded for the expert questionnaire. Before data analysis, we applied several exclusion criteria to ensure optimal data quality ($n = 19$ did not agree to participate in the study; $n = 71$ did not rate a single behaviour $n = 2$ did not answer a trap question correctly; $n = 21$ did not identify themselves as bird or nature conservationists; $n = 7$ were excluded based on the speed index developed by Leiner, 2019). None of the participants had systematic response patterns by giving the same answer for all behaviours. Thus, the final expert sample consisted of 188 self-identified expert participants, most of whom have an NGO background (see Table 2 for socio-demographic information).

3.1.2. Materials and procedure

After consenting to participate in the questionnaire, the participants answered socio-demographic questions related to their personal information (age, gender, place of work) and expertise (organisation, experience). Before presenting the behaviours, we showed the experts a definition of bird conservation that was derived from the responses in interviews from Study 1 '*In the context of this study, bird conservation can be described as the preservation of bird populations and endangered species. More precisely, it refers to all human actions that contribute to the conservation of natural habitats or the creation of new habitats for birds.*' Thereafter, the experts were asked to rate the impact of all 28 bird conservation behaviours. In the introduction text, they were informed of the origin of the behaviours. For each behaviour, we only showed the participants the definition of the behaviour (Table

Table 2. Sociodemographic information of the expert (study 2) and the population (study 3) samples.

		%		*M* (*SD*)	
Variable	Response Format	Experts	Population	Experts	Population
Gender	„*Male*"	75.53	52.10	-	-
	„*Female*"	24.47	47.90		
Age	18-29	8.50	13.01		
	30-39	11.69	14.42		
	40-49	11.69	13.86	52.80	52.57
	50-59	33.51	20.22	(13.71)	(16.52)
	60-69	26.60	17.74		
	≥70	7.44	20.78		
Federal state	Baden-Württemberg	3.19	13.02		
(Experts: Place of activity;	Bavaria	36.17	15.51		
Population: Place of living)	Berlin	1.60	3.32		
	Brandenburg	4.79	3.32		
	Bremen	1.06	.83		
	Hamburg	1.60	2.22		
	Hesse	.53	6.37	-	-
	Mecklenburg–Western Pomerania	.53	2.22		
	Lower Saxony	14.36	10.80		
	North Rhine-Westphalia	25.00	21.61		
	Rhineland-Palatinate	2.66	5.82		
	Saarland	.53	1.39		
	Saxony	1.06	4.43		
	Saxony-Anhalt	1.06	2.77		
	Schleswig-Holstein	3.72	3.60		
	Thuringia	1.06	2.77		
Active in bird conservation	„*Yes*"	100	2.77	-	-
	„*No*"	0	97.23		
Type of organisation	NGO	82.45	-		
	Nature Conservation Agency	17.55	-	-	-
	Scientific Institution	13.83	-		
	Other	22.34	-		
Years of bird conservation experience	-	-	-	18.68 (13.48)	-

It was possible to give multiple answers for the type of organisation as many people are active in more than one capacity.

A1). Based on previous prioritisation studies, we asked them to evaluate the behaviours based on the following statement: '*Please rate how high you think the positive effect of each behaviour is on bird conservation in Germany*' (Please et al. 2018; Linklater et al. 2019). The participants could respond on a Likert scale from 1 to 5 (1 = '*very low*', 2 = '*low*', 3 = '*moderate*', 4 = '*high*', 5 = '*very high*'). Additionally, participants could comment on each behaviour if they had a specific remark. The order of the behaviours was random and a trap question was included ('*Please click "very low" on the far left to demonstrate that you are paying attention to our study*').

3.2. Results

All bird conservation behaviours besides *Following a vegetarian diet* ($M = 2.91$, $SD = 1.16$) were rated higher than 3, the midpoint of the scale (see the impact column in Table 3). The highest-rated behaviours were *Being considerate of birds* ($M = 4.50$, $SD = .73$), *Spreading enthusiasm and interest* ($M = 4.41$, $SD = .75$) and *Contributing to an NGO* ($M = 4.37$, $SD = .67$). On the other hand, *Demonstrating* ($M = 3.05$, $SD = .90$) and *Setting up bird feeders and baths* ($M = 3.26$, $SD = 1.11$) were rated as the least impactful behaviours after *Following a vegetarian diet*. The average impact rating across all behaviours was 3.92.

3.3. Discussion study 2

By asking experts to rate the impact of the 28 conservation behaviours for birds in Germany, we were able to estimate an overall impact ranking for each behaviour. Since none of the behaviours received a low impact rating, performing any of the behaviours is expected to be positive for bird conservation in Germany. Nevertheless, there was some variance in the ratings since some behaviours were rated as highly impactful by nearly all experts, while others were only rated as moderately impactful on average (see Table 3). Not only motivated individuals, but also practitioners and researchers can derive useful conclusions from these results, especially in combination with existing literature, and guide future decisions based on them, as potentially impactful behaviours already present useful intervention targets. However, when implementing an intervention to encourage these bird conservation behaviours, it is necessary to consider their plasticity (Schultz 2011). Hence, we estimated the plasticity of the 28 behaviours using a population questionnaire (Study 3) and subsequently calculated prioritisation scores to rank all behaviours.

4. Study 3 – Quantifying the plasticity of bird conservation behaviours via a population questionnaire

In general, plasticity can be defined as the probability for something to change in a different

Table 3. Descriptive statistics for impact (study 2), prevalence (study 3), and adoption difficulty (study 3) of all 28 behaviours sorted by impact.

	Impact		Prevalence			Adoption difficulty		
Behaviour	*M*	*SD*	*M*	*SD*	% Missing	*M*	*SD*	% Missing
Being considerate of birds	4.50	.73	4.45	.80	2.49%	2.06	.94	4.99%
Spreading enthusiasm and interest	4.41	.75	2.57	1.27	1.66%	2.87	1.11	8.03%
Contributing to an NGO	4.36	.67	1.41	1.03	3.60%	3.85	1.07	17.72%
Bird-friendly gardening	4.27	.88	4.03	1.32	25.21%	2.36	1.07	17.17%
Following the law	4.24	.82	4.46	.85	.54%	2.14	.92	4.71%
Sensitising others	4.18	.81	2.18	1.25	1.66%	3.09	1.01	10.53%
Sharing knowledge	4.10	.87	2.27	1.19	3.05%	2.99	1.10	12.19%
Organising teaching events	4.07	.81	1.35	.87	2.22%	3.90	1.07	18.56%
Putting pressure on politics and agencies	4.05	.83	1.57	1.05	2.22%	3.87	1.03	15.24%
Gaining knowledge	4.04	.85	2.44	1.17	.55%	3.04	1.05	69.25%
Voting for bird-friendly parties	4.04	1.02	2.35	1.42	5.26%	3.33	1.16	14.40%
Responsible dog ownership	3.95	1.00	4.19	1.42	51.80%	2.28	1.11	29.92%
Responsible cat ownership	3.83	1.08	3.78	1.75	53.19%	3.24	1.34	41.27%
Consuming ecologically produced products	3.82	.95	3.34	1.16	.55%	2.57	1.09	5.54%
Donating money	3.75	.86	1.55	1.06	2.49%	3.39	1.27	16.34%
Taking part in bird counting events	3.69	.92	1.60	1.10	1.11%	3.33	1.21	14.68%
Paying NGO membership fees	3.63	.95	1.47	1.10	4.12%	3.65	1.21	17.45%
Avoiding and recycling waste	3.61	1.19	4.56	.81	1.11%	2.11	.98	3.60%
Becoming active in politics	3.57	1.05	1.47	1.05	3.60%	4.03	1.02	20.50%
Setting up nest boxes and birdhouses	3.57	.99	3.13	1.61	6.37%	2.36	1.12	9.70%
Marking windows	3.53	1.01	2.65	1.65	2.49%	2.65	1.17	8.03%
Consuming regionally produced products	3.49	1.02	3.71	.99	.28%	2.33	1.00	3.32%
Observing birds	3.47	1.00	3.54	1.19	.00%	2.19	1.09	55.40%
Using bikes or public transport	3.37	1.08	3.46	1.39	6.65%	2.97	1.29	8.03%
Considerate driving	3.28	1.09	4.10	1.15	12.47%	2.45	1.09	7.48%
Setting up bird feeders and baths	3.26	1.11	3.63	1.52	2.77%	2.08	1.04	6.93%
Demonstrating	3.06	.90	1.41	.92	1.94%	3.84	1.05	19.39%
Following a vegetarian diet	2.91	1.16	2.46	1.35	.83%	3.50	1.27	12.47%

A high value for impact indicates that a behaviour is estimated as more effective in conserving birds. A high value for prevalence indicates that a behaviour is performed more often and has lower plasticity (is less changeable). High scores on adoption difficulty indicate that a behaviour has lower plasticity (is less changeable). The results for prevalence and adoption difficulty are shown as measured and are subsequently reversed for the calculation of priorisation scores.

direction in response to external influences (York et al. 2002). In terms of bird conservation behaviour, we regard plasticity as the likelihood that such behaviour can be changed within the German population (Schultz 2011). As such, it includes both how often a behaviour is already performed (prevalence) and the degree to which it is malleable through intervention (adoption difficulty). Essentially, a behaviour with high plasticity is not already performed by many people in the target population and interventions can effectively change it. For example, when a new bird conservation app enters the market, the prevalence of its use will be low. Assuming that many people are willing to use the app in question, the behaviour of using these apps could be easily changed (e.g. by marketing campaigns). As a result, this example behaviour could be considered to have high plasticity. We estimated plasticity using a population questionnaire. This allowed us to analyse the bird conservation behaviours for a representative sample of the German population.

4.1. Method

Similar to Study 2, we used SoSci Survey (Leiner 2023) and collected data during July and August of 2022. In addition to the 28 behaviours identified in Study 1 (Table 1), the questionnaire also included scales on life experiences and values that are not part of this research project.

4.1.1. Population sample

We based the target sample size of 300 on comparable studies (Lakens and Ravenzwaaij 2022), with previous studies using sample sizes of 151 (Kneebone et al. 2017), 159 (Please et al. 2018) and 302 (Linklater et al. 2019) participants. To obtain a final sample of at least 300, we aimed to initially question a total of 400 participants. The data collection was performed via an online panel (Consumerfieldwork GmbH 2020), which allowed us to recruit a representative sample of the German population in terms of age, gender and location (federal state; all quotas according to Destatis [Statistisches Bundesamt] 2023b). Participants received a reward of 2 € for completing the questionnaire.

For the population questionnaire, we recorded a total of 549 pageviews. To filter the data for participants who took part diligently, we applied similar exclusion criteria to those used for Study 2 ($n = 16$ did not agree to participate in the study; $n = 93$ did not rate a single behaviour; $n = 21$ did not answer a trap question correctly; $n = 49$ were excluded based on the speed index [Leiner 2019]; $n = 9$

participants had systematic response patterns by giving the same answer for all behaviours). This resulted in a final general population sample of 361 participants (see Table 2 for socio-demographic information).

4.1.2. Materials and procedure

Similar to the experts in Study 2, after consenting, the participants first answered questions related to socio-demographic information (age, gender, place of living). Thereafter, they were asked about the prevalence and adoption difficulty of bird conservation behaviours. Before each block, the participants were asked if they understood how they had to answer the questions specifically. They could not progress unless they answered this question with '*Yes*'.

We measured behaviour prevalence by asking '*How often do you typically perform these behaviours?*', which could be answered on a Likert scale from 1 to 5 (1 = '*never*', 2 = '*seldom*', 3 = '*occasionally*', 4 = '*often*', 5 = '*very often*'). The answer format was based on the frequently used GEB-50 scale (Kaiser 2020), and the question itself was based on research suggesting that asking for typical behaviour delivers the most reliable results (Chang and Krosnick 2003). As in Study 2, we showed the participants the definition of each behaviour (Table A1). Participants could answer that they cannot perform the behaviour; in such cases, they were asked to provide a reason. These answers were treated as missing data. Again, the order of the behaviours was randomised and the trap question from Study 2 was included in this block of questions.

To measure adoption difficulty, we drew on participants' perceptions of how easily others would adopt these behaviours. We decided not to ask participants about their behaviour to avoid a logical confound with prevalence since it does not seem meaningful to ask a person who is already maximally engaged in a particular behaviour (e.g. someone who already follows an entirely vegetarian diet) how difficult it would be for an intervention to get them to maximally engage in this behaviour. To minimise this problem, we asked participants to rate how difficult it would be to maximally increase the behaviour in other people based on the reasoning that it would be unlikely that *all* people in a person's social environment would already maximally engage in any of the targeted bird conservation behaviours. Adoption difficulty success was thus operationalised as: '*How difficult do you think would it be to get everyone around you, e.g. family, friends and colleagues, to perform these behaviours as often as possible?*' Participants answered this question on a Likert scale ranging from 1 to 5 (1 = '*very easy*', 2 = '*easy*', 3 = '*neither*', 4 = '*difficult*', 5 = '*very difficult*') (Kneebone et al. 2017). It was possible to answer that a behaviour does not apply to the living situations of the people mentioned in the question. These responses were treated as missing data.

4.2. Results

4.2.1. Prevalence

Avoiding and recycling waste ($M = 4.56$, $SD = .81$), *Following the law* ($M = 4.46$, $SD = .85$) and *Being considerate of birds* ($M = 4.45$, $SD = .80$) were reported as the most frequently performed behaviours (see the Prevalence column in Table 3). In comparison, fewer people indicated that they are *Organising teaching events* ($M = 1.35$, $SD = .87$), *Contributing to an NGO* ($M = 1.41$, $SD = 1.03$) and *Paying NGO membership fees* ($M = 1.47$, $SD = 1.1$). The average prevalence for all behaviours was rated as 3.32. For most behaviours, there was a small percentage of people (between 0 and 6.65% each) that indicated they could not perform the behaviour (see Table 3). Especially for *Responsible cat ownership* (53.19%), *Responsible dog ownership* (51.80%), *Bird-friendly gardening* (25.21%) and *Considerate driving* (12.47%), this percentage was higher, with participants' self-reported reasons being that they did not possess cats or dogs, did not have access to a garden, did not use a car, or did not have a driver's licence.

4.2.2. Adoption difficulty

For adoption difficulty, most of the behaviours were estimated between 2 and 4 (see the Adoption difficulty column in Table 3). Only Becoming active in politics ($M = 4.03$, $SD = 1.02$) received a higher rating, with Organising teaching events ($M = 3.90$, $SD = 1.07$) and Putting pressure on agencies and politics ($M = 3.87$, $SD = 1.03$) as the next two highest-difficult behaviours. Being considerate of birds ($M = 2.06$, $SD = .94$), Setting up bird feeders and baths ($M = 2.08$, $SD = 1.04$) and Avoiding and recycling waste ($M = 2.11$, $SD = .98$) had the lowest adoption difficulty ratings of all bird conservation behaviours. The mean adoption difficulty rating for all behaviours was 2.94. The percentage of people who answered '*Does not apply*' was generally higher than for the prevalence question (see Table 3). Similarly, *Responsible cat* (41.27%) *and dog* (29.92%) *ownership* had the highest missing percentages; however, other behaviours had higher ratings when compared to the previous question.

5. Calculating prioritisation scores

Based on the results from the three conducted studies, we prioritised bird conservation behaviours. Prior studies have suggested various options for calculating a prioritisation score. One solution is to weigh impact and plasticity equally (with plasticity

being determined by both prevalence and adoption difficulty; Schultz 2011). To obtain this score (Prioritisation score 1 in Table 4), we averaged each behaviour's reversed prevalence (6 - prevalence) and reversed adoption difficulty (6 - adoption difficulty) from study 3 as indicators of the behaviour's plasticity. The average between this plasticity and the impact rating from Study 2 then yielded the behaviour's Prioritisation score 1:

$$\frac{\frac{(6-prevalence)+(6-adoption\ difficulty)}{2}+impact}{2}$$

While this is in line with our definition of plasticity, some have also conceptualised plasticity to be a distinct construct from prevalence (and plasticity an equivalent to adoption difficulty; Comber and Dayer 2019; Selinske et al. 2020). For this alternative, the results for impact, prevalence and adoption difficulty would be weighted equally (Prioritisation score 2 in Table 4). To obtain this score, we averaged each behaviour's reversed prevalence, reversed adoption difficulty and impact. This led to the following formula for Prioritisation score 2:

$$\frac{(6-prevalence)+(6-adoption\ difficulty)+impact}{3}$$

For the present study, we calculated both prioritisation scores since the different weighting might be relevant for different scenarios. Nevertheless, since the prior definition is somewhat more common, we will primarily analyse behaviours accordingly while also providing the results for the alternative.

5.1. Missing data

Missing data are important to consider for the prioritisation scores. For prevalence, participants could indicate that they cannot perform a behaviour. In terms of prioritisation, a behaviour that cannot be performed (for whatever reason) becomes irrelevant as a target for conservation efforts (just like a behaviour with maximum prevalence). For example, a campaign to improve gardening practices will not affect somebody already keeping an extremely bird-friendly garden, nor will it affect someone without a garden, since both cannot change this specific behaviour for the better. Accordingly, the missing data can be equally interpreted as the answer '*very often*', and we did so for the calculation of prioritisation scores. For adoption difficulty, participants could indicate that the behaviour does not apply to the living situation of the people in their social environment. We interpreted such responses to imply that these participants cannot provide meaningful information about the potential success of interventions targeting this behaviour. Hence, we excluded their 'missing' responses from the calculation of prioritisation scores.

Table 4. Prioritisation scores of all 28 human bird conservation behaviours.

Behaviour	Prioritisation score 1	Rank 1	Prioritisation score 2	Rank 2
Contributing to an NGO	3.87	1	3.70	1
Spreading enthusiasm and interest	3.84	2	3.66	2
Sensitising others	3.77	3	3.63	3
Sharing knowledge	3.74	4	3.61	4
Organising teaching events	3.72	5	3.61	5
Putting pressure on politics and agencies	3.67	6	3.54	8
Gaining knowledge	3.65	7	3.52	9
Donating money	3.64	8	3.60	6
Being considerate of birds	3.62	9	3.33	15
Taking part in bird counting events	3.61	10	3.59	7
Voting for bird-friendly parties	3.60	11	3.45	11
Paying NGO membership fees	3.54	12	3.50	10
Bird-friendly gardening	3.53	13	3.28	17
Following the law	3.47	14	3.21	20
Marking windows	3.44	15	3.41	12
Consuming ecologically produced products	3.43	16	3.30	16
Setting up nest boxes and birdhouses	3.41	17	3.36	13
Becoming active in politics	3.41	18	3.36	14
Responsible dog ownership	3.35	19	3.16	22
Observing birds	3.30	20	3.24	19
Consuming regionally produced products	3.23	21	3.15	23
Demonstrating	3.22	22	3.27	18
Setting up bird feeders and baths	3.20	23	3.18	21
Responsible cat ownership	3.16	24	2.94	27
Avoiding and recycling waste	3.14	25	2.98	26
Using bikes or public transport	3.08	26	2.98	25
Considerate Driving	3.00	27	2.91	28
Following a vegetarian diet	2.97	28	2.99	24

For details on the calculation of the two scores please see the Chapter *Calculating prioritisation score*. The scores were calculated based on the indicators from Table 3. However, prevalence and adoption difficulty were reversed, so that a high value for all three indicators corresponds to a higher prioritisation value. The correlation between the ranks of the two prioritisation scores is .94.

5.2. Results for prioritisation scores

Both methods for calculating the prioritisation score yielded comparable results, as indicated by a strong rank correlation (r = .94; see Table 4). Consequently we will only discuss the results of prioritisation score 1 (Table 4). To further test the robustness of our prioritisation score, we performed the previously described correlations only with the ranks of the prioritsation scores. Notably, the correlations (r = .71 and r = .55) indicate that our score is robust.

The resulting prioritisation of bird conservation behaviours ranked *Contributing to an NGO* (3.87) the highest, followed by *Spreading enthusiasm and interest* (3.84), *Sensitising others* (3.77), *Sharing knowledge* (3.74) and *Organising teaching events* (3.72). The five behaviours with the lowest ranks were *Responsible cat ownership* (3.16), *Avoiding and recycling waste* (3.14), *Using bikes or public transport* (3.08), *Considerate driving* (3.00) and *Following a vegetarian diet* (2.97).

6. General discussion

By combining the results from the expert and population questionnaires, we were able to calculate the prioritisation scores of 28 bird conservation behaviours that were identified in previous expert interviews. According to bird conservation experts, all 28 behaviours are likely to improve the state of bird populations in Germany if performed optimally. Nevertheless, they differ in terms of their impact and plasticity. Hence, our prioritisation sheds some light on which behaviours should be the focus of future research and bird conservation interventions in Germany.

As previously mentioned, there is relatively little comparable prioritisation research on conservation behaviours. Previous studies have focused on general biodiversity conservation behaviours in Victoria, Australia (Selinske et al. 2020) or the UK (Barbett et al. 2019). Regarding the geographical region, in terms of both ecological similarity and size, the UK is likely the best available comparison. Since other studies focused on very specific issues (cat ownership or dog ownership; Please et al. 2018; Linklater et al. 2019), their results do not directly compare to the general results of the present research. Although Comber and Dayer (2019) also focused on birds, their results are only partially comparable to ours since they specifically studied shorebirds along the US Atlantic coast. Despite the lack of previous research in this area, it is useful to compare and contrast our results. In the following section, we focus on the five highest- and lowest-rated bird conservation behaviours to keep the discussion to a reasonable length. Depending on the conservation context and the expertise of practitioners or researchers, other behaviours can also be important targets.

6.1. Highly prioritised bird conservation behaviours

6.1.1. Contributing to an NGO

Contributing to an NGO received the highest prioritisation score. Although this behaviour was ranked highly impactful, few people are engaged in it so far. Similar to our results, other studies have also noted that this is generally an impactful behaviour in biodiversity conservation (Barbett et al. 2019; Selinske et al. 2020). However, it is important to note that the high impact rating could be inflated by the fact that a large percentage of experts (77.66% in our study) are members of and/or active in NGOs. Nevertheless, NGOs take on many responsibilities in biodiversity conservation; for example, they advance environmental law and policy through their knowledge and political pull (Hupke 2015). Thus, *Contributing to NGOs* can strengthen them further. Moreover, many conservation issues require specialised work in which NGOs possess relevant knowledge and resources. Thus, it may be easier to achieve direct conservation success through them. The high plasticity of this behaviour is supported by our socio-demographic data, where only 2.6% of our representative general population sample reported being active in bird conservation. The membership figures of the two largest German nature conservation organisations, NABU (>900,000 members) and BUND (>265,000 members), appear impressive at first glance. However, this only corresponds to around 1.4% of the German population of around 83 million people, which indicates a comparatively low level of commitment. This low level of current engagement indicates potential for increased participation through targeted interventions, consistent with the concept of plasticity. However, this figure is illustrative rather than definitive, as it does not directly quantify plasticity; more robust evidence would be required to fully evaluate the willingness and capacity of individuals to adopt such behaviours. Importantly, the additional benefit of each additional member is likely to decrease at some point. In summary, joining a bird conservation NGO is ranked to be extremely effective for improving bird and general biodiversity conservation. Thus, it is crucial to identify what makes people join an NGO and especially what causes them not to do so. While there is a lack of research on this issue, we suggest that various factors, such as value alignment or threat perception, might be important in this regard (Eylering et al. 2022). Additionally, our sample might hint at an additional barrier since most experts were older males, which might dissuade potential members from other demographics.

6.1.2. Spreading enthusiasm and interest, and sensitising others

Spreading enthusiasm and interest and *Sensitising others* were ranked as the second- and third-most prioritised bird conservation behaviours. Although we discuss them in one section and they appear similar at face value, they differ in some aspects. *Spreading enthusiasm and interest* can be viewed as a behaviour that involves actively promoting the appreciation and protection of birds and their habitats, while *Sensitising others* involves raising awareness about bird conservation issues and encouraging others to take action to address them. These behaviours appear particularly relevant for the activists themselves since they were frequently mentioned during the interviews, perhaps explaining the high impact ranking. Interestingly, other studies did not rank similar behaviours as highly in terms of overall prioritisation score or impact. While Barbett et al. (2019) operationalised a much more specific behaviour (sharing a social media post), the scope of Selinske et al.'s (2020) comparable behaviours was slightly different (e.g. telling positive nature stories within a circle of influence), which may explain why the comparable behaviours received a much lower impact rating. Results from the Conservation Evidence Project suggest that awareness campaigns can be effective tools in nature conservation (Williams et al. 2012). For the present research, *Spreading enthusiasm and interest* and *Sensitising others* were defined abstractly and functionally based on their effects on others. This raises the question of which specific behaviours are most effective in achieving these effects and highlights the need for future, more targeted prioritisation studies in this area. While much environmental psychological research has been conducted on what increases predictor variables such as attitudes or motivation (Steg and De Groot 2018), working with flagship or charismatic species appears to be a promising approach in the field of biodiversity conservation (Lundberg and Arponen 2022). For researchers and practitioners, *Spreading enthusiasm and interest* and *Sensitising others* may be especially interesting since they are likely to spill over to other, more direct conservation behaviours (Truelove et al. 2014). Therefore, encouraging such behaviour is likely to positively affect other behaviours as well.

6.1.3. Sharing knowledge & organising teaching events

The fourth- and fifth-most highly ranked behaviours are also comparable since both serve the same function of educating others. While *Sharing knowledge* is more informal and does not depend on the setting, *Organising teaching events* is a formal and organised activity. The notion of educating others fits the frequently mentioned sentiment among conservationists that a lack of knowledge is a key barrier to conservation action (Mikołajczak et al. 2021). In particular, versions of the phrase 'In the end, we will conserve only what we love, we will love only what we understand, and we will understand only what we are taught' are often uttered (also during the interviews of Study 1). Moreover, these two behaviours are closely related to those ranked above them since they can easily involve *Spreading enthusiasm and interest* and *Sensitising others*, and are also likely to take place in or be organised by NGOs. Nevertheless, these behaviours are ranked relatively lower in previous studies (Barbett et al. 2019; Selinske et al. 2020). This is in line with several findings highlighting that mere knowledge about an issue will not automatically lead to pro-environmental behaviour (Frick et al. 2004). Thus, we suggest viewing the transfer of knowledge as a measure that will not be effective in isolation. While knowledge of a problem is an important pre-requisite, other predictors (e.g. values or attitudes) are likely more indicative of conservation behaviour. The differences in our results could be due to our expert sample, which mostly included people with a background in natural sciences, while other studies also included people from the social sciences, where the role of knowledge is already viewed more critically (Selinske et al. 2020).

6.2. Weakly prioritised bird conservation behaviours

6.2.1. Following a vegetarian diet

Following a vegetarian diet had the lowest prioritisation score. This finding is somewhat surprising given that, for example, Selinske et al. (2020) ranked reducing lamb and beef consumption among the most important biodiversity conservation behaviours. Moreover, there is a wealth of research suggesting that the meat production sector is one of the greatest threats to biodiversity and a major cause of other related environmental problems (e.g. climate change and excessive water usage; Djekic 2015). Agriculture threatens 86% of the 28,000 species at risk of extinction, with meat production significantly contributing to habitat destruction and environmental degradation (United Nations Environment Programme 2021). The persistent issues of land use for feeding crops or over-fertilisation should be similarly important for birds in Germany (Kandziora et al. 2014). While it is known that dietary behaviour is indeed difficult to change (O'Riordan and Stoll-Kleemann 2015), there are alternative explanations for the relatively low impact rating. For instance, meat consumption is only indirectly linked to bird conservation, and some species benefit from – or even depend on – grazing livestock (Nugent et al. 2022). Moreover,

dietary choices are often perceived as integral to a person's identity, making it potentially more difficult to make objective judgements about impact and plasticity (Nezlek and Forestell 2020). Specifically, our sample had several key demographic characteristics predicting a higher rate of meat consumption (male, older, Western; Alexandratos and Bruinsma 2012). Finally, it could also be argued that a vegan diet or alternative protein sources could have a more positive impact than a vegetarian diet, which raises the question of whether experts made this comparison during their impact rating. More research is required to explore the reasons behind the relatively low prioritisation score for following a vegetarian diet in terms of its impact on bird conservation in Germany.

6.2.2. Considerate driving & using bikes or public transport

Considerate driving had the second-lowest overall prioritisation score, followed by *Using bikes or public transport*. While *Considerate driving* primarily aims to avoid collisions between birds and cars, *Using bikes or public transport* has additional indirect benefits for birds (e.g. climate change mitigation). Many people have reported performing these behaviours already, which may have been influenced by social desirability (Krumpal 2013). Notably, both of these behaviours were not relevant or not analysed in comparable research. However, reports indicate that vehicle collisions caused in part by irresponsible driving are indeed a significant threat to birds (US Fish & Wildlife Service n.d.). In Europe, studies indicate that annual bird mortality from road traffic ranges from 350,000 to 27 million birds per country. These figures highlight the substantial impact of road traffic on avian mortality (Erritzoe et al. 2003). Importantly, since this threat mostly applies to a limited number of species, it might not be an impactful behaviour for birds overall, which could explain the relatively low impact rating of *Considerate driving* and *Using bikes or public transport* for the whole of Germany. Therefore, it should be noted that prioritisation studies that are specifically tailored to certain bird species or habitats may produce different results. The additional ecological benefits of *Using bikes or public transport* might not be much more impactful for bird populations in Germany. Thus, before focusing on changing people's mobility behaviour for bird conservation, it might be more effective to do so only in certain locations. However, it is important to note that these behaviours are certainly beneficial to other environmental causes as well.

6.2.3. Avoiding and recycling waste

In the present study, the fourth-lowest prioritisation score was for *Avoiding and recycling waste*. In particular, the large number of participants reporting that they already engage in this behaviour caused this low overall score, corresponding to the relatively well-adopted recycling systems in Germany (Cave 2017). The results of another study ranked a similar behaviour in a comparable range as the experts did for this study (Barbett et al. 2019). Littering and waste production are important ecological issues that we might not yet fully grasp the impacts of on biodiversity (especially microplastics; Wang et al. 2021). However, the results of the Conservation Evidence Project also suggest that better waste management is not very effective in achieving bird conservation (Williams et al. 2012). Hence, based on the available evidence, it is reasonable to conclude that *Avoiding and recycling waste* is not one of the most important behaviours to prioritise for bird conservation in Germany.

6.2.4. Responsible cat ownership

The low rating of *Responsible cat ownership* is perhaps a surprising result. Domestic cats have been identified as one of the greatest threats to birds and biodiversity in Germany and globally (Loss et al. 2013, Díaz et al. 2023; NABU - Naturschutzbund Deutschland e.V. n.d.), and previous prioritisation research also focused on cat ownership, albeit in a different geographical context (Linklater et al. 2019). In Germany, approximately 15.2 million domestic cats reside in 25% of households (Destatis [Statistisches Bundesamt] 2023a). While specific data on avian mortality caused by cats in Germany is limited, studies from other regions provide insight into the potential impact. For instance, in the United States, outdoor cats are estimated to kill around 2.4 billion birds annually (Loss et al. 2013). In Poland, cats are responsible for approximately 136 million bird deaths each year (Krauze-Gryz et al. 2018). Given the substantial cat population in Germany, it is plausible that domestic cats significantly affect local bird populations. However, the experts consulted in this study did not rank *responsible cat ownership* as a highly impactful bird conservation behaviour. Perhaps they compared the behaviour to not owning a cat at all, which would be more effective but was not mentioned during Study 1. The population sample also reported that cat ownership behaviour is difficult to change, which is unsurprising since pet owners have deep emotional bonds with their pets (Meehan et al. 2017). People likely believe that cats need to be let outdoors at all times of the year (cats are especially harmful during bird breeding season), which could have also influenced the expert ratings. Given the large threat that cats possess to birds in Germany, it remains important to study this further. As such, future research should investigate why the impact rating was not

estimated to be higher in the present study. Moreover, cat owner behaviour should also be analysed.

6.3. Lower- versus higher-rated behaviours

Overall, the highest-ranked behaviours tend to focus on community involvement and education. These include engaging in political processes to support bird conservation efforts, gaining knowledge about local bird species and their habitats, and donating money to conservation initiatives. Such behaviours often require individuals to take on responsibilities or actively work toward conservation goals, while also leveraging the power of awareness-raising and encouraging collective action. Their higher ranking suggests that these actions are perceived as both impactful and achievable, aligning with the notion that collective efforts can address conservation challenges more effectively than isolated individual actions (Lubell 2002).

In contrast, lower-ranked behaviours focus more on individual lifestyle choices, such as responsible pet ownership, waste reduction, recycling, and making conscious transportation or dietary choices. While these behaviours hold intrinsic value for bird conservation, they are often seen as having less direct impact or scalability when compared to collective actions. Furthermore, their adoption typically requires significant personal commitment, which can create barriers to widespread behavioural change. Nonetheless, these individual actions can play critical roles in specific contexts or as entry points for broader engagement, highlighting their importance despite their lower prioritisation (Bastini et al. 2023).

This distinction between collective and individual behaviours underscores a broader pattern observed in environmental conservation, where collective efforts – such as joining NGOs, participating in education initiatives, or engaging in political advocacy – are viewed as essential for systemic change. For instance, studies in climate change mitigation have shown that collective efforts are often prioritised for their ability to influence broader social, economic, and policy structures, facilitating large-scale transformations that individual actions alone cannot achieve (Stern 2000). Such collective actions are effective because they leverage social capital, collective efficacy, and shared norms to address complex ecological challenges (Stern 2000).

It is evident that community engagement and education are pivotal for effective bird conservation efforts in Germany. A balanced approach that integrates individual lifestyle changes with collective actions, including political engagement and financial support, will likely be most effective in achieving meaningful and sustained conservation outcomes.

6.4. Limitations

The results of this prioritisation study could be used to guide bird conservation decision-making in Germany. Although such a 'rough-and-ready' approach has many advantages, it is important to consider the potential limitations. During the planning of a prioritisation study, several decisions must be made, which influence the results.

6.4.1. Level of specificity

In the planning phase of this research, we decided to analyse bird conservation behaviour in Germany to create the largest impact possible. However, conservation is most effective when concentrated locally, as ecological requirements and conservation challenges can differ greatly across regions and ecosystems (Primack 2012). The requirements of ecosystems differ too strongly to generalise over a larger geographical context (e.g. Germany). Consequently, the behaviours prioritised in this study are often broader and less specific, likely functioning to enable future action rather than directly addressing localized conservation challenges. For instance, in Comber and Dayer's (2019) study on shorebird conservation, concrete actions such as carefully walking around shorebirds and leashing dogs on beaches were among the highest-prioritised behaviours, reflecting the specific needs of their context.

This broader scope in our study allows for identifying behaviours that may hold relevance across species and geographical contexts. Indeed, prioritisation research often identifies similar behaviours in different contexts, suggesting that certain conservation actions are more universally applicable. However, other behaviours may be highly context-specific, depending on the ecological and social factors at play. The listed behaviours in this study might be partially relevant for other regions (e.g. neighbouring countries to Germany) or taxa (e.g. insects), but could also differ strongly.

To address this limitation, future research should analyse which behaviours are universally impactful and which require tailoring to specific ecological and geographical contexts. Our results are most useful for conservation agencies and NGOs operating at the national level, focusing on birds as a group rather than on individual species or habitats. For regional projects or those targeting specific endangered species, additional prioritisation studies with a narrower focus would be necessary to identify the most impactful behaviours.

6.4.2. Methodological limitations

For the expert sample of Study 1, we attempted to contact experienced people from different regions and institutions in Germany. This resulted in

a sample consisting of mostly older males, which may have been a result of us contacting the highest-ranking people in each organisation. It is possible that people from another demographic have different viewpoints and may have provided additional behaviours. During the interviews, many experts mentioned behaviours that are only relevant to specific occupational groups. Although we did not analyse these behaviours further, they could be extremely important and have an even greater impact than those we analysed. For example, the agricultural sector has a significant impact on bird conservation (Katayama et al. 2015) and behavioural changes by farmers could be very efficient (Barrios et al. 2020). Accordingly, these often came up during the interview process.

Integrating *Traditional ecological knowledge (TEK)* with scientific research can enhance conservation strategies by incorporating diverse perspectives and practices (Albuquerque et al. 2021). However, our study focused solely on scientific expertise, excluding other forms of knowledge. We acknowledge that this exclusion may limit the comprehensiveness of our findings. Future research could aim to include TEK to provide a more holistic understanding of conservation behaviours.

In Study 2, we had the participants identify themselves as experts. While this allowed us to survey a relatively large sample, some might not have met our criteria if we had implemented filters such as years of experience, knowledge of the subject matter, or position in their institutions. It is unlikely that the results are strongly swayed because of this since the sample was relatively large and the experts averaged over 18 years of bird conservation experience. Moreover, the expert sample was not balanced on location. In particular, federal states close to the location of the principal investigator's institution (Osnabrück, located in Lower Saxony and bordering North Rhine-Westphalia) and some others (e.g. Bavaria) were strongly represented in the sample. In contrast, federal states from eastern Germany had very few participants. This imbalance could skew the results of the prioritisation since there could be some regional factors specific to eastern Germany that are not well represented in the present study.

For both Studies 2 and 3, the operationalisation of the bird conservation behaviours in Study 1 was an important factor. However, for Study 2, the phrasing of the behaviours could influence how the experts estimated their impact rating. Notably, it remains unclear what the experts compared each action to. While they might have compared the behaviours amongst each other, it is also possible that they used a counterfactual for each behaviour (i.e. doing the opposite). For some behaviours, these counterfactuals are clear (e.g. the counterfactual for *Contributing to an NGO* is not contributing). However, for behaviours such as *Responsible cat ownership*, there are multiple possible counterfactuals. Thus, it is important to carefully interpret the lower impact scores of this study. In summary, the descriptions of the behaviours would have influenced the answers of the respondents in certain ways. Elaborate pilot studies and other methods used to identify the behaviours (e.g. an iterative workshop format) could provide more clarity in future studies.

For both Studies 2 and 3, there was a relatively high number of participants that we excluded after they initially agreed to participate but did not rate a single behaviour. It is likely that these people opened the questionnaire out of interest but found the exercise of ranking 28 behaviours to be too effortful. In the case of the expert survey, they could also start the questionnaire again at a later point. Although we have no reason to assume that there was systematic dropout in a certain group, future research should incorporate more rigorous pilot testing to rule this out.

6.4.3. Prioritisation score

To calculate prioritisation scores, we estimated the impact and plasticity of each bird conservation behaviour included in our study. The concept of plasticity is especially complex. As previously mentioned, prior research has not used the concept consistently since some studies included prevalence and others viewed it as separate. The conceptualisation influenced the calculation of the prioritisation score. Essentially, a different weight for each factor was chosen according to the plasticity definition, which influenced the prioritisation scores. We suggest that practitioners and researchers should be aware of the different conceptualisations and use them to their advantage. For example, if an NGO is well versed in achieving behavioural change, it could place greater weight on impact to guide its decisions. Moreover, additional work should be focused on conceptualising plasticity. Recently, Kukowski et al. (2023) suggested that behavioural plasticity reflects a person's motivation, capability and the presence of barriers, which could represent a more well-rounded definition. They also analysed the concept of perceived plasticity, which may be an effective tool for future prioritisation research.

6.5. Practical implications and conclusions

Prioritisation studies have the potential to improve practical biodiversity conservation and guide researchers' decisions on the behaviours they analyse. The results of the present study on bird conservation behaviour suggest that efforts should focus on integrating bird conservation into the lives of the general population, particularly among non-conservationists and the broader public who may not yet be actively engaged in conservation effort. This can be achieved by increasing public

engagement, concern, and knowledge about bird conservation, ultimately serving as a foundation for future conservation initiatives. While behaviours requiring substantial private lifestyle changes remain impactful, they received a lower prioritisation ranking, suggesting that initial efforts should focus on promoting more accessible, everyday conservation actions.

Our results suggest that practitioners and policymakers should develop targeted interventions that aim to increase public engagement (especially through NGOs) and knowledge about bird conservation. NGOs play a crucial role in these efforts, especially through community-based initiatives, awareness campaigns, and advocacy (Jasanoff 1997). However, given the resource constraints many NGOs face, it is essential to involve additional stakeholders, such as local governments, businesses, and educational institutions, to create a more comprehensive and sustained approach. For instance, municipalities could integrate bird-friendly urban planning into their policies (Miller et al. 2008), businesses could support conservation initiatives through corporate social responsibility programs (Wolff et al. 2018), and schools could incorporate conservation education into curricula (Børresen et al. 2022).

To ensure the effectiveness of these interventions, it is crucial to consider and address the specific psychological factors such as values, attitudes, and motivations – that influence individuals' conservation behaviours. These psychological factors not only shape individuals' willingness to engage in conservation actions but also determine the success of interventions by influencing how people perceive and respond to conservation messages. For instance, aligning conservation initiatives with intrinsic values like biospheric and altruistic motivations can enhance long-term commitment to bird conservation efforts. This could involve the implementation of community-based conservation programmes, leveraging social media and other communication channels to raise awareness, and organising events and campaigns that directly address the unique psychological barriers and drivers of behavioural change. Additionally, efforts should be made to make bird conservation more accessible and appealing to the general public, such as by creating accessible bird-friendly habitats in urban areas or by offering educational opportunities and resources for people of all ages.

For future research, we recommend that studies investigate the factors that influence people's engagement and motivation to participate in bird conservation behaviours. This could help to identify effective strategies for promoting and sustaining behavioural change. Furthermore, it is important to explore the potential synergies and trade-offs between different bird conservation behaviours and develop integrated conservation approaches that consider the complexity and interdependence of different species and ecosystems. Finally, it is recommended that future studies use a multidisciplinary approach that combines insights from ecology, psychology, sociology and other relevant fields to advance our understanding of the human dimensions of biodiversity conservation.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

Compliance with ethical standards

The study was carried out in accordance with the national and institutional guidelines, the Declaration of Helsinki, the German Research Foundation, and the American Psychological Association. The study was explained to all participants before they took part. They were informed that all data will be de-identified to ensure participant anonymity. Participation was voluntary. Participants had the option to decline participation in the study at any time without consequence. All participants acknowledged an informed consent statement in order to participate in the study and were debriefed about the complete purpose of the study after surveys or interviews. The data were securely stored and could only be accessed by the authors of this study. As the research had no medical background, it involved no risks to our participants. Moreover, the research assessed no sensitive personal data. In consequence, an ethics approval from the Osnabrück University Ethics Committee was not required.

Data availability statement

All data, scripts, and interview materials can be accessed on OSF at https://osf.io/yj4gf/?view_only=8e02912d4da3476b99db452afaf2debf. The anonymized German interview transcripts can be requested via the corresponding author.

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Appendix

Table A1. Information about all bird conservation experts and their interviews.

Expert group	Age	Gender	Federal state	Interview length
NGO	67	M	Baden-Württemberg	0:29:13
NGO	75	M	Mecklenburg-Vorpommern	0:23:59
NGO	46	F	Bavaria	0:42:37
NGO	59	M	Berlin	0:39:36
NGO	–	M	Lower Saxony	0:25:53
NGO	48	M	Rhineland-Palatinate	0:31:29
NGO	65	M	North Rhine-Westphalia	0:35:19
NGO	71	M	Mecklenburg-Vorpommern	Written interview
Agency	65	M	Bavaria	0:38:54
Agency	62	M	Berlin	0:43:05
Agency	56	F	Hamburg	0:34:52
Agency	63	M	North Rhine-Westphalia	0:24:45
Agency	–	M	Brandenburg	1:04:12
Agency	45	M	North Rhine-Westphalia	0:36:12
Agency	53	M	Saxony-Anhalt	0:34:37
Research	44	F	Lower Saxony	0:35:37
Research	54	M	Rhineland-Palatinate	0:30:43
Research	53	M	Lower Saxony	0:36:00
Research	42	M	Lower Saxony	0:25:43
Research	56	M	Baden-Württemberg	0:26:00
Research	49	F	Hesse	0:13:12
M:	56.61	–	–	0:34:25
SD:	9.90	–	–	0:08:08

Two experts did not report their age, in both cases, the interviews ended before, as the experts had to leave the interview.