# The rarity of direct experiences of nature in an urban population

Daniel T. C. COX[1] (dan.t.cox@googlemail.com )*
Hannah L. HUDSON[1] (H.Hudson@exeter.ac.uk)
Danielle F. SHANAHAN[2] (danielleshanahan@gmail.com)
Richard A. FULLER[2] (r.fuller@uq.edu.au)
Kevin J. GASTON[1] (K.J.Gaston@exeter.ac.uk)

Running title: Experiences of nature

[1]Environment & Sustainability Institute, University of Exeter, Penryn, U.K.
[2]School of Biological Sciences, University of Queensland, Brisbane, Australia.

*Corresponding author: Environment & Sustainability Institute, University of Exeter, Penryn, Cornwall. TR10 9FE, U.K.; (+44) 1326 255795; dan.t.cox@googlemail.com

## Highlights

- The most common form of nature experience involves not being present in nature
- Accumulatively 75% of time in nature was experienced by just 32% of the population
- People who experience nature regularly are the exception as opposed to the norm
- Connectedness to nature was positively correlated with spending time in nature
- Deconstructing nature dose will allow the development of targeted health outcomes

## Abstract

As people live more urbanised lifestyles there is potential to lose daily contact with nature, diminishing access to the wide range of associated health benefits of interacting with nature. Experiences of nature vary widely across populations, but this variation is poorly understood. We surveyed 1,023 residents of an urban population in the UK to measure four distinctly different nature interactions: indirect (viewing nature through a window at work and at home), incidental (spending time outside at work), intentional (time spent in private gardens) and intentional (time spent in public parks). Scaled-up to the whole study population, accumulation curves of the total number of hours per week that people were exposed to each type of nature interaction showed that 75% of nature interactions were experienced by half the population. Moreover, 75% of the interactions of a type where people were actually present in nature were experienced by just 32% of the population. The average hours each individual experienced nature per week varied across interactions: indirect (46.0 ± 27.3 SD), incidental (6.4 ± 12.7 SD), intentional-gardens (2.5 ± 2.9 SD) and intentional-parks (2.3 ± 2.7 SD). Experiencing nature regularly appears to be the exception rather than the norm, with a person's connection to nature being positively associated with incidental and intentional experiences. This novel study provides baseline information regarding how an urban population experiences different types of nature. Deconstructing nature experience will pave the way for developing recommendations for targeted health outcomes.


## 1. Introduction

With over 70% of the global human population predicted to live in cities within 30 years (WHO, 2016a), urbanisation is considered one of the most significant health issues of the 21st century

(WHO, 2016b), tied as it is to growing levels of chronic, non-communicable and mental health conditions (Dye, 2008; Sundquist, Frank, & Sundquist, 2004). Urban nature has the potential to help mitigate many of these health issues (Keniger, Gaston, Irvine, & Fuller, 2013; Shanahan et al., 2015b), with demonstrable links between exposure to nature and health and well-being benefits (Hough, 2014; Keniger et al., 2013; Shanahan, Fuller, Bush, Lin, & Gaston, 2015a). These benefits span a remarkable range of health outcomes, with evidence for reduced all-cause mortality and mortality from cardiovascular disease (Donovan et al., 2013; Mitchell & Popham, 2008), reduced allergies (Hanski et al., 2012), enhanced general and self-reported health (e.g. Groenewegen, van den Berg, Mass, Verheij, & de Vries, 2012; Maas, Verheij, Groenewegen, de Vries, & Spreeuwenberg, 2006), improved self-reported wellbeing and a reduced risk of poor mental health (e.g. Bratman, Hamilton, & Daily, 2012; Bratman, Hamilton, Hahn, Daily, & Gross, 2015; Fuller, Irvine, Devine-Wright, Warren, & Gaston, 2007; White, Alcock, Wheeler, & Depledge, 2013) and improved cognitive ability (Berman, Jonides, & Kaplan, 2008; Han, 2009).

Within the urban environment, exposure to nature is more complex and versatile than often portrayed; to a greater or lesser extent many people are exposed to components of nature throughout their daily lives. Keniger et al., (2013) identified three types of nature interactions. First, there is robust evidence for the benefits from ‘indirect interactions’ with nature while not being present in it (e.g. having a view of nature from home or work), including increased psychological well-being (Kaplan, 2001) and reduced stress at work (Kaplan, 1993). Second, people benefit from ‘incidental interactions’ with nature while carrying out another activity (e.g. walking past street trees during daily activities), which can lead to decreased levels of stress

(Kaplan, 1993; Lottrup, Grahn, & Stigsdotter, 2013). Third, there is a broad range of benefits provided by 'intentional interactions' (e.g. where someone intends to interact with nature through visiting parks or gardens), including reduced mortality from cardiovascular disease (Mitchell & Popham, 2008) and improved mental health (Fuller et al., 2007).

Plainly, different people receive different levels of each kind of nature experience. This variation likely results from a combination of orientation and opportunity (Lin, Fuller, Bush, Gaston, & Shanahan, 2014; Soga & Gaston, 2015). Some people are more inclined towards interacting with nature (orientation), and some have greater access to those interactions (opportunity). Orientation and opportunity are themselves shaped by a wide array of factors including location, age, gender, ethnicity, income and education, and potentially complex interactions between them (Lin et al., 2014; McCormack, Rock, Toohey, & Hignell, 2010). The net outcome, combined with the composition of an urban population, will determine the extent to which nature interactions are distributed across that population in a more or less equitable fashion (with interactions being roughly equally distributed or disproportionately experienced by a small number of people). To date, this outcome is poorly understood.

Deconstructing people's daily nature experience is the first step towards better integrating science with planning and policy for improved health outcomes (Shanahan et al., 2015b). Modelling how, where and what type of nature people experience will allow a clearer understanding of how targeted green planning can be better incorporated into the daily lives of urban dwellers. For example, what kind of environments encourage walking (Middleton, 2010),

with the implications for behavioural change, advocacy, design and policy to create better urban environments.

In an urban population we examine four common nature interactions for which there is tangible evidence for pathways of benefit delivery: indirect interactions (time spent at home and at work in a room with a view of nearby nature); incidental interactions (time spent outside as part of job); intentional interactions (time spent in private gardens) and intentional interactions (time spent in public parks). We explore three questions: 1) How are experiences of nature distributed across different nature interactions? 2) How does this vary across the population? 3) How are these experiences distributed across socio-demographic groups?

## 2. Material and methods

This study was conducted within the urban limits of the 'Cranfield triangle' (52°07'N, 0°61'W), a region in southern England, U.K., comprising three adjacent towns of Milton Keynes, Luton and Bedford. These have a human population of c. 609,501 (2011 Census, UK), and occupy 166 $km^2$. An urban lifestyle survey, delivered online through a market research company (Shape the Future Ltd), was completed in May 2014 by 1,023 adults enrolled in their survey database. Participants were self-selecting and were compensated with a nominal fee. Within the questionnaire, we collected several socio-demographic covariates that could influence nature interactions including age, gender, the primary language spoken at home, personal annual income, highest formal qualification, self-assessment of health and nature orientation (Table S1 shows the variables and classifications for analysis purposes).

Respondents provided self-reported information on four types of common nature interaction that they experience in an average week:

(i) *Indirect interactions*: Time spent at home and at work in a room with a view of nearby nature (within 500m; defined as no view, trees, parks, countryside, lake, canal or river). Respondents were asked how many days a week they worked, before selecting how much time they spent in a room with a view of nature at home on an average workday and an average non-workday, and at work on an average working day. In each case respondents selected from the categories: Less than an hour; 1-2 hours; >2-4 hours; >4-6 hours; >6-8 hours; >8-10 hours; >10-12 hours; >12 hours. The mid-points of the selected categories were chosen (where 12 or more hours was treated as '12') and then the total time per week was calculated by summing the number of hours on a work day by the number of days worked, and adding the sum of the number of hours on a non-work day by the number of days not worked.

(ii) *Incidental interactions:* Time spent working outdoors in an average week. Respondents selected from the categories: No time; 5 hours or less; 6-10 hours; 11-20 hours; 21-30 hours; 31-40 hours; 41-50 hours; 51-60 hours; 61-70 hours; 71 or more hours; Most of the time (in a separate question respondents were asked how many hours they spend at work). The mid-points of selected categories were chosen (where 71 or more hours was treated as '71').

(iii) *Intentional interactions (gardens):* Time spent in private gardens. Respondents selected the total time spent in their private gardens in the last week from the categories; I don't have a garden / no time (these answers were combined, because both responses indicate no experiences of nature in private gardens), 1-30 minutes, 31 minutes to 1 hour, >1-3 hours, >3-5 hours; >5-7 hours, >7-9 hours, >9 hours. The mid-points of the selected categories were used for analysis purposes (where 9 or more hours was treated as '9').

(iv) *Intentional interactions (parks):* Time spent in up to seven public parks. Respondents selected from the categories; 1-29 minutes; 30 minutes -1 hour; >1-2 hours, >2-3 hours, >3-4 hours, >4 hours. The mid-points of the selected categories were identified (where 4 or more hours was treated as '4') and then the total time was summed across all public parks visited.

## 2.1. Statistical analysis

We built a generalised linear mixed model with a Gaussian error distribution to model the total time spent experiencing each type of nature interaction (dependent variable), with each respondent as a random effect, against the type of nature interaction, nature orientation, self-assessment of health, age, income, gender, education and ethnicity. We log-transformed the dependent variable so that it was approximately normally distributed, before testing for the effects of covariates and paired interactions (nature interaction*nature orientation, nature interaction*age, nature interaction*income). We used the 'MuMIn' package (Bartoń, 2015) to produce all subsets of models based on the global model and rank them based on AICc. Following Richards (2005) we retained all models where $\Delta AIC_c < 6$. We then used model-averaging to produce the coefficients with standard errors and 95% confidence intervals, of each retained parameter and interaction (Burnham & Anderson, 2002).

We scaled-up the total hours per week that survey respondents spent experiencing each type of nature interaction to the population of the Cranfield triangle. Based on the proportions indicated by the 2011 Census data we stratified by age (four level factor) to correct the survey population sample to that of the actual population (Appendix S1). We plotted accumulation curves for the total number of hours per week that both the survey respondents and the population of the

Cranfield triangle were exposed to each type of nature interaction, and for total time across interactions. We started with respondents who spent the greatest time experiencing nature, and then accumulatively added each respondent to the total population hours in the order of decreasing time spent experiencing nature.

## 3. Results

The average number of hours during which each individual experienced nature per week varied across interactions: indirect (46.0 ± 27.3 SD), incidental (6.4 ± 12.7 SD), intentional-gardens (2.5 ± 2.9 SD) and intentional-parks (2.3 ± 2.7 SD; Fig. 1a-d). Across all four nature interactions people spent on average 57.3 ± 31.9 SD hours per week (Fig.1e).

Accumulation curves were almost identical for survey respondents and when scaled up to the whole population for indirect interactions, which were experienced by the majority of people (Fig. 1a). For other kinds of nature experiences, scaling up led to somewhat slower rates of accumulation than for the survey respondents alone (Fig. 1). A small proportion of the survey population (13%) experienced 75% of the incidental interactions (Fig. 1b). The distribution of intentional experiences was similar for both private gardens and public parks, with 28% and 27% of the survey population, respectively, experiencing 75% of the total time (Fig. 1c and 1d). We found that 75% of all nature interactions were experienced by just 50% of the survey respondents and of the population.

Experiences of indirect and intentional (in gardens) interactions increased with age, while people over 60 had more intentional interactions in parks (Table 1). Respondents who experienced all

four types of nature interaction had better self-reported health (Table 1), while those who incidentally and intentionally interacted with nature had a higher nature orientation than those experiencing it indirectly (Table 1). Gender, education and ethnicity were not important predictors of time spent experiencing nature.

## 4. Discussion

We demonstrate that, across four common types of nature interaction, accumulatively 75% of nature experiences were experienced by just 50% of the population. However, accumulatively 75% of interactions where people were actually present in nature were experienced by just 32% of the population. Indeed, people who directly experience nature regularly in any given week are clearly the exception rather than the norm. This novel study provides baseline information regarding how experiences of nature vary across an urban population. This is a first step towards linking urban design and policy towards maximising the health benefits from urban nature.

### 4.1. Indirect interactions

For the majority of people, the most common method of experiencing nature is while not actually being present in it, but by viewing natural scenes through a window.

Importantly, having a room with a view of nature does not necessarily mean that people are continuously experiencing that view. Instead, at work and in the home most people spend a significant amount of time with their attention directed towards specific tasks, and the presence of a window with a natural scene allows micro-restorative experiences (Kaplan, 1993, 2001), with scenes that are more fascinating being likely to be more restorative (Kaplan & Kaplan, 1989). Here we show that there is great variation in the type of nature people can see from their

windows and this varies between work and home (Fig. S1). We show that street and residential trees are providing the lion's share of indirect nature experiences. An important contribution of future research would be to unpick how trees are distributed across the landscape in relation to the flow of people experiencing them. This would allow architects and planners to exploit key areas where the greatest number of people would interact with trees.

Despite research showing the benefits of nature views, such as office workers having perceived lower levels of job stress and higher job satisfaction (Kaplan & Kaplan, 1989), and residents of greener neighbourhoods reporting increased neighbourhood satisfaction and well-being (e.g. Kaplan, 2001), a significant number of people in this study had no good view of nature at work (33.8%) or at home (18.1%; Fig. S1). Neither nature orientation, age nor income were significant predictors of indirect interactions with nature, suggesting these experiences are more a consequence of opportunity, rather than orientation towards nature (i.e. you either live or work in a room with a view of nature, or you do not). Considering the benefits that visual access to nature provides there is considerable significant potential through innovative urban greening to further increase people's indirect exposure.

4.2. Incidental interactions

Half of all workers spent some time outside at work, although the steep accumulation curve shows that a large proportion of people spend most of their work hours outdoors, rather than many people spending a small proportion of time outdoors. Nature orientation showed a significant positive relationship with incidental time spent in nature, suggesting that either people with an increased orientation towards nature are more likely to choose jobs where they spend

time outside, and/or that daily nature experiences increase nature orientation (Soga & Gaston, 2015). A large proportion of the population spends a substantial amount of time in the workplace. Short work breaks are a common part of office culture and offer an important and largely untapped opportunity to promote healthy contact with nature. Indeed, attention restoration and self-esteem have been found to increase in as little as five minutes spent outside (Barton & Pretty, 2010), suggesting that access to nature at work can promote significant gains towards improving office health and productivity (Largo-Wight, Chen, Dodd, & Weiler, 2011).

Further research needs to explore daily incidental experiences of nature as people travel around the landscape. Unfortunately, this is not easily done and requires rather different approaches that are likely to be challenging to extrapolate to the entire population in the way that was done in this study. In future studies it will be important to unpick these experiences and the relative health benefits they provide, both from the nature people interact with, and how this varies across different activities people are engaged in during these interactions.

### 4.3. Intentional interactions

Private gardens provide an immediate and readily accessible way for people to experience nature. Considering that 92% of the survey respondents claimed access to a private green space, it is somewhat surprising that 75% of the time spent in gardens was experienced by merely 28% of the population. Clearly opportunity was not the driving force behind use, instead we found orientation to be a strong predictor. Such results are supported by previous research showing that people with a higher orientation towards nature have the potential to receive high levels of garden vegetation benefits through active and passive means (Lin, Gaston, Fuller,Wu, Bush, &

Shanahan, 2017), and spend more time in private gardens and public parks, while living in areas with more vegetation (Lin et al., 2014). Literature from the environmental psychology field also shows that appreciation of nature is a significant motivation for people to spend time in nature (Clayton, 2007).

The ten-fold increase in hours spent in private gardens over public parks probably reflects differences in ease of access and the fundamentally different roles that they play in people's lives. Time spent in parks increased with income possibly because wealthier neighbourhoods often have increased access to higher quality green space encouraging use (Shanahan, Lin, Gaston, Bush & Fuller, 2014; Soga, Yamaura, Aikoh, Shoji, Kubo, & Gaston, 2015). We did not find that income affected time in gardens, which supports the results of previous studies (Lin et al., 2017). We did find that both time in parks and in gardens increased with age, probably because people's relationship to nature changes as they get older (Shanahan et al., 2017) or simply because older people have more leisure time (Gauthier & Smeeding, 2003).

## 5. Conclusions

Within an urban population variation in daily nature experiences is driven by both opportunity and orientation. To reverse the trend of declining nature experiences, research and public policy need to address both of these components. Arguably the simplest approach is to increase the quantity of green infrastructure (Shanahan et al., 2015b; Soga et al., 2015), thereby increasing both indirect and incidental interactions. However, as shown here and by Lin et al. (2014) opportunity is not sufficient to encourage use. It is critical to design public health interventions that increase people's orientation toward nature. Both theory and evidence suggest that

orientation is influenced by regular outdoor play during childhood (Bixler, Floyd, & Hammitt, 2002; Thompson, Aspinall, & Montarzino, 2008). However, there is also enormous scope to increase orientation in adults through participation in nature-based activities (Scott, Amel, & Manning, 2014). Those who do not interact with nature may lose the substantial benefits associated with health and well-being (Keniger et al., 2013; Shanahan et al., 2015a). The health and well-being benefits of experiencing nature are now well established. The challenge is encouraging a greater proportion of the population to engage with the natural world around them. However, care needs to be taken, as a rise in the number of people accessing green spaces for health benefits might threaten urban ecosystems and the very health benefits that people seek (Stanley et al., 2015). Deconstructing types of nature experiences, as done here, is critical for guiding recommendations and policy to ensure that across the population the most people can benefit from interactions with nature.

**Data accessibility**

Due to third party restrictions, the data are available on request from the corresponding author. The dataset will be available from the NERC Environmental Data Information Centre from mid 2017.

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**Table 1:** The relationship between the total time spent experiencing each type of nature interaction (log-transformed) for each respondent and covariates. Respondent is a random effect, and model averaged parameter estimates and confidence intervals are given for factor levels relative to a comparative base factor level (Health, very poor; Nature interaction type, Indirect). Significant variables and factor levels are shown as $*P < 0.05$; $**P < 0.01$; $***P < 0.001$.

**Table 1:** The relationship between the total time spent experiencing each type of nature interaction (log-transformed) for each respondent and covariates. Respondent is a random effect, and model averaged parameter estimates and confidence intervals are given for factor levels relative to a comparative base factor level (Health, very poor; Nature interaction type, Indirect). Significant variables and factor levels are shown as *$P$ <0.05; **$P$ <0.01; ***$P$ <0.001.

| Variable | Estimate (SE) | 95% Confidence intervals |
|---|---|---|
| Intercept | 1.97 (0.3)*** | 1.39; 2.55 |
| Income | 0.06 (0.03) | -0.01; 0.12 |
| Nature orientation | 0.09 (0.9) | -0.09; 0.27 |
| Age | 0.00 (0.01) | -0.02; 0.03 |
| Ethnicity | 0.04 (0.04) | -0.05; 0.12 |
| *Health* | | |
| Poor | 0.04 (0.11) | -0.18; 0.26 |
| Average | 0.22 (0.10)* | 0.02; 0.42 |
| Good | 0.24 (0.10)* | 0.05; 0.44 |
| Very good | 0.28 (0.10)** | 0.08; 0.48 |
| *Nature interaction* | | |
| Incidental | -2.14 (0.33)*** | -2.79; -1.50 |
| Intentional (garden) | -2.65 (0.44)*** | -3.51; -1.79 |
| Intentional (park) | -2.78 (0.42)*** | -3.60; -1.95 |
| *Nature orientation: Nature interaction* | | |
| Nature orientation: Incidental | 0.18 (0.08)* | 0.01; 0.34 |
| Nature orientation: Intentional (garden) | 0.33 (0.09)*** | 0.16; 0.50 |
| Nature orientation: Intentional (park) | 0.31 (0.08)*** | 0.15; 0.48 |
| *Age: Nature interaction* | | |
| Age: Incidental | 0.00 (0.02) | -0.03; 0.03 |
| Age: Intentional (garden) | 0.07 (0.02)*** | 0.04; 0.10 |
| Age: Intentional (park) | 0.04 (0.02)* | 0.01; 0.07 |
| *Income: Nature interaction* | | |
| Income: Incidental | 0.15 (0.04)*** | 0.07; 0.24 |
| Income: Intentional (garden) | -0.05 (0.04) | -0.13; 0.04 |
| Income: Intentional (park) | 0.09 (0.04)* | 0.01; 0.18 |
| Conditional $R^2$ | 0.42 | |

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**List of figures**

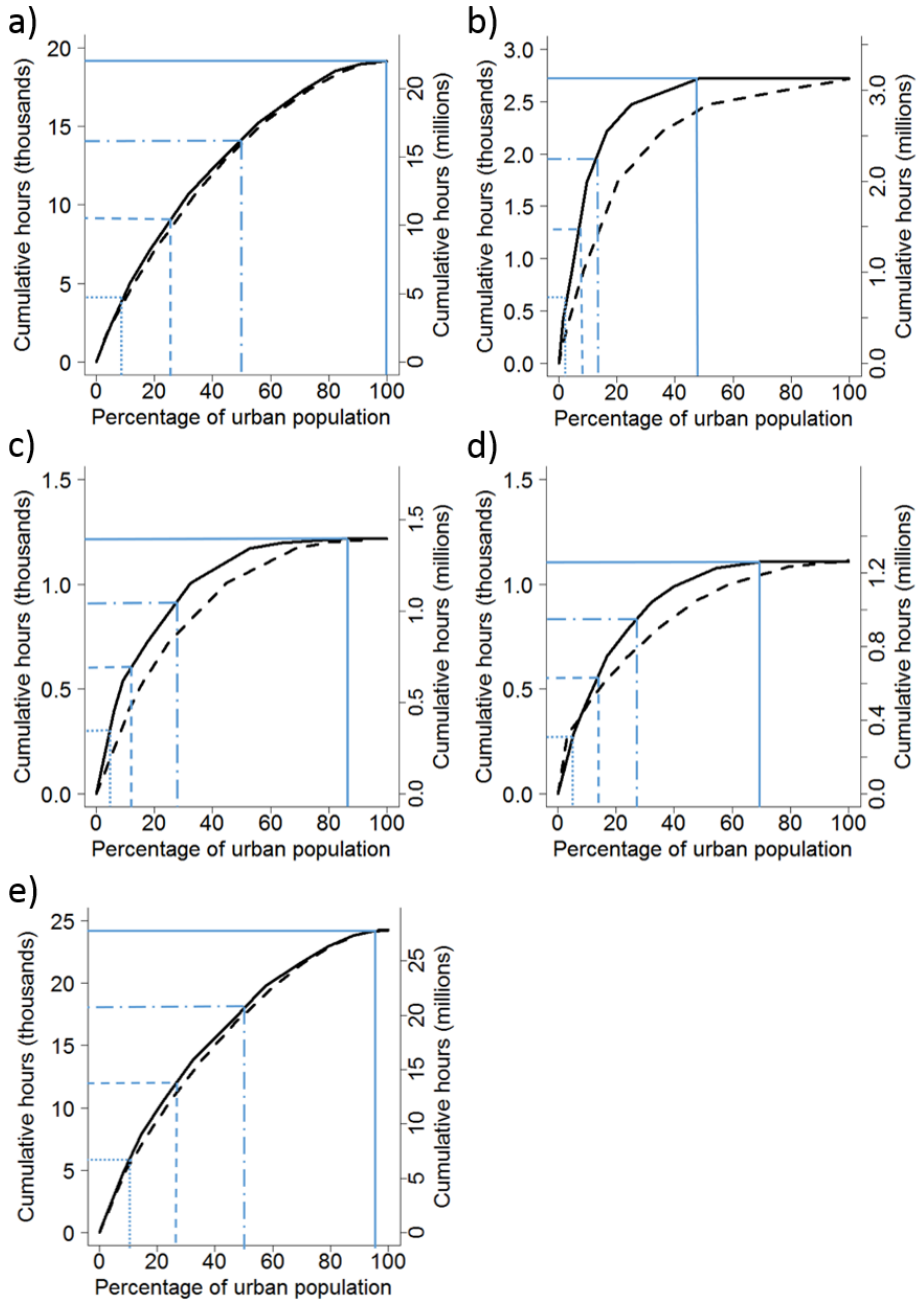


**Figure 1**. Cumulative hours spent per week experiencing different nature interactions by survey respondents (left y axis; solid curve) and scaled up to the whole population of the Cranfield triangle (right y axis; dashed curve): a) indirect interactions (in a room with a view of nearby nature); b) incidental interactions (working outside); c) intentional interactions (private gardens); d) intentional interactions (public parks); e) the total time across all interactions. We show the

percentage of the population that account for 25% (dotted line), 50% (dashed line), 75% (dash/dot line) and 100% (solid line) of the total nature experienced.

## Acknowledgements

Thank you to Robert Bush, Brenda Lin and Julie Dean for consultation in survey development.

## Ethical clearance

This research was conducted with approval from the Bioscience ethics committee of the University of Exeter (project number 2013/319). Participants provided written consent at the beginning of the online survey.

## Funding

DTCC, HLH & KJG were funded by NERC grant NE/J015237/1. D.F.S. is supported through ARC Discovery Grant DP120102857 and the Centre of Excellence for Environmental Decisions (CEED, Australia); R.A.F. holds an ARC Future Fellowship.

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