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ANALYSIS

Willingness to pay for birdsong

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ABSTRACT

We present the first estimate of the causal effect of auditory sensation on willingness to pay and the first estimate of the marginal value of bird song, using constructed soundscapes. We compare willingness to pay values for increases in bird wildlife habitat quality and quantity between samples where respondents are played recordings of soundscapes compared to respondents who do not get to listen to these simulated soundscapes. Willingness to pay for habitat quality enhancements were found to be significantly larger in the treated “with soundscapes” sample, mainly due to treatment reducing cost sensitivity. Methodologically, this paper reports on the use of simulated soundscapes in choice experiments as a means of increasing the information respondents have before making their choices.

1. Introduction

What are the economic benefits of bird song to people? Natural soundscapes are a cultural ecosystem service, and birdsong makes an important contribution to such soundscapes (Uebel et al., 2021). This implies that birdsong itself has a value that potentially goes beyond the values of the existence of birds and the value of seeing them (which are the values typically communicated in Discrete Choice Experiments (DCEs)), in addition to the indirect economic benefits birds provide through their role in ecosystem functioning (Hanley and Perrings, 2019). It is possible that valuation studies that do not explicitly assess the value of birdsong may underestimate the benefits people receive from habitat restoration and conservation projects. We know that people are willing to pay to avoid negative soundscapes such as traffic (Moretti and Wheeler, 2025), so they may also be willing to pay for increases in positive soundscapes. Moreover, current trends in biodiversity loss are bringing about changes in soundscapes whose contribution to well-being is unlikely to be recognized by environmental managers and policy-makers.

A growing literature in environmental psychology suggests that contemporaneous exposure to birdsong, and indeed to many other natural “soundscapes”, is associated with increases in indicators of mental well-being (Ratcliffe et al., 2020; Uebel et al., 2021; Uebel et al., 2025). This research shows the value of birdsong as a restorative environment to facilitate recovery after stress, to reduce anxiety, and improve mood (Ratcliffe et al., 2020). Quantifying the restorative value of birdsong relies on studies that assess the contribution of birdsong to recovery after a stressful situation (Ratcliffe, 2021). Exposure to nature sounds has been linked to faster stress recovery than environmental noise (Alvarsson et al., 2010), and natural soundscapes are generally rated as more restorative and preferred than urban soundscapes (Krzywicka and Byrka, 2017). A systematic review by Aletta et al.

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(2018) highlights associations between positive soundscape perceptions and health-related outcomes. Most directly related to birdsong, Ferraro et al. (2020) experimentally increased audible birdsong on walking trails and found positive effects on perceived biodiversity and self-reported well-being. These studies suggest that birdsong and other natural soundscapes can have psychological and experiential value, but they do not estimate willingness to pay. The value of birdsong may go beyond its function in stress recovery, or health outcomes. To provide an alternative perspective, we use a stated preference DCE to assess how birdsong contributes to the value people attribute to hypothetical habitat restoration projects which increase bird species diversity and abundance. That is, we ask the question: how does willingness to pay for habitat improvements change when people are exposed to the differences in natural soundscapes associated with these conservation investments?

The challenge addressed in this paper is to separate out the contributions to utility of birdsong, relative to the contribution due to the presence of birds in a specific habitat. There can be no bird song without birds, but we wish to estimate the *additional* value generated by acoustic exposure: additional, that is, to visual stimulus and a pure existence value. Here, we use constructed soundscapes generated from actual bird species distribution and abundance data for three habitat types in the UK. Soundscapes were produced for three levels of increasing ecosystem quality for each habitat type. These levels are designed to be consistent with the levels of the attribute "habitat quality" used in the DCE design. Our treatment sample could hear the differences in soundscape implied by their choices, while the control group could not. This approach helped us solve a basic design problem that there is no song without birds, whilst the presence and abundance of specific types of song depend on the availability of appropriate quality and type of habitat. Moreover, we also needed to capture what an assemblage of species sounds like, rather than individual species, since an experience of visiting any of our case study habitats typically consists of hearing multiple rather than single species.

Many studies have investigated people's WTP for changes in bird species distribution, and the opportunities to watch birds. For example, De Salvo et al. (2022), for example, examine specialised birders' preferences for birdwatching sites using latent class models, finding bird rarity and probability of seeing birds is important, Steven et al. (2017) estimate the WTP of birdwatchers for different experiences at specific locations (Australia and UK), using a bid vehicle of entry fees to the site. The attributes employed were the number of threatened species at a site, the presence of endemic species, and species diversity. Boeri et al. (2020) undertook a choice experiment for four attributes of coastal bird species in UK: the number of bird species (species richness), number of individual birds (abundance), the probability of seeing rare or unusual bird species, and the probability of seeing large flocks of birds (wildlife spectacles). A one-time donation is used as the bid vehicle. With respect to the sounds made by birds, we are only aware of one study which has included these in a stated preference design. King et al. (2025) combine a range of sources of natural sounds in UK woodlands set at "low", "medium" and "high" levels for UK forests. The authors note that…"*the mechanism for changes in the variety of sounds was described as changes to the management in the new woodland [that] could promote a greater variety of sounds, for example, more bird sounds. It could also include having more trees with broad leaves to increase rustling noises in the wind.*" Importantly, bird song was therefore only one component of these natural soundscapes, and sounds were played to all respondents. Results showed a negative WTP to move from "low" to "medium" soundscapes but a positive WTP to move from "medium" to "high", with the standard deviation estimates exceeding the mean for both level changes within a mixed logit model. However, the research design meant that no specific treatment effect of exposure to the natural soundscape could be estimated. Our work therefore represents the first estimate of the causal effect of auditory sensation on willingness to pay.

Our work can also be seen within the context of a literature on the effects of alternative framings of information on stated preferences for an environmental good. Our study uses two framings for changes in habitat quality and quantity: with and without birdsong. Other authors have shown framing effects to matter for the size of WTP estimates. For example, Eppink et al. (2019) showed that changes to how visual information was presented to respondents affects choice consistency in a DCE of lake water quality improvement, whilst Matthews et al. (2017) found that switching to a virtual reality tool for conveying information changed stated values for coastal erosion management in New Zealand. Our paper adds to this literature by investigating the effects of an acoustic framing of information on stated values for habitat conservation.

We believe that our work is interesting for three main reasons. First, giving people richer information allows us to disentangle the effects of habitat restoration more generally from the benefits of birdsong specifically. Respondents are unlikely to have thought about the implications of habitat restoration on birdsong, and would also find it hard to form a consistent prediction of what a new soundscape (associated with an investment in improvements to habitat quality and/or quantity) would sound like. Providing an acoustic framing may thus change preferences for habitat restoration. Second, the richer, more specific information given in the acoustic framing may also reduce measurement errors, because we make sure people have the same soundscape in their minds when making their choices. Otherwise, each respondent is likely to have imagined something different when presented with the same choice card. Third, we discuss a range of different potential mechanisms that might lead to changes in preferences. We find that treatment increased the closeness respondents felt between themselves and nature, and reduced the importance of the cost attribute, while increasing the importance of the habitat quality attribute, in their decisions.

2. Experimental design

To ascertain willingness to pay (WTP) for changes in bird habitat, and whether natural soundscapes influence this WTP, we carried out a split-sample Discrete Choice Experiment (DCE).

2.1. The sample

The survey was initially designed with experts in ecology and psychology along with subject matter experts in bird conservation. The sound design was based on successful design used in previous papers (Uebel et al., 2021, 2025). The survey was further improved after qualitative, "think out loud" interviews with two members of the public. Finally the pilot included open-ended questions for feedback which led to the final design.

Respondents were recruited online. The survey provider was Qualtrics LLC. Qualtrics was contracted to recruit a UK general-population online panel sample, with quota targets intended to approximate national representativeness by age, gender and region. Qualtrics applied provider-level quality-control checks as part of fieldwork. These included monitoring the data collection process, using attention filters and survey-timing checks, and conducting a standard data scrub to identify poor-quality responses. The data scrub reviewed whether respondents straight-lined through the survey, provided gibberish responses, or sped through the questionnaire. These include tools for identifying potentially fraudulent responses, duplicate submissions and bot activity. Survey was recruited to be representative of the UK population on gender, age, region and income. An initial pilot study of 100 respondents was undertaken, and feedback was sought on the attributes, the design and the credibility of the survey options. The main survey was then implemented in Winter 2024/5, using a web-based panel of respondents drawn from the UK population, $n = 1094$ (523 treatment, 571 control). Respondents were not aware of the subject of the survey before agreeing to participate. Study ethics application was approved by the Glasgow University College of Medical Veterinary and Life Sciences ethics committee, approval number 200230149.

We used a split-sample and randomised respondents into treatment and control. We also included a number of demographic questions. These included: respondent's postcode, whether they live in an urban or rural area, their age, education, and gender, how often they visit green spaces, and whether they have difficulty hearing. People with greater knowledge about birds may view them with greater affection (Cox and Gaston, 2015). We therefore also included a 10-question quiz on birds in the survey. This took the form of a picture of a bird and with multiple choices answers, where respondents were asked to identify the bird.[1] The score out of 10 was used as a proxy for the extent of bird knowledge of respondents. We further surmised that more sound-sensitive respondents could be more affected by the soundscape treatment. We therefore included the 5-question noise sensitivity index of Benfield et al. (2014). This gives a score of 0–30, with 30 being the most sensitive to noise. We present summary statistics for our sample in the appendix in table A1 and show UK population figures beside our sample figures.

2.2. Generation of soundscapes

As noted above, we made use of a split-sample treatment. In the treated sample, respondents were prompted to listen to 25-s audio clips of simulated soundscapes. In the control sample, this option was not available (Fig. 1). Two soundscapes accompanied each choice card: one representing an avian soundscape in the baseline situation, and one representing an avian soundscape in a management alternative which improved the quality of the habitat in question (described below), thus changing the population of birds which could be heard there.

Sound files were constructed using two sources of data: the BTO/JNCC/RSPB Breeding Bird Survey (BBS) and Xeno-canto, an online repository hosting recorded bird sounds from all over the world (www.xeno-canto.org). The BBS is an annual UK bird survey running since 1994, with volunteers visiting specific 1-km grid squares twice in the breeding season (March–June) (Freeman et al., 2007). They record the species and numbers of birds found (both visually and aurally), and the habitat in which each was detected. These data are aggregated and used to monitor population trends in UK bird species.

We extracted habitat-specific species lists for the three focal habitats in our survey (broadleaved woodland, semi-natural grassland, and farmland arable) from the BBS data. We then downloaded, processed, and standardised sound files from Xeno-canto for each of these species (see Morrison et al., 2021, Uebel et al., 2025, and Uebel et al., 2026 for details). Secondly, we quantified average species richness for each focal habitat in each BBS square where that habitat occurred to identify three levels of *quality*, with the top two deciles of species richness taken to represent high quality, the middle two deciles as medium quality and the bottom two deciles as low quality. Finally, for each focal habitat we ranked species in order of prevalence according to the average number of individuals detected in each focal habitat in each BBS square where that habitat occurred.

For each quality level in each habitat we then constructed a 25-s soundscape for use in the "treated" sample, with which respondents in this sample could compare the baseline soundscape for that habitat with an improved level of quality. Low quality soundscapes contained one species, medium quality soundscapes contained two species, and high quality soundscapes contained four species. The species included were the most prevalent one, two or four species in the relevant habitat-quality species lists. We created the soundscapes by inserting a randomly selected downloaded sound file for each predetermined species into a 25-s file, with playback volume selected at random from a uniform distribution to simulate birds at different distances from the observer. This gave us three quality levels for each of the three habitats, making nine sound clips in total. The sound clips are available in the online appendix.

2.3. The hypothetical market

Respondents were confronted with a number of conservation choices set in the context of habitat restoration in the UK. Three habitat types were selected, on the basis that examples of each can be found in much of the UK: broadleaved woodland, semi-natural grassland and arable farmland. Respondents were told that "…*this survey is about the restoration of wild bird habitats. In particular, those of songbirds. In the UK, 70 of over 200 wild bird species are on the 'red list'. This means their survival in the UK is under threat. In this survey we are interested in your opinions about the restoration and protection of wild bird habitats*". For each habitat type, simple information was conveyed on current threats to their status, and on the types of birds found therein (see Table 1). Respondents were then told that their local Wildlife Trust could take actions to improve both the quality and quantity of these focal habitats locally and thereby improve the conservation status of birds nesting in those habitats: "*This survey explores opinions about possible actions to improve and extend bird habitats in your county*." They were also told that without such actions "…*bird numbers and habitat size for many species will continue to decline*".

Funding of Wildlife Trusts in the UK is mainly through charitable donations. We thus used a donation to the Wildlife Trust as the payment vehicle in the stated preference exercise, through which better habitat quality/higher habitat quantity could be purchased by the respondent. Since voluntary donations are known to not be demand-revealing (Johnston et al., 2017), we made use of a provision point mechanism (PPM). PPMs are a form of voluntary contribution where if a threshold is not met, the good or service is not provided. In this case, we focus on the public good of increased quality and quantity of bird habitats. A PPM has been shown to improve the demand-revealing properties of voluntary payment mechanisms (Bush et al., 2013); and has also been shown to reduce "protest" answers where those who do not trust government will always vote for the status quo no matter the change in attributes of the alternative option (Cunha-e-Sá et al., 2024). Respondents were thus told:

"In this survey you will be asked about proposed projects to improve bird habitats in the UK. This will involve improving the amount of species in the habitat by improving its quality, and extending the size of the habitat. The amount of improvement in how many different bird species you could find in this area (what ecologists call 'species richness') or habitat size varies depending on the projects. Each project has an associated cost. Costs are met by donations by members of the public. ***There is a threshold of donations needed for the project to be carried out.*** *Once the initial project is completed it can be maintained through existing reoccurring donations. This means that the Wildlife Trust requires enough one-off donations from enough people to carry out a project to improve the habitat quality or size.* ***If the threshold is not met the project could not be carried out.****"* (bold text as per actual survey instrument).[2]

The pilot study indicated information on quantity improvements in habitats was well understood, but quality improvements less so. We therefore added even more detailed information, based on actual Wildlife Trust actions and ecological experts views, the exact type of improvement each habitat could see to improve quality (see Table 1 for details saw).

We also attempt to minimise bias from our hypothetical market design by using an honesty elicitation mechanism that asks respondents to answer truthfully (Jacquemet et al., 2013). We included follow-up

[1] The bird quiz was developed by D.J Gains and published under Creative Commons Attribution License (CC BY 3.0).

[2] Note the "and" in "…its quality, and extending the size of the habitat" should be an "or" as is presented in the choice cards, but the typo remained in the original survey so we include it verbatim here. This could potentially have led to some confusion for respondents.

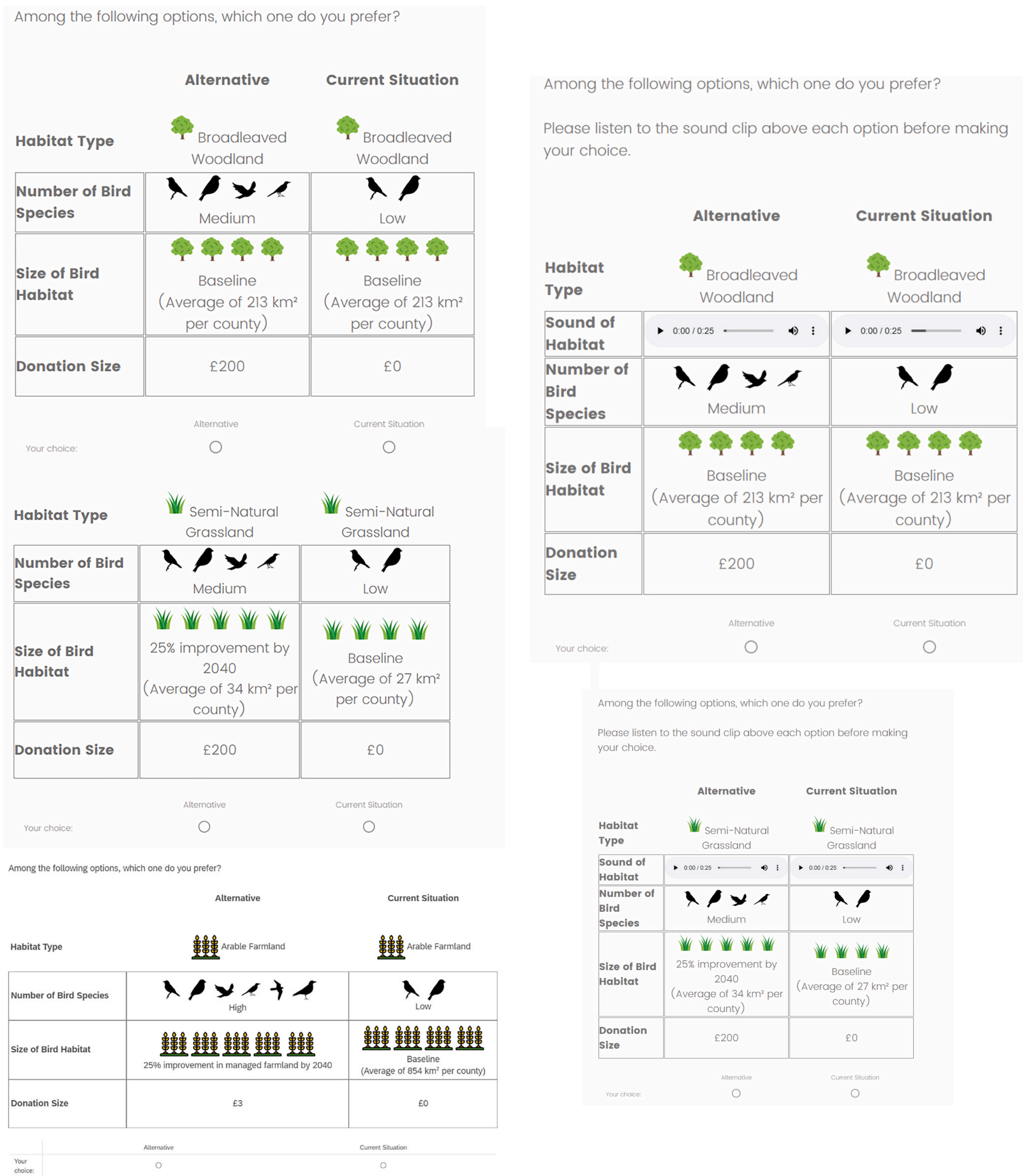

Fig. 1. Example choice cards with no exposure to soundscapes (control group). (b) Example choice cards for treated sample, with exposure to soundscapes.

questions at the end of the survey on respondents' views on the credibility of the donation scenarios used in the survey. We also include a respondent attention score following the method proposed by Kane and Costa (2024). Inattention in online surveys can lead to attention bias and low-quality responses (Berinsky, 2014). We therefore include an attention check to check the quality of the sample and see if high attention responses are different. The attention check consists of showing an example choice card to each respondent. After they make their choice, they are asked three questions about the levels taken by the attributes on that card. The attention score is the number of questions they get correct, from 0 to 3. We consider scores of 2 and 3 as high attention and 0 and 1 as low attention.

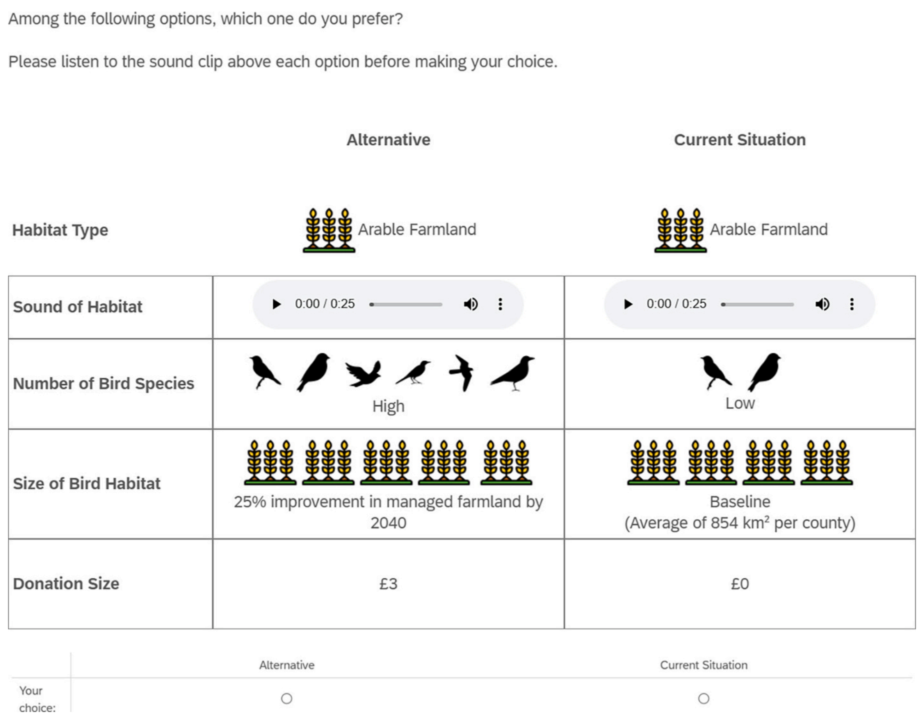

Fig. 1. (*continued*).

Table 1
Information provided on habitat types used in survey.

Habitat type	Text provided to respondents
Broadleaved woodland	Broadleaved woodland covers around 7.5% of England. Much woodland was cleared to make room for agriculture, or planted with conifers but the extent is now stable. Broadleaf woodland species include many native songbirds such as: the robin, blackbird, song thrush, as well as summer migrants like spotted flycatchers, redstarts, cuckoos and winter migrants like redwings, waxwings, hawfinches. The wildlife trust could improve the quality of this habitat for birds by management to control deer grazing, retaining standing and fallen dead wood, and reducing disturbance from humans.
Semi-natural grassland	This habitat consists of grassy vegetation normally less than 1 m high. It is often used to provide feed for livestock and makes up about 1% of the area of England. This grassland has been affected by intensive grazing, leading to the loss of many species over the last 70 years. Grassland bird species include: curlew, yellow wagtail, starling, meadow pipit, snipe, lapwing, golden plover, and barn owl. The Wildlife Trust could improve grassland quality by controlling livestock density and grazing, reducing chemical use, and helping the land retain more moisture.
Arable Farmland	Arable farmland covers about 26% of England, mostly in the East and South-east. Agricultural intensification has reduced biodiversity, with a 60% decline in farmland birds over the past 50 years. Species found here include skylark, yellowhammer, grey partridge, and linnet. The Wildlife Trust could help improve the quality of this habitat by working with farmers to create field margins, set-aside land, hedgerows, and reduce chemical use.

2.4. The choice tasks

All respondents were shown 8 choice cards. On each choice card there were 2 options: an “Alternative” and the “Current Situation”. The “Current Situation” had zero cost (donation amount). For each habitat type, choices were described by three attributes: “Number of Bird Species”, “Size of Bird Habitat”, and “Donation size”. For brevity, we refer to these from now on as “Quality”, “Quantity” and “Cost”. The attributes were chosen in consultation with experts in ecology, psychology and economics, and further informed by results of the pilot. The levels of each attribute are shown in Table 2. We show example choice cards in Fig. 1. Choice profiles were generated using Ngene to construct a D-efficient design. Each respondent completed 8 choices out of a possible 12. These 12 choices were split into 3 blocks of 4 questions. Each respondent was first shown an example question from one habitat, then two random blocks from the other two habitats, with 4 choice tasks for each habitat type. This allowed us to see if WTP varied by habitat type. We carried out power calculations based on the guidelines in Rainey (2025). Our calculations, based on our assumptions, gave us 80% power for a minimal detectable effect of £28 difference in willingness to pay between the treatment and control groups.

We randomised whether respondents were in the treatment or control group. The control group was shown only text and images, while the treatment group was provided with soundscapes which matched (i) the status quo habitat quality and (ii) habitat quality in the specific alternative in each choice card. Respondents were asked to…. “*Make sure you are in a quiet place before carrying out the survey because you will have two sound clips on every choice. These reflect the sound of the habitat and are based on the quality of that habitat. Before listening to the sound recordings we would like you to calibrate the volume on your computer so that it is at a comfortable level. Please click play and listen to the below test recording and adjust your volume so that you can hear the speech as if the person were talking next to you. Using headphones is also much preferred over earphones if you have access to these.*”

Crucially, soundscape variation was entirely determined by the quality attribute, as in when quality (species diversity) is “high”, then the sound file will be of the “high” type. Thus, there was no variation in

Table 2
Attribute Levels used in choice experiment design.

Attribute	Levels
Number of Bird Species	High, Medium, Low
Size of Bird Habitat	25% improvement by 2040, 10% improvement by 2040, Baseline
Donation Size (once-only)	£200, £150, £10, £3

the soundscapes which respondents were exposed to which depended on variation in the quantity of each habitat protected in the relevant choice profile: variations in soundscapes depended entirely on variations in habitat quality, as proxied by species diversity.

2.5. Econometric model

As is standard in choice experiments, we follow the random utility model. We assume utility is derived from a deterministic component and a stochastic component. When given the choice between options, respondents are assumed to choose the option that gives them the highest utility, where the utility of each choice is determined by its attributes, as shown in Eq. (1).

$$U_{ij} = \boldsymbol{\beta}_i^{\prime}\boldsymbol{x}_{ij} + \boldsymbol{\gamma}^{\prime}\boldsymbol{z}_i + \epsilon_{ij} \tag{1}$$

where U_{ij} is the utility of choosing option j for individual i, $\boldsymbol{x}_{ij}$ is a vector of attributes for each choice, $\boldsymbol{\beta}_i^{\prime}$ is a vector of random coefficients on the attributes that vary for each individual and we assume $\boldsymbol{\beta}_i \sim N(\boldsymbol{\Theta}, \boldsymbol{\Sigma})$, $\boldsymbol{z}_i$ is a vector of socio-economic variables such as age and income, $\boldsymbol{\gamma}$ fixed coefficients for these, and ϵ_{ij} the stochastic component of utility not determined by the variables in our model.

For our main results we use a mixed logit model, where the probability of choosing option j is given by P_{ij} and is estimated with the integral in (2).

$$P_{ij} = \int \prod_{t=1}^{T} \frac{\exp\left(\boldsymbol{\beta}_i^{\prime}\boldsymbol{x}_{ij} + \boldsymbol{\gamma}\boldsymbol{z}_i\right)}{\sum_k \exp\left(\boldsymbol{\beta}_i^{\prime}\boldsymbol{x}_{ik} + \boldsymbol{\gamma}\boldsymbol{z}_k\right)} f(\beta_i\theta, \sigma) d\beta \tag{2}$$

Our random coefficients are assumed to follow normal distributions. The donation size coefficient is fixed in our main estimates, as otherwise there can be complications in model convergence (Train and Weeks, 2005). We use maximum likelihood estimation to estimate both the mean of each random parameter and the standard deviation. We take 1000 draws per random parameter/individual.

When we estimate in WTP space we multiply all choice coefficients by the cost coefficient. We assume the cost coefficient follows a log-normal distribution.

2.6. Estimand

Given we prompt respondents to listen to sounds but cannot observe them actually listening to the sounds in their homes, we cannot directly estimate an average treatment effect (ATE), or local average treatment effect (LATE) without making assumptions about treatment compliance. However, we still estimate a causal estimand, namely the Intention to Treat Effect (ITT), the effect of being assigned to treatment. The ITT is less than or equal to the ATE and LATE if the relevance and exclusion restriction assumptions are met.[3] This would mean our estimates are attenuated compared to if all respondents had listened to the sound. Relevance is met if a non-zero share of people actually listened to the sound. It is possible the exclusion restriction, that assignment to treatment only influences the choices through sound, may not be true for some participants. Just having an extra box that shows the sound can be listened to may increase willingness to pay as well. In this case the causal treatment effect is a combination of hearing sounds and seeing sound is available on the choice card.

[3] The other assumptions are automatically satisfied through the study design namely: independence (we assigned people randomly to arms), monotonicity (treatment can only increase probability of hearing our sounds, not decrease it because otherwise they cannot access the sounds), stable unit treatment value (assignment does not change respondents' ability to influence outcomes of other respondents during the survey).

3. Results

In our sample, 73% of respondents had high attention (two or more attention questions correct) with almost half the sample (47%) getting two questions correct. 27% were low attention. This is in line with the results for Kane and Costa (2024), therefore we consider the panel to be of sufficient quality. The high attention percentage was similar in Treatment and Control (75% high attention in Control and 72% in Treatment). We consider our preferred results to be the high attention sample (greater than 1 score on attention check). However, we also estimate separate models for the full sample and get similar results.

In the appendix (table A2) we show results from a balance test according to the method in Hansen and Bowers (2008). The results indicate there is no evidence of differential attrition between the treatment and control groups. We nevertheless include all our demographic variables in our choice models to aid precision and explore preference heterogeneity.

Following Swait and Louviere (1993), we estimated three nested pooled mixed logit models to test whether treatment affects a scale parameter (are preferences more or less certain under treatment) as well as the standard taste parameters (does treatment change preferences). The three models were: a full model allowing both scale and taste shifts, a scale-only model restricting preferences to be equal across groups, and a taste-only model fixing the scale parameter at unity. Likelihood ratio tests reveal that taste shifts are jointly significant beyond any scale differences (LR = 79.98, 10 df, $p < 0.001$), while the scale parameter is not significant once taste shifts are accounted for (LR = 1.47, 1 df, $p = 0.23$). We therefore adopt the taste-only specification as our preferred model in all cases. This model fits as well as the unrestricted model while being more parsimonious, and yields a cleaner interpretation in which treatment-control differences are attributable to genuine preference shifts rather than differences in choice consistency. This is consistent with the view that the treatment altered respondents' valuations of birdsong attributes, rather than simply making their choices more or less certain.

In Table 3 we present the results for our full sample main specification models. This includes both a simple conditional logit and a mixed logit for both the treatment group and the control group. We see that in all models each attribute affects utility in the expected direction: increased cost decreases the utility of a choice, both medium and high quality are preferred to the “status quo” of low quality, and the same is true for quantity. The coefficients on the high and medium values of the attributes are similar to each other, indicating that perhaps respondents value moving away from low quality or quantity but are relatively insensitive to the values beyond this.

Examining the treatment effect, we can see in the third column of Table 3 the difference between coefficients in the treatment and control samples for the conditional logit models. We also carry out a Wald test to see if the differences are statistically significant. The difference in the cost and high-quality coefficients are significantly different. The absolute difference in cost is quite large, with the control group perceiving costs to be more important in decreasing the utility of an option. In column six of Table 3, we repeat the exercise for the mixed logit model. Again, the cost coefficient for the control group is more than twice as large in magnitude and significantly different. There are larger differences between the coefficients in the mixed logit compared to the conditional logit, but only the difference in the quality and cost coefficients are statistically significant. We see no significant differences in the standard deviation estimates of the random parameters between treatment and control. We can also see in Fig. 2 that the treatment lowers the alternative specific constant (asc). The asc is difficult to interpret but it would mean that if status quo and alternative on the choice card had all the same attribute values, the treated group would be slightly less likely to choose the alternative. This is interesting as the treated group chose the alternative 69.5% of the time, while the control group chose it 65.7% of the time. Therefore although the treated group chose the alternative

Table 3
Pooled MNL and mixed logit taste-only model, full sample.

Parameter	Pooled MNL		Pooled mixed logit	
	Control	Treatment effect	Control	Treatment effect
Alternative Specific Constant	−0.2782 (0.4600)	−0.4673* (0.2750)	0.5162 (0.6347)	−1.0247** (0.4040)
Quality-Medium	0.8669*** (0.1118)	0.1875 (0.1663)	1.1146*** (0.1647)	0.4904* (0.2537)
Quality-High	0.7991*** (0.1067)	0.2917* (0.1590)	0.9640*** (0.1584)	0.5754** (0.2414)
Quantity-Medium	0.3473*** (0.1023)	0.0036 (0.1518)	0.5437*** (0.1491)	0.0853 (0.2235)
Quantity-High	0.4059*** (0.0839)	−0.0435 (0.1278)	0.5737*** (0.1291)	0.0166 (0.1983)
Donation Size	−0.0071*** (0.0006)	0.0042*** (0.0008)	−0.0112*** (0.0010)	0.0069*** (0.0013)
SD Quality-Medium			1.7259*** (0.1696)	0.0589 (0.2465)
SD Quality-High			1.5768*** (0.1692)	−0.0691 (0.2319)
SD Quantity-Medium			1.0740*** (0.1797)	−0.2206 (0.2597)
SD Quantity-High			0.6789*** (0.2034)	−0.0487 (0.3130)
Log-likelihood	−4858.91		−4573.00	
N (observations)	8752		8752	
K (free params)	50		58	
AIC	9817.83		9262.00	
BIC	10,171.68		9672.47	

Notes: Estimates are from pooled multinomial logit and pooled mixed logit taste-only models for the full sample. The Control columns give baseline coefficients for the control group. The Treatment effect columns give treatment-shift coefficients, so treatment-group coefficients equal Control plus Treatment effect. Mixed logit SD rows report estimated standard deviations of random parameters and are not applicable to the MNL model. Robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

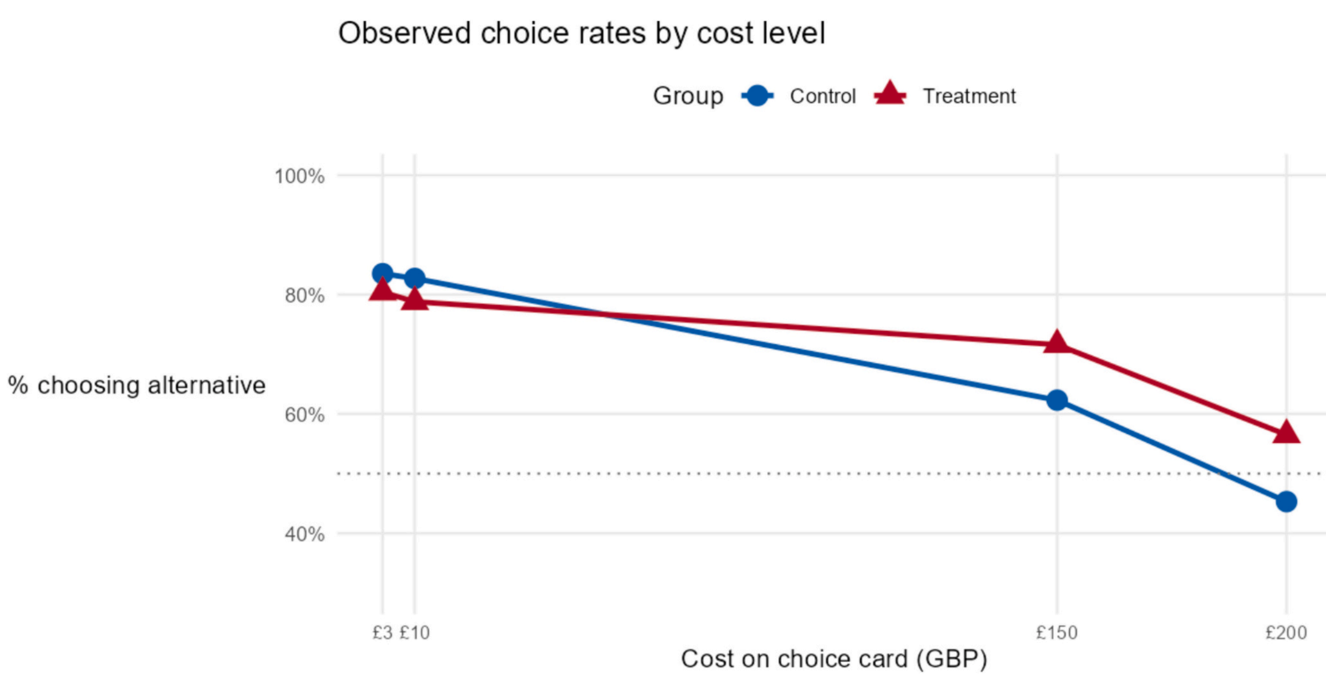

Fig. 2. Probability of Choosing Alternative Against Cost.

more often, they have a lower asc. We can see in Fig. 2 that at low cost levels, the treated group chose the alternative less, whereas at high cost levels they chose it more. There may be some treatment effect in lowering the asc, that is dominated as costs get higher and the lower treatment group cost coefficient matters more.

Overall, our results suggest the treatment of playing birdsong causes respondents to be less sensitive to costs in making their choices and rate quality changes from the status quo more highly. In Fig. 3 we plot the coefficients and 95% confidence intervals for our preferred mixed logit specification.

In Table 4, we carry out the same exercise but only for high attention respondents (those that scored 2 or more in the attention check questions). The results are qualitatively similar, but in almost all cases the magnitudes of the coefficients are larger in the high attention sample. Similarly, the treatment effects tend to be larger between treatment and control when we use the high attention sample. A final difference is that all the differences between treatment and control for the habitat *quality* coefficients are significant at the 1% level, but for *quantity* the differences are still not statistically significant. This suggests that not only are high attention respondents in the treatment group less sensitive to cost than the control group (similarly to the full sample results), but the treatment also causes them to perceive the quality attribute as giving more utility. These results are also plotted for the mixed logit model in Fig. 4.

Finally, in Table 5, we look at the difference in coefficients in willingness to pay by dividing the negative of the pooled model coefficient by the cost coefficient. We see that the treatment group has much higher point estimates of WTP for all attributes, in both high attention and full sample. Even though the difference between cost coefficient was higher in preference space in the pooled sample, there is little difference in overall WTP. In summary, exposure to bird song has a large and statistically significant effect on people's WTP for an improvement in habitat

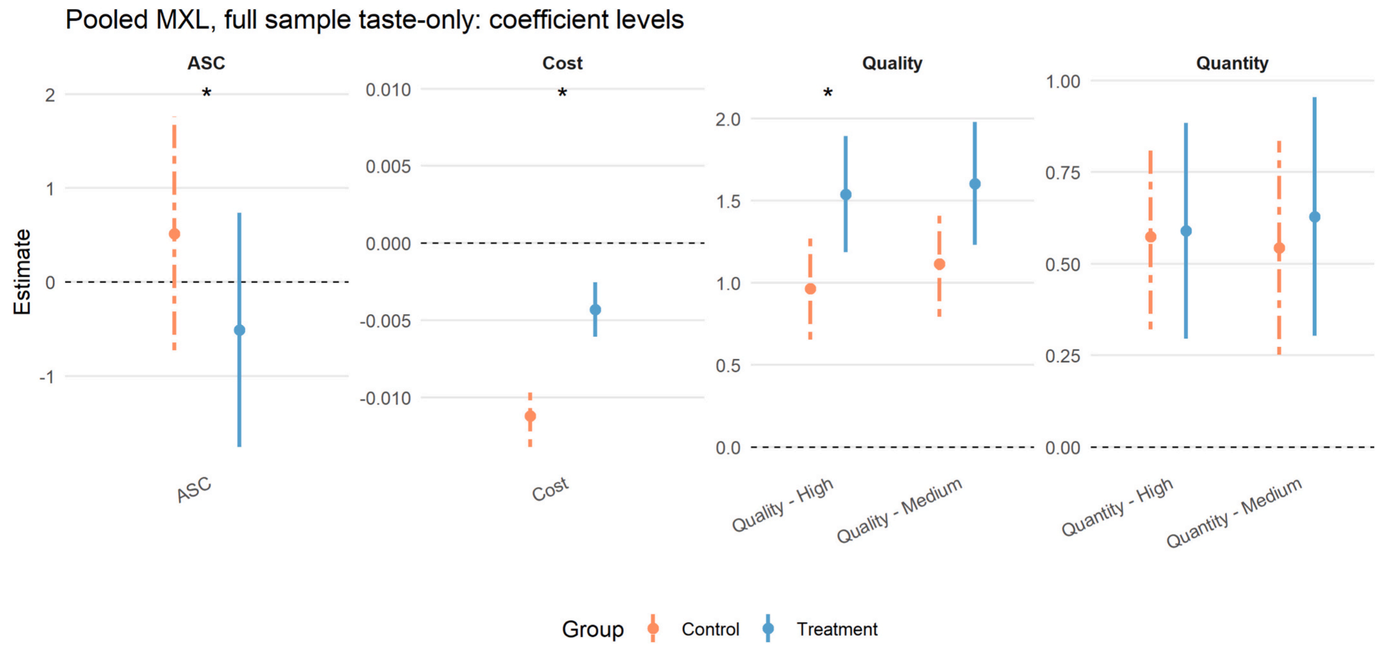

Fig. 3. Preference Coefficients, Mixed Logit Model, Full Sample. Notes: Points show coefficient estimates from the pooled mixed logit taste-only models. Error bars show 95% confidence intervals based on robust standard errors. Treatment coefficients equal the control coefficient plus the estimated treatment-shift coefficient. Asterisks indicate treatment-control differences significant at the 5% level.

Table 4
Pooled MNL and mixed logit taste-only model, high-attention sample.

Parameter	Pooled MNL		Pooled mixed logit	
	Control	Treatment effect	Control	Treatment effect
Alternative Specific Constant	−0.2262 (0.9068)	−0.8758*** (0.3346)	1.5408 (1.2247)	−1.8371*** (0.5428)
Quality-Medium	0.9094*** (0.1309)	0.4221** (0.2009)	1.1940*** (0.2220)	0.9691*** (0.3548)
Quality-High	0.9307*** (0.1219)	0.4731** (0.1887)	1.1115*** (0.2071)	0.8768*** (0.3259)
Quantity-Medium	0.3040** (0.1199)	0.0674 (0.1805)	0.5791*** (0.1935)	0.1875 (0.2901)
Quantity-High	0.4260*** (0.0965)	−0.0198 (0.1459)	0.7256*** (0.1730)	−0.0494 (0.2549)
Donation Size	−0.0100*** (0.0008)	0.0060*** (0.0011)	−0.0170*** (0.0016)	0.0107*** (0.0020)
SD Quality-Medium			2.3864*** (0.2540)	−0.1149 (0.3668)
SD Quality-High			2.1402*** (0.2527)	−0.4986 (0.3198)
SD Quantity-Medium			0.7744** (0.3626)	0.1947 (0.4320)
SD Quantity-High			−0.4730 (0.4048)	1.0480* (0.5363)
Log-likelihood	−3228.79		−2981.62	
N (observations)	6400		6400	
K (free params)	50		58	
AIC	6557.58		6079.24	
BIC	6895.78		6471.56	

Notes: Estimates are from the high-attention taste-only pooled, multinominal logit and mixed logit model. The Control column gives baseline coefficients for the control group. The Treatment effect column gives treatment-shift coefficients, so treatment-group coefficients equal Control plus Treatment effect. Robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

quality, with most of this difference being due to the effects of treatment (exposure to sound) on their sensitivity to the cost of the conservation action. Overall, our results show respondents are willing to pay more for the same set of attributes when they can hear the changes in birdsong that might accompany them and that most of the WTP amount can be attributed to this aural effect.

3.1. Difference by habitat

We next examine whether there are differences in preferences across habitat types. As explained in section 2, each respondent was given four choice tasks per habitat for a random selection of two habitats out of a possible three (Woodland, Grassland, and managed Farmland). We test whether respondents exhibit different preferences for quality and quantity depending on the habitat type, and whether the treatment effect differs across habitats. We show overall results in Table 6, we plot the results from mixed logit models for cost in Fig. 5, for the quality coefficients in Fig. 6, and for quantity in Fig. 7.

We can see in Fig. 5 that the coefficients are very different for the control group across the three habitats, but all are similar in magnitude for the treatment group. However, for woodland, the difference between treatment and control is not statistically significant at the 5% level (although it is at the 10% level). For quality (Fig. 6), there is little difference between treatment and control except for farmland, where the treatment group values high quality more than the control group. For quantity (Fig. 7), there are some clear differences across habitats, with grassland quantity having less value to respondents. In woodland, the treatment seems to reduce the coefficient on quantity. In summary, without sound, the biggest difference in habitats was in the cost coefficients, with sound treatment leads to all habitat types having similar cost coefficients. We suggest this means the biggest effect of aural treatment is on changing sensitivity to costs. We also see much lower

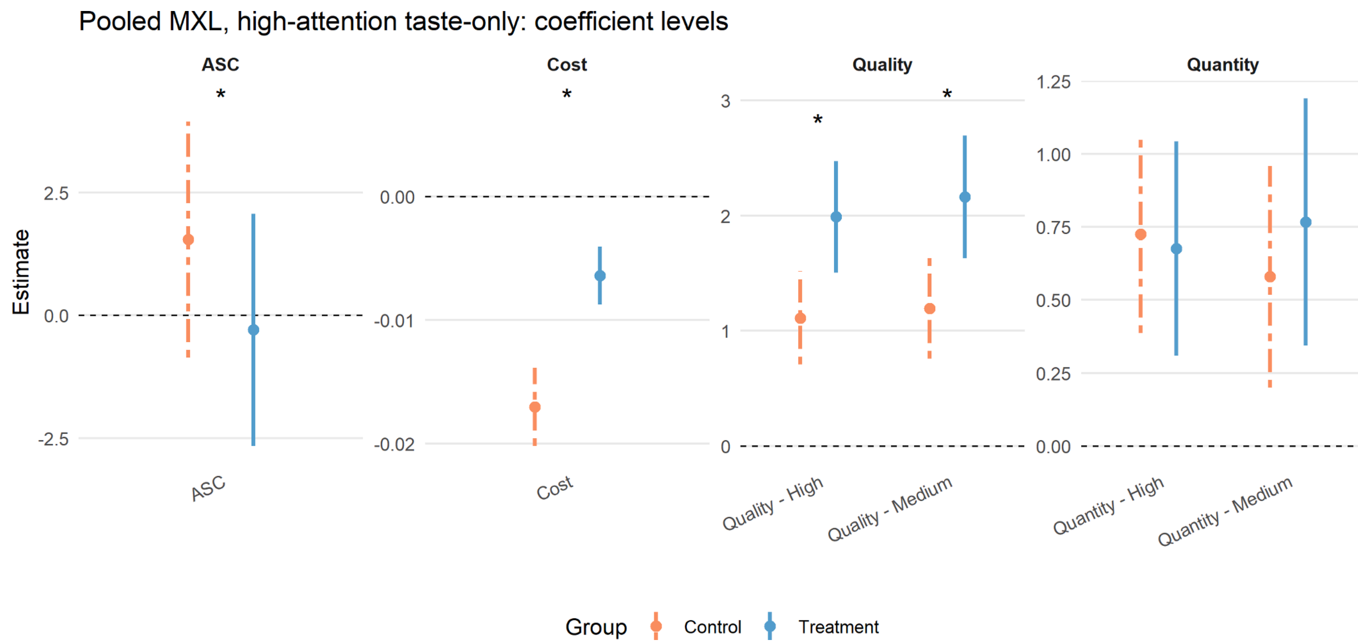

Fig. 4. Preference Coefficients, Mixed Logit Model, High Attention Sample. Notes: Points show coefficient estimates from the pooled mixed logit taste-only models. Error bars show 95% confidence intervals based on robust standard errors. Treatment coefficients equal the control coefficient plus the estimated treatment-shift coefficient. Asterisks indicate treatment-control differences significant at the 5% level.

Table 5
WTP from pooled mixed logit taste-only models, £.

Pooled mixed logit				
Sample	Attribute	Control WTP	Treatment WTP	Treatment effect
Full sample	Quality-Medium	99.5*** (19.8)	376.0*** (103.7)	276.5*** (105.5)
Full sample	Quality-High	86.0*** (18.8)	360.6*** (100.6)	274.6*** (102.4)
Full sample	Quantity-Medium	48.5*** (15.6)	147.3** (59.3)	98.8 (61.3)
Full sample	Quantity-High	51.2*** (13.8)	138.3** (54.4)	87.1 (56.1)
High-attention sample	Quality-Medium	70.2*** (15.7)	340.2*** (87.5)	270.1*** (88.9)
High-attention sample	Quality-High	65.3*** (14.9)	312.7*** (81.9)	247.4*** (83.3)
High-attention sample	Quantity-Medium	34.0*** (12.6)	120.6** (48.2)	86.5* (49.7)
High-attention sample	Quantity-High	42.6*** (11.6)	106.4** (41.6)	63.7 (43.2)

Notes: WTP values are calculated from the pooled mixed logit taste-only models. The treatment effect is Treatment WTP minus Control WTP. Standard errors use the delta method. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

effects in woodland for cost, which are not statistically significant at the 5% level. Different habitats have different soundscapes so it may be expected that effects are heterogenous. It is also possible, given attenuated control cost coefficient, that people are already less cost-sensitive for woodland, so treatment makes no difference, whereas it makes the biggest difference for farmland.

4. Potential mechanisms

Our results show that the treatment group has a difference in willingness to pay for bird habitat improvements, mainly due to a lower cost coefficient. Here we offer some suggestions on why that difference might occur.

How might the playing of the soundscapes affect people's choices? It could be a framing effect. Lades et al. (2025) review the behavioural economics literature on stated and revealed preference elicitation, finding choices can depend on the context (i.e. the frame) in which they are made. For example, marketing literature has found that playing sounds can make a difference in what, and how much people buy (North et al., 1999; North et al., 2003; Spendrup et al., 2016). We ask some debriefing questions about what the respondent considered important when they made their choices (Fig. 8). In all cases, the treatment group was less likely to consider any attribute important. The biggest difference is on the cost attribute. This could potentially be down to a framing effect.

Listening to the sound clips might have reduced the use of cognitive shortcuts in the treatment group. This could include negativity bias, i.e. giving disproportionate weight to negative information such as the payment vehicle (Watanabe et al., 2019). As shown in Fig. 8. when asked which attribute was important for their choice, respondents in the control group chose cost more than any other attribute. This was not true in the treatment group.

Alternatively, respondents in the treatment group may consciously place less weight on other aspects of their choice because the sounds make them feel more connected to nature. Connectedness to nature is associated with more environmentally responsible behaviour (Frantz and Mayer, 2014; Mackay and Schmitt, 2019; Whitburn et al., 2020). We asked a question about how respondents view themselves and nature (their relationship with nature), and results are shown in Fig. 9. The treatment group was more likely to view themselves in the top two "most connected to nature" categories than the control group (see Fig. 10).

An important theoretical perspective in the environmental psychology literature highlights the well-being effects of natural soundscapes based on attention restoration theory (Ratcliffe et al., 2013). Attention restoration theory (Kaplan and Kaplan, 1989; Kaplan, 1995) suggests that exposure to nature replenishes the limited cognitive resources we need for more focused attention (Berman et al., 2008). Listening to before-and-after soundscapes in the choice experiment might thus improve respondents' directed-attention with regard to other information in the choice tasks, and might therefore reduce the use of cognitive shortcuts. However, we see no real difference in the proportion of "high

Table 6
Habitat-specific pooled mixed logit taste-only models.

Habitat	Parameter	Control	Treatment effect
Woodland	ASC	−1.5828 (1.1260)	−0.1517 (0.8662)
Woodland	Quality-Medium	2.3413*** (0.4427)	0.0963 (0.5335)
Woodland	Quality-High	1.6541*** (0.3435)	0.5381 (0.4716)
Woodland	Quantity-Medium	1.7459*** (0.3873)	−0.6114 (0.5196)
Woodland	Quantity-High	1.3168*** (0.3198)	−0.5550 (0.4423)
Woodland	Donation Size	−0.0071*** (0.0017)	0.0039* (0.0023)
Woodland	SD Quality-High	1.5178*** (0.3240)	–
Woodland	SD Quality-Medium	2.6557*** (0.3719)	–
Woodland	SD Quantity-Medium	1.8449*** (0.3315)	–
Woodland	SD Quantity-High	1.0682*** (0.3291)	–
Grassland	ASC	−0.7594 (1.0418)	−1.3386* (0.7524)
Grassland	Quality-Medium	1.0873*** (0.3142)	0.6958 (0.4406)
Grassland	Quality-High	1.1913*** (0.2700)	0.4305 (0.4008)
Grassland	Quantity-Medium	0.1840 (0.2626)	0.3035 (0.4188)
Grassland	Quantity-High	0.3001 (0.2120)	0.5215 (0.3683)
Grassland	Donation Size	−0.0117*** (0.0016)	0.0078*** (0.0021)
Grassland	SD Quality-Medium	1.6013*** (0.2472)	0.0000
Grassland	SD Quality-High	1.5208*** (0.2829)	0.0000
Grassland	SD Quantity-Medium	1.1649*** (0.2330)	0.0000
Grassland	SD Quantity-High	0.9918*** (0.3071)	0.0000
Farmland	ASC	2.1474* (1.2304)	−1.9068** (0.8073)
Farmland	Quality-Medium	0.9064*** (0.3433)	0.8903* (0.4780)
Farmland	Quality-High	0.5970** (0.2987)	1.1164** (0.4512)
Farmland	Quantity-Medium	0.5650 (0.3468)	0.6420 (0.4711)
Farmland	Quantity-High	0.6111** (0.2771)	0.1245 (0.3873)
Farmland	Donation Size	−0.0167*** (0.0022)	0.0106*** (0.0024)
Farmland	SD Quality-Medium	2.0933*** (0.3099)	–
Farmland	SD Quality-High	1.7804*** (0.3076)	–
Farmland	SD Quantity-Medium	1.9977*** (0.3119)	–
Farmland	SD Quantity-High	0.8907*** (0.3335)	–

Notes: Estimates are from habitat-specific pooled mixed logit taste-only models. Treatment shifts in random-parameter standard deviations were fixed at zero in the habitat models. The Control column gives baseline coefficients for the control group. The Treatment effect column gives the corresponding treatment-shift coefficient, so treatment-group coefficients equal Control plus Treatment effect. Robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

attention" respondents in treatment or control.

We also observe that 85% of people in the treatment group responded that they viewed the choices as "credible" or "very credible", compared to 78% in the control group. This may be down to the experience-description gap. Experiencing the change in soundscape perhaps made the intervention more credible.

We test these mechanisms with a simple OLS regression on of the treatment assignment indicator on each mechanism variable. The results in Table 7 show that increasing the connection between self and nature, increasing the importance of the quality attribute, and lowering the importance of the cost attribute, are statistically significant, which suggests these mechanisms may be important.

Other possible mechanisms exist which we cannot test for. These include respondents in the treatment group responding from experienced utility rather than decision utility perspective, which can lead to different effects in stated preference elicitation (Tinch et al., 2014); users in the treatment group may be getting "use-value" from the sounds and therefore this is in addition to the "non-use" value; or that there is an extra information effect due to exposure to sound, which can also affect stated preference estimates of willingness to pay (Needham et al., 2018). Furthermore, exposure to soundscapes may introduce a use-value component that is not present for the control group. By listening to the clips, respondents experience part of the good itself, which may shift their responses away from a strictly non-use valuation. Our experiment still estimates the effect of sensory framing, but we recognise that this framing may not just be based on non-use values. This would still be informative for understanding how richer representations of environmental change can shape stated preferences.

5. Discussion and conclusion

Economic valuation studies might undervalue habitat restoration projects if preferences for changes to the natural soundscape are not accounted for. One way in which such preferences might be accounted for is through the use of sensory information. To assess the potential significance of this omission, we conducted a stated preference DCE to estimate the economic value of birdsong, as proxied by willingness to pay for changes in three habitat types in the UK, which included a treatment group who received auditory information accompanying each choice. We thus provide the first estimate of the causal effect of aural information on willingness to pay, and the first estimate of the marginal willingness to pay for birdsong.

We found that respondents in the treatment group WTP values four or five times higher for habitat restoration than the control group. Although we did not find such strong effects for the woodland habitat when we disaggregated by habitat. Our paper thus has implications for

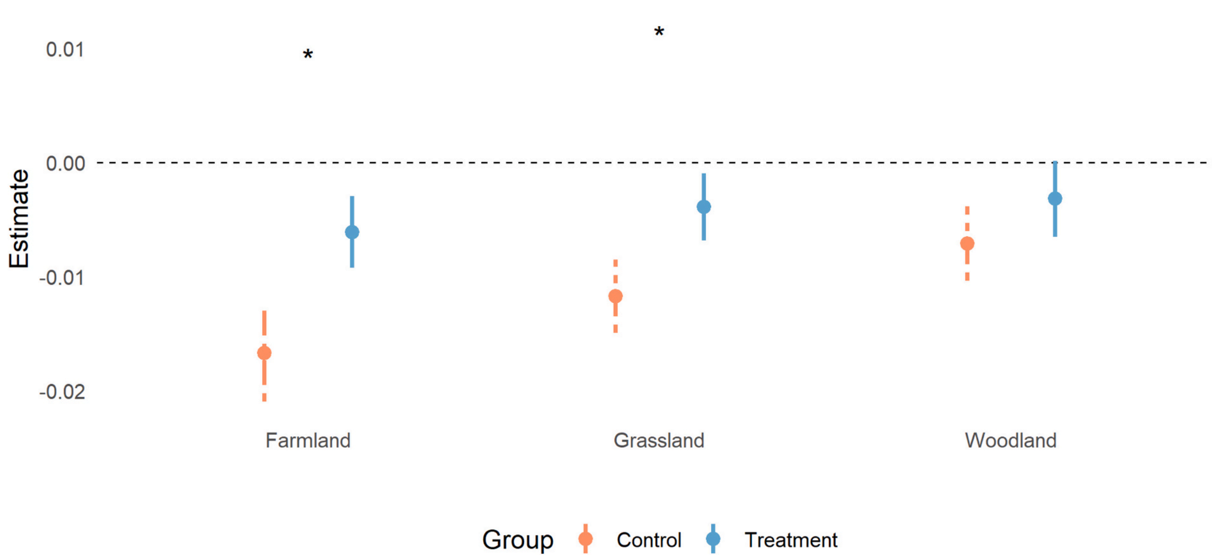

Fig. 5. Cost Coefficients, Different Habitats, Mixed Logit Model.

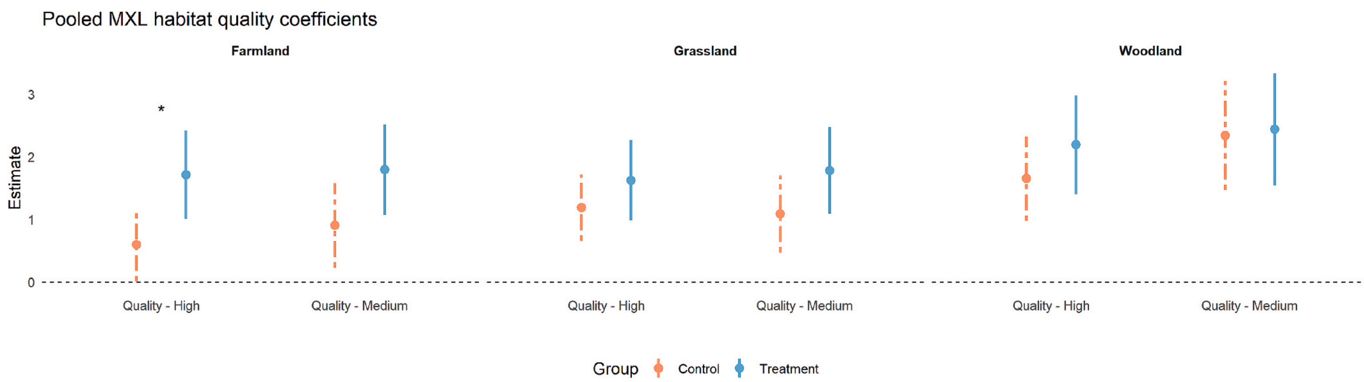

Fig. 6. Quality Coefficients, Different Habitats, Mixed Logit Model.

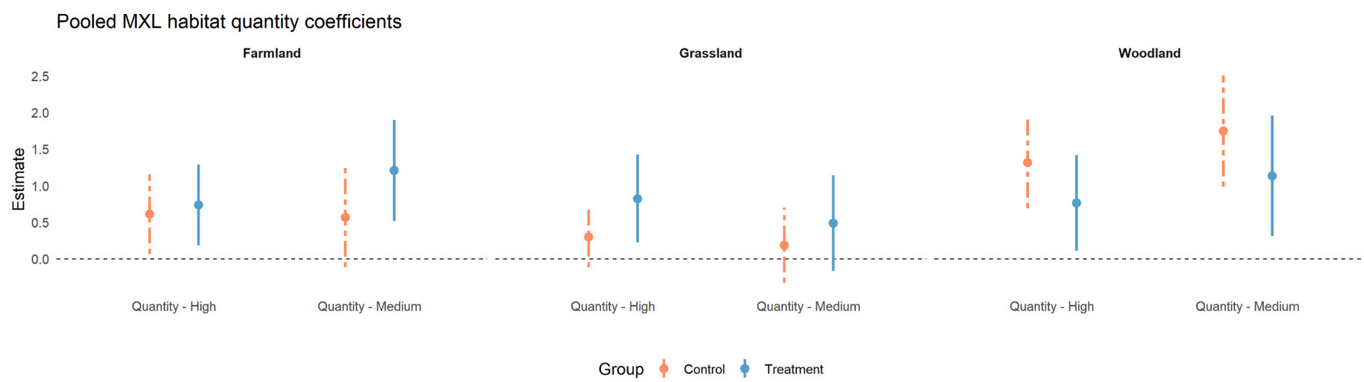

Fig. 7. Quantity Coefficients, Different Habitats, Mixed Logit Model. Notes: Points show coefficient estimates from the pooled mixed logit taste-only models. Error bars show 95% confidence intervals based on robust standard errors. Treatment coefficients equal the control coefficient plus the estimated treatment-shift coefficient. Asterisks indicate treatment-control differences significant at the 5% level.

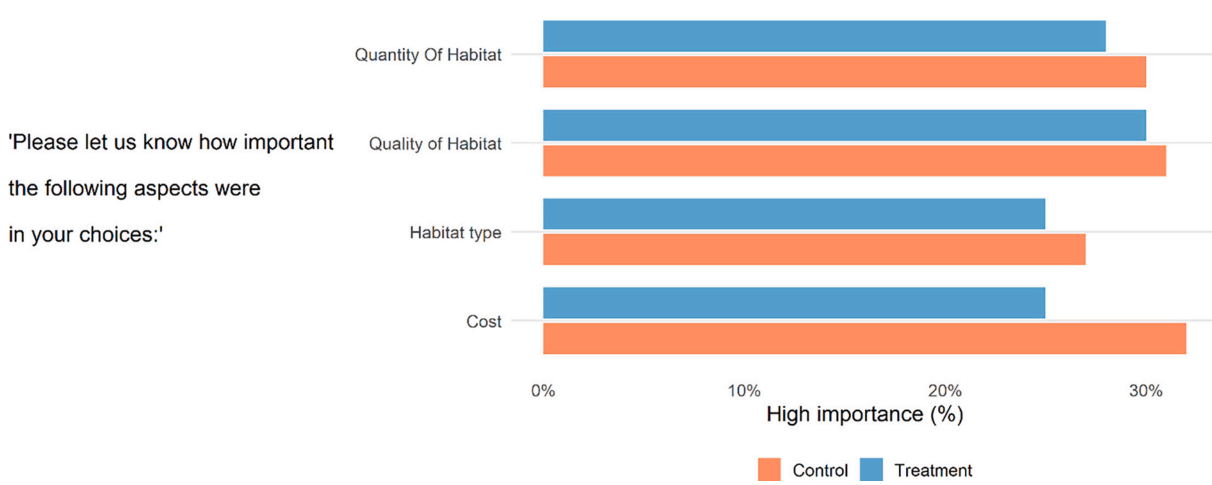

Fig. 8. Importance Question Results.

the literature on valuation studies, especially concerning habitat restoration. Our results show that making these soundscape changes salient can substantially alter stated preferences, although our design cannot determine whether this moves estimates closer to, or further from, "true" WTP.

Second, we find that the increased WTP is mostly driven by respondents in the treatment group showing less sensitivity to the cost attribute. We discuss a range of possible mechanisms suggested by our follow up questions in the survey, including: framing effects, lessening negativity bias, connectedness to nature, attention restoration, increased credibility and experienced vs decision utility. Our tests indicate that increasing the connection between self and nature, increasing the importance of the quality attribute, and lowering the importance of the cost attribute may be important mechanisms.

We also did not find evidence for scale effects in our pooled models, once taste effects were included. Note this contrasts with the Mokas et al. (2021) who used VR and found visual information made the treated group more certain of their preferences. This may mean that not all sensory information is alike, in that auditory information may have an entirely different effect compared to visual information in DCEs.

Results also showed a variation in willingness to pay for changes in the quality and quantity across three distinct UK habitat types –

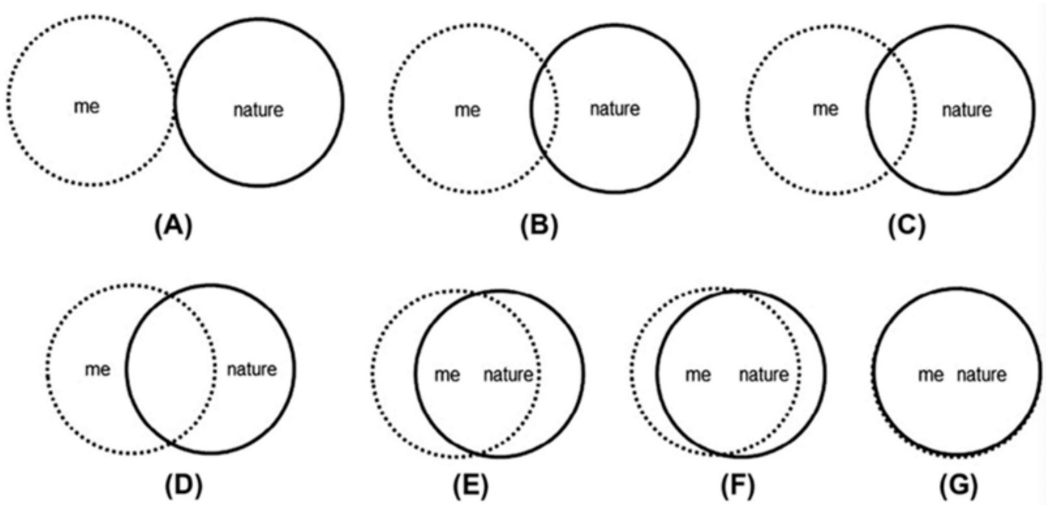

Fig. 9. Self and Nature Question. "Thinking about your place in the world, to what extent do you feel 'part of nature'? Which of the above (A - G) best represents you feelings?"

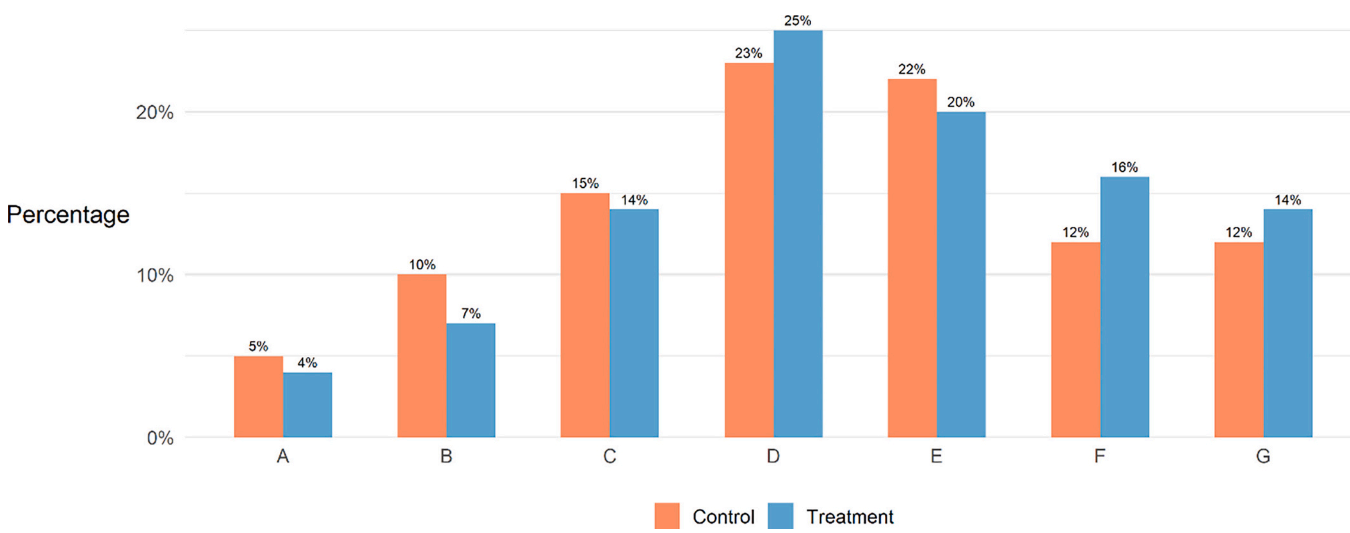

Fig. 10. Answers to Self and Nature Question.

Table 7
Mechanism regression results.

Outcome	Control mean	Treatment effect	SE	t	p	N
Self-Nature (1–7)	4.315	0.2201**	(0.0994)	2.215	0.0269	1094
Importance: Quality of Habitat	0.576	0.0663**	(0.0295)	2.249	0.0247	1094
Importance: Quantity of Habitat	0.569	0.0255	(0.0299)	0.853	0.3940	1094
Importance: Cost	0.608	−0.0685**	(0.0299)	−2.291	0.0222	1094
Importance: Habitat Type	0.497	0.0437	(0.0302)	1.446	0.1483	1094
Credibility	0.734	0.0062	(0.0267)	0.231	0.8173	1094

Notes: OLS regressions of each mechanism outcome on the treatment indicator. Robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

grassland, arable farmland and woodland. This mirrors comparable results in Browning et al. (2024), who find large variations in willingness to pay for increases in different habitat types in England, with the largest WTP values associated with the scarcer habitat types. Access to the associated changes in soundscape had an effect on how big the WTP differences were between the three habitats considered, although less so for woodland. It should also be noted that there is no significant difference between willingness to pay for improving quality or quantity from "low" to "medium" compared to "medium" to "high": that is, respondents cared about improving both the quality and quantity of habitats above the baseline "low" condition, but were indifferent, it seems, to how big an improvement was offered. There is thus evidence here of an insensitivity of willingness to pay to variations in the scope of the environmental good, so long as some improvement above the baseline is achieved (Heberlein et al., 2005). Note that the treatment effect we detect here (that being able to listen to soundscapes significantly changes stated preferences for habitat conservation) is therefore specific to changes in habitat quality, as proxied by species richness, since our manipulation of soundscapes into "Low", "Medium" and "High" was solely based on hypothetical quality changes for each type.

Variation in how much of the habitat would be conserved – referred to here as “quantity” – had no effect on the generated soundscapes used in the treated sample. It is thus to be expected that any treatment effect we detect would relate to willingness to pay for variations in habitat quality, rather than variations in habitat quantity.

Our research contributes to the insights gained from the literature in environmental psychology that examines the impact of birdsong and other soundscapes on outcomes such as stress recovery (e.g. Ratcliffe, 2021). Our DCE allows us to assess the economic value of birdsong by examining its impact on stated preferences for conservation. Our paper also enhances stated preference work on the value of conserving birds since we use a split- sample design to isolate the effects of bird song alone on WTP. Our design allowed us to isolate the impact of changes to the natural soundscape on respondents' WTP for habitat improvements.

Our paper has a number of limitations. Our design was purposively made simple in order to isolate the treatment effect of sound, and not cognitively overwhelm respondents, but this could mean respondents are making more assumptions, due to the lack of attributes in the design. Therefore, the observed treatment effect could be due to the interaction of these assumptions with the sound information. It is possible that a design with a richer attribute set would not see the same treatment effect as we observe. We also do not have information on respondents' previous donations, which could be an important factor in WTP.[4]

To conclude, we find that the framing of habitat quality changes matters when eliciting WTP. In this study, this framing allowed us to disentangle the value of birdsong from the general value of habitat restoration, the existence of birds and the experience of seeing them. More generally, our study provides further evidence of the importance of clearly describing the attributes that may matter to respondents in valuation studies, and of sensory information's effect on valuations. Acoustic experiences are associated with a large increases in WTP for habitat quality improvement in our case study. This suggests soundscapes are an important ecosystem service arising from bird conservation projects and are valued by the general public.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ecolecon.2026.109125.

CRediT authorship contribution statement

Anthony Higney: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Charlotte Gerling:** Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Claire Buchan:** Writing – review & editing, Writing – original draft, Visualization, Software, Formal analysis, Data curation. **Simon Butler:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Funding acquisition, Conceptualization. **Liam Crowther:** Writing – review & editing, Writing – original draft, Validation. **Melissa Marselle:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Eleanor Ratcliffe:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Konrad Uebel:** Writing – review & editing, Writing – original draft, Methodology, Data curation. **Nick Hanley:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

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Data availability

Data will be made available on request.

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