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Distance and Regional Effects on the Value of Wild Bee Conservation

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Abstract

Many wild bee species are threatened across Europe, and with them the pollination function they provide. While numerous studies have assessed the value of bees as pollinators of crops, little is known about the non-marked value of bees. Using a choice modelling experiment, we examine these non-market values in Germany by identifying citizens' willingness to pay (WTP) for wild bee conservation initiatives in four states. Effects of distance, state and regional affiliation are scrutinised, as previous research found these to affect respondents' choices. Random parameter logit and latent class models are used to capture preference heterogeneity. Overall, we find strong support of wild bee conservation and a clear preference for improvement relative to the status quo, particularly in natural areas and for rare or endangered species. The yearly WTP for conservation initiatives ranges from 227 to 447€ per household. Our results show distance and regional effects on WTP. Initiatives in respondents' home states are preferred, and increasing distance to initiatives in other states result in a slightly reduced WTP. Additionally, we observe regional preferences within an eastern and a western home region. These preferences are not explainable by socio-demographic characteristics, home state or distance and probably linked to social and cultural affiliations. We conclude that for widespread support in society and effective conservation initiatives, policy proposals must address this spatial heterogeneity from distance and regional effects.

Keywords Choice experiment · Distance effect · Latent class · Non-market valuation · Random parameter logit · Regional identity · Biodiversity

1 Introduction

As part of the global biodiversity crisis, we are witnessing rapid declines of many wild bee species. In Europe, over a third of all wild bee species are estimated to be threatened, and around 9 to 12% to be extremely rare or extinct (Westrich et al. 2011; Nieto et al. 2014; IPBES 2016). Habitat fragmentation, agricultural intensification and agrochemicals,

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climate change and pathogens were identified as the main drivers of this defaunation (Benton et al. 2002; Winfree et al. 2009; Potts et al. 2010; Westrich et al. 2011; IPBES 2016; Reilly et al. 2020). Wild bee decline sparks growing concern about their resilience and the ecological functions attributed to this group (Potts et al. 2010). Nearly 90% of all flowering plant species are animal-pollinated (Ollerton et al. 2011). Accounting for about a fifth of these pollinators, wild bees are the biggest and most important group (Ollerton 2017; Klein et al. 2018). They thereby add to genetic diversity of crops and wildflowers, increase ecosystem resilience and contribute to the production of food resources (Potts et al. 2010; Ollerton et al. 2011; Hallmann et al. 2017). Beyond their role as pollinators, wild bees also fulfil other important ecological functions, including nutrient cycling and providing a food source for other organisms, like birds (Hallmann et al. 2017). Thus, conservation needs of wild bees are closely linked, but not limited to their value as pollinators for biodiversity and agriculture (Reilly et al. 2020). Nevertheless, an estimated total of 5% to 8% of annual global crop production volumes would be lost if pollinators were to disappear (Klein et al. 2018). This is equivalent to US$127–US$184 billion or 9.5% of the global agricultural revenue in 2005 (Gallai et al. 2009; Bauer and Sue Wing 2016).

Problematically, consequences of bee declines have overwhelmingly been assessed with a focus on such dependencies of the agricultural sector and human welfare (e.g. Leonhardt et al. 2013; Schulp et al. 2014; Nogué et al. 2016; Klein et al. 2018). These assessments rely on market-based techniques, such as production functions or replacement costs (Hanley et al. 2015; IPBES 2016). While these methods are useful from a production policy perspective, they fail to address non-marketable contributions, such as cultural and spiritual values of wild bees, their existence value or wider ecological functions (Breeze et al. 2015). As a consequence, many policy decisions to protect wild bees are solely founded in market-based findings, ignoring non-market and non-use values reflecting the wider contribution to ecosystem functionality and human wellbeing (Kleijn et al. 2015).

In the present paper, we employ a stated preferences (SP) method to elicit respondents' willingness to pay (WTP) for wild bee conservation, to capture both their use and non-use values beyond their crop pollination services and to assess the role of spatial effects for this WTP. We do this by incorporating conservation attributes, which respondents could value to be of direct, indirect, or no benefit, based on subjective judgement and distance to the good. An example is the land use attribute, which allowed respondents to choose between conservation initiatives in natural, urban or agricultural areas, the respective targeted species and main pollination services provided. In a discrete choice experiment (CE), we offer respondents a series of choice sets with differing levels of these conservation attributes and determined their WTP for individual attributes and scenarios of wild bee conservation initiatives (Johnston et al. 2017). This also includes an analysis of how respondents' WTP is affected by spatial aspects, such as affiliation to a state or a region as well as distance to the state where a conservation initiative takes place. For this purpose, the CE includes an attribute for the state where the initiatives would be located, which could overlap with the respondents' state of residence (home state). These states are allocated to one of two neighbouring regions (East/West; this information is not disclosed to the respondents). These two regions were heavily influenced in their cultural, social and economic development by decades of separation until reunification in 1990 (Brunner and Walz 1998; Kuechler 1998; Schweiger 2019). Finally, we include an attribute into the model measuring the shortest Euclidean distance between the geographical centre of the municipality of respondent n (estimated using the respondent's postal code) and the border of the state where the conservation initiative is suggested. By including these attributes of distance, state and regional affiliation into the design, we enable the analysis of spatial effects on respondents' choices and can explain some of the heterogeneity within the sampled group.

2 Spatial Heterogeneity Effects in Valuation Studies

Numerous studies have found the valuation of biodiversity conservation to be influenced by distance, social and cultural affiliation and other aspects of spatiality (Sutherland and Walsh 1985; Davis and Tisdell 1999; Loomis 2000; Lundhede et al. 2014; Dallimer and Strange 2015; Czajkowski et al. 2017; Bakhtiari et al. 2018). Drivers for this effect can be cultural connections to nature and environmental awareness, economic capacity and education level in the respective countries (Samdin et al. 2010; Ressurreição et al. 2012). Many studies have assessed the effect of distance on WTP through continuous spatial discounting, thus assuming a decreasing value for goods with increasing proximity (Bateman et al. 2006; Pascual et al. 2012). However, often these spatial effects are clustered and have been shown to be rather affected by geopolitical, environmental and jurisdictional factors. This is meaningful, as many environmental non-marketed goods are themselves affected by underlying factors of spatiality, such as the availability of important cultural and natural sites (Campbell et al. 2009; Yao et al. 2014). Authors therefore suggest that exploratory spatial analyses need to be extended beyond standard distance assessments to better capture non-continuous patterns (Campbell et al. 2008; Johnston and Ramachandran 2014). Such spatial effects can for instance be reflected in a higher WTP for conservation investments in respondents' home region or country than another region or country (see e.g. Bakhtiari et al. 2018; Czajkowski et al. 2017; Dallimer et al. 2015).

Notably, spatial effects also depend on the good under assessment. They might not be consistent for non-use values and there might be no significant decay in classes of more general environmental goods, which primarily address non-use values (Hanley et al. 2003; Bateman et al. 2006; Jacobsen and Thorsen 2010; Boxall et al. 2012; Meyerhoff 2013; Johnston and Ramachandran 2014; Glenk et al. 2020). This study covers use and non-use values of wild bees and thus provides a unique opportunity to observe, how this combination influences conservation choices under distance and state or regional affiliation scenarios.

The objective of this study is therefore to assess if such spatial effects can be identified in the conservation of wild bees in Germany and whether WTP values differ between geographical and socio-political regions. For this purpose we define the following null hypotheses:

H1 : Distance to the state does not affect respondents' WTP, if wild bee conservation initiatives are offered outside respondents' home state.

H2 : State or region of the conservation initiative does not affect respondents' WTP.

Our a priori expectation is that all hypotheses will be rejected. We test the hypotheses by applying random parameter logit and latent class models on the attributes of the choice experiment, and by subsequently calculating the marginal WTP for attributes and selected choice scenarios.

This study makes a novel contribution to the scarce literature on non-market values of wild bee conservation and the role of distance and regional effects on these values. Although a few studies have applied SP techniques to evaluate the degree of public support for wild bee conservation policies in Europe, both were located in the UK (for studies outside of Europe, see Narjes and Lippert 2016; Penn et al. 2019; Stevens et al. 2015). The first study by Breeze et al. (2015) used CE to identify tax payers' WTP for two pollination services, the aesthetic values of wildflower pollination and the maintenance of local produce supply in the UK. In the second study, Mwebaze et al. (2018) conducted personal interviews and applied contingent valuation to estimate respondents' WTP for a theoretical national bee protection policy. The contribution of this paper is thus threefold. First, to expand the available research on non-market based valuations and WTP for wild bee conservation beyond the UK to mainland European countries. Second, to assess which effect distance, state and regional affiliations have on citizens' preferences for wild bee conservation initiatives. Third, to evaluate preferences for other attributes of these initiatives, such as the size of the conservation area and the targeted land use type (such as natural, urban or agricultural areas).

3 Methodology

3.1 Study Area and Data Collection

The study was located in Germany based on two reasons. First, long-term research has documented staggering declines in wild bees and other pollinating insect species (Westrich et al. 2011; Hallmann et al. 2017). Germany is among the countries in the European Union with the highest pollination limitation (Leonhardt et al. 2013; Nogué et al. 2016), so declines indicate that the lack of insect pollination may affect ecosystem functioning and economic revenues from agriculture (Schulp et al. 2014). Second, it provides a unique setting to study regional influences on motives for wild bee conservation initiatives. To assess whether there is an effect of distance, state or regional affiliation, we chose four bordering German states, namely Lower Saxony, Hesse, Thuringia and Saxony-Anhalt (Fig. 1). Two of the states, Thuringia and Saxony-Anhalt, are located in the eastern region of Germany, in the territory of the former German Democratic Republic (GDR). The two other states, Lower Saxony and Hesse, are part of the western region, in the former Federal German Republic (FGR). Three of the states have approximately the same surface area, Lower Saxony is around twice the size. Shared borders and the close proximity due to small state sizes made it possible to test for the effect of distance to states with initiatives and separate it from a possible affiliation effect to the respective state or region.

The attributes of the choice sets were chosen accordingly to analyse distance and affiliation effects in the CE. Understanding of the attributes, the CE set-up and the entire survey were tested and adjusted using two focus groups with six participants each, a small pre-test with six individuals and a pilot with 347 respondents in the four states. The survey was subsequently approved by the Research Ethics Committee of the University of Copenhagen. In the period of January to March 2020, data was collected from 1295 respondents approximately evenly spread across the four states. The survey was distributed by the survey institute *Respondi* to a selection of participants of their panel database. Participants were informed via email about the survey with the incentive to collect points, which could

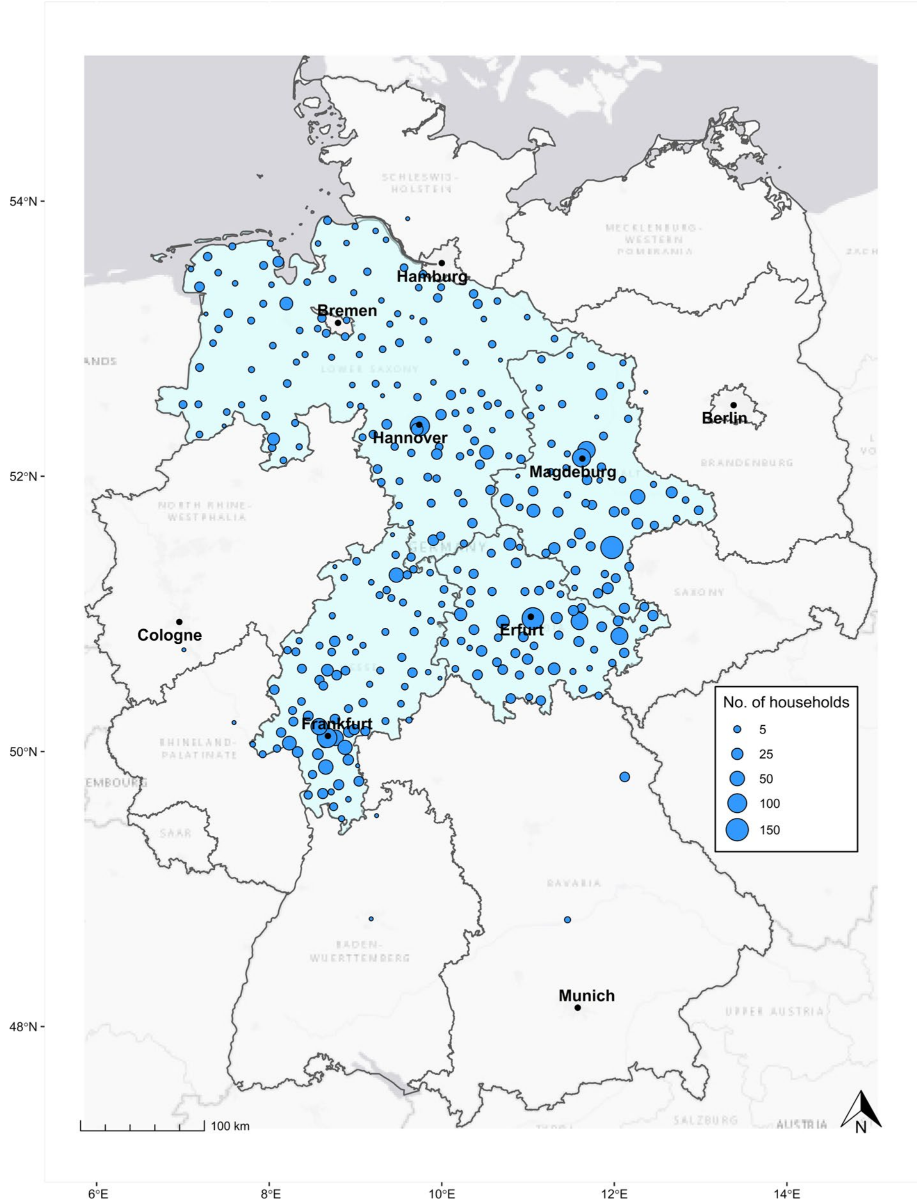

Fig. 1 Accentuated states outline the study area within Germany. The distribution of respondent households is indicated by blue clusters. State codes: NDS = Lower Saxony (West), HES = Hesse (West), THU = Thuringia (East), SA = Saxony-Anhalt (East)

be exchanged for vouchers, cash or donations. The sample, defined as the complete group of participants from all four states, was chosen to be representative in terms of age for the German population. Respondents' state of residence at the time of survey completion was defined as their *home state*. Accordingly, *home region* was defined for the western region as respondents residing in Lower Saxony or Hesse at the time of survey completion (hereafter: western home region) and for the eastern region as respondents residing in Thuringia or Saxony-Anhalt (hereafter: eastern home region).

3.2 Survey Design

The survey consisted of four sections: introduction, 12 choice sets (CS) presenting attributes of conservation initiatives, follow-up questions to the CS, as well as socio-environmental and demographic questions. The German original and an English translation of the survey can be found in Supplementary Material S1.A and S1.B. In the introduction, respondents were presented with basic information on wild bees, their ecological functions and consequential deficiencies in pollination due to their decline in Germany. This section was also used to assess the level of pre-existing knowledge on these issues, and to get information on respondents' personal state affiliation to the four respective states (i.e. if they had lived in one of the states before or have family or friends there; see Q5 in S1). In the following, respondents were informed about possible measures to counter the decline in wild bee populations and associated pollination services, such as agri-environmental schemes, reduced pesticide applications, hedgerows, native flowering plants and seed mixes, habitat restoration and the maintenance of fallow land (Menz et al. 2011; Blackmore and Goulson 2014; Breeze et al. 2014; Chateil and Porcher 2015; Holland et al. 2015; Senapathi et al. 2015; Johnson et al. 2017; Sutter et al. 2018).

After an introduction to the attributes of the initiatives, respondents were given 12 CS each with two alternatives for conservation initiatives and a status quo option if they wanted to opt out.[1] Each alternative 'package' represented a scenario of changes in welfare due to a concrete proposal of a conservation initiative, as compared to the baseline of the current situation (Johnston et al. 2017) (Table 1). To increase survey validity and reduce free riding, respondents were reminded, that, if the initiatives were implemented, all German households had to pay a mandatory annual contribution to this fund (consequentiality). Budget and repeated opt out reminders were added before each CS to reduce a potential hypothetical bias, as cheap talk scripts may fail to address these effectively (Ladenburg and Olsen 2014; Alemu and Olsen 2017).

Using the Ngene software (ChoiceMetrics 2018), 24 CS were designed and assigned to one of two blocks, aiming for a d-efficient design for an MNL model using fixed priors from the pilot. Assignment to a block and order of CS were randomised for each respondent. Depending on the block, each level of the area attribute appeared four times, and each land use type was selectable three to five times. Each of the states appeared five to seven times, so respondents had the possibility to choose their home state on average in six of the 12 cases. In the design of the first survey, the *area* attribute was not fully balanced. Therefore, a smaller data collection was conducted in April 2020, where this was corrected, to enable testing for scope sensitivity of the attribute.

In the follow-up questions, respondents were asked about their choices (Q9–12 in S1) and valuation of individual attributes (Q13–15 in S1). This information was used to

[1] The effect of the number of alternatives to use is yet an unresolved issue (Mariel et al. 2021), weighting aspects of incentive compatibility, cognitive burden, amount of information and incentives for heuristics. Weng et al. (2021) find problems of convergence validity comparing a status quo option with one, two or three alternatives. While we have no test of the effect here, we note that a SQ and two alternatives is today the most applied form.

Table 1 Choice set attributes, attribute levels and descriptions

Attributes	Levels	SQ levels	Attribute description
Total area (ha)	10,000 15,000 20,000	0	Area of land allocated to implement wild bee conservation initiatives distributed across the selected state
State (location of the initiative)	Lower Saxony[W] Hesse[W] Thuringia[E] Saxony-Anhalt[E]	–	Possible location of the conservation initiative
Land use type Target species Main pollination service	*Natural area* Endangered and rare species Wild plant pollination *Urban area* Endangered and rare species Garden plant pollination *Agricultural area* Common species Crop pollination	–	Bundles of land use type, target species and main pollination service that the initiative would focus on. The elements of the bundles are linked, so the choice of a specific land use type implied the species and pollination service this would focus on
Annual contribution to wild bee fund (€/year)	25, 50, 75, 100, 200, 400	0	Framed as an annual financial contribution to a specially created wild bee fund, managed by the environmental ministry of the respective federal state

Two alternatives were offered with different combinations of attributes, a third option (status quo/SQ) offered no initiatives at no costs

W = state located in western region; E = state located in eastern region

identify strategic[2] and protest[3] bidders, as protesting is often driven by scepticism towards the payment vehicle or policy scenario (Meyerhoff and Liebe 2009; Rakotonarivo et al. 2016). Responses on attribute preferences were used to assess respondents' comprehension of the choice experiment and countercheck their statements with choices in the CS. The final section asked respondents to reveal their socio-environmental attitudes and demographics (Q17–34 in S1).

3.3 Econometric Analysis

A utility function was specified over the attributes that were assumed to impact the choice of respondent n for a particular alternative i, representing a wild bee conservation initiative:

[2] Strategic bidders were defined as those respondents that stated "No matter what it takes, I like the idea of doing something for nature" and/or "Irrespective of the costs, I choose the best initiative for nature" in Q12 and always chose the highest possible bid in each of the 12 CS (see S1).

[3] Protest bidders were defined as respondents that stated "I am against this type of survey", "I already pay enough duties", "I already pay enough duties, I think the farmers should pay for it" and/or "I already pay enough duties, but I would like to pay if it was through a private donation" in Q11 and chose the status quo in all 12 CS (see S1).

$$U_{ni} = ASC_i + \beta_{1n}Area_i + \beta_{2n}Statehs_{ni} + \beta_{3n}Dist\_state_{ni} + \beta_4 HSWW_{ni} + \beta_5 HSEE_{ni} + \beta_{6n}Luse1_i + \beta_{7n}Luse2_i + \beta_{8n}Luse3_i + \beta_{9n}Cost_i + \varepsilon_{ni} \quad (1)$$

Alternative Specific Constants (*ASC*) were defined for the alternatives ASC1 and ASC2, while ASC3 was applied for the status as a baseline. *Area* captured the levels of the respective attribute. *Statehs* (initiative in home state) was a dummy variable coded as 1, if the state offered in alternative *i* was the same as the home state of respondent *n*. *Dist_state* (distance to state) measured the Euclidean distance in kilometres from the home municipality of respondent *n* to the border of the state offered in the alternative *i*.[4] The variables *HSWW* and *HSEE* were dummies capturing regional preferences. *HSWW* (home state and initiative in western region) was 1, when a respondent *n* living in the western region chose an alternative *i,* in which the state was also located in the western region; and otherwise 0. *HSEE* (home state and initiative in eastern region) worked by the same token for respondents living in the eastern region. *Luse1-3* were dummy variables for the three bundles in the land use type attribute, with *luse1* for natural areas, *luse2* for urban areas and *luse3* for agricultural areas. *Cost* referred to the payment vehicle of an annual contribution to a wild bee fund.

Based on previous research, it was assumed that respondents' preferences for most attributes vary. To capture this, two different models were used in the analysis. To assess attribute preferences, distance and regional effects for the entire sample, we chose a continuous Random parameter logit model (RPL). However, the survey incorporated both attributes that primarily address direct, personal benefits of pollination services, as well as attributes which appeal to more altruistic motivations of wild bee conservation. Therefore, we hypothesised that respondents may differ in their motivations and could be grouped in classes characterised by certain socio-demographic, regional and environmental properties. For a more detailed subsequent analysis of these properties, we included a latent class model (LC).

3.3.1 Random Parameter Logit Model

The RPL model accounts for continuous taste heterogeneity by allowing the β coefficients of random parameters to differ between respondents, each being characterised by a location parameter μ and scale parameter σ (Hensher and Greene 2003; Knoefel et al. 2018). In our model, coefficients of all parameters except for *HSWW* and *HSEE* were specified to be random and normally distributed. The negative of the cost attribute was random and log-normally distributed, as a negative preference for this attribute was assumed for all respondents (Train and Weeks 2005). The R package APOLLO was used in RStudio 1.2.5042 to estimate the RPL model with 10,000 MLHS draws for the random distributions, see APOLLO code in S2.A (Hess and Palma 2019; R Core Team 2020). For parameters with normal distribution, mean and standard deviations of the coefficients could directly be estimated from the model. For the log-normal cost attribute, the moments of

[4] The *dist_state* variable thereby indicated not the distance to the initiatives themselves, as commonly done in distance decay studies, but the distance to the state where the initiative was located. Since the location of the initiative within the state was not specified, respondents close to state borders were not considered to experience spill over effects from their close proximity to the state.

the distribution had to be calculated as such: mean: $\exp(\mu + 0.5 * \sigma^2)$; median: $\exp(\mu)$; standard deviation: $\sqrt{(\exp(\sigma^2) - 1) * \exp(2\mu + \sigma^2)}$.

From the model results, respondents' WTP for protecting wild bees through a state fund could be calculated. WTP is defined as the maximum amount a person is willing to give up for a non-market good. Marginal WTP (mWTP or WTP_i) describes the willingness to pay for a one unit change in an attribute of the good, keeping all other attributes constant. WTP_i for attribute i is expressed as the ratio of the mean marginal utility of the attribute i (β_i) to the mean marginal utility of the cost attribute (β_{cost}) (Mariel et al. 2021), namely

$$WTP_i = \frac{\beta_i}{\beta_{cost}} \tag{2}$$

and can be calculated directly for models with normally distributed parameters. However, as the cost coefficient was log-normally distributed in the here reported RPL model, the moments of the parameter (mean, median, standard deviation) were not directly given. Therefore, the WTP_i distribution for each attribute i was simulated by taking random draws from the distribution of each attribute i and the cost attribute, and calculating the mWTP for each draw (Krinsky and Robb 1986) This was repeated a million times to create the WTP_i distribution. Finally, the mWTP for attribute i was identified as the mean of this WTP_i distribution. To estimate the cost attribute distribution, the median was used instead of the mean, as it is less sensitive to extreme values than mean and standard deviation, because of the long upper tail of the log-normal distribution (Train and Weeks 2005; Breeze et al. 2015; Sagebiel et al. 2017; Knoefel et al. 2018). Then, the overall WTP for specific scenarios was calculated for a specific policy as the sum of the mWTPs from the relevant attributes. This policy WTP was subsequently downscaled by the share of respondents that rejected wild bee conservation initiatives altogether. Zero and protest bidders were not removed, because their inclusion did not significantly impact the estimations. Besides the RPL reported here, additional RPL models were estimated to assess the role of individual attributes such as area and state, as well as the personal affiliation to states (see Supplementary Material S3.A–F).

3.3.2 Latent Class Model

The LC model accounts for unobserved heterogeneity by assuming that the distribution of the preferences can take a number of discrete values in a number of classes and that there is no heterogeneity within each class, thus replacing the concept of continuously distributed random parameters. β coefficients are estimated for S classes and a probability $\pi_{n,s}$ is determined for each respondent n of belonging to that class s, where $0 \leq \pi_{n,s} \leq 1 \forall s$ and $\sum_{s=1}^{S} \pi_{n,s} = 1$ (Hess and Palma 2019). In our model, the same parameters as in the RPL entered into the LC model and all parameters varied across classes. Respondents' utility and thereby the likelihood to belong to a certain class is affected by socio-demographic and economic characteristics (Hanley et al. 1998; Hess and Palma 2019). As we had no a priori assumptions about the possible number of classes, we estimated a two-class model, where we linked class allocation probabilities for the LC to the socio-demographic explanatory variables *age* (years), *gender*, *income* (€), *level of education* (years), as well as three of the *states* (compared to a baseline state, see S3.H). This model showed that most of the socio-demographics do not affect class allocation and main results, therefore we decided to use the individual-specific variables *age* (years), a dummy for home region (coded 1 for *eastern home region*, with western home region as the baseline) instead of the state-level dummies, and a three-level dummy for level of urbanisation (*urbanisation level: urban* was used as the baseline). A few respondents did not give information on the individual-specific variables, such as age, and were therefore removed before the estimation. The LC model was estimated in Latent GOLD 6.0 without socio-demographic class allocation parameters for two to ten classes (Vermunt and Magidson 2021). It was further estimated in APOLLO with two, three and four classes including socio-demographic variables for class allocation (for APOLLO LC model code, see S2.B). The best model was chosen based on the model performance (BIC, AIC, LL, Pseudo R^2) and patterns of class profiles observed in the model output, resulting in a three-class model (detailed in the results).

All attributes entered linearly into the model, so attribute mWTP could directly be calculated from the model parameters for each class s according to Eq. (2). The average WTP across classes was then calculated by multiplying each attribute i mWTP value with the class share (class allocation probability) and taking the sum:

$$WTP_{average} = \sum_{s=1}^{S} classShare_s * mWTP_{si} \tag{3}$$

Standard errors were estimated in APOLLO using the delta method (Hole 2007; Carson and Czajkowski 2019; Hess and Palma 2019). As above, the share of respondents rejecting initiatives was subtracted from the WTP estimates, and zero and protest bidders were not removed.

4 Results

Across the four states, 1295 surveys were completed, resulting in 15,540 choice observations. Respondents were representative with regards to age for the German population[5] (Table 2). The data set was slightly overrepresented by female respondents and higher education groups. With an average net household income of 2404 €/month, income was below the population mean. Income was less equally distributed than at the national level, indicated by the higher Gini coefficient. 97% of the respondents participated in the choice experiment, the remaining 3% rejected any wild bee conservation initiatives after the introduction. As reasons for their support, respondents cited pressing environmental issues, wild bees' importance for our food production and anthropocentric impacts onto the environment, followed by wild bees' existence values and the joy of observing them (77%, 59%, 45%, 33% and 16% respectively). Overall awareness of the diversity and decline of wild bee communities was very high (58% and 83% of the respondents respectively). According to our definitions, only 2% of the respondents could be identified as strategic bidders, and 4% as protest bidders (see footnotes 2 and 3). The status quo option was chosen 25.7% of the time.

The RPL and LC models reported in Tables 3 and 4 were estimated based on the utility function (Eq. 1) including parameters on initiatives in home states (*statehs*) and home

[5] In a latent class model, it was tested whether other socio-demographics (gender, income, education) affect the results and WTP estimates across states (see Supplementary Material S3.H). This showed no effect. Therefore the sample was defined at the level of all four states and results to be representative for the German population.

Table 2 Socio-demographic characteristics of respondents for the full sample and for state-level subsamples. Parameters in percent (%) unless stated otherwise. Where possible, the data was compared with national or state population data from Statistisches Bundesamt (2019) and www.deutschlandinzahlen.de

Parameters	Full sample	German population	Lower saxony		Hesse		Thuringia		Saxony-anhalt	
			State sample	Pop	State sample	Pop	State sample	Pop	State sample	Pop
No. of respondents	1295		318		355		314		308	
Sex										
Female	52.8	50.7	52.2	50.6	47.9	50.6	53.5	50.5	58.4	50.7
Male	47	49.3	47.8	49.4	51.8	49.4	46.5	49.5	41.2	49.3
Diverse	0.2	–	0	–	0.3	–	0	–	0.3	–
Age										
Average (years)	44.1	44.4	45.5	44.1	43.4	43.3	43.1	46.7	44.5	47.3
Distribution (%)										
< 26 years	14	24	12.3	24.8	16.6	24.7	14.3	20.3	12.3	19.7
26–39	25.7	19	25.5	17.6	24.5	19.2	28.3	17.7	24.7	17.2
40–59	41.6	29.1	38.4	29.4	41.4	29.4	41.7	28.7	45.1	29
> 59	18.7	27.9	23.9	28.2	17.4	26.7	15.6	33.2	17.8	34
Level of education										
Sec school (grade 10)	31.6	45.9	33.6		31.6		30.6		30.5	
Higher sec school (grade 12/13)	18	21.4	15.7		23.4		15.9		16.3	
Vocational school	24.9	–	24.8		18.3		29.9		27.6	
Higher degree (MSc, MA, PhD)	24.7	15.5	25.5		24.7		23		25.6	
Current primary occupation										
People in paid work	64.5	53.5	61.9	51	63	55.3	66.9	48.5	65.9	45.1
Student	7.4	–	6.3		9.1		6.4		7.8	
Pensioner	14.7	22	18.6		13.5		13.1		14	
Unemployed	3.1	4.3	3.4		2.3		3.8		2.9	
Other	10.3	–	9.8		12.1		9.8		9.4	
Monthly net household income										
Average (€)	2404	3399	2557	3121	2641	3395	2124	2792	2274	2411

Table 2 (continued)

Parameters	Full sample	German population	Lower saxony		Hesse		Thuringia		Saxony-anhalt	
			State sample	Pop	State sample	Pop	State sample	Pop	State sample	Pop
Distribution (%)										
< 450 €	4.6		3.1		3.9		5.1		5.5	
450–1000	10		8.5		7.9		12.1		10.4	
1000–1500	17.4		17		13.5		18.3		18.8	
1500–3000	36.6		39		38.3		30.1		34.7	
3000–6000	19.1		16		23.1		15.5		19.2	
6000–10,000	1.7		1.6		2.8		0.6		1.6	
> 10,000	0.8		1.3		0.8		0.6		0.3	
Gini coefficient	37.6	31.1	38.8		36.2		37.5		37	

Parameters in percent (%) unless stated otherwise. Where possible, the data was compared with national or state population data from Statistisches Bundesamt (2019) and www.deutschlandinzahlen.de

Table 3 RPL model results

Attribute		Parameter		WTP (€)	
ASC1	μ	2.74***	(0.11)	353.1	(8.7)
	σ	– 0.62***	(0.06)		
ASC2	μ	2.61***	(0.11)	336.6	(7.7)
	σ	– 0.49***	(0.08)		
ASC3[a]	μ	0	(NA)	–	–
	σ	0	(NA)		
Total area (ha)	μ	0.25***	(0.05)	32.6	(3.9)
	σ	– 1.10***	(0.05)		
Initiative in home state	μ	1.24***	(0.08)	161.5	(5.9)
	σ	– 1.27***	(0.08)		
Distance to state (km)	μ	– 0.0019***	(0.0005)	– 0.23	(0.4)
	σ	0.0083***	(0.0006)		
Home state and initiative in Western region	β	0.21***	(0.06)	27.7	(0.7)
Home state and initiative in Eastern region	β	0.19**	(0.06)	24.1	(0.6)
Initiative in natural areas[b]	μ	1.00***	(0.06)	126.1	(5.5)
	σ	– 1.37***	(0.07)		
Initiative in urban areas[b]	μ	0.59***	(0.06)	78.2	(4.5)
	σ	– 1.27***	(0.07)		
Cost[c] (€/year)	μ_{log}	– 4.88***	(0.08)	–	–
	σ_{log}	2.31***	(0.08)		
Model statistics					
LL final	– 10430.96				
AIC	20897.91				
Pseudo R^2	0.367				
Number of individuals	1250				
Number of observations	15000				

Standard errors of coefficients and WTP estimates in brackets

[a]ASC = alternative-specific constant; ASC3 for the status quo scenario (alternative 3) was used as a baseline and describes the utility from status quo (no initiatives) as opposed to the two other initiative alternatives

[b]Land use variables (luse1 and luse2 respectively); the two dummy levels are measured against the baseline Initiative in agricultural areas (luse3)

[c]Cost is a logarithmic variable and measured in Euro; re-calculated estimates: $\mu = 0.11$, $\sigma = 1.34$

***$P < 0.001$; **$P < 0.01$; *$P < 0.05$

regions (*HSWW* and *HSEE*), as well as model fit. Model fit was assessed by comparing Pseudo R^2, the AIC, BIC and log likelihood between models. In the RPL, all model parameters were significant and with the expected signs. Standard deviations of all random parameters were statistically significant and large compared to the mean. This indicates considerable unobserved taste heterogeneity among the respondents with regards to all attributes (Table 3). Both alternative-specific constants (*ASC1* and *ASC2*) were positive and significant, but not different from one another, so an alternative order bias between the

Table 4 LC results with socio-demographic variables

Attribute		Class 1		Class 2		Class 3		Weighted average WTP (€)
		Parameter	WTP (€)	Parameter	WTP (€)	Parameter	WTP (€)	
ASC1	β	2.78*** (0.18)	1135.6 (191.7)	1.66*** (0.14)	114.4 (9.7)	−2.39*** (0.39)	−412.1 (87.6)	531.9
ASC2	β	2.64*** (0.18)	1075.0 (183.1)	1.61*** (0.13)	111.2 (9.4)	−2.31*** (0.38)	−399.5 (85.3)	502.8
ASC3[a]	β	0 (NA)	–	0 (NA)	–	0 (NA)	–	–
Total area (ha)	β	0.21*** (0.03)	85.2 (16.2)	0.11** (0.05)	7.8 (3.3)	−0.38** (0.14)	−65.0 (25.8)	33.5
Initiative in home state	β	0.54*** (0.05)	221.1 (37.6)	0.83*** (0.09)	57.4 (7.0)	2.59*** (0.27)	447.9 (70.2)	209.8
Distance to state (km)	β	−0.0003 (0.0003)	−0.12 (0.14)	−0.0004 (0.0005)	−0.03 (0.04)	−0.0006 (0.0019)	−0.11 (0.32)	−0.1
Home state and initiative in Western region	β	0.14** (0.05)	58.2 (22.0)	0.26*** (0.07)	18.2 (5.2)	0.40 (0.27)	69.5 (47.4)	47.5
Home state and initiative in Eastern region	β	0.18*** (0.05)	75.2 (22.6)	0.02 (0.09)	1.2 (6.4)	0.34 (0.28)	57.9 (49.7)	48.5
Initiative in natural areas[b]	β	0.84*** (0.05)	341.9 (39.6)	0.07 (0.08)	4.5 (5.2)	−0.64*** (0.15)	−110.4 (30.6)	153.1
Initiative in urban areas[b]	β	0.59*** (0.04)	242.2 (33.4)	−0.24*** (0.07)	−16.5 (4.9)	−0.74*** (0.15)	−128.7 (29.7)	93.1
Cost[c] (€/year)	β	−0.0025*** (0.0003)	–	−0.0145*** (0.0008)	–	−0.0058*** (0.0007)	–	–
Class assignment								
Intercept[d]	δ	0 (NA)	–	−0.39* (0.23)		−2.48*** (0.31)		
Age (years)	γ	0 (NA)	–	0.0001 (0.0046)		0.03*** (0.0056)		

Table 4 (continued)

Attribute		Class 1		Class 2		Class 3		Weighted average WTP (€)
		Parameter	WTP (€)	Parameter	WTP (€)	Parameter	WTP (€)	
Eastern home region[e]	γ	0 (NA)	–	−0.44*** (0.14)		−0.06 (0.16)		
Urbanisation level: sub-urban[f]	γ	0 (NA)	–	0.31* (0.17)		0.56** (0.21)		
Urbanisation level: countryside[f]	γ	0 (NA)	–	0.04 (0.18)		0.23 (0.22)		
Model statistics								
Class shares		50.2%		31.8%		18%		
LL final		−11,117.054						
AIC		22,298.108						
BIC		22,462.297						
Pseudo R^2		0.3949						
Number of individuals		1250						
Number of observations		15,000						

Standard errors of coefficients and WTP estimates in brackets

[a] ASC = alternative-specific constant; ASC3 for the status quo scenario (alternative 3) was used as a baseline and describes the utility from status quo (no initiative) as opposed to the two other initiative alternatives

[b] = land use dummies (luse1 and luse2 respectively); as compared to the baseline 'Initiative in agricultural areas' (luse3)

[c] = cost is a logarithmic variable and measured in Euro

[d] = delta a (δ_a) for class 1, as compared to delta b for class 2

[e] = dummy to indicate respondents' home region; as compared to the baseline 'Western home region'

[f] = dummy to indicate respondents' urbanisation level; as compared to the baseline 'Urban'

*** $P < 0.001$,** $P < 0.01$,* $P < 0.05$

two could be ruled out. The *area*[6] attribute was positive and significant. As expected from economic theory, the *cost* parameter was significantly negative for all respondents. This is based on the rationale that respondents are reluctant to give up a value, even if it increases their utility (Bakhtiari et al. 2018; Knoefel et al. 2018). These parameter patterns were the same for the RPL models at individual state level.

A LC model with three classes was chosen, based on model performance and the profiles of the classes observed in the model output. Based on standard deviations of the random parameters, we hypothesised that distinct groups exist within the sample and tested this by estimating LC models with two to ten classes. Although model measures of fit (LL, BIC, AIC, Pseudo R^2) improved with each class, the largest gain in performance was observed between a two- and three-class model. Further, class allocation probabilities to some classes in higher class models grew very small and signs of attribute non-attendance were observed. As the choice of classes must also account for this significance of parameters, the LC with three classes was chosen (Scarpa and Thiene 2005). These three latent classes of respondents showed distinct profiles—in the following referred to as class 1, class 2 and class 3. For all classes, the *cost* parameter was negative. For class 1, results were similar to the RPL. *ASC1* and *ASC2* were positive and significant. *Area* was positive and significant. For class 2, many parameters differed from class 1 and from the RPL output, but general tendencies remained the same. The *ASCs* were positive and significant, as well as *area*, but with smaller coefficients than in class 1. Compared to class 1, the individual-specific socio-demographic variables indicated that respondents living in the western region and in rural areas were more likely to belong to class 2.

Class 3 showed very different preferences from the other two classes. The alternative ASCs were strongly negative, and also *area* was negative and significant. Mean class allocation probabilities for class 1, 2 and 3 were 50.2%, 31.8% and 18% respectively.

The chosen models showed a clear effect of distance, state and regional affiliation on respondents' preferences, based on which the two posed hypotheses (H1 and H2) were rejected. Furthermore, they revealed differences in preferences for land use type and species to be targeted by the initiatives. The distance and regional parameters were included into the model after the estimation of two RPLs based on attributes from the choice experiment at the individual state level (see Supplementary Material S3.A, B). In the first model (S3.A), utility preferences for each of the four home states were measured by including state-dummies into the model and using one state as a baseline. In all four home states, there was a negative preference for bee conservation initiatives in other states. With the exception of Hesse, respondents in all states showed a less negative preference towards the other state in their region in comparison to the other two states outside their region. As this pattern could not be solely explained by home state and distance to state, we chose to include the regional parameters (*HSWW* and *HSEE*) in the RPL and LC models. An overview of all relevant models is given in the Supplementary Material S3.A–I.

[6] After correcting the design in the second data collection in April 2020, the attribute showed a linear increase in preference and thus scope sensitivity (see S3.E and F).

4.1 Distance Effect

In the RPL, the distance to state parameter was small, but significant and negative (Table 3). In all three classes of the LC model, distance to state was negative, but not significant (Table 4).

4.2 State and Regional Effects

In the RPL model, the interaction parameter between the state offered for initiatives and the respective respondent's home state (*statehs*) had a positive coefficient (Table 3). To assess whether this positive state effect was limited to respondents' own residence in the state or was also affected by other forms of attachment, an additional RPL model was estimated with variables on state affiliation: a *state affiliation* dummy parameter was included in the model, which was coded 1 when respondents lived in the offered state before, have family or friends there (see S3.C). This model also showed a positive effect of these state affiliation variables on mWTP for the offered state. The interaction parameters of offered initiatives and respondents' residence in one of the states of the western (*HSWW*) and eastern regions (*HSEE*) were positive, indicating that respondents have positive preferences for initiatives in either of the states of their home region. In the LC model, *statehs* was positive for all three classes and significant (Table 4). The two parameters on initiatives in home region differed between the classes. As in the RPL, *HSWW* and *HSEE* were both positive and significant in class 1. In class 2, *HSWW* was also positive and significant. However, *HSEE* was almost zero and non-significant, indicating that preferences within this class differed between regions. In class 3, both regional parameters were positive, but had large standard errors and were non-significant.

Follow-up questions revealed that a majority of the respondents considered wild bee conservation initiatives necessary in their home state (95%). In statements testing altruism, 21% were keen to support initiatives in states where people have fewer resources for conservation and 31% believed in the importance of conservation efforts in states where economic development is also necessary. Between regions, respondents living in the eastern region scored significantly higher in both altruism statements (26% and 36% respectively) than respondents living in the western region (17% and 26% respectively). T-tests confirmed that these differences between the groups were significant.

Respondents could choose their home state on average in six out of 12 choice sets (7474 choice sets across 1255 respondents), and chose to do so about 53% of the time (3964 choice sets). Only 135 respondents always chose their home state in a choice set, when it was offered. In choice sets, where respondents were offered their home state, they chose the status quo in 22.1% of the cases. In choice sets, where they were not offered their home state, they chose the status quo in 26.4% of the times, slightly higher than the average.

4.3 Land Use Type

In the RPL, the dummy-coded land use type attribute had positive coefficients for initiatives in natural (*luse1*) and urban areas (*luse2*) focusing on rare or endangered species, compared to the agricultural areas baseline with a focus on common species (*luse3*). The coefficient for natural area was the largest (Table 3).

In the LC model, results again differed between classes (Table 4). In class 1, the land use parameters *luse1* and *luse2* were positive and significant, so conservation initiatives were

Table 5 Household-level WTP for selected scenarios for wild bee conservation initiatives

Willingness to pay scenarios	Random parameter logit model €/year	Latent class model €/year
Eastern region, 15,000 ha		
Natural areas	349	447
Urban areas	303	389
Agricultural areas	227	299
Western region, 15,000 ha		
Natural areas	353	446
Urban areas	307	388
Agricultural areas	231	298

'Eastern region, 15,000 ha' reports WTP for respondents living in the eastern region for initiatives in their home state. 'Western region, 15,000 ha' reports WTP for respondents living in the western region for initiatives in their home state

valued highest by respondents in natural areas, followed by urban areas, in comparison to agricultural land. What is more, *luse1* was the strongest single parameter for this class after the ASCs. Class 2 pointed at a rejection of initiatives in urban areas, as this parameter was negative and significant, compared to the baseline of agricultural land. Initiatives in natural areas were slightly positive, but not significantly different from the baseline. In class 3, both land use parameters *luse1* and *luse2* were negative and significant, showing a preference of the baseline attribute *luse3* for initiatives in agricultural areas over natural and urban areas. The attribute for initiatives in urban areas was the most negative in this class.

Patterns from the RPL and the latent class 1 were partially reflected in the follow-up questions. 43% prioritised conservation in natural areas to ensure wild flower pollination over 30% in agriculture and 20% in cities to secure pollination there. Rare and endangered bees were preferred for 29% of the respondents, common species for only 5%. Two-third of the respondents believed that wild bees should be protected anywhere to reduce human impact on the environment (67%).

4.4 Willingness-to-Pay Scenarios

Marginal WTP was estimated for each of the parameters of the RPL and LC models (Tables 3, 4). From these, the overall WTP for different scenarios was calculated by summing the respective parameters:

1. *Eastern region*: WTP of respondents living in the eastern region for a medium sized (15,000 ha) conservation initiative in the different land use types in their home state.
2. *Western region*: WTP of respondents living in the western region for a medium sized (15,000 ha) conservation initiative in the different land use types in their home state.

These scenarios were estimated at regional level, based on the results from the RPL in Table 3. Estimates were adjusted by the share of survey respondents that rejected initiatives for wild bee conservation altogether. WTP estimations from the LC were generally higher than from the RPL model (Table 5). Despite the use of the median for the WTP simulation in the RPL model, mWTP standard deviations were large, because the scale parameter of the cost attribute distribution was large.

5 Discussion

5.1 Support for Wild Bee Conservation, Distance and Regional Effects

The purpose of this study was to expand the existing literature on non-market values of wild bee conservation to understand the level of support for wild bee conservation, and the spatial and socio-demographic characteristics that determine approval or rejection of suggested policy initiatives. This was done by testing two hypotheses concerned with distance (H1), state and regional effects (H2), and assessing respondents' preferences for other conservation attributes, such as target land use and species. The study highlights a strong overall support for wild bee conservation initiatives in all participating German states, with 97% of the respondents being in favour of countering species loss. This is reflected in high WTP estimates, widespread awareness about wild bee declines and a strong preference to avoid the status quo. Results are in line with previous studies from the UK (Breeze et al. 2015; Mwebaze et al. 2018). Compared to the two previous studies, WTP estimates are a bit higher. This is possibly rooted in the broader focus of this study beyond crop pollination services, highlighting wild bees' inherent existence values. The survey identifies a combination of motivating factors, such as the desire to halt negative anthropocentric impacts, the understanding that pollinators are important for food production and bees' existence values. Misinformation[7] and increased media attention may as well have played a role in increasing awareness and the motivation to act[8] (Schell et al. 2017). An assessment of the follow-up questions (Q11 in S1) revealed scepticism towards the payment vehicle as a motivation for protesting. For those respondents who always choose the SQ, distrust in governance and policy implementation, as well as inflated bureaucracy may be strong drivers for protest bidding and the rejection of the choice scenarios.[9] This was in line with focus group findings, where several participants indicated distrust towards the state to allocate resources for and monitor the necessary initiatives (pers. commun.).

The hypothesis stating that distance to states with conservation initiatives has no effect on WTP (H1) can be rejected. It was expected that the distance effect would be bigger, as respondents were hypothesised to be partially motivated by the personal benefits of pollination services. However, it can be disputed how much the small, but significant negative distance effect in reality matters and where it originates from. Studies found distance decay effects to vary between types of environmental goods and their value for society, with a

[7] Several respondents made a statement that is attributed to Albert Einstein (though not documented) stating that if bees disappeared off the face of the Earth, man would only have four years left to live. While this is a widespread belief, research disproves this claim (Klein et al. 2018).

[8] 66% of participants in a study on nature awareness stated that they knew about wild bee species decline and ranked it as the most important group to protect in agricultural landscapes (Schell et al. 2017).

[9] Examples of statements by respondents (NB: corrected for spelling mistakes and translated by the authors): "Politics should do it because they have enough money and still would not do it, rather pocket the money you pay."; "The federal government should use the billions that it otherwise wastes."; "The German state has money for that, but throws it out the window."; "The state is in a position to cover any expenditure from the federal budget!".

lesser or no effect for non-use values (Hanley et al. 2003; Bateman et al. 2006; Glenk et al. 2020). Wild bees in this study were framed to be of varying degree of use to respondents, providing pollination services but also having an inherent (existence) value in themselves. Thus, small distance effects found here may have resulted from respondents' high valuation of non-use values. Howsoever, as the observed effect is small, national support for wild bee conservation is not expected to be significantly affected by distance. Finally, the identified distance effect was even smaller in the LC model and not significant for any class.

A far larger effect on respondents' WTP is observed by state and regional affiliation, concluding in the rejection of H2. In both models, initiatives in respondents' home states are clearly preferred and result in high mWTP estimates. Together with the additional model on state affiliation (see S3.C), this allows the conclusion that own current and previous residence, as well as relatives' residence affect respondents' choices for the location of the initiative. With regards to regional affiliation, respondents identify not only with initiatives in their home state, but also in the other state that is located within their home region (Table 3). This indicates a level of regional identity within the eastern and western home regions, which is stronger than national ties when concrete negative environmental impacts are anticipated for the regions. However, the results from the LC model outline differences in this effect between classes (Table 4). While the largest class (1) shows similar patterns as the RPL, with both regions exhibiting slight positive preferences for in-region initiatives, preferences for in-region initiatives are strongly positive, but non-significant in the smallest class (3), due to the large standard error. Finally, the second class (2) shows a split pattern. Respondents living in the western region have a higher likelihood to be in this class, and have a significant strong preference for initiatives in their home region. In contrast, respondents living in the eastern region do not share this tendency, as indicated by an almost neutral, non-significant coefficient. With around a third of the respondents being captured in this class, this hints at some very interesting regional dynamics. Additionally, despite lower income levels and higher income inequalities (Table 2), eastern respondents are willing to pay about the same amounts for initiatives in their home region as their counterparts in the West (Table 5), which impacts their household budget relatively more. Furthermore, follow-up questions on altruism revealed that around 10% more of residents in the eastern region are willing to support initiatives in regions with fewer resources and lower economic development than residents in the western region. We thereby find stronger evidence for non-continuous spatial variation along geopolitical thresholds than the direct distance to the good. This is supported by the literature (Loomis 2000; Brouwer et al. 2010; Johnston 2011; Johnston and Ramachandran 2014), which identifies higher WTP and support for projects within particular geopolitical or jurisdictional boundaries compared to continuous distance assessments. Thus, cultural affiliation appears to be much more important than proximity, although these two effects can be confounded. The causes of these regional preference differences are not clear. Regional identities and their effects on nature awareness and conservation strategies have been identified and hypothesised numerous times in the literature (see e.g. Bakhtiari et al. 2018; Chaney 2005; Czajkowski et al. 2017; Friehe and Pannenberg 2020; Jacobsen and Thorsen 2010; Moilanen and Arponen 2011; Möller 2018; Ressurreição et al. 2012). They can be founded in social, environmental, cultural, economic and political realities. However, in this study, they are not explainable by socio-demographic characteristics, home state or distance. It is thus striking to find indications that such regional identities impact respondents' willingness to engage in conservation efforts between the two regions. As the survey was not designed to scrutinise the motivators for such choices, causes could not be identified within the scope of this paper. More research is hence needed to understand the respondents' underlying motives to support wild bee conservation in their home states, home regions or in other parts of the country. Nonetheless, these results highlight the importance of accounting for spatial effects in valuation of biodiversity and natural resources. Not accounting for spatial heterogeneity likely results in over- or underestimations of respondents' WTP (Concu 2007; Brouwer et al. 2010; Pascual et al. 2012), thus including these aspects into welfare estimates would clearly be beneficial to environmental management and policy proposals (Campbell et al. 2008; Johnston 2011).

Finally, standard deviations for all attributes were larger than the means in the RPL model. This indicates that respondents have widely differing preferences for all attributes of wild bee conservation initiatives, a finding supported by the preferences displayed in the three classes of the LC model. This result mirrors previous research specifically on wild bee conservation (Breeze et al. 2015; Mwebaze et al. 2018), but also on general nature awareness and willingness to engage in conservation efforts (Spash et al. 2009; Bartczak 2015; Schell et al. 2017; Taye et al. 2018). Latter studies found conservation support to vary largely with political orientation, deontological and ethical motivations or social norms. Nonetheless, our results overall highlight a tendency towards conservation attributes, which focus on the conservation aspect with no or little direct benefit for respondents over attributes with greater direct personal benefit for respondents: conservation in natural areas was preferred over urban and agricultural areas by a majority of the respondents. Likewise, prioritisation of rare and endangered species over common species was confirmed in follow-up questions. This indicates that if policy makers want support for conservation policies, they may appeal to citizens for support not necessarily from a perspective of monetary and personal benefits, but from a holistic perspective of ecosystem functioning and humanity's role in the environment.

5.2 Reflections and Outlook

Wild bee conservation studies are challenged by the commodification of their ecological function as pollinators, which results in the value of wild bees being reduced to a public good in agricultural systems (Kasina et al. 2009; Mwebaze et al. 2010; Lefebvre et al. 2015). However, wild bees have an intrinsic value within socio-ecological systems, of which only a fraction is beneficial to people (Kleijn et al. 2015; Melathopoulos et al. 2015). It is therefore difficult to disentangle their use and non-use values, as well as direct and indirect benefits people receive from their presence and diversity (Hanley et al. 2015; Mwebaze et al. 2018). Consequently, users and non-users of conservation initiatives cannot be clearly identified, which is important for welfare valuation studies (Hanley et al. 2003; Bateman et al. 2006) and for the analysis of distance and other spatial effects (Glenk et al. 2020). We therefore adopted the assumption in this study that benefits from wild bee conservation are equally distributed among all citizens of the participating states, including non-tax payers. We furthermore acknowledged that opinions on use or non-use values of these benefits are subjective and may vary with respondents' preferences and with distance (Hanley et al. 2003). This is crucial when discussing the magnitude of the identified distance effect. Though the conservation of rare and endangered species in natural areas can be argued to provide fewer direct benefits to respondents than common species on agricultural land, providing crop pollination services (Kleijn et al. 2015), it cannot be concluded with certainty that the choice of the former over the latter by most respondents is the cause for the small distance effect.

While we found spatial aspects to affect respondents' WTP, this study was not designed to identify the root causes of these effects in the study area, which are likely founded in a complex combination of social, economic and political dimensions (Glenk et al. 2020). Our study highlights differences between residents of the eastern and western regions with regards to their willingness to engage in conservation initiatives across state and regional boundaries. The patterns overlap with the socio-political border between the former West German states (former FGR) and the New Laender (former GDR). While we know from previous studies that such boundaries can be crucial in affecting citizens' identities and choices (Dallimer and Strange 2015), we cannot conclude that the formerly different political ideologies still affect respondents' preferences thirty years after reunification. This therefore presents a unique opportunity for future research on regional identity effects on altruism, environmental awareness and conservation choices for this particular study area.

Finally, high WTP estimates indicate great support for wild bee conservation in society, but must also be approached with caution. WTP may be exaggerated by respondents' strong motivation for improvement relative to the status quo and to protect nature in a broader sense (see also Breeze et al. 2015). This could cause an embedding effect, where wild bee conservation is valued as a proxy for nature conservation as a whole (Fischhoff et al. 1993), or 'warm glow', where respondents make financial contributions to conservation to get a feeling of reward for the act of giving (Jacobsen et al. 2012). While these are legitimate motivations within a utility theoretical framework, it can be questioned to what extent values elicited in this way can be isolated to the good in question and thus be related to impact the scope of the contribution.

6 Conclusion

Results from this study demonstrate that there is widespread awareness of wild bee decline and support for conservation among the German public. This support is greatest for efforts in natural landscapes and less strong for human-shaped urban and agricultural land, emphasising the public's desire to support conservation regardless of personal benefits or use value. The models show large preference differences between respondents. Distance effects were minor, but affiliation to a state or region proved to be significantly impacting respondents' WTP for conservation initiatives. Cultural, economic or environmental differences, as well as personal affiliations possibly explain existing regional identities of residents in the East and West, which affect WTP, altruism and conservation choices. However, the complexity of these effects could not be explored at sufficient detail in this study, and further research is highly recommended to identify causes and motives for these effects.

This research adds to the scarce literature on non-market valuation of wild bee conservation in Europe. It is thereby an essential input for policy makers' decisions on urgently needed conservation investments, which are currently predominantly founded in marked-based assessments. Different communication strategies need to be employed in policy proposals to mobilise the greatest possible support in society and increase public and scientific understanding of the causes of and possible solutions to species declines. Finally, this study stresses that such policies must account for spatial heterogeneity, caused by cultural and economic differences between the regions. Failing to understand and address regional preferences can result in mismatches between policies and population support and a reduced effectiveness of conservation initiatives.

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