

Extinction of experience: the loss of human–nature interactions

Masashi Soga^{1*} and Kevin J Gaston²

Increasingly, people are becoming less likely to have direct contact with nature (natural environments and their associated wildlife) in their everyday lives. Over 20 years ago, Robert M Pyle termed this ongoing alienation the “extinction of experience”, but the phenomenon has continued to receive surprisingly limited attention. Here, we present current understanding of the extinction of experience, with particular emphasis on its causes and consequences, and suggest future research directions. Our review illustrates that **the loss of interaction with nature not only diminishes a wide range of benefits relating to health and well-being, but also discourages positive emotions, attitudes, and behavior with regard to the environment, implying a cycle of disaffection toward nature.** Such serious implications highlight the importance of reconnecting people with nature, as well as focusing research and public policy on addressing and improving awareness of the extinction of experience.

Front Ecol Environ 2016; 14(2): 94–101, doi:10.1002/fee.1225

For the vast majority of its existence humanity has been intimately connected with, and has directly gained a broad range of benefits from, the natural world. However, over recent decades more and more people worldwide, and especially children, are interacting less and less with nature (Figure 1). This shift is not simply limited to a loss of engagement with pristine areas or wilderness environments, but also involves changes in a wide diversity of activities and experiences, including time spent in urban greenspaces and observing urban wildlife. Although it is difficult to pinpoint exactly what has led to this decline in spontaneous outdoor activities, several possible triggers have been identified, such as

rapid growth in the number and proportion of people living in urban areas (Turner *et al.* 2004; Zhang *et al.* 2014); technological advancements and the emergence of sedentary pastimes such as watching television, playing computer games, and using the internet (Pergams and Zaradic 2006; Ballouard *et al.* 2011); and the overscheduling and micromanagement of children’s lives (Clements 2004; Hofferth 2009). For many people today, outdoor nature experiences are being replaced by virtual alternatives (Pergams and Zaradic 2006; Hofferth 2009; Ballouard *et al.* 2011).

In his memoir *The Thunder Tree*, Robert M Pyle (1993) termed this ongoing alienation of humans from nature the “extinction of experience”, and argued that this “is not just about losing the personal benefits of the natural high. It also implies a cycle of disaffection that can have disastrous consequences.” Looking back to his childhood experiences near the suburbs of Denver, Colorado, Pyle emphasized that direct, personal contact with natural environments is vital in forging a person’s emotional intimacy with nature, and cannot be replaced by vicarious experiences (Pyle 1993). Nabhan and St Antoine (1993) also warned that “children’s very ability to perceive the environment may be diminished by the replacement of multisensory experiences in richly textured landscapes with the two-dimensional world of books or the audiovisual world of TV, videos, and movies”. From an evolutionary perspective, Wilson (1984, 1993) further argued that humanity has an intimate emotional attachment to nature, and especially to living biota, that is deeply rooted in our biology. He proposed the so-called “biophilia hypothesis”, which states that because humans have evolved with and been part of nature, we still show inherited earlier adaptations that make us likely to function well when we are exposed to natural environments

In a nutshell:

- Fewer and fewer people, and especially children, have daily contact with nature, an ongoing alienation termed the “extinction of experience”
- Consequences of the loss of interaction with nature include deteriorating public health and well-being, reduced emotional affinity toward nature, and a decline in pro-environmental attitudes and behavior, implying a cycle of disaffection toward nature
- Researchers and policy makers need to focus more attention and effort on planning how best to reduce the extinction of experience and reconnect people with nature, which contributes greatly both to achieving healthy societies and overcoming a wide range of environmental issues

¹Department of Urban Engineering, School of Engineering, The University of Tokyo, Tokyo, Japan *(masashi.soga.mail@gmail.com); ²Environment and Sustainability Institute, University of Exeter, Penryn, UK

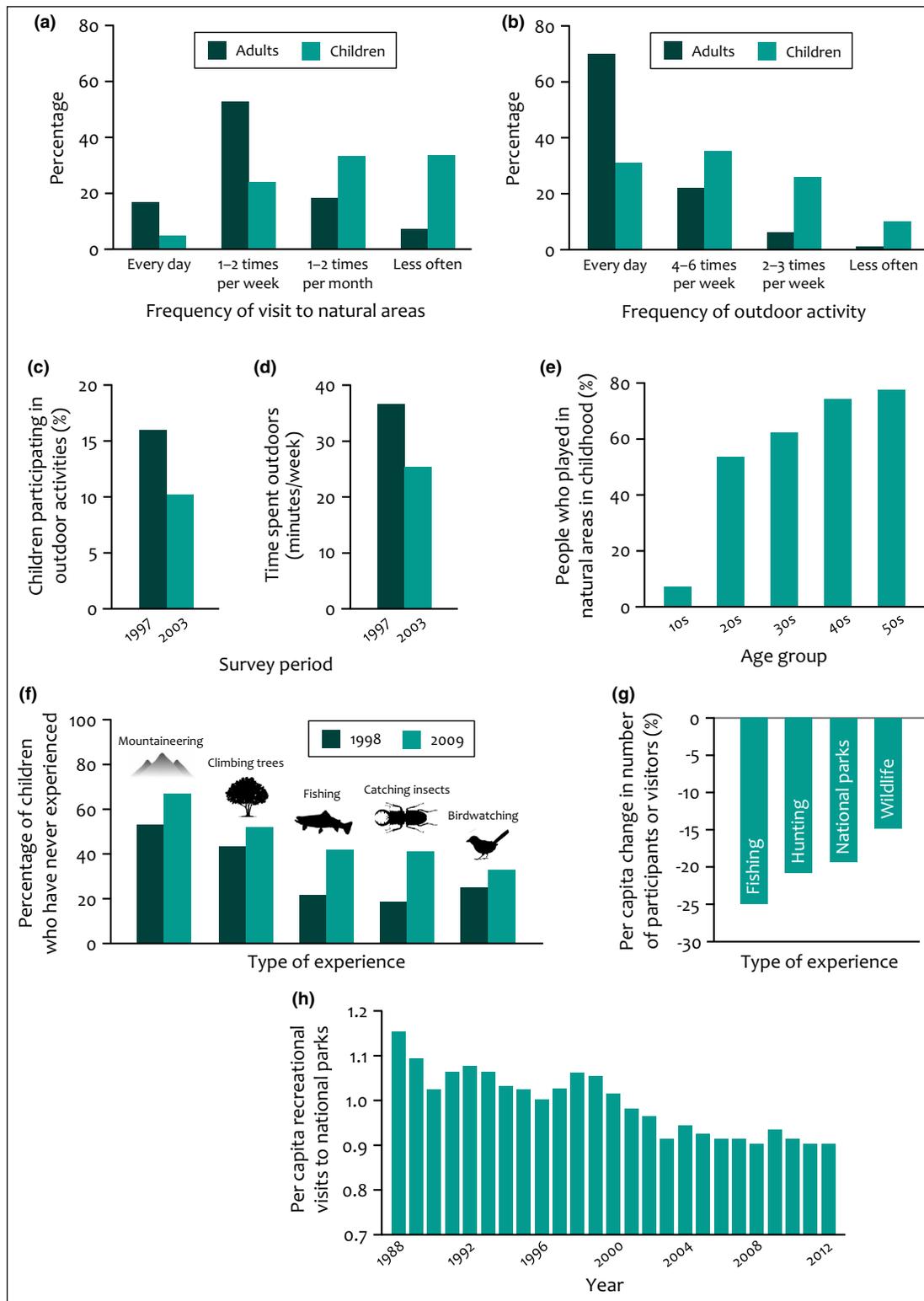


Figure 1. Empirical evidence demonstrating that children today spend less time engaged in outdoor nature experiences as compared with previous generations. Data from (a) the UK (England Marketing 2009), (b) the US (Clements 2004), (c and d) the US (Hofferth 2009), (e and f) Japan [(e) report to the Ministry of the Environment, www.env.go.jp, and (f) report to the National Institution for Youth Education, www.niye.go.jp], (g) the US (report to the Minnesota Department of Natural Resources, www.dnr.state.mn.us), and (h) the US (report to the National Park Service, www.nps.gov).

(Wilson 1993). In a similar vein, Kellert (2002) observed that society has become “so estranged from its natural origins, it has failed to recognize our species’ basic dependence on nature as a condition of growth and development”.

Over the decades since the conception of the extinction of experience, researchers from a wide range of disciplines have provided evidence demonstrating the serious consequences associated with this idea. Those who do not directly interact with nature are likely to lose substantial benefits associated with health and well-being (Keniger *et al.* 2013; Shanahan *et al.* 2015), are less likely to perceive and value the advantages that such interactions bring (Bixler *et al.* 2002), and are less motivated to want to visit and protect it (Wells and Lekies 2006; Ward Thompson *et al.* 2008). As a result, the extinction of experience has increasingly been viewed both as a major public-health issue (Shanahan *et al.* 2015) and as one of the fundamental obstacles to reversing global environmental degradation (Miller 2005; Balmford and Cowling 2006). Despite greater awareness of this lack of engagement with nature, however, little is known about the phenomenon. Indeed, although there is a growing literature concerning the decline in human–nature interactions, most attention to date has focused on the benefits to health and well-being that result from outdoor experiences (eg Keniger *et al.* 2013; Hartig *et al.* 2014; Shanahan *et al.* 2015), and a more comprehensive discussion is still needed. Here, we present the current state of understanding regarding the loss of human–nature interactions (with a particular emphasis on the causes and consequences thereof), summarize previous key findings, and suggest future research directions. We consider a wide diversity of types of human–nature interactions and assume that the “experience of nature” of concern is not limited to engagement with pristine or wilderness areas but includes, for example, urban parks (Lin *et al.* 2014), planted vegetation (Kardan *et al.* 2015), and allotments (community gardens; van den Berg *et al.* 2010).

■ Causes

Loss of opportunity

Arguably, the root driver of the loss of human–nature interactions is the decline in opportunities to directly experience nature (Figures 2a and 3a). Over the past half-century, an ever-growing number of humans have rapidly concentrated themselves and their activities into urban areas, where a high proportion of space is composed of artificial material and is segregated from natural systems and processes (Turner *et al.* 2004; Grimm *et al.* 2008). It is well known that people who live farther from natural areas, or who live near degraded natural areas, interact less frequently with nature (Figure 3a; Neuvonen *et al.* 2007; Soga *et al.* 2015). In China,

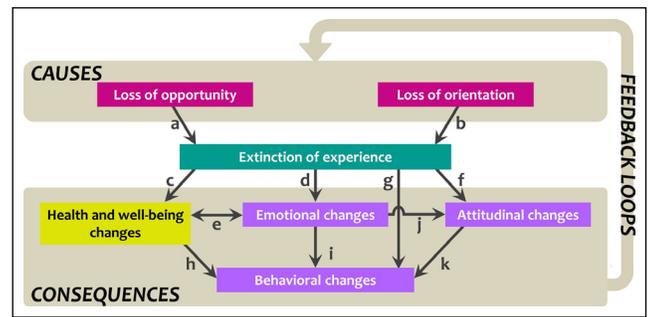


Figure 2. The causes (loss of opportunity and orientation) and consequences (changes in health and well-being, and emotions, attitudes, and behavior toward nature) of the extinction of experience, and the potential pathways among them. Extinction of experience can lead to a feedback loop in which the consequences accelerate further loss of interactions with nature. Note that this schematic diagram does not necessarily represent all potential factors and processes.

for instance, a survey of more than 1000 elementary-school students revealed that those living in rural areas visited natural environments in their neighborhoods and participated in a wider range of nature-based activities more frequently than did students living in city centers (Zhang *et al.* 2014). Impoverishment of local flora and fauna also limits opportunities to experience nature, given that neighborhood environments are often the only sites in which many people encounter nature in their daily lives (Turner *et al.* 2004; Samways 2007). Indeed, Kai *et al.* (2014) recently suggested that the extirpation of local woodland birds in southwest China eroded local knowledge of these species, especially among the younger generations who can no longer experience the sights and sounds of these birds directly.

Loss of orientation

The loss of people’s positive orientation toward engaging with nature – that is, their reduced emotional affinity with nature – is another important factor driving reductions in human–nature interactions (Figures 2b and 3b). Following the development of various methodologies and measures (eg Connectedness to Nature Scale, Nature Relatedness Scale), researchers identified a positive relationship between the level of an individual’s emotional connectedness to nature and the frequency of their visits to natural places (Mayer and Frantz 2004; Nisbet *et al.* 2009). For instance, Cheng and Monroe (2012), demonstrated that people with a strong emotional connectedness to nature reported being more likely to spend time in natural environments. This suggests that those who have a greater orientation toward nature are more motivated to directly experience it.

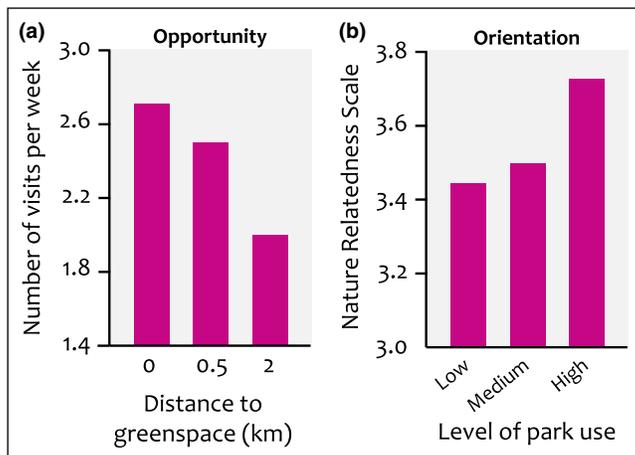


Figure 3. Causes of the loss of interactions with nature. (a) Effects of having opportunities to experience nature directly (distance to greenspace) on the frequency of contact with nature reported in Finland (Neuvonen *et al.* 2007). (b) Effects of orientation toward nature (measured by the Nature Relatedness Scale; see Nisbet *et al.* 2009) on the frequency of visits to urban parks reported in Australia (Lin *et al.* 2014).

Although the extent to which orientation contributes to the loss of interactions with nature remains poorly understood, recent studies indicate that its influence on people's use of nature is long-lasting and is comparable to – and sometimes stronger than – the influence of opportunity. Hinds and Sparks (2008) and Ward Thompson *et al.* (2008) demonstrated that more frequent exposure to natural areas during childhood enhances a person's feeling of being emotionally connected with nature, which positively affects their intentions to visit these environments as adults. In Brisbane, Australia, Lin *et al.* (2014) also found that the frequency of people's use of urban greenspace was driven more by their level of emotional connectedness to nature than by the degree of neighborhood greenspace coverage (Figure 3b). Given that completely different measures are required to address the loss of opportunity and of orientation, additional research focusing on their relative importance and interaction is needed.

Consequences

Researchers have explored the consequences of the loss of daily contact with nature, which can be roughly categorized into four types, consisting of changes in (1) health and well-being, (2) emotions, (3) attitudes, and (4) behavior toward nature (Figures 2, 4, and 5). Although not mutually exclusive, for convenience we discuss these separately here.

Changes in health and well-being

The most immediate outcome of the loss of interactions with nature is the loss of the associated benefits to

health and well-being (Figures 2c and 4; Keniger *et al.* 2013; Hartig *et al.* 2014). A number of studies have found a positive relationship between levels of exposure to nature and people's physical health and psychological well-being (Figure 4, a and b; van den Berg *et al.* 2010; Kardan *et al.* 2015), as well as social contacts and cohesion (Figure 4c; Sugiyama *et al.* 2008; van den Berg *et al.* 2010). Although the majority of studies examined short-term health benefits, recent research has documented long-lasting influences of exposure to nature, such as on the incidence of diabetes (Lachowycz and Jones 2011); circulatory and heart disease (Maas *et al.* 2009); and, more generally, on longevity in senior citizens (Takano *et al.* 2002). Regular contact with nature is also thought to be vital in ensuring proper social, emotional, cognitive, and motor development in children and youths (Keniger *et al.* 2013; Dadvand *et al.* 2015). Thus, it is widely acknowledged that just as with taking a supplemental vitamin, regular exposure to natural environments is a necessary ingredient for a healthy life (the so-called “vitamin G”, in which the G represents greenspace), and can in some instances be equally as effective as more conventional forms of medical treatment (Groenewegen *et al.* 2006; Shanahan *et al.* 2015).

Emotional changes

Not only does the loss of interactions with nature undermine human health and well-being, it also changes people's emotions toward nature, including their affinity to, interest in, and love of nature (Figures 2d and 5a). In the US, recreational play in natural environments during childhood positively influenced people's later interest in natural environments and outdoor recreation activities (Bixler *et al.* 2002). In the UK, survey respondents who had grown up in rural environments exhibited a more positive emotional connection with nature than did those who grew up in urban environments (Figure 5a; Hinds and Sparks 2008). Furthermore, exposure to natural environments and direct contact with nature was shown to ameliorate people's “biophobia”, or the fear of and aversion to nature (Zhang *et al.* 2014). Importantly, these positive emotional changes are not only triggers for environmental attitudes and behavior, but are also closely associated with psychological health and well-being, by helping to improve such factors as vitality and life satisfaction (Figure 2e; Capaldi *et al.* 2014).

Attitudinal changes

Evidence shows that loss of interactions with nature changes people's attitudes toward nature, including the values they place on it, their beliefs concerning the environment, their perceived norms of environmental

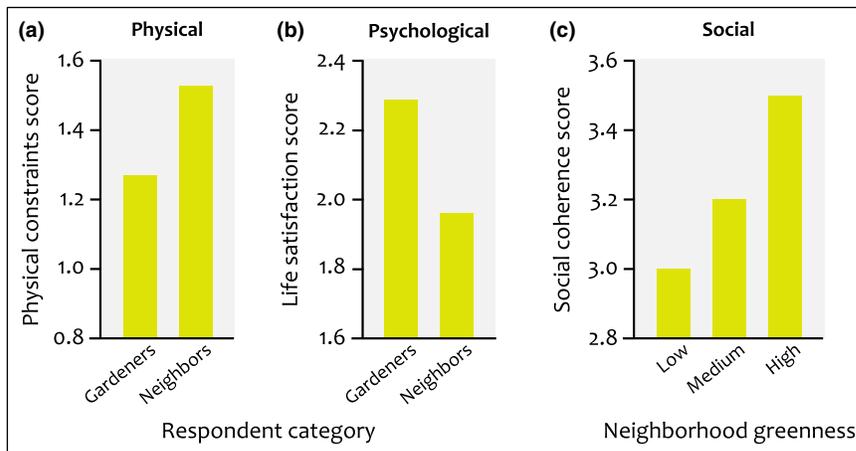


Figure 4. Changes in health and well-being due to loss of interactions with nature. (a) Physical health (physical constraints) and (b) psychological well-being (life satisfaction) reported in the Netherlands (van den Berg *et al.* 2010). (c) Social health (social coherence scores) reported in Australia (Sugiyama *et al.* 2008). Exposure to nature was measured by (a and b) participation in allotments (community gardening) and (c) levels of neighborhood greenspace. In panels (a) and (b), “neighbors” refers to the control group (ie those who did not participate in gardening).

ethics, and their willingness to protect nature (Figures 2f and 5b). Interviews with more than 500 undergraduate students revealed that their current views concerning the environment were related to the degree of their participation in outdoor activities as children or youths (Ewert *et al.* 2005). In a survey of over 1000 US citizens, respondents’ participation in childhood activities in natural settings (eg hiking or playing in the woods, planting trees or seeds) was found to have a positive effect on their environmental attitudes as adults (Figure 5b; Wells and Lekies 2006). Likewise, people’s willingness to pay for recovering lost neighborhood urban greenspace in Hong Kong was significantly positively related to the frequency of their visits to such areas (Lo and Jim 2010). Notably, such benefits may not require regular contact with natural environments; even just a few days of outdoor experience can have long-term effects on an individual’s emotional affinity with nature, ecological beliefs and knowledge, and willingness to display pro-environmental behavior (eg Collado *et al.* 2013).

Behavioral changes

A reduction in the rate of interaction with nature changes people’s behavior toward nature (Figures 2g and 5b). In the US, participation in recreational activities in forested areas (eg hiking, birdwatching, fishing) had a positive influence on a wide range of pro-environmental behaviors, including larger donations for nature protection and environmentally conscious consumption, and a greater likelihood of voting for a political candidate who is committed to environmental

protection (Nord *et al.* 1998). Similarly, the frequency of participation in nature-related activities during childhood was found to have a positive influence on current levels of participation in pro-environmental behavior (eg recycling; Figure 5b; Wells and Lekies 2006). Children in Spain who participated in environmental actions (eg recycling, water and energy conservation) visited natural environments more frequently than those who did not (Collado *et al.* 2015). These behavioral changes are likely mediated by the health and well-being, emotional, and attitudinal changes mentioned above (Figure 2, h–k). Indeed, Wells and Lekies (2006) and Collado *et al.* (2015) observed that nature experience has both direct and indirect influences on people’s participation in pro-environmental behavior, suggesting a close association between

people’s emotional connectedness to nature, their view of environmentalism, and their likelihood of engaging in environmentally friendly actions. It is clear that complex associations exist among health and well-being, emotion, attitudes, and behavior toward nature.

Feedback loops

Unfortunately, there are likely to be several feedback pathways by which the consequences of loss of human–nature interactions can cause further disaffection and apathy toward nature, through loss of orientation and opportunity (Figure 2). First, changes in an individual’s emotional connection with nature – such as a loss of emotional affinity with, love of, or interest in nature – may decrease their future personal orientation toward engaging with nature. Direct experience of nature increases people’s further willingness to visit and experience nature, sometimes even several decades later (eg Bixler *et al.* 2002; Ward Thompson *et al.* 2008). Second, erosion of an individual’s orientation toward nature may also influence that of other individuals, especially those in younger (and therefore future) generations. Indeed, the beliefs and lifestyles of those in the same society as a child – such as their family, peers, and school teachers – are likely to influence the extent to which the child has an emotional affinity to and experiences with nature (Milligan and Bingley 2007; Cheng and Monroe 2012). Third, changes in public attitudes toward nature – that is, people’s loss of value of nature and of environmental norms and concerns – may also lead to further loss of opportunity to experience nature. To quote Miller (2005), “[if

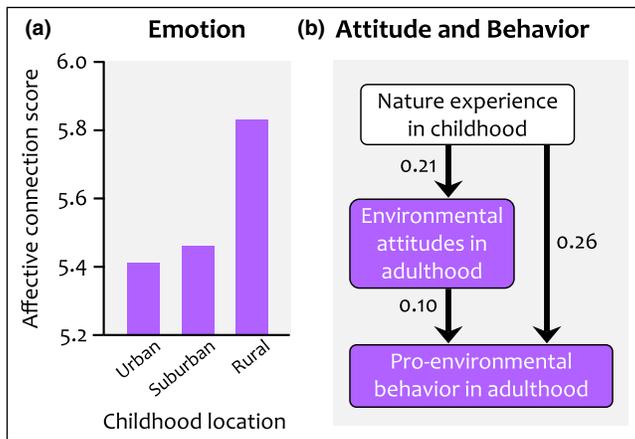


Figure 5. Emotional, attitudinal, and behavioral changes due to loss of interactions with nature. (a) Emotional change (levels of emotional connectedness to nature) reported in the UK (Hinds and Sparks 2008). (b) Attitudinal and behavioral change (levels of environmentalism and participation in pro-environmental behavior) reported in the US (Wells and Lekies 2006). Exposure to nature was measured by (a) childhood environments and (b) participation in nature-based activities in childhood. Values in panel (b) represent standardized mean effect size of participation in nature-based activities in childhood and environmental attitudes on pro-environmental behavior, estimated by structural equation modeling (see more details in Wells and Lekies 2006).

people no longer value nature or see it as relevant to their lives, will they be willing to invest in its protection?" Environmental attitudes (willingness to pay for biodiversity enhancement) have been positively related to self-reported psychological well-being benefits derived from nature (Dallimer *et al.* 2014). Through this feedback loop, publically acceptable standards with regard to environmental health may also decline, because most people measure the state of the environment against the best that they remember from their early years, a phenomenon known as the "shifting baselines syndrome" (Pauly 1995). Finally, a decline in positive behavior toward the environment – such as a growing indifference toward recycling, environmentally conscious consumption, and making donations to organizations that fund nature protection – may further reduce opportunities to experience nature more directly.

■ Reducing the extinction of experience

Given the substantial benefits of interactions with nature, it is important to limit and eventually reverse the extinction of experience and its associated negative feedback loops (Keniger *et al.* 2013; Hartig *et al.* 2014). Also, if there is to be broad-based public support for reversing global environmental change, daily opportunities for people to experience nature must be provided,

so as to forge emotional ties to nature (Miller 2005; Balmford and Cowling 2006).

Increasing opportunity

Arguably the simplest approach for mitigating the extinction of experience is to provide more green infrastructure in the towns and cities where most people live or work (Shanahan *et al.* 2015; Soga *et al.* 2015). Indeed, the level of outdoor activities that people engage in, along with their exposure to nature, tends to be positively associated with the amount of neighborhood urban greenspace available (eg Neuvonen *et al.* 2007; Soga *et al.* 2015). Crucially, such greenspaces must be easily accessible and designed in such a way that they can be reached on foot or by bicycle (Soga *et al.* 2015). Increasingly, both the amount of urban greenspaces and their proximity to people are reflected in public policy commitments. For example, the UK government agency Natural England recommends that everyone should have access to natural greenspaces of at least 2 ha in size, located within 300 m of their homes (www.naturalengland.org.uk). In Australia, a national campaign called 2020 Vision aims to increase urban greenspace throughout the country by 20% by 2020 (2020vision.com.au). To ensure that such recommendations, campaigns, and actions yield optimal results, it will be critical to determine how much greenspace is sufficient to attain particular public-health and well-being outcomes (Shanahan *et al.* 2015).

In addition to traditional parks and managed playgrounds, lightly managed natural environments (ie areas managed for nature) also have an important role in reducing the extinction of experience: such high-quality natural environments provide urban dwellers not only with memorable experiences that may enhance their emotional attachment to the outdoors, but also with greater motivation to further experience nature (Bixler *et al.* 2002). These natural environments, being in close proximity to built environments, could generate more opportunities for urban dwellers to experience nature, given that some wildlife species may extend their home ranges into adjacent residential areas ("spillover effects"). Thus, in urban areas, preserving and restoring lightly managed greenspaces – even those with reduced spatial extent or connectivity – would be beneficial not only for conserving biodiversity but also for mitigating the extinction of experience for nearby residents (Pyle 1993; Samways 2007).

Increasing orientation

In many cases, merely increasing the opportunity to experience nature directly will not be sufficient to redress the extinction of experience, although city planning commonly uses area-based targets as a means of encouraging people to visit greenspaces. It is unlikely that

a large number of people will use natural environments in their neighborhood, even if these areas have a high aesthetic or recreational value and are located close to their homes (Lin *et al.* 2014). This clearly highlights the need to enhance both the opportunity and the orientation components in tandem.

Since both theory and evidence have suggested that an individual's orientation toward nature is influenced by regular outdoor play during childhood (Kals *et al.* 1999; Bixler *et al.* 2002; Ward Thompson *et al.* 2008), parents need to encourage their children to engage in outdoor recreational activities, especially unstructured play. Broader environmental and policy changes are also necessary (eg social marketing campaigns, educational and outreach programs). Fortunately, in response to increased societal attention to nature-deficit phenomena and their consequences, public policies and agencies are now focusing efforts on developing emotional affinity to nature in children. The National Environmental Education Foundation (www.neefusa.org), for instance, recently introduced a nationwide program called the Children in Nature Initiative, aimed at encouraging children and families to participate in outdoor-recreation activities. To make these programs more effective, researchers must examine – in greater detail – the extent to which influences of childhood interactions with nature persist over time and whether repeated, short-term experiences have a cumulative effect.

Although much attention is being focused on childhood experiences, people's orientation toward nature is also likely to be reinforced by direct interactions in adulthood. Indeed, Scott *et al.* (2014) recently observed that adults' participation in nature-based activities enhances their emotional ties to nature, which in turn affects their self-reported pro-environmental behaviors. Green job training also reinforces young adults' positive attitudes and behavior toward the environment (Falxa-Raymond *et al.* 2013). Given these potential implications, future policy should more closely examine adult-oriented social-marketing campaigns and nature-based job-training programs.

■ Conclusions

Urban nature undoubtedly plays a central role in reducing the extinction of experience and in reconnecting humans with nature (Miller 2005; Shanahan *et al.* 2015; Soga *et al.* 2015). Nevertheless, most people, including city planners and policy makers, often consider urban greenspace and other natural components in residential areas to be luxuries rather than necessities. To bridge this gap in perception, we argue that the importance of experiencing nature must be conveyed to a larger audience. By participating in broad-based partnerships with policy makers, city planners, education professionals, and local citizens, researchers can further contribute to reducing the extinction of experience.

■ Acknowledgements

We thank S Gaston and T Kubo for comments and discussion. MS was supported by the Japan Society for the Promotion of Science (No 15J04422); KJG was supported by Natural Environment Research Council grant NE/J015237/1.

■ References

- Balloard JM, Brischoux F, and Bonnet X. 2011. Children prioritize virtual exotic biodiversity over local biodiversity. *PLoS ONE* 6: e23152.
- Balmford A and Cowling RM. 2006. Fusion or failure? The future of conservation biology. *Conserv Biol* 20: 692–95.
- Bixler RD, Floyd MF, and Hammitt WE. 2002. Environmental socialization quantitative tests of the childhood play hypothesis. *Environ Behav* 34: 795–818.
- Capaldi CA, Dopko RL, and Zelenski JM. 2014. The relationship between nature connectedness and happiness: a meta-analysis. *Front Psychol* 5: 976.
- Cheng JCH and Monroe MC. 2012. Connection to nature: children's affective attitude toward nature. *Environ Behav* 44: 31–49.
- Clements R. 2004. An investigation of the status of outdoor play. *Contemp Iss Early Child* 5: 68–80.
- Collado S, Staats H, and Corraliza JA. 2013. Experiencing nature in children's summer camps: affective, cognitive and behavioural consequences. *J Environ Psychol* 33: 37–44.
- Collado S, Corraliza JA, Staats H, and Ruiz M. 2015. Effect of frequency and mode of contact with nature on children's self-reported ecological behaviors. *J Environ Psychol* 41: 65–73.
- Dadvand P, Nieuwenhuijsen MJ, Esnaola M, *et al.* 2015. Green spaces and cognitive development in primary schoolchildren. *P Natl Acad Sci USA* 112: 7937–42.
- Dallimer M, Tinch D, Hanley N, *et al.* 2014. Quantifying preferences for the natural world using monetary and nonmonetary assessments of value. *Conserv Biol* 28: 404–13.
- England Marketing. 2009. Report to Natural England on childhood and nature: a survey on changing relationships with nature across generations. Cambridgeshire, UK: England Marketing.
- Ewert A, Place G, and Sibthorp J. 2005. Early-life outdoor experiences and an individual's environmental attitudes. *Leisure Sci* 27: 225–39.
- Falxa-Raymond N, Svendsen E, and Campbell LK. 2013. From job training to green jobs: a case study of a young adult employment program centered on environmental restoration in New York City, USA. *Urban For Urban Gree* 12: 287–95.
- Grimm NB, Faeth SH, Golubiewski NE, *et al.* 2008. Global change and the ecology of cities. *Science* 319: 756–60.
- Groenewegen PP, van den Berg AE, de Vries S, and Verheij RA. 2006. Vitamin G: effects of green space on health, well-being, and social safety. *BMC Public Health* 6: 149.
- Hartig T, Mitchell R, de Vries S, and Frumkin H. 2014. Nature and health. *Ann Rev Publ Health* 35: 207–28.
- Hinds J and Sparks P. 2008. Engaging with the natural environment: the role of affective connection and identity. *J Environ Psychol* 28: 109–20.
- Hofferth SL. 2009. Changes in American children's time – 1997 to 2003. *Electronic Int J Time Use Res* 6: 26–47.
- Kai Z, Woan TS, Jie L, *et al.* 2014. Shifting baselines on a tropical forest frontier: extirpations drive declines in local ecological knowledge. *PLoS ONE* 9: e86598.
- Kals E, Schumacher D, and Montada L. 1999. Emotional affinity toward nature as a motivational basis to protect nature. *Environ Behav* 31: 178–202.

- Kardan O, Gozdyra P, Mistic B, *et al.* 2015. Neighborhood green-space and health in a large urban center. *Sci Reports* 5: 11610.
- Kellert SR. 2002. Experiencing nature: affective, cognitive, and evaluative development in children. In: Kahn Jr PH and Kellert SR (Eds). *Children and nature: psychological, sociocultural, and evolutionary investigations*. Cambridge, MA: MIT Press.
- Keniger LE, Gaston KJ, Irvine KN, and Fuller RA. 2013. What are the benefits of interacting with nature? *Int J Environ Res Public Health* 10: 913–35.
- Lachowycz K and Jones AP. 2011. Greenspace and obesity: a systematic review of the evidence. *Obes Rev* 12: e183–89.
- Lin BB, Fuller RA, Bush R, *et al.* 2014. Opportunity or orientation? Who uses urban parks and why. *PLoS ONE* 9: e87422.
- Lo AY and Jim CY. 2010. Willingness of residents to pay and motives for conservation of urban green spaces in the compact city of Hong Kong. *Urban For Urban Gree* 9: 113–20.
- Maas J, Verheij RA, de Vries S, *et al.* 2009. Morbidity is related to a green living environment. *J Epidemiol Commun H* 63: 967–73.
- Mayer FS and Frantz CM. 2004. The connectedness to nature scale: a measure of individuals' feeling in community with nature. *J Environ Psychol* 24: 503–15.
- Miller JR. 2005. Biodiversity conservation and the extinction of experience. *Trends Ecol Evol* 20: 430–34.
- Milligan C and Bingley A. 2007. Restorative places or scary spaces? The impact of woodland on the mental well-being of young adults. *Health Place* 13: 799–811.
- Nabhan GP and St Antoine S. 1993. The loss of floral and faunal story: the extinction of experience. In: Kellert S and Wilson EO (Eds). *The biophilia hypothesis*. Washington, DC: Island Press.
- Neuvonen M, Sievänen T, Tönnies S, and Koskela T. 2007. Access to green areas and the frequency of visits – a case study in Helsinki. *Urban For Urban Gree* 6: 235–47.
- Nisbet EK, Zelenski JM, and Murphy SA. 2009. The nature relatedness scale: linking individuals' connection with nature to environmental concern and behavior. *Environ Behav* 41: 715–40.
- Nord M, Luloff AE, and Bridger JC. 1998. The association of forest recreation with environmentalism. *Environ Behav* 30: 235–46.
- Pauly D. 1995. Anecdotes and the shifting baseline syndrome of fisheries. *Trends Ecol Evol* 10: 430.
- Pergams OR and Zaradic PA. 2006. Is love of nature in the US becoming love of electronic media? 16-year downtrend in national park visits explained by watching movies, playing video games, internet use, and oil prices. *J Environ Manage* 80: 387–93.
- Pyle RM. 1993. *The thunder tree: lessons from an urban wildland*. Boston, MA: Houghton Mifflin.
- Samways MJ. 2007. Rescuing the extinction of experience. *Biodivers Conserv* 16: 1995–97.
- Scott BA, Amel EL, and Manning CM. 2014. In and of the wilderness: ecological connection through participation in nature. *Ecopsychology* 6: 81–91.
- Shanahan DF, Fuller RA, Bush R, *et al.* 2015. The health benefits of urban nature: how much do we need? *BioScience* 65: 476–85.
- Soga M, Yamaura Y, Aikoh T, *et al.* 2015. Reducing the extinction of experience: association between urban form and recreational use of public greenspace. *Landscape Urban Plan* 143: 69–75.
- Sugiyama T, Leslie E, Giles-Corti B, and Owen N. 2008. Associations of neighbourhood greenness with physical and mental health: do walking, social coherence and local social interaction explain the relationships? *J Epidemiol Commun H* 62: e9.
- Takano T, Nakamura K, and Watanabe M. 2002. Urban residential environments and senior citizens' longevity in megacity areas: the importance of walkable green spaces. *J Epidemiol Commun H* 56: 913–18.
- Turner WR, Nakamura T, and Dinetti M. 2004. Global urbanization and the separation of humans from nature. *BioScience* 54: 585–90.
- van den Berg AE, van Winsum-Westra M, de Vries S, and van Dillen SM. 2010. Allotment gardening and health: a comparative survey among allotment gardeners and their neighbors without an allotment. *Environ Health-Glob* 9: 74–85.
- Ward Thompson C, Aspinall P, and Montarino A. 2008. The childhood factor: adult visits to green places and the significance of childhood experience. *Environ Behav* 40: 111–43.
- Wells NM and Lekies KS. 2006. Nature and the life course: pathways from childhood nature experiences to adult environmentalism. *Children, Youth, and Environments* 16: 1–24.
- Wilson EO. 1984. *Biophilia*. Cambridge, MA: Harvard University Press.
- Wilson EO. 1993. Biophilia and the conservation ethic. In: Kellert S and Wilson EO (Eds). *The biophilia hypothesis*. Washington, DC: Island Press.
- Zhang W, Goodale E, and Chen J. 2014. How contact with nature affects children's biophilia, biophobia and conservation attitude in China. *Biol Conserv* 177: 109–16.