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Public support for conserving bird species runs counter to climate change impacts on their distributions

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1.Introduction

Many studies have documented that the general public is "willing to pay" for biodiversity protection, particularly for endangered native species[1-3]. However, there is increasing evidence that global climate change will alter the spatiotemporal occurrences and abundances of many species at continental scales[4-11]. This will have implications for efficient conservation of biodiversity. In this paper, we investigate if the general public in Denmark are equally willing to pay for the preservation of birds potentially immigrating and establishing breeding populations due to climate change as they are for native species populations currently breeding in Denmark, but potentially emigrating due to climate change. We find that Danish citizens are much more willing to pay for the conservation of birds native to Denmark, than for bird species moving into the country – even when the potential range shifts are associated with climate change. Thus, people derive a higher value from preserving native species in situ than species moving into their geographical areas. Conservation investments rely heavily on public funding[12, 13] and hence on public support. We suggest that cross-country coordination of conservation efforts should take our findings into account in order to strike a better balance between cost-effectiveness concerns and the concerns of the general public.

Over the last few decades, there is considerable evidence that many species groups have adjusted their distributions and phenologies in response to climate change[10, 14]. While some changes may not threaten the survival of a species, there is a growing concern that some may be pushed out of the geographical area where suitable habitats exist[7, 8] . For such species, the potential for geographical range shifts have already been hampered by the loss of natural habitats[6]. Thus, conservation management is under pressure to come up with cost-efficient strategies for handling this additional complexity as re-iterated at the Nagoya convention[15]. Successful conservation programs, however, do not only rely on their cost-effectiveness but also on popular support for public spending[16]. Hence, investigating the willingness of citizens to support national, as well as international, conservation programs in the context of climate-induced shifts in species ranges is an important matter.

Biodiversity conservation results in various economic benefits, including significant non-use (existence) values[17]. Most valuation studies of biodiversity apply stated preferences methods, as these are able to include non-use values[18]. Such studies have documented the willingness of people to pay for the preservation of biodiversity, particularly for endangered species[1-3]. This study applies a sub-category of stated preference methods known as choice modelling, which is based on the Random Utility Model[19]. Using realistic scenarios of global climate change impacts on birds and their conservation value as seen in a European-wide context[20] for constructing the choice exercise (Fig. 1b), we investigate if the general public in Denmark is equally willing to pay for the preservation of climate-induced immigrating breeding birds as they are for native species currently breeding in their country (Fig. 1a).

2. Methods

We used a choice modelling based survey instrument implemented with a sample of the Danish population. The choice model relies on the Random Utility Model[19] and here we report the results of a conditional logit assuming that the error terms are independently and identically drawn from an extreme value distribution. Several other econometric specifications were applied and showed patterns identical to the results reported here.

As is common in the choice modelling literature, we assumed that the utility of a good can be described as a function of its attributes. In a choice set where alternative versions of a good is described by variation in its attributes, respondents are assumed to choose the alternative that give them the highest indirect utility. Since observation of utility can only be made imperfectly, the Random Utility Model provides the basis for estimation. It can be formally described as:

$$U_{ij} = V_{ij}(y_i - t_j, x_j, x_i) + \varepsilon_{ij} \qquad (1)$$

Where U_{ij} represents individual i's indirect utility from a change in bird population levels. The term V_{ij} is deterministic and is a function of individual i's income y reduced by a tax payment t for alternative j, the alternatives' attributes x_j and the individual's characteristics, z_i. The term ε_{ij} is stochastic, i.e. it cannot be observed by the analyst. If we assume the error terms to be independently and identically drawn from an extreme value distribution, the Random Utility Model is specified as conditional logit.

If the utility function U is linear in its arguments and collecting all the arguments in the vector x_{ki} for a given alternative k and individual i, we can write $U_{ki} = \beta' x_{ki}$, where β is a vector of parameters describing alternatives in terms of population levels, European status, native status and price. Using the conditional logit model, the probability of an individual *i* choosing alternative *k* over a set of alternatives *J* is given by

$$\Pr_i(k) = \frac{\exp(\mu\beta' x_{ki})}{\sum_j^J \exp(\mu\beta' x_{ji})} \qquad (2)$$

where μ is a scale parameter which for simplicity typically is normalized to unity. The marginal value in terms of Willingness to Pay (WTP) of any attribute is computed as the negative of the coefficient on that attribute divided by the coefficient on the tax payment variable. Standard errors for the WTP estimates are estimated using the Delta Method.

3.Data and Survey Design

Data for analysis were collected through the use of an internet based questionnaire which was developed for investigating if the general public in Denmark are equally willing to pay for the preservation of climate-induced immigrating breeding birds as they are for native species currently breeding in their country, but under similar pressure from climate change. The questionnaire was tested thoroughly by means of individual interviews, focus group meetings and a pilot data collection. Birds of equal charisma and level of recognisability were chosen to represent the groups of native and immigrating species.

This resulted in a final questionnaire version used to collect data in January 2011 by use of an internet panel (made available by Analyse Denmark) of more than 25,000 individuals. A total of 1,600 individuals were invited to answer and the data collection was closed when 893 individuals had selected a preferred alternative from three different options (No Policy (current), (New) policy

1, (New) policy 2) in six scenarios. Following the completed data collection, data were scrutinized for anomalies. Some 30 respondents chose the status quo alternative (‘No Policy’ option) with a consequential zero tax payment in all six choice sets and motivated this response pattern with ‘the initiatives should not be financed through income tax’. It is standard in the environmental valuation literature to assume that such respondents have not been willing to reveal their true preferences but rather protested against the payment vehicle and thus we excluded them from the sample. Likewise 27 respondents never choose the status quo and reasoned it by ‘I only considered whether the price was reflecting what I would like to contribute to a good cause’. These respondents were excluded too. Our overall results are not sensitive to the limited number of exclusions. The final sample contained 836 respondents and a total of 5,016 choices.

The experimental design was a d-optimal design for a multinomial logit model, and the design used in this study had a d-error of 0.01767 and consisted of 18 choice situations. These were allocated into three blocks, implying that each respondent had to complete six choice situations. Furthermore, the ordering of attributes was changed for half of the respondents in order to avoid order-effects. The ex post d-error for the final model was 0.00066, which is fully adequate.

4. Results

The main set of results presented here (Table 1) are based on a conditional logit model. We also estimate a model which allows for describing and estimating a distribution for β as random parameters and hence accounting for preference heterogeneity in the population. This random parameter logit model[1, 2] describes the probabilities as integrals of the standard conditional logit function over the distribution of β in the n’th choice occasion:

$$\Pr_{in}(k)=\int\left(\frac{\exp(\mu\beta_i' x_{kin})}{\sum_j^J \exp(\mu\beta_i' x_{kin})}\right)\phi(\beta\mid b,W)d\beta), \qquad (3)$$

Here $\phi(\beta\mid b,W)$ is the distribution function for β, with mean b and covariance W and μ is a scale parameter which for simplicity typically is normalized to unity. Estimation of the likelihood function based on (3) requires that assumptions be made about which coefficients are random, about the joint distribution of these coefficients, and that the error variance is constant. Finally, we estimate a number of models with interactions.

We highlight the following patterns of our results: irrespective of the projected overall population development in Europe, people state significantly higher willingness to pay for conserving native species relative to species moving into their geographical area (Fig. 2). Looking at the details for native species, people state higher preferences for preserving population levels as ‘Abundant’ rather than ‘Scarce’ (Fig. 2; Table 1). Furthermore, people state significantly higher preferences for preserving species that are expected to have a decreasing population in Europe relative to those that are expected to be stable. People thus prefer conservation actions targeted at native species, which are expected to become relatively scarcer in the future.

For immigrant species, people also have significantly higher preferences for preserving birds expected to decrease in population levels relative to those expected to remain stable at the European level. It is noteworthy, however, that people express significantly higher preferences for securing future preservation at the ‘Scarce’ level than at the ‘Abundant’ level, irrespective of European population development. In fact, the parameter for a future local population at the ‘Abundant’ level for immigrant species predicted to be stable in Europe is not significantly different from zero. This pattern is exactly opposite to that seen for the group of native species. As an example this implies that people are willing to pay 150 Euro per year and household for the conservation at the abundant level of species like the golden plover (*Pluvialis apricaria),* which is currently found in Denmark, but threatened at the European level. The grey-headed woodpecker (*Picus canus*) is equally threatened at the European level, but is not a breeding species in Denmark. For such species, people are only willing to pay 60 Euro for preservation at the abundant level. They are, however, willing to pay 111 Euro in total for preserving such species at the scarce level.

A random parameter model allowing for distributions around the estimated parameters (See Table 2) showed a similar pattern of willingness to pay and also revealed that preference heterogeneity was fairly low. More detailed examination of the pattern of responses among respondent sub-groups revealed that people more knowledgeable about birds, and people believing climate change to be man-made, had significantly higher preferences for protecting native species relative to people less knowledgeable about birds or not believing climate change to be man-made (see Table 3 and Table 4). People's preferences for conserving immigrant species were not significantly different across these sub-groups. The pattern can be interpreted as a willingness to help mitigate effects of climate change, rather than accepting change and adaptation, reflecting the more general theory of endowment effects or loss aversion[21, 22].

It is possible that individual's preferences towards conservation of immigrant species are influenced by a concern that some such species could be ecologically damaging. We controlled for this by informing respondents prior to the choice sets about the difference between invasive and immigrant species in order to avoid misunderstandings. This was successful, as in a follow-up question only 95 respondents (11%) stated that they thought immigrant species could be potentially negative for Danish nature, whereas 225 (27%) and 335 (43%) thought it might be positive or neutral, respectively. Excluding those respondents who believe immigrant species could be potentially negative for the Danish nature does not change the pattern of the results (See Table 5). Thus, our results do not reflect concerns about damages due to invasive species.

5. Discussion and Conclusions

The results of this study add perspective to the discussion of the welfare economic effects of international biodiversity conservation efforts. The value people derive from conservation outcomes goes beyond species richness, density and threatened status, but also reflects to a very high degree peoples' perception of the species' origins in a geographical, historical and possibly cultural sense and context. As a result of this, we find that a country's citizens are much more willing to support the conservation of birds native to the country, than for bird species moving into the country – even when this runs counter to the potentially inevitable range shifts associated with climate change.

This finding has important implications for nature conservation, conservation science and policy practice. Placing higher priorities on national conservation efforts may reduce cost-efficiency, despite being popular with tax payers[23]. Conservation management research has shown that coordination across political boundaries may greatly improve cost effectiveness, allowing conservation targets to be achieved at lower cost[24]. For the same reason, international biodiversity policies focus on coordination of efforts. However, our results show that such coordination may run counter to the preferences and welfare of citizens whose tax dollars pay for many conservation actions. This matters when climate change sets species populations into motion across national boundaries. The merits of geopolitical coordination of conservation efforts[12, 13] are not contested by our study. However, because our results show that people may derive a higher value from preserving native species in situ than species moving into their geographical areas, we suggest that coordination efforts should take this into account to strike a better balance between actions which minimize the cost of achieving biodiversity conservation targets with the values and concerns of the general public.

In situations where climate change causes significant changes in species distributions, preserving native species may be excessively costly. This should be made clear to the public when relevant, as our results otherwise indicate a very real risk of wasting conservation efforts on potentially lost causes: Politicians may find popular support high for preserving native species under pressure, and opt for this in spite of potentially very uncertain gains. To counteract this, we stress the need for sound scientific knowledge and assessments of climate change impacts on species distribution and geographical shifts of breeding range[25]. This discussion even applies to public reluctance towards optimal timing of relocating species that cannot keep pace with climate change[26]. Improved information should be able to guide the policy process and allow people to factor in the likelihood of preservation efforts to succeed in light of climate change pressure, thereby re-aligning public support with what is possible in conservation terms.

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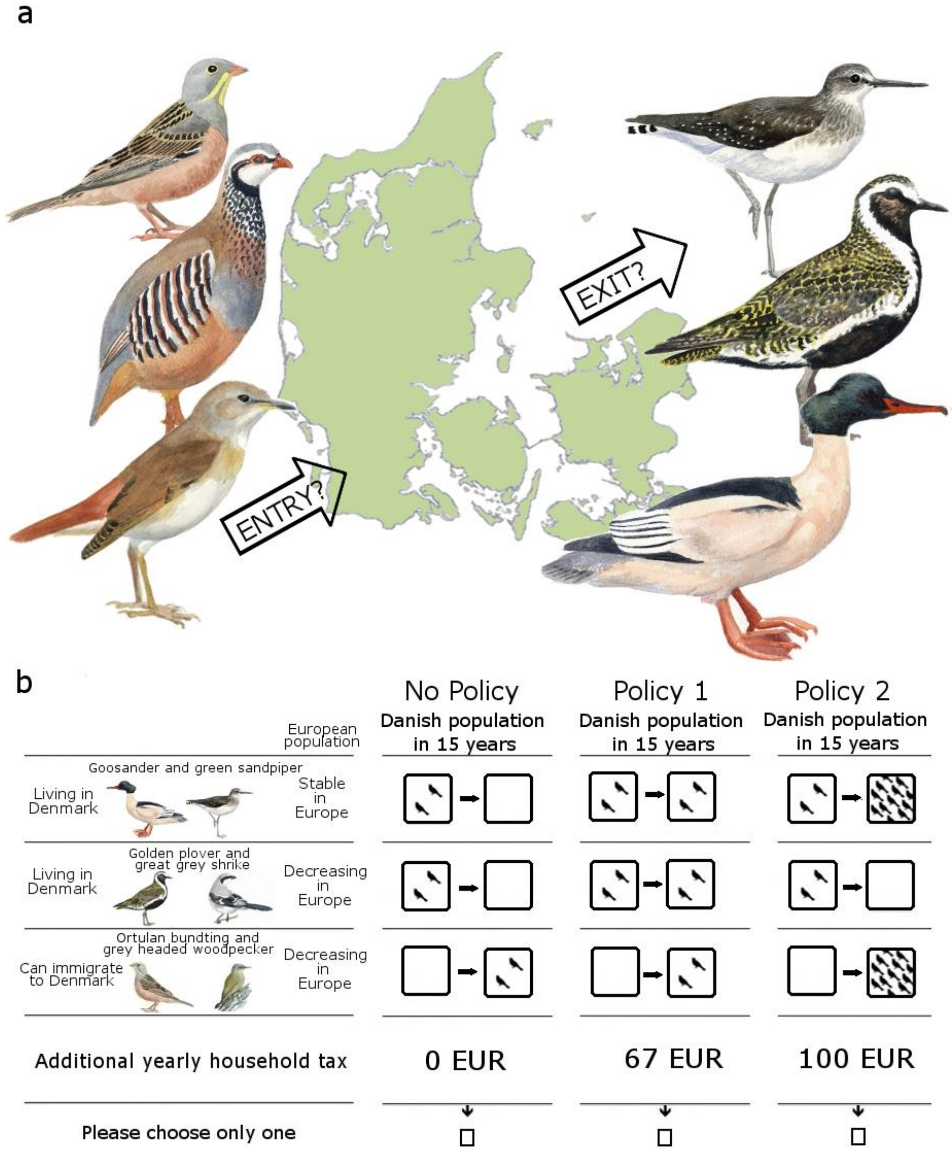

Figure 1. Panel a illustrates the overall challenge for conservation management, using the example of Denmark: Species currently breeding in Denmark may emigrate in the future as climate change alters habitats, whereas others may immigrate and settle for the same reason. In Panel b, we show one example of how the decision situation was presented to respondents as a choice between policies, each respondent answering several such choice sets. The pictograms illustrating bird groups (not living in Denmark or extinct ;scarce ;abundant) were explained to respondents before completing the choice tasks.

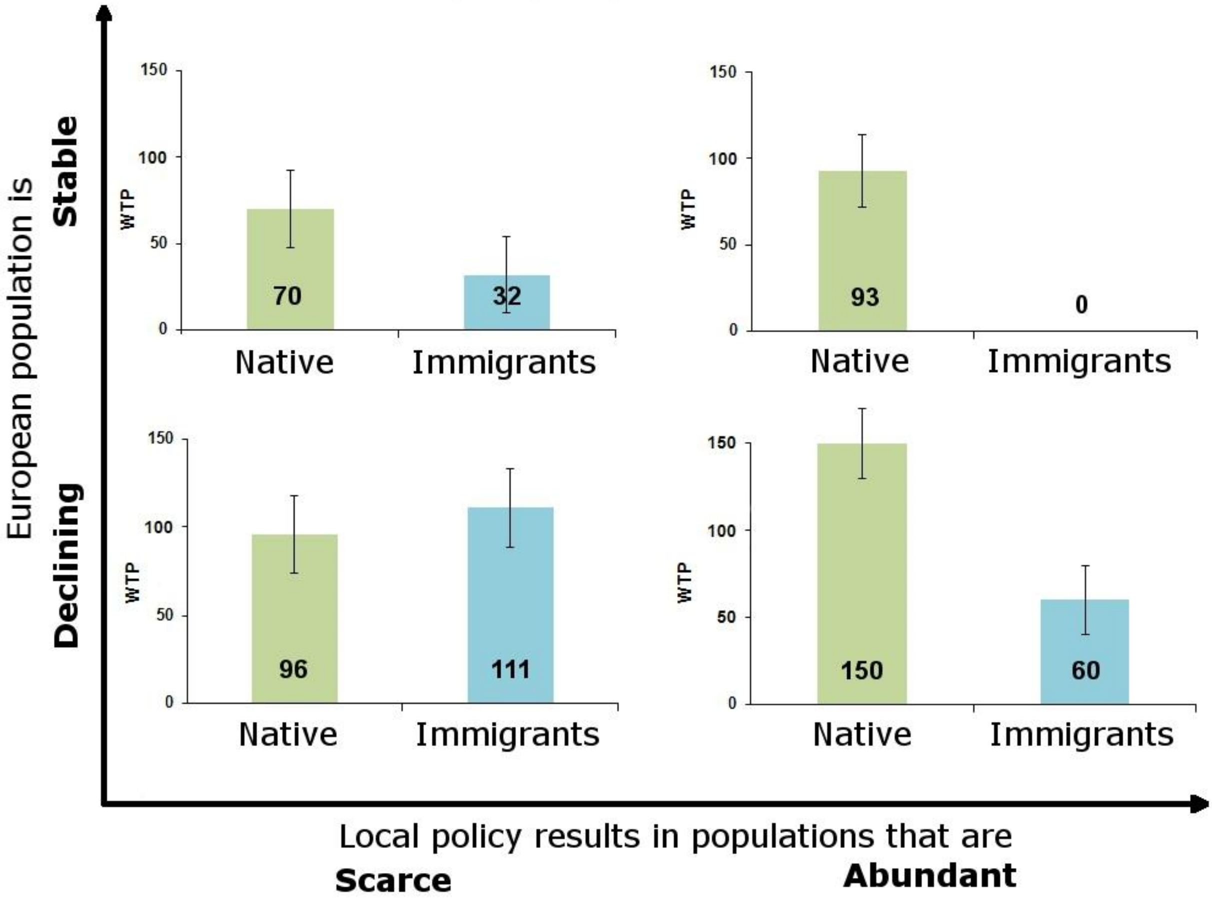

Figure 2. Peoples mean willingness to pay (WTP) for preserving birds as a function of predicted European population (large vertical axis), local policy outcome (large horizontal axis) and whether the bird group is native or immigrating (colours). The columns show mean WTP in Euro/household and year. The error bars indicate 95 per cent confidence intervals for WTP.

Table 1. Result of the conditional logit estimation in preference space. Columns 3-5 show preference coefficients, significance levels and standard errors for the combinations of species groups and future policy outcome in Denmark (DK) in column 1 and 2. Columns 6-7 shows the related mean Willingness to Pay (WTP) estimates (€/household and year) and standard error of this. Significance levels at 0.1 % are indicated with three asterisks (***), 1 % with two asterisks (**) and 5 % with one asterisk

	POLICY OUTCOME VARIABLES	PREFERENCE COEFFICIENT		STANDARD ERROR	WTP (EUR)	STANDARD ERROR WTP
	Price	-0.0010	***	0.00005	N/A	N/A
	Alternative Specific Constant	-0.2691	***	0.05653	-34	6.58
Groups of Native Species	**Stable** in Europe Preserved as **Abundant** in DK	0.7279	***	0.05069	93	8.69
	Stable in Europe Preserved as **Scarce** in DK	0.5452	***	0.05588	70	7.92
	Decreasing in Europe, Preserved as **Abundant** in DK	1.1747	***	0.05306	150	9.96
	Decreasing in Europe, Preserved as **Scarce** in DK	0.7476	***	0.05488	96	8.54
Groups of Immigrating Species	**Stable** in Europe Preserved as **Abundant** in DK	-0.0528		0.08450	-7	10.8
	Stable in Europe Preserved as **Scarce** in DK	0.2473	**	0.08731	32	11.35
	Decreasing in Europe, Preserved as **Abundant** in DK	0.4680	***	0.08343	60	10.21
	Decreasing in Europe, Preserved as **Scarce** in DK	0.8723	***	0.07772	111	10.80
	Number of observations	*5,016*				
	Log Likelihood Value	*-4,577.90*				
	Chi square	*1,865.48*				
	Pseudo R^2	*0.17*				

Table 2. Results of the random parameter logit model.

	Policy Outcome Variable	Preference Coefficient (random parameter)		Standard Error	WTP (EUR)	Standard Error WTP
	Price	-0.0011	***	0.00060	N/A	
	Alternative Specific Constant	-0.2551	***	0.06172	-30	6.66
Groups of Native Species	**Stable** in Europe	0.8919	***	0.06369	106	10.05
	Preserved as **Frequent** in DK	(0.0953)		(0.25004)		
	Stable in Europe	0.7831	***	0.07565	93	9.98
	Preserved as **Scarce** in DK	(0.0140)		(0.18743)		
	Decreasing in Europe,	1.5224		0.08012	181	12.24
	Preserved as **Frequent** in DK	(0.0106)	***	(0.40000)		
	Decreasing in Europe,	1.0826	***	0.07827	129	10.57
	Preserved as **Scarce** in DK	(0.0165)		(0.21009)		
Groups of Immigrating Species	**Stable** in Europe	-0.0467		0.08791	-6	10.47
	Preserved as **Frequent** in DK	(0.0473)		(0.26811)		
	Stable in Europe	0.2933	**	0.08942	35	10.78
	Preserved as **Scarce** in DK	(0.0473)		(0.26811)		
	Decreasing in Europe,	0.0344		0.15838	4	18.80
	Preserved as **Frequent** in DK	(2.2948)	***	(0.33611)		
	Decreasing in Europe,	1.0265	***	0.08530	122	10.80
	Preserved as **Scarce** in DK	(0.0758)		(0.60679)		
	Number of observations	*5,016*				
	Log Likelihood Value	*-4,559.14*				
	Chi square	*1,903.00*				
	Pseudo R^2	*0.17*				

Note: Figures in parentheses are related to the estimated standard deviation around the random parameter, cf. equation (3). Significance levels at 0.1 per cent are indicated with three asterisks (***), 1 per cent with two asterisks (**) and 5 per cent with one asterisk (*)

Table 3. Results of the conditional logit model estimation with interaction effects of people believing climate change is man made

	VARIABLE	PREFERENCE COEFFICIENT		STANDARD ERROR	WTP (EUR)	STANDARD ERROR WTP
	Price	-0.0010	***	0.0001		
	Alternative Specific Constant	-0.2715	***	0.0566	-35	7
Groups of Native Species	**Stable** in Europe					
	Preserved as **Frequent** in DK	0.5890	***	0.0854	75	12
	- climate change interaction effect	0.2129	*	0.1019	27	13
	Stable in Europe					
	Preserved as **Scarce** in DK	0.3248	**	0.0960	41	12
	- climate change interaction effect	0.3280	**	0.1133	42	15
	Decreasing in Europe,					
	Preserved as **Frequent** in DK	0.9750	***	0.0926	124	13
	- climate change interaction effect	0.2973	**	0.1129	38	14
	Decreasing in Europe,					
	Preserved as **Scarce** in DK	0.5739	***	0.0973	73	13
	- climate change interaction effect	0.2561	*	0.1179	33	15
Groups of Immigrating Species	**Stable** in Europe					
	Preserved as **Frequent** in DK	0.1590		0.1415	20	18
	- climate change interaction effect	-0.3045		0.1639	-39	21
	Stable in Europe					
	Preserved as **Scarce** in DK	0.5666	***	0.1503	72	19
	- climate change interaction effect	-0.4495	**	0.1713	-57	22
	Decreasing in Europe,					
	Preserved as **Frequent** in DK	0.4126	**	0.1470	53	18
	- climate change interaction effect	0.0850		0.1742	11	22
	Decreasing in Europe,	1.0394	***	0.1194	132	16

Preserved as **Scarce** in DK				
- climate change interaction effect	-0.2441	0.1318	-31	17
Number of observations	*5,106*			
Log Likelihood Value	*-4,555.80*			
Chi square	*1,909.68*			
Pseudo R^2	*0.173*			

Note: Significance levels at 0.1 per cent are indicated with three asterisks (***), 1 per cent with two asterisks (**) and 5 per cent with one asterisk (*)

Table 4. Results of the conditional logit model estimation with interaction effects of respondents knowing 3 or more of presented birds

	VARIABLE	PREFERENCE COEFFICIENT		STANDARD ERROR	WTP (EUR)	STANDARD ERROR WTP
	Price	-0.0010	***	0.0001		
	Alternative Specific Constant	-0.2694	***	0.0566	-34	7
Groups of Native Species	**Stable** in Europe					
	Preserved as **Frequent** in DK	0.6069	***	0.0629	77	9
	- knowledge interaction effect	0.3193	**	0.0985	41	13
	Stable in Europe					
	Preserved as **Scarce** in DK	0.3827	***	0.0694	49	9
	- knowledge interaction effect	0.4278	***	0.1082	54	14
	Decreasing in Europe,					
	Preserved as **Frequent** in DK	1.0596	***	0.0671	135	11
	- knowledge interaction effect	0.3123	**	0.1098	40	14
	Decreasing in Europe,					
	Preserved as **Scarce** in DK	0.6068	***	0.0697	77	10
	- knowledge interaction effect	0.3734	***	0.1133	47	15
Groups of Immigrating Species	**Stable** in Europe					
	Preserved as **Frequent** in DK	0.0249		0.1040	3	13
	- knowledge interaction effect	-0.2032		0.1552	-26	20
	Stable in Europe					
	Preserved as **Scarce** in DK	0.2137	*	0.1090	27	14
	- knowledge interaction effect	0.0808		0.1582	10	20
	Decreasing in Europe,					
	Preserved as **Frequent** in DK	0.4590	***	0.1053	58	13

- knowledge interaction effect	0.0512		0.1644	7	21
Decreasing in Europe,					
Preserved as **Scarce** in DK	0.9010	***	0.0918	115	13
- knowledge interaction effect	-0.0644		0.1256	-8	16
Number of observations	*5,016*				
Log Likelihood Value	*-4,560.26*				
Chi square	*1,900.76*				
Pseudo R^2	*0.172*				

Note: Significance levels at 0.1 per cent are indicated with three asterisks (***), 1 per cent with two asterisks (**) and 5 per cent with one asterisk (*)

Table 5. Results of the conditional logit model estimation without respondents who state that immigrating species are bad for nature

	Variable	Preference Coefficient		Standard Error	WTP (EUR)	Standard Error
	Price	-0.0010	***	0.0001		
	Alternative Specific Constant	-0.1758	***	0.0600	-23	7
Groups of Native Species	**Stable** in Europe Preserved as **Abundant** in DK	0.7341	***	0.0534	96	10
	Stable in Europe Preserved as **Scarce** in DK	0.5115	***	0.0590	67	9
	Decreasing in Europe, Preserved as **Abundant** in DK	1.1330	***	0.0558	149	11
	Decreasing in Europe, Preserved as **Scarce** in DK	0.7065	***	0.0582	93	9
Groups of Immigrating Species	**Stable** in Europe Preserved as **Abundant** in DK	-0.0540		0.0891	-7	12
	Stable in Europe Preserved as **Scarce** in DK	0.1869	***	0.0928	25	12
	Decreasing in Europe, Preserved as **Abundant** in DK	0.4320	***	0.0878	57	11
	Decreasing in Europe, Preserved as **Scarce** in DK	0.7895	***	0.0821	104	12
	Number of observations	*4,446*				
	Log Likelihood Value	*4,078.60*				
	Chi square	*1,611.65*				
	Pseudo R^2	*0.165*				

Note: Significance levels at 0.1 per cent are indicated with three asterisks (***), 1 per cent with two asterisks (**) and 5 per cent with one asterisk (*)