

# Leisure activities and social factors influence the generation of cultural ecosystem service benefits

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## ARTICLE INFO

### Article history:

Received 7 June 2017

Received in revised form 19 March 2018

Accepted 27 March 2018

Available online 7 April 2018

### Keywords:

Benefits from nature

Biodiversity

Recreation

Countryside

Social antecedents

Nature connection

## ABSTRACT

The relationship between cultural ecosystem services (CES) and the many diverse aspects of biodiversity is complex and multi-faceted. A large public survey in Wiltshire, UK, was used to assess associations between public benefits from certain species groups in the local countryside, and (i) social antecedents, (ii) engagement in different outdoor leisure activities (iii) indirect nature experience via media-related activities and (iv) species group charisma and abundance.

Practitioners of leisure activities with a nature-related theme, whether outdoor activities or indoor media-related activities, reported significantly higher levels of benefit from named species groups, as did respondents whose personal background demonstrated an elevated degree of nature-relatedness. Benefits were also related to the charisma of the species group: enhanced benefit through nature-related activities and social factors was significant for less charismatic species, but inconclusive for more charismatic species. Respondents who participated in outdoor leisure activities without a nature focus were unlikely to report enhanced benefits from species groups in the local landscape.

To maximise people's CES benefits from broader aspects of biodiversity it may be necessary to encourage an active interest in biodiversity, leading people to participate or seek knowledge and understanding, and in turn develop a stronger sense of connectedness to nature.

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## 1. Introduction

Studying how biodiversity relates to cultural ecosystem service (CES) provision presents several challenges to researchers; it is difficult to quantify CES-derived benefits, which are commonly based on self-reporting methods (Bieling and Plieninger, 2013; Boerema et al., 2016), and further challenges relate to the diversity of types of benefits and well-being outcomes, such as psychological restoration (Kaplan, 1995; Hartig et al., 2003; White et al., 2013), improved physiological health (English et al., 2008; Jordan, 2009; Hanski et al., 2012), better social relations (Kuo and Sullivan, 2001; O'Brien and Murray, 2006; Morris and Urry, 2006; Weinstein et al., 2015), and spiritual development (Bhagwat, 2009; Lewicka, 2011). There is the added difficulty of defining

CES; a range of definitions and classifications exist and continue to evolve (Millennium Ecosystem Assessment, 2005; Chan et al., 2011; Church et al., 2011, 2014; CICES, 2017).

Whilst effects of interaction with 'green space', nature and wildlife, on human well-being are well accepted (BirdLife International, 2004; MacKerron and Mourato, 2013; Russell et al., 2013; Lovell et al., 2014; Alcock et al., 2015; Wheeler et al., 2015), the relationship is complex and multi-faceted and the mechanisms of benefit generation are poorly understood (Clark et al., 2014; Lovell et al., 2014; Belaire et al., 2015; Sandifer et al., 2015; Cox and Gaston, 2016; Graves et al., 2017). How service and benefit generation respond to variation in biodiversity at different levels (e.g. within-species, between-species, ecosystem-level), and the effects of particular species, or species groups is complex to characterise (Hooper et al., 2005; Costanza et al., 2007; Schneiders et al., 2012; Clark et al., 2014; Cumming and Maciejewski, 2017; Graves et al., 2017). So, while there is considerable global concern

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about declining biodiversity (Burns et al., 2016; Butchart et al., 2010; Barnosky et al., 2011 al), it is unclear how such changes might affect our well-being, or how conservation of CES might relate to biodiversity conservation (Czech et al., 1998; Clergeau et al., 2001; Luck et al., 2011; Cumming and Maciejewski, 2017; Krause and Robinson, 2017).

This paper considers whether there is evidence for associations between the benefits that the public consider that they get from the presence of common species groups in the local countryside and a range of factors relating to the benefit recipients and their activities and practices. As with Ecosystem Services (ES) generally, there is a range of definitions for the various associated concepts, such as well-being, benefit and service (Millennium Ecosystem Assessment, 2005; Chan et al., 2011; Church et al., 2011, 2014). For the purposes of this work, well-being is defined as a holistic positive mental and physical state of an individual or social group, and quality of life as a measure of the extent of well-being. The CES benefits may be considered to be any state or condition, or associated object (such as a work of art), which is positively valued by the receiving person, and which results from the interaction of the person and an environmental setting. The CES 'service' may be considered to be the role that the environmental setting (and associated biodiversity) plays in the co-production of such benefits.

The framework used here to conceptualise the benefit generation processes is given in Fig. 1. Under this framework, the various species groups of interest are located in the environmental setting (left-hand side) where the people may interact with them directly (in the field), or indirectly (through the media).

Indirect and direct interaction with biodiversity in the environmental setting are transformed by a number of benefit pathways into benefits that contribute to wellbeing (right hand side). Such benefit pathways can be considered to be any process through which aspects of the environmental setting (of which biodiversity is a feature) lead to the creation of benefits, and in the case of cultural ecosystem services may be considered as psychological processes of interpretation (Potter and Wetherell, 1987; King et al., 2017).

The public's perception of aspects of biodiversity is important in two key ways. First, there is the question of what people can perceive (can detect with the senses) including the levels of biodiversity that are salient to the public (Lindemann-Matthies et al., 2010; Graves et al., 2017; King et al., 2017). Second, of importance is how they perceive it (evaluation of what they detect) (Iftexhar and Takarna, 2008; Bayne et al., 2012; Qiu et al., 2013; Russell et al., 2013; Coll et al., 2014; Belaire et al., 2015; Botzat et al., 2016; Grilli et al., 2016; Kaltenborn et al., 2016; Silva-Andrade et al., 2016; Cumming and Maciejewski, 2017; Gundersen et al., 2017), including which species and habitats the public find attractive and charismatic (Lorimer, 2007; Fischer et al., 2011; Ducarme et al., 2013; MacDonald et al., 2015; McGinlay et al., 2017).

A wide range of human factors (social, cultural, educational, psychological, cognitive and emotional) are likely to influence how different people respond to different aspects of biodiversity in the landscape and how such encounters generate benefits and human well-being (Manfredo and Vaske, 1995; Vaske and Manfredo, 2012; Church, et al., 2014). Previous research has demonstrated that significant factors influencing environmental attitudes and behaviours, satisfaction with recreational experience in the countryside and people's desire to conserve nature, may include: level of education, age and social class, knowledge of the local environment and wildlife, and factors affecting a sense of place and of connection to nature such as childhood experience of the countryside (Nisbet et al., 2009; 2011; Fariás-Torbidoni, 2011; Zelenski and Nisbet, 2014; Gifford, 2014).

A key element in shaping people's perceptions, experience and evaluation of nature are their practices (Bieling and Plieninger, 2013; Russell et al., 2013), whether nature-focused (such as bird-watching), or whether undertaken where the landscape and biodiversity form a backdrop to the activity. The importance of practices is reinforced by Church et al. (2014) in their model of cultural ecosystem services, whereby the interplay of cultural practices (activities and interactions) and environmental spaces are mutually reinforcing in leading to well-being (Willis, 2015), such that leisure-nature interactions contribute to psychological well-being. The importance of the biotic aspect of the landscape to an individual's evaluation of it and their quality of experience in it may therefore vary from crucial to entirely incidental or even irrelevant. For example, Fariás-Torbidoni (2011) identified a typology of hikers: nature-minded hikers, sporting hikers and general-purpose hikers, with differing motivations and preferences and so reasons for their visits to particular landscapes. Furthermore, in reference to choice of landscape for recreational activities, De Valck et al. (2016) note that the type of recreational activity (e.g. hiking, cycling etc.) appears to modify substitutability patterns substantially among nature sites.

For the purposes of this work, interviewees who said that they engaged in an activity were described here as 'practitioners'. In this context their leisure activities were viewed as more than just 'things they happened to do' but also in some way formed a part of their identity. No connotation with professions or work was intended. Rather the connotation was with being part of a 'community of practice' for a particular activity.

In this context, by means of a survey of the public, we sought to determine the benefits that members of the public report that they receive from the presence of common species groups in the local countryside, by answering the following question:

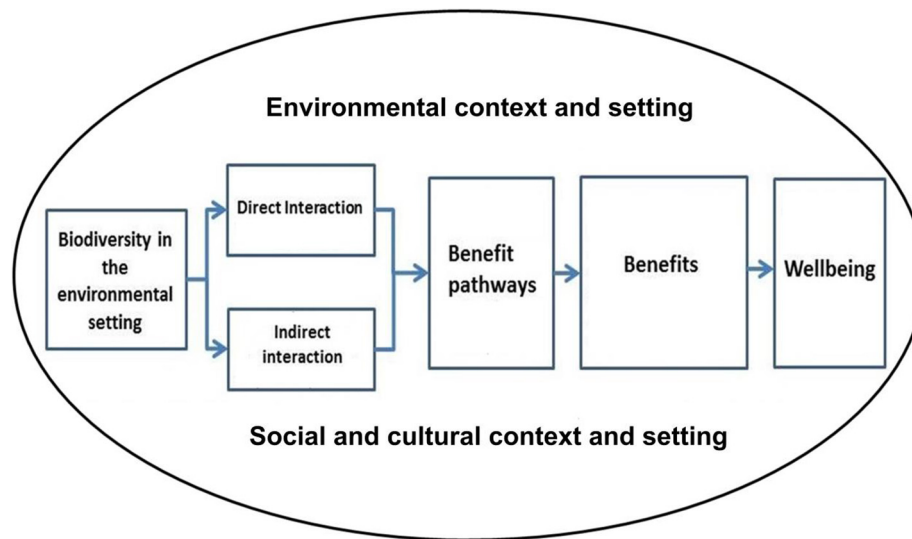
To what extent are reported benefits associated with factors that characterise the interaction between people and biodiversity, specifically: (i) social antecedent and demographic factors; (ii) a range of common outdoor leisure activities; (iii) a number of indirect media-related activities; (iv) broad species group charisma and; (v) variation in provision (abundance) in the local landscape?

Such findings contribute to an understanding of the aspects of biodiversity, and biodiversity change that influence the provision of cultural ecosystem service benefits to the public. This in turn could inform policy and practical options for enhancing ecosystem service benefit supply. This paper builds on the previous work by McGinlay et al. (2017), which considered the broader patterns of variation in responses by the public to differences between species groups.

## 2. Methods

### 2.1. Overview

The research question was addressed through a questionnaire survey, administered in the County of Wiltshire, England, which was a focal lowland landscape for the Wessex-BESS project (<http://wessexbess.wixsite.com/wessexbess>), studying a range of ecosystem services. Wiltshire is in Central Southern England and is typical of multi-functional lowland landscapes, whilst also having distinctive natural and cultural features that contribute to its regionally distinctive landscapes. The area is readily accessible to a large population in the surrounding area (the population of Wiltshire is approximately 470 000, and that of immediately adjacent



**Fig. 1.** Conceptual framework used to theorise the link between encounters and interactions with flora and fauna and the generation of biodiversity-supported cultural ecosystem service (BSCS) benefits, leading to human well-being.

counties is 5.4 million), and popular for tourism, making it a good study landscape for CES benefits.

The survey elicited from members of the public the benefit they considered that they received from selected species groups commonly encountered in the local countryside (song birds, butterflies, flowering plants, beetles/bugs, brambles and nettles). Benefits were elicited both for current abundance of these groups and under a range of proposed future abundance scenarios, recorded as the respondent's self-reported enjoyment and satisfaction with the various scenarios. We use the terms enjoyment and satisfaction to denote perceived benefit and wellbeing. While the term satisfaction is in common usage, it has its foundations in the moral philosophy of utilitarianism (Mill, 1863; White, 2006), whereby people seek outcomes that gain pleasure and avoid pain. Utility, expressed in terms of satisfaction, can provide a measure of personal and, by aggregation, societal happiness and wellbeing (Bruni and Porta, 2005; Perman et al., 2011, 62). Although the data were collected from individual respondents and analysed as a dataset of individual responses, it should be recognised that each individual response will also be influenced by shared societal values, attitudes and perspectives (Kenter et al., 2015). In our survey of the public, we use ordinal categories of enjoyment and satisfaction to indicate the contribution of different groups of species to perceived personal benefit and hence wellbeing, and to explore how enjoyment and satisfaction vary with changes in relative abundance.

## 2.2. Survey method

The questionnaire-based survey was undertaken during August–October 2015, as part of a wider survey of CES benefits received by members of the public (see Appendices S1–S3 in Supplementary Information). Each interviewee was presented with a form showing photographs of selected species groups (see Appendix S1, supplementary information) and asked to respond to the questions shown in Fig. 2 and Table 1 for each species group in turn. Interviewees were asked to provide a satisfaction score for alternative abundance scenarios, namely 'Current', 'Missing', 'Decreased' and 'Increased'. 'Current' referred to existing presence in the landscape, 'Missing' refers to a complete loss of the species from the local landscape and 'Decrease' and 'Increase' referred to a change in abundance of  $-50\%$  and  $+50\%$  respectively from the 'Current' scenario. Responses for each scenario were measured on

a 7-point scale (Very negative/quite negative/slightly negative/neither positive nor negative/slightly positive/quite positive/very positive), with negative and positive scores equally distributed around a zero anchor ( $-3$  to  $+3$ ).

Respondents were asked to provide data on demographic and social antecedent factors (experience of nature education; religion; self-reported awareness and knowledge of the local landscape and of local wildlife; educational attainment; amount of time in childhood spent in the countryside; residency; gender; age; income; employment; health and mobility) (Appendix S2, Supplementary information). Respondents were also asked about their outdoor leisure activities in the local countryside (walking or hiking; walking the dog; cycling; running; horse riding; bird watching; artistic activities (painting/drawing/photography); conserving nature/volunteering; angling/fishing; shooting and field sports; camping) and about their indirect nature interactions via media with a nature-related theme (reading; watching films and TV programmes; listening to radio) (Appendix S3, Supplementary Information).

## 2.3. Interpretation of survey question responses to the four abundance scenarios

The baseline assessment or 'current' scenario inevitably relies on the interviewee having a personal impression of current levels of abundance of the named species group in the contemporary Wiltshire countryside and so is susceptible to bias according to the interviewee's personal knowledge. Nevertheless, this impression is related to the interviewee's level of knowledge, understanding and interaction with the Wiltshire countryside, and acts as their personal reference point. This understanding of the current situation serves as a baseline and, as noted by Fischer et al. (2011), influences the attitude towards a change in abundance of the species group, and so gives some measure of the likely change in the level of satisfaction and by implication in CES benefit generation under the proposed changes in abundance.

## 2.4. Species groups represented on survey forms

The six broad species groups were chosen to be farmland-relevant groups that members of the public were likely to be familiar with and that we considered to represent a spectrum of

Can you tell us how much the feelings of enjoyment or satisfaction that you get from the countryside in Wiltshire are affected by its plants and animals?

- How would you rate the effect of these plants and animals (that currently exist in Wiltshire) on the enjoyment or satisfaction that you get from the countryside, compared to it being without them? Note: "enjoyment" or "satisfaction" here is in any way at all: for example through seeing, hearing, smelling, or just knowing they exist
- What would be the effect on your enjoyment or satisfaction from the countryside if these plants and animals that currently exist in Wiltshire were no longer there? What would your rating be in this case?
- What would be the effect on your satisfaction from the Wiltshire countryside if there were only half as many as there are now (50% fewer)? What would your rating be in this case?
- What would be the effect on your satisfaction from the Wiltshire countryside if there were half as many again as there are now (50% more)? What would your rating be in this case?

Fig. 2. Question posed to respondents for the species groups.

Table 1

Response rubric to capture interviewee's self-reported enjoyment and satisfaction with the named species group in the Wiltshire countryside under four abundance scenarios.

	Effect on enjoyment or satisfaction from the countryside						
	Very negative	Quite negative	Slightly negative	Neither positive nor negative	Slightly positive	Quite positive	Very positive
<b>Current</b> Present as they are now	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>Missing:</b> No longer present at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>Decreased:</b> presence <sup>*</sup>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>Increased:</b> presence <sup>**</sup>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

<sup>\*</sup> A halving (50% less).

<sup>\*\*</sup> Half as many again (50% more).

charisma for the public (McGinlay et al., 2017). Czech et al. (1998) found that plants and birds were rated more favourably than invertebrates by the public in a US study. We therefore used these three groups. However, because these groups are very broad, three plant and two invertebrate species groups were chosen, with varying characteristics, to investigate whether public responses to them varied across a spectrum of attractiveness and charisma.

All survey forms contained the same images of representatives of two of the species groups - flowering plants and songbirds. However, two batches of forms were used with different images for invertebrates and less charismatic plants. One batch contained an image of a blue butterfly and of nettles and the other an image of a beetle/shieldbug and of brambles. In this way, and in the context of the larger questionnaire as a whole, the interviewee was not overburdened with too many species to assess at once, but six species groups in total were rated during the survey. The images used are reproduced in [Appendix S1 in Supplementary Information](#).

Images were therefore included for species groups that were hypothesised to be generally appealing or 'charismatic' to the public (song birds, butterflies and flowering plants), but also groups that could be considered less charismatic or more 'ambiguous' in appeal (beetles/shieldbugs, brambles and nettles); that is, species groups that could be perceived by the public to have both positively- and negatively-valued attributes. Thus, we avoided using species groups which are widely perceived very negatively (see [Appendix S1 in SI for more details](#)).

The intention was to elicit a general response to a broad species group represented by the image and the broad group name with its associated connotations, rather than to the specific species depicted. There was therefore no requirement for the respondent to possess detailed or species-specific knowledge. The name of

the exact species depicted in the images was not provided in order to avoid intimidating interviewees who were not familiar with particular species. Instead the image caption used the broad group categories (including merging shieldbugs with the superficially similar beetles).

## 2.5. Models of interaction with species groups

Possible 'interactions' with biodiversity that might define or influence an individual's relationship with species groups in their local landscapes can be broadly conceptualised as:

1. Encounters with biodiversity as part of a planned outdoor leisure/recreation activity which has the aim of an interaction with nature;
2. Encounters with biodiversity as part of a planned outdoor leisure/recreation activity which does not have the specific aim of an interaction with nature;
3. Incidental interactions with biodiversity as members of the public go about their daily lives, such as walking or driving to work;
4. Indirect interaction through the media on nature-related themes, mainly reading, watching television programmes or films, or listening to the radio; and
5. Any indirect and non-use relationship with wildlife in the landscape including existence value, bequest value, option value (Mace and Bateman, 2011).

Interviewees were asked about how they interacted with their local landscapes with regards to a range of common outdoor pursuits or leisure practices (that may or may not have plants or



animals as a focus) that the respondent might engage in, such as walking or bird-watching (see [SI Appendix S3, Question 1](#)), and with regards to common indirect interactions through the mass media (see [SI Appendix S3, Question 2](#)). These common interactions therefore covered points 1, 2 and 4 above, thereby focusing on the people's intentional practices rather than incidental or more abstract interactions.

## 2.6. Sampling approach and procedure

549 members of the public were interviewed face to face by a team of 11 interviewers in a wide range of locations in Wiltshire to obtain a sample that was generally representative of adults in Wiltshire. Interviewers were trained beforehand in interviewee selection to minimise sample bias and in delivering the questionnaire so as not to lead interviewees in their responses. Locations included public streets, shopping centres, supermarket car parks, parents at children's playgroups, tertiary colleges, care homes for the elderly and individuals in their homes. The data from the demographic questions were processed during the survey in order to check for biases in the sample which could be redressed during the survey.

## 2.7. Data analysis

Graphical and statistical methods, guided by the research questions, were used to investigate any associations between species groups, antecedent factors (demographics classifications, interests and leisure activities) and stated benefits. The response data consisted of ordered categorical scales for self-reported enjoyment and satisfaction (coded  $-3 \dots +3$ ) with the six species groups at the four levels of abundance. The social antecedents and countryside activities were recorded as two-level factors (e.g. 'Yes', 'No'; 'Male', 'Female'), three-level ('No', 'Not now, but used to', 'Yes, now') or multi-level (e.g. age group). Non-parametric (permutation) statistical analyses were performed in R (R Core Team, 2016), mainly using the *coin* package for non-parametric permutation methods (Hothorn et al., 2006 & 2008).

The associations between antecedent factors and satisfaction with abundance of each species group were explored using the Wilcoxon-Mann-Whitney (WMW) test for factors with two possible levels, and the Kruskal-Wallis (KW) test for factors with more levels (see e.g. Higgins, 2004). Where there were only two possible states of the explanatory variable, the WMW test can be used to estimate the shift in the distribution of responses. To allow this to be applied to all the countryside activities, the two 'yes' categories ('previously' and 'now') were combined. Where the KW test for a multi-level factor indicated a possibly significant association, a WMW test was performed using the extreme values to estimate the direction and maximum magnitude of the change. If the factor had an obvious order (e.g. age group), this was usually the lowest and highest levels with sufficient responses to give meaningful results; otherwise the levels were chosen based on the responses. The magnitude of the change between intermediate levels would be smaller.

Each test was applied to every combination of species group and abundance (24 combinations) and each response was used in 28 tests (the number of factors considered). Therefore, there was a high risk of false positive results if the p-values were used in naïve hypothesis tests.

The problem of false positives is mitigated by the fact that the purpose is not to identify individual associations (e.g. between walking in the country and satisfaction with the current abundance of flowers), but to seek systematic patterns of responses. The probability of an association between an activity and a species group at all four levels of abundance being a false positive is much

lower than for a single response. For this reason, all results are given with p-values to three decimal places, rather than coding them as significant, highly significant, and so on.

Associations between different antecedent factors were explored using two-way contingency tables and Fisher's exact test (e.g. Higgins, 2004) with simulated p-values (because of small numbers).

## 3. Results

### 3.1. Sample obtained

549 individuals were interviewed. The demographic profile of the interviewees broadly matched that for Wiltshire in terms of age, gender, and ethnicity. In total 77% of interviewees were permanent residents of Wiltshire, 4.8% temporary residents and the remaining 18.2% described themselves as visitors. The sample was biased, relative to the general population of Wiltshire, towards respondents at the lower end of the income spectrum, towards the higher end of the education qualification spectrum, towards the non-religious and those not in paid employment. A comparison between selected demographic statistics for the survey sample and for the Wiltshire population is provided in McGinlay et al. (2017). Key results are provided in the main text, whilst further supporting results tables are included in the [Supplementary Information section Appendix S4](#).

### 3.2. Variation in response with participation in leisure activities with or without a nature focus

Positive responses to the ambiguous species groups were clearly associated with bird-watching, participation in nature conservation and membership of a nature conservation organisation (Tables 2a–c). Fisher's exact test indicated an association between all three activities, and participation tended to increase with age. For practitioners, all three showed positive (+1) shifts in response relative to non-practitioners for current or increased abundance and negative shifts (−1)<sup>1</sup> for decreased or missing abundance for at least 8 of the 12 species group × abundance combinations. These shifts were seen for all levels of abundance of nettles, which were proposed to be the least charismatic of the species (McGinlay et al., 2017). Shifts relative to non-practitioners were not seen for the missing state of beetles and brambles for all three activities and for a few other combinations for these species groups.

The other outdoor leisure activities about which participants were questioned generally showed little evidence of consistent differences between the practitioners and non-practitioners for any of the species groups. These activities took place in the countryside, but did not have a specific nature/biodiversity focus (Table S4.1a–i, Appendix S4 in SI).

Overall, practitioners of the three nature-related activities responded more positively to the presence and increased abundance of the less charismatic species groups and negatively to their reduced abundance, when compared with non-practitioners. A significant difference between practitioners and non-practitioners was not found, however, for the more charismatic species groups.

Positive responses to the ambiguous species groups were also clearly associated with reading, watching television and listening to radio programmes with a nature/wildlife-related theme (Table 3a–c). Fisher's exact test found an association between all three media-related activities ( $p < 0.001$ ) and participation tended to increase with age ( $p < 0.001$ ).

<sup>1</sup> The shift is an estimate of the change in the median benefit score between practitioners and non-practitioners of the activity in question.

**Table 2**

Estimated shift (p-value in brackets) from one-sided Wilcoxon-Mann-Witney test for change in reported satisfaction associated with engagement in a specified activity. The shift is an estimate of the difference in self-reported satisfaction for each of the 24 scenarios (species group x abundance scenario) for practitioners compared with non-practitioners.

	Flowers	Birds	Butterflies	Beetles	Brambles	Nettles
<b>a. Membership of a nature conservation-related organisation (yes vs no) (Total responses: No – 315; Yes, previously – 0; Yes, now – 232; not answered – 2)</b>						
Missing	0	0	0	0	0	–1 (0.000)
Decreased	0	0	0	0	0	–1 (0.000)
Current	0	0	0	1 (0.001)	1 (0.000)	1 (0.000)
Increased	0	0	0	1 (0.000)	1 (0.001)	1 (0.000)
<b>b. Involved in nature conservation activities (yes vs no) (Total responses: No – 452; Yes, previously – 32; Yes, now – 63; not answered – 2)</b>						
Missing	0	0	0	0	0	–1 (0.000)
Decreased	0	0	0	–1 (0.000)	–1 (0.005)	–1 (0.001)
Current	0	0	0	1 (0.001)	1 (0.000)	1 (0.000)
Increased	0	0	0	1 (0.001)	0	1 (0.000)
<b>c. Bird watching (yes vs no) (Total responses: No – 374; Yes, previously – 18; Yes, now – 155; not answered – 2)</b>						
Missing	0	0	0	0	0	–1 (0.000)
Decreased	0	0	0	–1 (0.000)	0	–1 (0.000)
Current	0	0	0	1 (0.000)	1 (0.000)	1 (0.000)
Increased	0	0	0	1 (0.000)	1 (0.002)	1 (0.000)

**Table 3**

Estimated shift (p-value in brackets) from one-sided Wilcoxon-Mann-Witney test for change in reported satisfaction associated with engagement in a specified activity. The shift is an estimate of the difference in self-reported satisfaction for each of the 24 scenarios (species group x abundance scenario) for practitioners compared with non-practitioners.

	Flowers	Birds	Butterflies	Beetles	Brambles	Nettles
<b>a. Reading (I read about nature in books/magazines/newspapers) (yes vs no) (Total responses: No – 195; Yes, previously – 0; Yes, now – 344; not answered – 10)</b>						
Missing	0	0	0	–1 (0.000)	–1 (0.000)	–1 (0.000)
Decreased	0	0	0	–1 (0.000)	–1 (0.000)	–1 (0.000)
Current	0	0	0	1 (0.000)	1 (0.000)	1 (0.000)
Increased	0	0	0	1 (0.000)	1 (0.003)	1 (0.000)
<b>b. TV (I watch films and television programmes on nature) (yes vs no) (Total responses: No – 66; Yes, previously – 0; Yes, now – 479; not answered – 4)</b>						
Missing	0	0	0	0	0	–1 (0.005)
Decreased	0	0	0	–1 (0.030)	0	–1 (0.018)
Current	1 (0.000)	0	0	1 (0.001)	1 (0.008)	1 (0.020)
Increased	1 (0.000)	0	1 (0.000)	1 (0.004)	0	0
<b>c. Radio (I listen to radio programmes on nature) (yes vs no) (Total responses: No – 355; Yes, previously – 0; Yes, now – 183; not answered – 11)</b>						
Missing	0	0	0	0	0	–1 (0.000)
Decreased	0	0	0	–1 (0.000)	–1 (0.001)	–1 (0.000)
Current	0	0	0	1 (0.000)	1 (0.000)	1 (0.000)
Increased	0	0	0	1 (0.000)	1 (0.000)	1 (0.001)

Reading about wildlife gave 1 unit shifts in response for all abundance levels of the three less-charismatic species groups. Radio listening gave 1 unit shifts for all except the missing state for beetles and brambles. The results for television viewing were less comprehensive, with 1 unit shifts for only 7 of the 12 possible combinations for the less-charismatic species groups, only one of which was for brambles, and relatively large p-values in some cases. Conversely, there were 1 unit shifts for the response to increased abundance of flowers and birds, and to current abundance for flowers. The relatively weak responses found for television viewing may be due to its ubiquity: only 12% of the participants said that they did not watch nature-related programs, compared with 64% for radio and 35% for reading.

Again, practitioners of the nature-related activities responded more positively to the presence and increased abundance of the less charismatic species groups and negatively to their reduced abundance, when compared with non-practitioners, whilst this difference between practitioners and non-practitioners was generally not found for the more charismatic species groups.

To investigate whether media related activities were associated with a response in the absence of other nature-related activities, the subset of the sample who did not participate in the bird watching, conservation or membership of a conservation organisation was used. For this group, reading about nature (no – 144; yes 103) showed a consistent 1 unit shift ( $p < 0.02$ ) in the usual direction for all the less-charismatic species groups. Similar effects were present for radio listening and television viewing, but not for all combinations of species group and abundance.

Participation in these media-related activities therefore appeared to be associated with differing responses to the ambiguous species groups, independent of any association with the other nature-related activities.

### 3.3. Variation in response with demographic factors and social antecedents

Three social antecedent factors were found to be positively associated with self-reported enjoyment and satisfaction with the presence of the broad species groups in the local landscape; self-reported awareness of the local landscape; self-reported awareness of local wildlife and; past experience of nature-related education.

Self-reported awareness of landscape and wildlife were associated with variation in expressed satisfaction for several species groups under different abundance scenarios (Table 4a–b). These factors indicate interest in or knowledge about the countryside and wildlife. Shifts in responses were in the direction of increased satisfaction with current and increased abundance, and decreased satisfaction with decreased and missing abundance associated with increased wildlife or landscape awareness. Analysis of the extremes of the ranges using the WMW test (Table 5a–b) found large shifts in the distributions for the less charismatic species groups (beetles/shieldbugs, brambles and nettles). Therefore, again, any positive association between reported benefit and presence of the species group was strongest for the less charismatic species groups.

**Table 4**

p-value from the Kruskal-Wallis test for change in reported satisfaction associated with social antecedents with multi-level responses.

	Flowers	Birds	Butterflies	Beetles	Brambles	Nettles
<b>a. Self-reported awareness of landscape (Total responses: None/very little – 18; A little – 66; A moderate amount – 234; A considerable amount – 184; A great deal – 46; not answered – 1)</b>						
Missing	0.003	0.000	0.044	0.000	0.032	0.000
Decreased	0.000	0.000	0.028	0.001	0.181	0.000
Current	0.001	0.011	0.515	0.000	0.001	0.000
Increased	0.004	0.001	0.067	0.000	0.262	0.000
<b>b. Self-reported awareness of wildlife (Total responses: None/very little – 19; A little – 84; A moderate amount – 254; A considerable amount – 156; 5–30; not answered – 6)</b>						
Missing	0.056	0.000	0.032	0.000	0.124	0.000
Decreased	0.000	0.000	0.143	0.001	0.367	0.000
Current	0.003	0.041	0.721	0.000	0.001	0.000
Increased	0.011	0.002	0.046	0.000	0.061	0.000

**Table 5**

Estimated shift (p-value in brackets) from the two-sided Wilcoxon-Mann-Witney test for change in reported satisfaction associated with social antecedents for most widely differing groups where the KW test indicates a significant association. The shift is an estimate of the difference in self-reported satisfaction for each of the 24 scenarios (species group x abundance scenario) for the first group (a great deal) compared with the second (none/very little).

	Flowers	Birds	Butterflies	Beetles	Brambles	Nettles
<b>a. Self-reported awareness of landscape (A great deal vs None/very little)</b>						
Missing	0	0	0	–3 (0.000)	–1 (0.077)	–3 (0.003)
Decreased	–1 (0.000)	–1 (0.001)	0	–3 (0.001)	NS	–2 (0.001)
Current	0	0	NS	3 (0.000)	2 (0.021)	3 (0.001)
Increased	0	0	NS	3 (0.001)	NS	3 (0.000)
<b>b. Self-reported awareness of wildlife (A great deal vs None/very little)</b>						
Missing	NS	0	0	–1 (0.008)	NS	–2 (0.030)
Decreased	–1 (0.001)	0	NS	–2 (0.030)	NS	–2 (0.022)
Current	0	0	NS	1 (0.009)	2 (0.001)	3 (0.011)
Increased	0	0	0	2 (0.014)	NS	2 (0.027)

NS – result of KW test was not significant.

Having had education about nature was associated with shifts in the same direction in most cases, though not as strongly (Table 6).

There were fewer significant associations between these three education, knowledge and awareness-related factors and responses to the more charismatic species groups (flowers, birds and butterflies), for which the variation within the sample tended to be smaller. (The interquartile range was 0 or 1 for all the charismatic species groups and 2–4 for the others.) Unsurprisingly, the three factors were not independent: Fisher's exact test found associations with  $p < 0.0025$  between all pairs.

The variation in responses according to self-reported knowledge of Wiltshire landscapes is illustrated by the boxplots in Fig. 3. The association between landscape knowledge and expressed satisfaction is particularly evident for 'ambiguous' species, especially nettles, showing the shifts in the distribution described above. Similar patterns were seen for the other factors.

Participant age was also strongly associated with survey responses (Tables 7 and 8). Older participants (65–74 years old) had a 1 to 2 units shift in satisfaction for the less charismatic species groups when compared with the youngest participant age group (18–24 years old). There were also shifts of +1 for increased abundance and –1 for decreased abundance of all three charismatic species groups.

**Table 6**

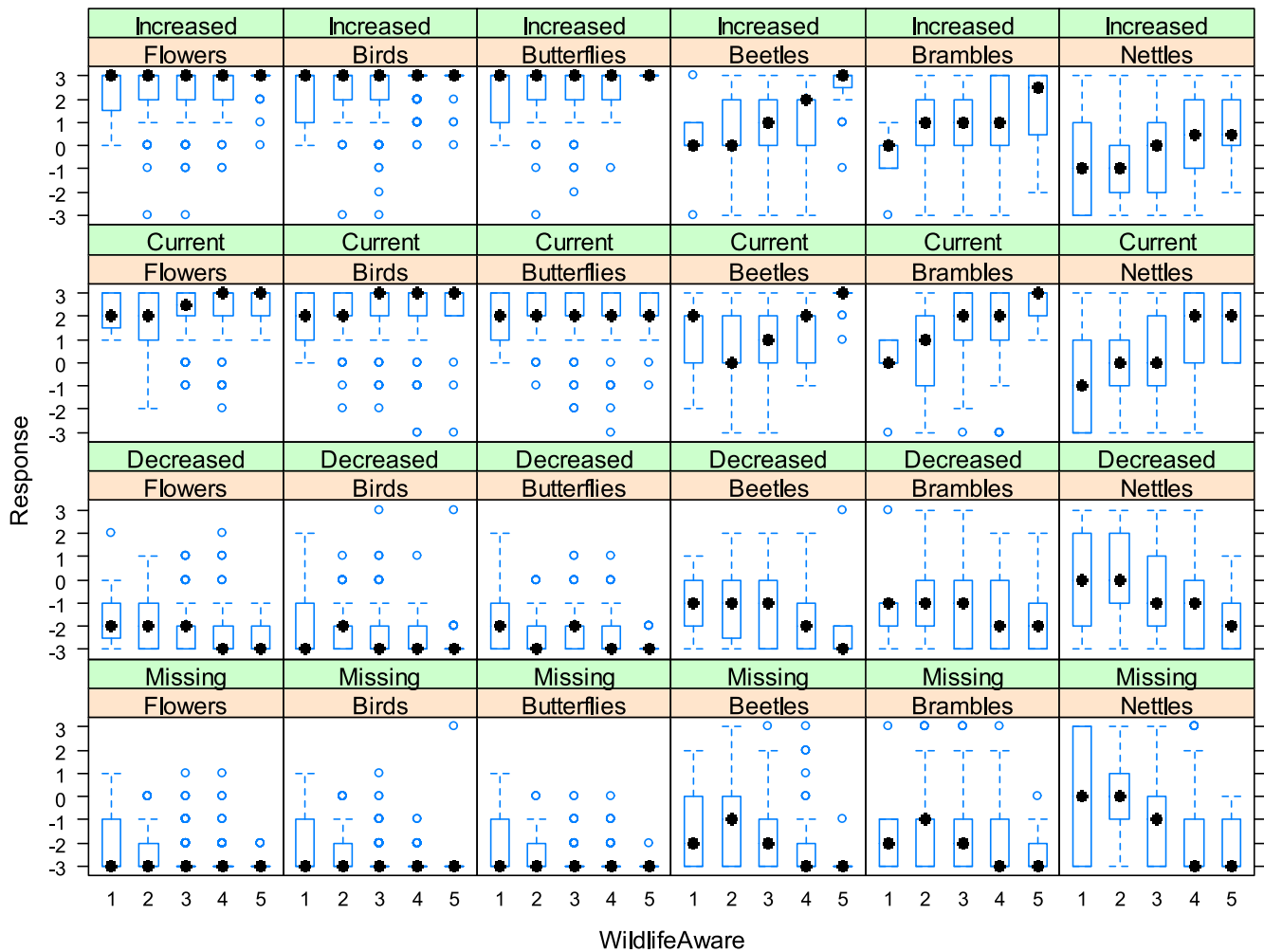
Estimated shift (p-value in brackets) in reported satisfaction associated with education about nature (yes vs no) from the two-sided Wilcoxon-Mann-Witney test (Total responses: No – 403; Yes – 112; not answered – 34). The shift is an estimate of the difference in self-reported satisfaction for each of the 24 scenarios (species group x abundance scenario) for practitioners compared with non-practitioners.

	Flowers	Birds	Butterflies	Beetles	Brambles	Nettles
Missing	0	0	0	0	0	–1 (0.000)
Decreased	0	0	0	–1 (0.001)	0	0
Current	0	0	0	1 (0.006)	1 (0.003)	1 (0.003)
Increased	0	0	0	1 (0.006)	0	0

The boxplots of the distributions of responses (Fig. 4) appear to show a trend for the intermediate age groups, with a slight decline in the oldest (over 75 years) group, although this cannot be tested reliably.

Fisher's exact tests found associations between age and all of the aforementioned factors ( $p < 0.0025$ ). However the larger shifts associated with landscape and nature awareness indicate that the effects cannot be explained solely by age. This was reinforced by repeating the tests after subtracting the median response for each age group: most of the effects remained although some of the shifts were smaller. (This result should be treated with caution, since the scales cannot be assumed to represent equal intervals).

Most other personal attributes such as gender, occupation, income, general health and religious belief showed little or no association with the responses. The p-values from the Kruskal-Wallis tests and the estimated shifts for these personal attributes are given in Tables S4.2a–g and Tables S4.3a–g respectively in Appendix S4 in the supplementary information for completeness. There were some associations with general level of education and time spent in the countryside as a child (Table S4.2a–b and Table S4.3a–b, Appendix S4 in the supplementary information), but the pattern was inconsistent. Residential status showed numerous shifts in response (Table S4.3c Appendix S4 in the supplementary information) between permanent and temporary



**Fig. 3.** Boxplots of expressed satisfaction for six species groups and four abundance scenarios by categories of self-declared wildlife knowledge (1 – low; 5 – high).

**Table 7**

p-value from the Kruskal-Wallis test for change in reported satisfaction associated with social antecedents with multi-level responses. Age group (Total responses: age 18–24: 72; age 25–44: 132; age 45–64: 184; age 65–74: 100; age 75+: 59; not answered – 2).

	Flowers	Birds	Butterflies	Beetles	Brambles	Nettles
Missing	0.001	0.000	0.016	0.006	0.000	0.000
Decreased	0.000	0.000	0.003	0.000	0.000	0.002
Current	0.000	0.000	0.446	0.000	0.000	0.000
Increased	0.000	0.000	0.000	0.000	0.028	0.008

**Table 8**

Estimated shift (p-value in brackets) from the two-sided Wilcoxon-Mann-Witney test for change in reported satisfaction associated with social antecedents for most widely differing groups where the KW test indicates a significant association. NS – result of KW test was not significant Age group (65–74 vs 18–24). The shift is an estimate of the difference in self-reported satisfaction for each of the 24 scenarios (species group x abundance scenario) for the first group (e.g. age 65–74) compared with the second (e.g. age 18–24).

	Flowers	Birds	Butterflies	Beetles	Brambles	Nettles
Missing	0	0	0	–1 (0.006)	–1 (0.000)	–2 (0.000)
Decreased	–1 (0.000)	–1 (0.000)	–1 (0.000)	–2 (0.000)	–1 (0.000)	–1 (0.000)
Current	1 (0.000)	0	NS	2 (0.000)	2 (0.000)	2 (0.000)
Increased	1 (0.000)	1 (0.000)	1 (0.000)	2 (0.000)	1 (0.014)	1 (0.001)

residents; unusually most were for the charismatic species groups. However, it is notable that almost all the temporary residents were under 35 years. When the medians by age group were subtracted from the responses, all but two results for the differences between

permanent and temporary residents (missing birds and decreased beetles) were not significant, indicating that the difference between the two groups cannot be distinguished from the results for age.



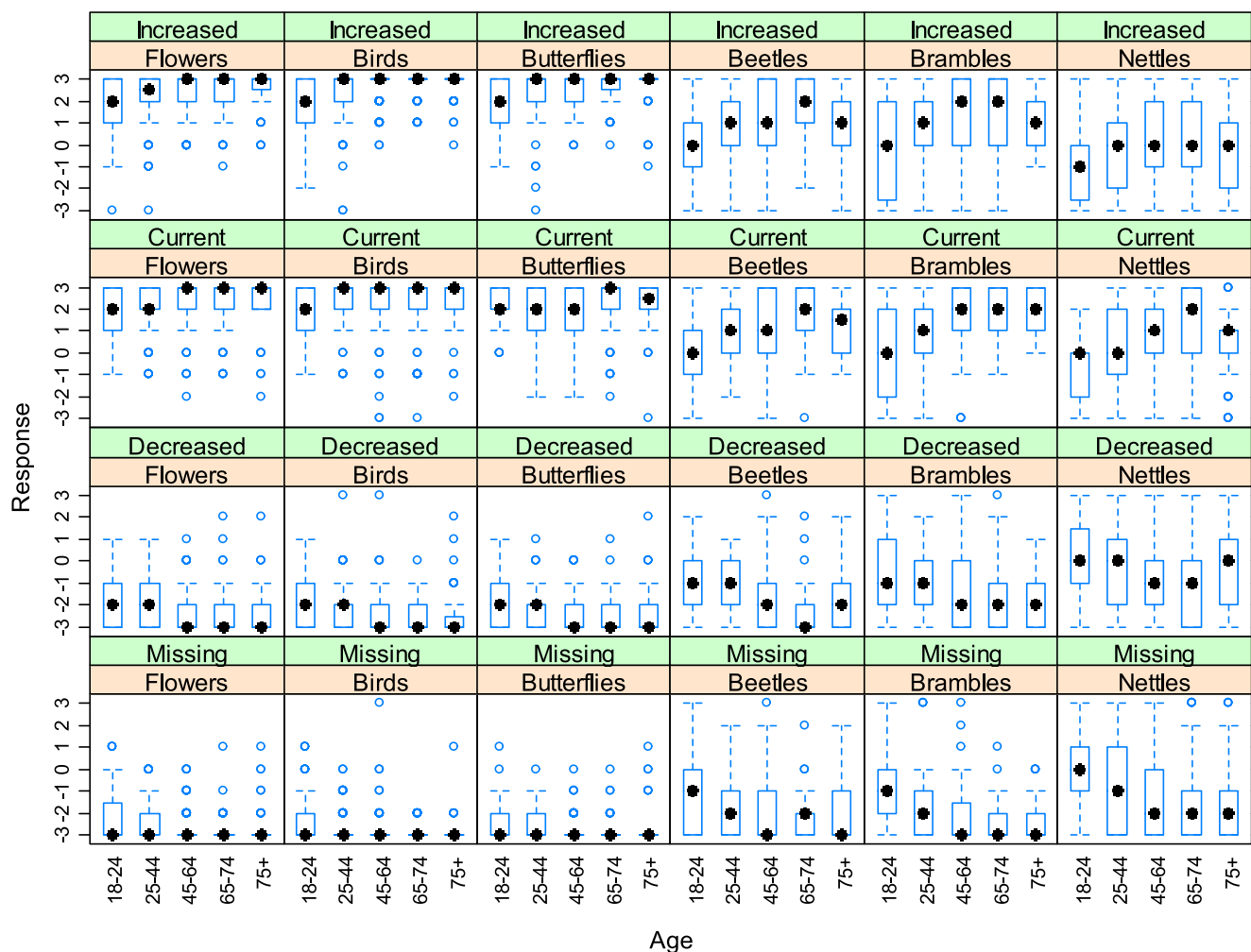


Fig. 4. Boxplots of expressed satisfaction for six species groups and four abundance scenarios by age group.

#### 4. Discussion

Assessing public responses to variations in biodiversity is problematic, not least because of challenges associated with defining biodiversity in ways that are salient to the public (Lindemann-Matthies et al., 2010; Graves et al., 2017; King et al., 2017; McGinlay et al., 2017). Here we have characterised biodiversity in terms of the varying presence of six broad species groups that may be expected to be readily recognisable to the general public without specialist knowledge.

The distinctive response patterns of the results demonstrated that people were able to articulate the relative magnitude of benefits that they felt that they received from different species groups and how these varied according to abundance in the landscape. Overall response patterns to proposed changes in abundance of species groups were predictable, with interviewees generally responding positively to the presence and proposed increased abundance of species groups in the landscape, and negatively to reduced abundance i.e. positively to maintained and increased supply of that from which they derive benefit and negatively to reduced supply (see Figs. 3 and 4, and also McGinlay et al., 2017 for further details of this aspect of the analysis). However, important conclusions may be drawn from the variation in these patterns between different species groups and the differing characteristics of the interacting human agent. Such variation needs to be understood to appreciate the relationship between species and

ecosystem composition and CES benefit supply (Cumming and Maciejewski, 2017; Graves et al., 2017).

The results indicate that the CES benefit generation mechanisms may be different depending on the characteristics of the species group (whether the species group is considered charismatic or not) and also of the human agent. As regards the human agent, the benefit generation mechanisms appear to depend on whether or not the person feels a degree of 'nature relatedness' or 'connection to nature'. These two dichotomies will in reality be ranges of the degree to which the species group is considered charismatic or the human agent 'connected to nature', but we may consider here the more extreme archetypes in order to theorise the various possible pathways to benefit indicated in the centre of Fig. 1.

A number of social factors were found to be associated with significant differences in the self-reported benefits for at least some of the species groups: self-reported knowledge of the local countryside; self-reported knowledge of local nature and; past experience of nature education. All three of these factors indicate past engagement with, knowledge of, or interest in the local countryside and natural features, and so may be considered plausible indicators of a sense of connection to nature. This agrees with the previous research that environmental behaviour and attitudes and satisfaction with engagements with nature are associated with, and enhanced by, a greater sense of nature connectedness/relatedness, demonstrated through factors such as knowledge of the local environment and wildlife, a sense of place, and of

connection to nature (Nisbet et al., 2009; 2011; Fariás-Torbidoni, 2011; Gifford, 2014; Zelenski and Nisbet, 2014). Gifford (2014) also found that general level of education and childhood experience of the countryside were significant factors and whilst the results in this work were somewhat inconclusive for these two factors, childhood experiences and general level of education would be expected to be interrelated with the first three factors (self-reported knowledge of the local countryside and of local nature, past experience of nature education).

As reported by Gifford (2014), age again was found to be a significant factor in the degree of benefit received, increasing with age. Older age groups may be expected to have experienced more interactions with nature and accumulated more experience and knowledge, and therefore may have a more developed sense of nature-relatedness. Reported benefits were observed to peak in the 65–74 years age groups that would be expected to include the recently-retired with more time and energy to spend on nature related hobbies and interests. The possible slight decline in reported benefits for the over 75s (which could not be confirmed statistically) may result from declining options (as a result of factors such as poor health) to interact at least directly with nature, leading to a declining sense of nature relatedness.

Similarly, three practices were also seen to be associated with a significant difference in the self-reported satisfaction for at least some of the species groups: membership of a conservation organisation; bird-watching and; involvement in nature conservation activities. The practising of these three nature-related activities was again related to a pre-existing interest in nature and aspects of wildlife, and their practice appeared to be associated with enhanced benefits derived from less charismatic species groups. Engagement in these activities is again indicative of a greater sense of nature-relatedness generally (Nisbet et al., 2009; Gifford, 2014) that in turn is likely to be further reinforced by their practice as an aspect of personal identity (Church et al., 2014). A sense of nature-relatedness would be expected to be associated with a greater sense of empathy with wildlife in general and derived benefits in terms of happiness or well-being (Ward-Thompson et al., 2008; Nisbet et al., 2011; Fariás-Torbidoni, 2011) through interacting directly or indirectly with the species groups, and to greater enthusiasm for their enhanced abundance and greater concern for their loss. In this regard, whilst our conceptual framework in Fig. 1 is presented as a linear process, in reality there is likely to be a feedback process in which nature-related experiences condition future interactions. In this way, positive interactions that generate CES benefits for people further condition them to respond positively to similar interaction in the future through the building of a sense of nature-connectedness.

Where an activity did not have any particular nature/biodiversity-related theme, there was no observed association between these activities and self-reported benefit. For such activities, a person may take flora, fauna or habitats into account indirectly through their perception of broader landscape quality, thereby influencing choice of where to undertake the activity (De Valck et al., 2016). However, they may undertake the activity irrespective of the presence or absence of particular species groups and so the benefit they derive from these species groups is not significantly influenced by their leisure activity to an extent which may be detected readily. Overall then the benefits derived from a species group appear to depend partly on the group's relevance to the activity. Where the presence, absence or abundance of the broad species groups might only add to general enjoyment as a backdrop to the activity or as an aspect of broader landscape quality (Willis, 2015), this effect was not detected in this survey. On the basis of this survey, it therefore appears that the countryside may only act as a broad setting for these activities, so the practitioners

do not focus on or consciously receive a greater benefit from these species groups than non-practitioners.

Engagement with media-related activities with a nature-related theme was also associated with enhanced reported benefits from some species groups and, importantly, this association was seen even when practitioners did not practice the other more active and outdoor activities that were associated with enhanced benefits. Russell et al. (2013) describe 'perceiving' as one of a series of 'channels' to CES benefits, which are modes of interaction from 'knowing' at the most detached form of interaction through to 'living within' as the most intimate and intense, with each channel being associated with different CES benefits. Research on the hypothesised 'extinction of experience' (Miller, 2005; Soga and Gaston, 2016) has problematized the increasing replacement of outdoor experience of nature with virtual and indoor leisure activities. These results nevertheless suggest that whilst such outdoor experience may well be essential to developing a sense of connection to nature, indoor media-related activities with a nature-related theme can still play their role in stimulating interest, knowledge and understanding of nature and biodiversity, allowing people to derive greater benefits from nature. Collado et al. (2013) found that benefits from nature may not require regular contact, and that just a few days exposure can increase someone's affinity for and appreciation of nature. For social groups with limited opportunities to experience nature first-hand, nature-focused indoor media-related activity may therefore help to build a sense of connection to nature that in turn could enhance the benefits from whatever limited opportunities for outdoor nature experiences may be available.

In summary, as the social factors and practices most strongly associated with enhanced reported benefit indicate a sense of nature connectedness, this appears to constitute a key psychological mechanism for CES benefit generation and a key pathway to benefit for those with a more developed sense of nature relatedness.

This greater sense of nature relatedness was associated with increased self-reported benefits generally for the less charismatic species, whilst the reported benefits for the more charismatic species groups generally were not significantly different for the more and less nature-connected respondents. The more nature-connected respondents therefore appeared to have scope to receive greater net benefits from nature, as they received similar benefits from the more charismatic species groups (as do the less nature-connected respondents), but also received more benefit from the less charismatic species groups, when compared with less nature connected respondents.

As regards the assertion here that more nature-connected respondents reported greater benefits from the less charismatic species groups (when compared with less nature-connected respondents), but not from the more charismatic groups, a caveat should be noted. It is possible that a corresponding effect for more charismatic species groups exists but was not detected in this work.

Firstly, any effect may be smaller for more charismatic species and so was not detected with our approach. Alternatively, Figs. 3 and 4 show that for charismatic species, most responses were at or near the extremes of the 7-point scale. We cannot therefore rule out the possibility that more nature-connected respondents were unable to express increased satisfaction with more charismatic species groups relative to the less nature-connected respondents, as most respondents were awarding scores at or near the maximum possible score, making any variation in scores difficult to detect.

Nevertheless, the benefits reported by respondents were still greater overall for the more charismatic species, whatever the respondent's degree of nature-relatedness, highlighting the importance also of species group charisma to benefit generation mechanisms. Broad species group charisma was therefore seen to be

another key factor in CES benefit generation mechanisms, and the concept of charisma in nature conservation has been researched from a number of perspectives (Lorimer, 2007; Fischer et al., 2011; Ducarme et al., 2013; MacDonald et al., 2015) as discussed in greater detail in McGinlay et al., 2017.

Graves et al. (2017) found that aesthetic preference for wild-flower communities was unaffected by social group factors or by knowledge of nature and so appears to be fairly universal, with people generally responding in similar ways. The limited degree of variation in reported benefit for the more charismatic species in our study indicates that CES benefits therefore come via an 'aesthetic' pathway, that is, a high proportion of benefit generated is aesthetically driven. Conversely, for less charismatic species groups, the pathway to the enhanced benefit for more nature-related people may come from a non-aesthetically driven pathway involving a broader emotional or psychological sense of connection, sense of place or of caring for non-human life. Further work would be required to demonstrate the existence of such benefits for less charismatic species groups. However, some evidence for this may be seen in work by Cox and Gaston (2016) that indicated that bird feeding was a practice driven by concern for bird welfare and a wider sense of connection to nature that also delivered psychological benefits to people. Whilst birds were one of our more charismatic groups here, if bird feeding could reinforce people's wider sense of connection to nature, this allows them to access psychological benefits that are not purely aesthetic in origin, and which they also may be able to derive from the less charismatic.

In summary then, there may exist both aesthetic and non-aesthetic pathways to benefit from interaction between people and broad species groups. The importance of the aesthetic pathway would be likely to be more important for the more charismatic groups, logically enough, as aesthetics would be likely to form part of their 'charisma' (Lorimer, 2007; MacDonald et al., 2015) and this pathway appears to be less sensitive to the human agent's sense of nature-connectedness. For less charismatic species this aesthetic component of benefit generation is lower, hence the lower overall benefit scores, but the benefit scores can be enhanced by increasing benefits generated via non-aesthetic pathways, which may be more strongly associated with a sense of nature-relatedness.

Nature conservation specialists commonly use iconic or charismatic species to catch the public's attention, and engage them in nature conservation (Krause and Robinson, 2017). The discussion above has the interesting implication therefore that, if conservationists succeed in engaging people and enhancing their sense of nature-relatedness, this may enhance people's ability to derive cultural ecosystem service benefits from *all* species groups, whether more or less charismatic in their appeal. Charismatic and iconic species may therefore be most important in benefit generation for those in society with the weakest sense of nature-relatedness, whereas, for a society that is more nature-related, the importance of CES benefits from the everyday, the common-place and the less iconic could also be important.

These findings also have scope to inform how leisure practices in the landscape interact with biodiversity provision, and benefit derivation therefrom. Management of the landscape for multi-functional use and multiple benefits for diverse users requires understanding of how different social and user-groups derive benefits from diverse practices in different landscapes, their diverse motivations, and associated satisfactions. The implication for actors wishing to increase public appreciation of nature and biodiversity is that it is not enough simply to attract people to activities based in the countryside, if they do not encourage a direct engagement with biodiversity that develops people's sense of connection to nature or nature-relatedness. The most effective approach might involve directly stimulating an active interest in nature and biodiversity in the local landscape leading people to participate or seek

knowledge and understanding. This stimulation need not necessarily be through direct interaction in the countryside, but also in people's homes through various media.

Our approach explored expressed values for different scenarios of the abundance of selected species groups considered separately and anchored around perceptions of current provision. It was not feasible nor intended in this multi-purpose survey to explore perceptions of trade-offs or synergies in abundance between different species groups. This could be done, for example, by exploring pairwise comparisons of abundance across species groups, or the satisfaction associated with different bundles of species abundance. Such alternative approaches to scenario assessment might identify differences in biodiversity values according to different demographic profiles that have not been found here. This is clearly an important topic for future research.

## 5. Conclusions

Practitioners of leisure activities with a nature-related theme, whether outdoor activities or indoor media-related activities, reported significantly higher levels of benefit from named species groups. Similarly, respondents whose personal background demonstrated an elevated degree of nature-relatedness also reported significantly higher levels of benefit from the named species groups. They were also more likely to be positive about proposed increases and negative about proposed decreases in species group abundance than non-practitioners or people with a weaker sense of connection to nature.

Benefits were also related to the charisma of the species group: enhanced benefit through nature-related activities and social factors was significant for less charismatic species, but inconclusive for more charismatic species. Practitioners who participated in outdoor leisure activities without a nature focus, and who may use the local landscape as a backdrop but are not focussed on aspects of the landscape's biota, generally did not report benefits differently from non-practitioners.

The variation in reported benefits between people with differing levels of connection to nature suggest that a sense of nature-connectedness may constitute a significant pathway to CES benefits, and that such benefits can be enhanced by nurturing and developing people's sense of nature-relatedness. The variation in reported benefits from more or less charismatic broad species groups also indicate that there may exist aesthetic and non-aesthetic pathways to CES benefits also. The former appears to be more important for more charismatic species and may be enhanced by increased provision. The latter may also be enhanced by again nurturing people's sense of connection to nature, as this is associated with greater reported benefits from the less charismatic species groups.

An enhanced sense of nature-relatedness may be fostered in the public through engagement with nature and wildlife either formally or informally. Formal means include environmental and nature-related education, whilst informal means may be through encouraging people to engage directly with nature-related activities. Either route would build people's sense of awareness, knowledge and understanding of nature and biodiversity, leading to an enhanced sense of connection to nature, thereby allowing people to derive greater benefits from a broader range of flora and fauna in their local landscapes, not just the charismatic, but the everyday and common-place.

## Acknowledgements

For their assistance and co-operation during the undertaking of this research, thanks are due to: Wiltshire Wildlife Trust and Wilt-



shire Council, as well as to the many stakeholders, survey interviewers and to the anonymous interviewees who kindly gave their time. Finally, thanks are due to the anonymous reviewers for their helpful comments leading to the significant improvement of the manuscript. Any remaining shortcomings or errors are our responsibility alone.

The work was undertaken as part of the 'Wessex BESS' project: *Biodiversity and the provision of multiple ecosystem services in current and future lowland multifunctional landscapes* [grant number: NE/J014710/1], a landscape-scale research project funded by the Natural Environment Research Council (NERC) and supported by the Biotechnology and Biological Sciences Research Council (BBSRC) on the interrelationship between biodiversity and ecosystem service provision in a lowland multi-functional landscape. This project was in turn part of the overall NERC-funded BESS programme (Biodiversity and Ecosystem Service Sustainability) which examined the relationships between biodiversity and ecosystem service provision in a range of contrasting landscapes in the UK.

All data supporting this study are openly available from the Cranfield University CORD data repository at <https://doi.org/10.17862/cranfield.rd.5217337>.

## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.ecoser.2018.03.019>.

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