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Public preferences for multiple dimensions of bird biodiversity at the coast: insights for the cultural ecosystem services framework.

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Keywords: coastal management, coastal zones, discrete choice experiments, ecosystem

services, willingness to pay, valuation, biodiversity.

Abstract

Biodiversity is valuable to society, including through its contribution to cultural benefits: "the non-material benefits people obtain from biodiversity and ecosystem services through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences". Biodiversity encompasses numerous measures, but the distinct values of these measures have been little studied. We conducted a discrete choice experiment to elicit respondents' (n=3 000) willingness to pay for increases in four measures of bird diversity in UK coastal ecosystems: number of bird species (species richness), number of individual birds (abundance), probability of seeing rare or unusual bird species, and probability of seeing large flocks of birds (wildlife spectacles). Respondents had a positive willingness to pay (through one-time voluntary donations) for increases in all four measures (mean £3 to £5 per household). However, using latent class analysis we found considerable heterogeneity of preferences, identifying four classes of respondents with strikingly different levels of marginal willingness to pay for the four measures. Income, age, environmental activity, visits to environmental settings, and gender were important determinants of class membership. While focusing on birds, our results demonstrate the importance of a multi-dimensional conceptualisation of biodiversity in broader ecosystem management, rather than focussing

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on a single aspect such as species richness or abundance. Our findings also highlight the implications of heterogeneous public preferences for biodiversity for conservationists, planners, shoreline managers and developers. These need to be considered in the development of new frameworks for ecosystem services, and when planning and funding conservation actions so that the cultural benefits will accrue across a range of social groups.

1. Introduction

Biodiversity provides many benefits to humans, including cultural benefits: "the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences" (MEA 2005; see also, TEEB, 2010; Satterfield *et al.* 2013; Fish *et.al*. 2016; Oleson *et al.*2016; EEA, 2018). In addition to the cultural importance of biodiversity, broader links have been hypothesised between biodiversity and human wellbeing (Dallimer *et al.* 2012; Clark, 2014; White *et al.*2017), with benefits ranging from psychological restoration (e.g. Kaplan, 1995; Cracknell *et al.*2018) and improved physiological health (e.g. Hanski *et al.* 2012), to better social relations (e.g. Weinstein *et al.* 2015). However, little is understood about the significance of different measures of biodiversity, e.g. the number of species (richness), the number of individuals, number of rare species, or behaviour for example such as birdsong or wildlife spectacles caused by birds flocking together (Börger *et al.* 2014; Dallimer *et al.* 2014; Faccioli *et al.* 2015). It is therefore largely unknown how different forms of biodiversity change will affect human well-being and welfare (e.g. Keniger *et al.* 2013, Lovell *et al.* 2014, Cracknell *et al.* 2015). Looking at coastal bird communities, Luisetti *et al.* (2011) report that marginal willingness to pay for species richness, declines above four bird species, but such studies are rare. Key determinants behind social preferences are also poorly understood (Sali *et al.* 2008). A range of social factors such as income, gender, age, and environmental attitudes may combine with cultural variations in how biodiversity is perceived and valued (Ressurreição *et al*. 2012).

Birds are appreciated by many people undertaking outdoor activities or in their social settings. However, birding more specifically is also a deliberately undertaken activity which takes diverse forms: from short excursions during other activities to enjoy the sights, sounds and behaviour of birds; to trips to nature reserves or other areas, using equipment such as binoculars and infrastructure such as bird hides; to 'twitching' (UK) or 'catching' (US) which involves dedicated trips to see rare birds (Connell, 2009). The significance of species diversity as a factor across a large proportion of avitourism strategies has been highlighted (Steven *et al.* 2017). Coastal ecosystems support large numbers of waterbirds and the UK is of global importance for these species due to its location on migratory flyways, and extensive, productive estuarine mudflat and saltmarsh habitats (Frost *et al.* 2019a; Stroud *et al.* 2001). Many of these wetland sites are classified as Special Protection Areas (SPAs), in accordance with the EC 'Birds Directive' (2009/147/EC), as part of the Natura 2000 network, or as Wetlands of International Importance under the Ramsar Convention, to provide protection to the bird populations that they support, especially overwintering species. The selection criteria for SPAs focus on the numbers of individual species or overall assemblage of birds that regularly occur on a site (Stroud *et al.* 2016). The Wetland Bird Survey (WeBS) monitors the populations of non-breeding waterbirds in the UK, providing data on the numbers and trends of waterbirds occurring at site and national levels (Frost *et al*. 2019b). These data inform the selection of conservation sites and also track the conservation status of feature species of these sites (Cook *et al.* 2013). While numbers of several waterbird species have declined in the UK in recent decades (Brown *et al*. 2015, Frost *et al*. 2019b), there has been a general increase in the numbers of species (i.e. species richness) and functional diversity (an index that measures trait dispersion) of waterbird communities occurring on estuarine and coastal sites since the 1980s (Mendez *et al.* 2012). An important driver of these changes is climate change, which has been linked with shifts in species' wintering distributions towards continental Europe (Austin & Rehfisch 2005, Maclean *et al.* 2008; Johnston *et al.* 2013) and impacts on populations on their Arctic breeding grounds (Rehfisch & Crick 2003; Robinson *et al*. 2009). Shellfishing (van Gils *et al*. 2006; Atkinson *et al*. 2010), increased disturbance (Stillman *et al.* 2007), loss of habitat due to sea-level rise (Durrell *et al*. 2006; Iwamura *et al*. 2013) or coastal development (Burton *et al*. 2006; Goss-Custard *et al*. 2006) may also contribute to site-specific changes.

Using avian biodiversity in UK coastal ecosystems as a case study, this paper aims to provide a deeper understanding of what is important about biodiversity and to whom. There are multiple trade-offs between different services – for example, whether coastal space should be prioritised for production, conservation or cultural services such as recreation, and what combination of services are possible (Bradbury *et al.* 2010; Fisher *et al.* 2011; Ruijs, *et al.* 2013; Howe *et al.* 2014; Burdon *et al.* 2017; Burdon *et al.* 2018). Given this, a better understanding of the value of these cultural services to different beneficiaries can inform coastal ecosystem management. Such knowledge is crucial to ensure that decisions about development or conservation consider the full range, and distribution, of benefits. We use a discrete choice experiment (DCE) to investigate people's preferences for changes in bird biodiversity based on realistic future coastal scenarios, along four measures: species richness, abundance, probability of seeing rare species and the probability of seeing wildlife spectacles. This is the first paper we know of to use stated preference methods to explore the significance of these four measures of biodiversity. Finally, we also highlight the implications for ecosystem management more broadly.

2. Methods

In our study, we used Willingness to Pay (WTP) as a measure of social preferences. WTP can be identified as the amount of money that, if taken away from an individual and used to increase the availability of a public good, leaves their utility constant. In this case, the willingness to pay was for different combinations of the four measures of biodiversity outlined above (biodiversity metrics). An alternative approach would be to use attitudinal questions to gauge social preferences, and indeed in preparing the alternative scenarios for our discrete choice experiment, we drew on such data (see 2.2 below). However, that paradigm of decision theory assumes no resource constraints on people's preferences, and does not force respondents to trade-off increases or decreases in the different measures of biodiversity.

2.1 Discrete Choice Experiments (DCE)

Citizens' preferences for changes in bird biodiversity were elicited by employing a DCE (Louviere et al. 2000; Bateman *et al*. 2002; Lipton *et al*. 2014; Johnston *et al*. 2017), a stated preference survey-based technique widely used in non-market valuation in environmental economics (e.g. Beharry-Borg and Scarpa, 2010; Yao *et al.* 2014). The DCE aims to identify citizens' preferences for different coastal management options. It was devised to explore the trade-offs that people are willing to make from the varying consequences of alternative management options for bird biodiversity. We presented respondents with hypothetical, but realistically designed scenarios relating to bird biodiversity and asked for their preferred options. This allowed us to elicit preferences for alternatives which do not exist: systematic variations in the four measures of bird biodiversity and related policy alternatives. As such, the research does not observe choices made in real markets and challenges to the reliability of such data arise for different reasons, including the cognitive challenge for respondents in deliberating between choices. A key justification for the method is that a stated preference approach allows the research to go over the 'frontier', extending the area of investigation beyond current market choices, in terms of future alternatives, attributes, or attribute levels. The four measures concerned were: number of species, number of individuals, presence of rare species and probability of observing natural spectacles. While we expected people to prefer higher levels of each measure, we also expected preference heterogeneity across different sub-groups of the population, depending on their characteristics.

2.2 Operationalisation: focus groups, pre-test interviews and survey instrument

Focus groups and discussions with stakeholders were employed to determine the attributes in the DCE and to design the survey instrument, which was then finalized using pre-test interviews. Firstly, the questions were trialled in two workshops in the coastal zones of Essex and Morecambe Bay (n=21 and n=16) based on a broad range of stakeholders involved with the Essex Coastal Forum and Morecambe Bay Partnership respectively. At each workshop, respondents were involved in a deliberative survey, using an electronic voting system to provide preference responses to pictures about bird biodiversity. This technique allowed engagement with the mental construct of biodiversity being used by the respondents, with the aim of improving the construct validity of survey questions. For example, the term 'wildlife spectacle' was found to provide the best description for the variety of bird displays and behaviour which influenced visitor choice. Terms and phrases about 'biodiversity' subsequently used in the questionnaire drew on the distinctions understood by laypeople. For example, respondents suggested that we used the word 'types' instead of 'species' of bird, to aid understanding.

The survey instrument was then pre-tested using face-to-face interviews with a convenience sample of 15 random students, academics and members of the general public in a UK city, to: confirm that the DCE included all important attributes and that respondents understood that those attributes could hypothetically vary independently; assess respondents' ability to understand and accept the survey instrument; and assess that the hypothetical scenarios were acceptable to respondents. Finally, these interviews were used to assess the length and wording of the survey instrument. During the pre-test interviews, respondents were asked to complete the survey instrument while "thinking aloud" – describing their considerations while carrying out the questionnaire.

In the early stage of the questionnaire development we considered different payment methods. After reviewing and testing in focus groups and having discussed different options with stakeholders, such as higher cost of living, increase in local or regional taxes, introduction of a new tax and donation, we decided to use a donation as it was perceived to be a common way of funding activities linked to coastal preservation and bird biodiversity. We had to exclude new taxes or other payment vehicles in the DCE as they were found not to be plausible or acceptable for the type of intervention.

2.3 The survey instrument and experimental design

Respondents were presented with six independent choices between alternative, hypothetical coastal management options. These were options for coastal improvements or infrastructure that third sector organizations could promote and/or implement to avoid long term deterioration caused by human activity to coasts and wildlife in the UK (see appendix A, supplementary info, for the full questionnaire). We asked respondents to consider how a change in policy at the site could impact on bird biodiversity as explained below. This scenario reflects the situation in countries such as the US and UK where conservation charities are significant landowners. It was explained that new funding would be necessary to support long term improvement in environmental quality and that, given the current political and economic situation, funding could only come from citizens' donations. Avian ecologists input knowledge on how attributes might change under different scenarios, and levels of the outcomes were chosen which were meaningful to respondents and avoided cognitive overload (Börger *et al.* 2018). Respondents were asked to select their preference from sets of alternative options, with information provided on the related outcomes for different bird measures. The bird measures used were (choice of levels in brackets):

- The number of **different species** of birds (referred to as 'types' in our questionnaire following piloting, to ensure comprehensibility) that a respondent can see during a visit (decrease, increase, remain at current levels);
- The total **number** of **individual birds** a respondent might see during a visit (decrease, increase, remain at current levels);
- The **probability of seeing a particular type of bird** that is **rare or unusual** (higher, lower, remain at current level);
- The probability of the presence **of a wildlife spectacle** (e.g. thousands of birds in a flock) (higher, lower, remain at current level).

Our study therefore tracked outcomes that can be linked to both structural diversity and functional diversity (in terms of behavioural traits). Each scenario was characterised by a one-off donation required to develop the relevant coastal management options, which ranged between £1 and £15. Including these measures and levels, the DCE was designed employing the four most common 'efficiency under uninformative priors' criteria for the indirect utility coefficients (Ferrini and Scarpa, 2007; Scarpa and Rose, 2008; Kessels *et al.* 2009). We used more than one criterion, updating the design in each of the six waves in order to maximise the statistical power of the DCE and capture as many trade-offs as possible. The final design resulted in sixty-six different choice tasks which were divided into eleven blocks to avoid respondents' fatigue (Campbell *et al.* 2015). An example of a choice task is shown in Figure 1.

Figure 1 Example Choice Card

Attribute	Management option 1	Management option 2	Current Management
Number of different **types** of birds you can see when you visit	Decreased	Decreased	Current
Number of **individual birds** you might see when you visit	Decreased	Current	Current
Likelihood of seeing a particular **type of bird** that is **rare or unusual** for the area	Higher	Higher	Current
Probability of the presence of **wildlife spectacle** (e.g. thousands of birds in a flock)	Current	Higher	Current
Right to **access (proximity)**	No access	Full access	Full access
Cost	**£1**	**£5**	**£0**
choice	☐	☐	☐

2.4 The study sample

A questionnaire was designed and administered online to a representative sample of the UK general population in November 2015, via an online survey. The survey instrument was started by a total of 3,524 respondents randomly selected from the pool of contacts supplied by a research company, screened to be representative of the population in terms of three quotas: male to female ratio, age and employment status, While results from online DCE surveys are often similar to face-to-face interviews, there may be some selection bias resulting from conducting the survey online using an opt-in panel. Given the respondents are drawn from an online panel, this potentially limits the generalizability of the results. However, for the research strategy, this has to be weighed against the tractability of recruiting such a large sample. After eliminating 135 respondents who answered the survey too quickly and/or inconsistently (completed the survey in less than a minute, when the median time for completion was just below 15 minutes, and answered questions with constant pattern – e.g. always the first or the last option) and 389 respondents who did not complete the whole sequence of choices in the DCE, the final sample comprised 3,000 respondents.

2.5 Analytical Framework and Preference Analysis

The analytical framework used for modelling the data in the discrete choice experiments is described in Appendix B, supplementary data. Analysis of DCE data is based on the random utility maximisation (RUM) theory (Thurstone, 1927; Manski, 1977) and the choice probability was modelled using the mixed logit multi-nominal probability function (McFadden and Train, 2000). The clustering of the respondents based on their preferences for biodiversity in coastal areas was conducted using semi-parametric latent class analysis, and clusters selected according to AIC3 criteria (Wedel and Kamakura, 2000).

3. Results

In this section we present the socio-economic characteristics of the sample, with a focus on the variables included in the Latent Class (LC) model, and then report the preference analysis results generated from the Discrete Choice Experiment (DCE) data.

3.1 Descriptive statistics

The sample is broadly representative of the UK population (Table 1). Compared to the general population (UK Census, 2011), our sample is slightly more educated, but similar in terms of income distribution and employment with 54% working full or part time. Households were representative of the average household in the UK, with a size around 2 people per household and about 59% married or living together. In the last 12 months, 77% of respondents had visited a coastal area, while the average distance of respondents' households from the coast was 29 miles.

Table 1 Comparison of Sample with UK Census and ONS data

	Sample	**UK Population 2011**
N (people)	3,000	63.182 million
Age (years)	45.5	46.5
Female	51%	51%
People per household	1.9	2.3
Marital Status		
Single	28%	34.7%
Married	46%	46.5%
Divorced	8%	8.8%
Living with partner	13%	-
Separated	2%	2.7%
Widowed	3%	7.0%
Employment		
Work full time and self employed	39%	51.6%
Work part time	15%	13.7%
Student	5%	5.8%
Retired	22%	13.9%
Home	8%	4.3%
Unable	5%	6.4%
Unemployed	5%	4.4%
Education		
Other	47%	61%
A-Levels	15%	12%
University degree	38%	27%
Household Gross Annual Income[7]		
less than £10,000	13%	10%
£10,000 to £30,000	45%	45%
£30,001 to £60,000	31%	35%
more than £60,000	11%	10%

1. Data from Effects of Taxes and Benefits on UK Household Income ONS SN7470

3.2 Preference analysis

The multinomial logit model (MNL) indicated that respondents showed significant ($p<0.01$) responses to all variations from the current situation (Table 2). Respondents preferred increases in all biodiversity measures compared to the current situation, and disliked decreases.

The positive coefficient for the current situation suggests that, overall, respondents prefer to maintain the current state of coastal management, while the negative coefficient for cost shows that respondents in general do not like to pay more for the same outcome. Based on the MNL model average WTP for an increase in the number of species of birds in coastal areas is about £5 per household (Table 3). Considering the 22 million households in the UK, this is equivalent to an overall £110 million that could, in theory, be donated to environmental

[7] Data from Effects of Taxes and Benefits on UK Household Income ONS SN7470

organisations for bird conservation in the UK coastal environment. This WTP is significantly higher than those for all the other measures (as shown by the 95% confidence intervals), namely an increase in total number of individual birds; an increased likelihood of seeing rare or unusual species; and an increased in the probability of seeing a wildlife spectacle. These were not statistically different from each other and valued at approximately £3.50 per household.

LC results are presented in the second part of Table 2 and the corresponding WTP for each biodiversity measure in the right hand side of Table 3.

Table 2: Preference analysis, results from MNL and LC models (observations = 18,000, respondents = 3,000).

Attribute	*MNL model*		*LC model*							
			Class 1		**Class 2**		**Class 3**		**Class 4**	
	Coeff	**St. err.**	**Coeff**	**St. err.**	**Coeff**	**St. err.**	**Coeff**	**St. err.**	**Coeff**	**St. err.**
Current situation	0.148***	0.04	2.023***	0.11	-1.979***	0.14	-1.789***	0.18	0.550***	0.13
Decline in number of species	-0.461***	0.04	-0.523***	0.10	-0.238***	0.06	-0.515***	0.06	-1.482***	0.13
Increase in number of species	0.371***	0.02	0.331***	0.09	0.178***	0.05	0.436***	0.05	1.076***	0.09
Decline in total number of birds	-0.357***	0.02	-0.353***	0.10	-0.212***	0.06	-0.439***	0.06	-1.047***	0.09
Increase in total number of birds	0.256***	0.02	0.122	0.09	0.195***	0.05	0.321***	0.05	0.687***	0.07
Decline in incidence of rare species	-0.294***	0.02	-0.384***	0.09	-0.063	0.05	-0.371***	0.06	-0.895***	0.09
Increase in incidence of rare species	0.256***	0.02	0.360***	0.09	0.090*	0.05	0.308***	0.05	0.711***	0.08
Decrease in spectacles	-0.302***	0.02	-0.412***	0.10	-0.144**	0.06	-0.343***	0.05	-0.947***	0.09
Increase in spectacles	0.237***	0.02	0.442***	0.09	0.162***	0.05	0.249***	0.05	0.580***	0.07
Cost	-0.070***	0.02	-0.342***	0.03	-0.223***	0.02	0.051***	0.01	-0.119***	0.01
LC – Membership probability	**100%**		**37.91%**		**21.45%**		**20.34%**		**20.30%**	
Model for Classes			**Coeff**	**St. err.**	**Coeff**	**St. err.**	**Coeff**	**St. err.**	**Coeff**	**St. err.**
Intercept			0.378**	0.15	0.425*	0.23	-0.328	0.22	-0.474*	0.25
Female (Y/N)			-0.073	0.07	-0.066	0.09	-0.095	0.09	0.234**	0.10
Age			0.013***	0.00	-0.015***	0.00	0.001	0.00	0.000	0.00
Age not disclosed (Y/N)			0.841***	0.24	-0.852***	0.39	0.246	0.32	-0.235	0.39
Visited the coast in last year (Y/N)			-0.294***	0.07	0.050	0.11	0.213**	0.11	0.031	0.11
Member of Environmental Org. (Y/N)			-0.507***	0.09	-0.027	0.12	0.291***	0.10	0.243**	0.11
Income: £10K - £30K			-0.165*	0.10	0.101	0.15	-0.060	0.14	0.124	0.16
Income: £30K to £60K			-0.340***	0.11	0.121	0.16	-0.010	0.15	0.229	0.17
Income: more than £60K			-0.318***	0.13	-0.166	0.19	0.114	0.18	0.370**	0.19
Log-likelihood	-18,097.10		-13,937.30							
parameters	10		67							
AIC	36,214.3		28,020.6							
BIC	36,274.4		28,459.1							

Notes: * p<0.1; ** p<0.05; *** p<0.01; only those variables significant in the final selected model are presented – variables not significant in the LC model were marital status, employment status, level of education achieved, number of dependent children in the household, number of people in the household. In this study, coefficients in the class membership probability are effect-coded. It is therefore possible to estimate coefficients for C-1 classes and retrieve (as the negative sum of the non-omitted classes) the coefficients for the omitted class.

Table 3: Welfare analysis (WTP) from MNL and LC models.

Attribute	MNL model		LC model					
	MNL		**Class 1**		**Class 2**		**Class 4**	
	WTP (£)	**95% C.I.**	**WTP (£)**	**95% C.I.**	**WTP (£)**	**95% C.I.**	**WTP (£)**	**95% C.I.**
Decline in number of species	*-6.58****	[-7.27 to -5.88]	*-1.53****	[-2.17 to -0.89]	*-1.07****	[-1.59 to -0.54]	*-12.50****	[-16.23 to -8.77]
Increase in number of species	*5.29****	[4.74 to 5.85]	*0.97****	[0.44 to 1.50]	*0.80****	[0.33 to 1.27]	*9.08****	[6.51 to 11.65]
Decline in total number of birds	*-5.09****	[-5.71 to 4.47]	*-1.03****	[-1.63 to -0.43]	*-0.95****	[-1.44 to -0.46]	*-8.83****	[-11.29 to -6.37]
Increase in total number of birds	*3.66****	[3.16 to 4.15]	*0.36*	[-0.17 to 0.89]	*0.87****	[0.44 to 1.31]	*5.80****	[4.25 to 7.34]
Decline in incidence of rare species	*-4.19****	[-4.77 to 3.61]	*-1.13****	[-1.67 to -0.58]	*-0.28*	[-0.75 to 0.19]	*-7.55****	[-9.85 to -5.25]
Increase in incidence of rare species	*3.65****	[3.16 to 4.13]	*1.05****	[0.55 to 1.56]	*0.40*	[-0.05 to 0.85]	*5.99****	[4.24 to 7.74]
Decrease in spectacles	*-4.30****	[-4.91 to -3.70]	*-1.21****	[-1.81 to -0.60]	*-0.64****	[-1.13 to -0.15]	*-7.99****	[-10.32 to -5.65]
Increase in spectacles	*3.38****	[2.90 to 3.87]	*1.29****	[0.79 to 1.80]	*0.72****	[0.26 to 1.19]	*4.89****	[3.47 to 6.31]

Note: * p<0.1; ** p<0.05; *** p<0.01 Given the positive cost coefficient WTP are not computed for Class 3.

Class 1 respondents (the largest class) have a positive coefficient for the current situation and the strongest aversion to donate (cost), leading to low levels of WTP. Nevertheless, preferences for changes in biodiversity measures are statistically significant (at $p<0.01$) for all except an increase in the number of birds. Respondents in this class were more likely to be older, less likely to have visited the UK coast in the last year and less likely to be members of environmental organizations than those in other classes. Interestingly, and coherent with their higher cost aversion compared to other classes, respondents with lower income were more likely to be members of this class.

Class 2 respondents had a negative preference for the 'no intervention' option. This class also differs from the others and from the MNL estimates as they exhibit a lower level of preference for the probability of seeing rare birds. As in the previous class, respondents associated with this class also have a fairly high aversion to cost, and low WTP (Table 3). This class was associated with younger respondents (Table 2).

Class 3 respondents showed strong positive preferences for increases (and strong negative preferences for decreases) in all measures of bird biodiversity. All coefficients have the expected sign and are highly statistically significant and the coefficient associated with the current situation is negative. Unusually, the cost coefficient is positive meaning that respondents in this class would prefer higher costs, all else equal. Respondents in this class were likely to be environmental NGO members and visitors to the UK coast. As the cost coefficient was positive, it was not possible to compute meaningful WTP measures and this class is excluded from Table 3.

Class 4 respondents had the strongest preferences for improvements across all bird biodiversity measures and the highest WTP, resulting from a very low cost aversion. Indeed respondents in this class have a cost coefficient one third of that in class 1 and half that in class 2. They were also characterised by a positive and statistically significant coefficient for the 'no improvement' (Current Situation) option. Respondents in this class tended to have the highest incomes, to be female and members of environmental organizations.

4. Discussion: preferences for different measures of biodiversity

The analysis of survey results from the MNL model shows that all four measures of bird biodiversity are important determinants of people's choices, in line with our hypotheses of public support for improved biodiversity. Preferences for higher species richness have been seen previously (e.g. Linemann-Matthies *et al*. 2010; Luck *et al.* 2011), as have a relationship between species richness and wellbeing outcomes (e.g. Dallimer *et al.* 2012). Given the representative nature of our sample, our results provide some warrant for UK ecosystem services assessments to suggest that scenarios which enhance biodiversity relating to birds, but also more broadly, will improve flows of cultural ecosystem services. Although our results do not allow us to infer the form of any functional response of preference to number of species (c.f. Luisetti *et al*. 2011), they are useful in highlighting the significance of species richness relative to other measures of biodiversity, but also the importance of all four measures. Future studies should explore further precision of metrics which could be used to evaluate this (Johnston *et al*. 2012). Conservation measures which target a particular metric are likely to benefit other measures too, but it is still possible for people to separately conceptualise these metrics and furthermore public access infrastructure could be designed to enhance the experience of certain metrics. The segmentation provided by the LC model shows that these preferences are not homogeneous and that social and broader cultural characteristics play an important role. We find evidence for four classes of respondent, with income, age, membership of environmental NGOs, visit rate to coastal (nature) settings, and gender characterizing the classes. While the actual values that people seem prepared to pay would need to be validated by testing in real-life situations, the relative values for different options, and between different respondent classes, are extremely informative. Interestingly, in the MNL results, and most classes of the LC analysis, the coefficients for decreases tend to be larger than for increases in the biodiversity measures. This may indicate loss aversion or declining marginal WTP (as found by Luisetti *et al.* 2011), or that respondents believe that avoiding loss is more plausible than achieving gains in biodiversity.

Class 3 respondents show a positive coefficient for price: they have a positive preference to donate a higher amount of money to implement a specific coastal management option. This is contrary to standard theory. It could be an artefact of the survey instrument, in particular the choice of a voluntary donation as the payment vehicle. Alternatively it could be due to a warm glow or sense of altruism associated with making donations (Meyerhoff & Liebe, 2006) or social desirability bias, leading them to answer the question in ways that they believe will be viewed favourably by others (Andreoni, 1990). However, it is also possible that respondents in this class believe that small(er) amounts of money cannot actually change the situation and they are therefore perceiving price as signalling other attributes such as chance of success. Just as consumers tend to identify high price of extra virgin olive oil as a quality indicator, often purchasing the most expensive products on sale (Scarpa and Del Giudice, 2004; Cicia *et al*. 2002; Di Vita *et al*. 2013), the donation can be seen as a proxy for 'quality'. This would justify respondents' willingness to donate higher amounts (all other things being equal) in order to ensure a high quality and meaningful improvement to coastal bird biodiversity. Respondents who visit the coast and are members of environmental organizations are most likely to be in this class. This further explains the positive preference for higher donation, and why that reflects rational economic behaviour for this class of respondents, assuming the money donated could be related to the quality of the intervention. Such an interpretation is also supported by our research to establish the validity of the survey instrument. In this case, there was strong support for donations, rather than contributing by paying an additional tax. Indeed, as expected from the focus groups and discussion with stakeholders, people are used to the idea that this type of activity is funded by donation and that their choices reflect their actual willingness to pay. Because it is impossible to know for certain the reasons for this positive coefficient, we would urge caution when interpreting the magnitudes of WTP from this group. Nevertheless, we believe the main finding that respondents appear to value all four measures of biodiversity is unaffected.

5. Implications for policy and practice

5.1 Nature conservation and protected area management

Third sector organisations play a key role in nature conservation, with voluntary donations providing a major proportion of funding (Somper, 2011). The segmentation found in WTP has implications for environmental organizations working on biodiversity on the UK coast. For example, this understanding could help organisations target different segments of the population with different messages to raise awareness, or request different amounts of donations to raise support. For example, there is an argument to propose a recurring donation to members of Class 3, suggesting that this could improve the quality of coastal management, while for Class 4, a one-off donation requested could be higher than that for Class 1 and 3, as members of Class 4 are less cost sensitive. Furthermore, there is an interesting difference between classes in the degree to which respondents would pay for positive improvement (classes 2 and 3) versus respondents who would pay to avoid deterioration (classes 1 and 4). Finally, the first two classes could be attracted by the option to provide small donations, e.g. online or at events away from the coast. The results support the maintenance of species, and rare species, in protected area management, but they also underline the importance of managing sites for other biodiversity measures, including the abundance of birds and the spectacles which may result.

5.2 Bird habitat creation in climate adaptation and development schemes

Coastal ecosystems, including those which are important for migratory birds, are subject to highly dynamic land-sea interactions, and under future scenarios of rising sea-levels resulting from human induced climate change, face pressure from 'coastal squeeze'. Habitat creation through managed realignment is an increasingly important response with over 100 schemes in Europe and North America alone covering 13 000 ha (Estevez, 2014) and evidence that these can create meaningful waterbird assemblages (Mander *et al.* 2007). In seeking to negotiate trade-offs between services such as flood risk, food production, nature conservation, public amenity and other factors, many such schemes have proposed sensitive public access as a benefit. The findings of this paper support this justification that initiatives such as the creation of reserve infrastructure may result in increased cultural ecosystem services, for example, by increasing the probability of seeing wildlife spectacles (Bhatia, 2011). Notably, while the selection criteria and conservation objectives for protected areas such as EU SPAs typically focus on the numbers of individual species or overall assemblage of birds that regularly occur on a site (Stroud *et al.* 2016), this work also found that other measures of biodiversity were important in determining WTP. Well-designed infrastructure in coastal developments and habitat restoration schemes, which maximise wildlife interaction, could therefore create improved cultural ecosystem services, especially in sites close to where people live.

High development pressures in the coastal zone are well attested. An ecosystem services approach can be proactive about assessing the risks of development for bundles of ecosystem services, moving beyond consideration of impacts on media of air, soil or water (Baker, 2013). However, to consider impacts on biodiversity and the implications for cultural ecosystem services, such an approach should draw on an understanding of social determinants in estimating the net benefits of coastal development. Our model showed a stratification of social groups, including those which are highly supportive of biodiversity (Class 3); those who are willing to support biodiversity as part of a bundle of ecosystem service benefits (Class 4); and a further significant proportion who visit the coast less often and are unlikely belong to an environmental NGO which might be taken as an indicator of conservation interests (Class 1). Understanding the significance of cultural ecosystem services implies understanding the variation in population perceptions (Jefferson *et al* 2014). Such an approach is recognised in policies such as the UK 25 year Environment Plan, which highlights working with stakeholders to value ecosystem services. Valuations based on simple assertions that proximity to nature will induce benefits in well-being to all, miss the point that conservation has further work to do in improving public understanding and experience.

6. Conclusions

The ecosystem services framework is commonly presented as a conceptual model with a cascade of interactions between biodiversity, ecosystem processes, ecosystem services, goods & benefits and human wellbeing. This demands improved understanding of the cultural pathways by which humans value biodiversity. This paper provides two major contributions. Firstly, instead of using a single measure of biodiversity, the research assessed multiple dimensions of avian biodiversity, and found that several components are consistently valued, including the number of species (species richness), the number of individual birds (abundance), the probability of seeing rare or unusual species, and the probability of seeing large flocks (wildlife spectacles). As such, public preferences are broader than just the abundance of each species present on a site, the measure that is usually the basis for the selection of sites for protection. Further research which explores preference saturation rates for these diverse biodiversity measures, across a range of species groups, is warranted. Secondly, by conducting latent class analysis of a discrete choice experiment, from a representative sample of a national population, the research found evidence for key determinants of preference for human beneficiaries. Since planning and management decisions are a matter of social choice, it is important to understand the social determinants which influence the range of societal preferences- the social filters which affect perceptions of biodiversity (Pett *et al*. 2016) and engage different sectors of society.

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Appendicies A and B

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