Extinction of experience:
evidence, consequences and challenges of
loss of human-nature interactions

Running title: The extinction of experience

MASASHI SOGA¹* AND KEVIN J. GASTON²

¹Department of Urban Engineering, School of Engineering, The University of Tokyo, 7-3-1, Hongo,
Bunkyo, Tokyo 113-8656, Japan
masashi.soga.mail@mail.com, +81 (0) 358416248
*Corresponding author

²Environment and Sustainability Institute, University of Exeter, Penryn, Cornwall TR10 9FE, UK.
K.J.Gaston@exeter.ac.uk, +44 (0) 1326 255795
ABSTRACT (148/ about 150 words)

A high proportion of people are becoming progressively less likely to have direct contact with nature in their everyday lives. More than 20 years ago, Robert M. Pyle termed this ongoing alienation “the extinction of experience”. However, 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, as well as suggesting future research directions. Our review illustrates that the loss of interactions with nature does not just diminish a remarkable range of health and wellbeing advantages, but also discourages people’s positive emotions, attitudes, and behavior with regard to the environment, implying a cycle of disaffection towards nature. Such serious implications highlight the significance of reconnecting people with nature, and the importance of focusing research and public policy on addressing and building greater awareness and better understanding of extinction of experience.

Keywords: Biophilia; Ecosystem services; Green infrastructure; Outdoor recreation; Sustainability; Urban parks

IN A NUTSHELL (100/100words)

● More and more people, especially children, have less and less contact with nature, an ongoing alienation termed “the extinction of experience”.

● Consequences of loss of interactions with nature include degradation of public health and wellbeing, loss of emotional affinity to nature, and decline in pro-environmental attitudes and behavior, implying a cycle of disaffection towards nature.

● Researchers and policy makers need to focus more attention and efforts 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.
Escalating alienation of humanity from the natural world

Humanity has for the vast majority of its existence been intimately connected with the natural world, and has directly gained a broad range of benefits. However, this historical personal experience is today drastically weakening. Indeed, in recent decades, in a trend being seen widely across the world, more and more people, especially children, have less and less interaction with nature (Figure 1). This is not simply limited to a loss of engagement with pristine or wilderness environments, but comprises changes in a wide diversity of activities and experiences, including through spending time in and observing urban greenspaces and their associated wildlife. Although it is difficult to pinpoint exactly what has given rise to such a rapid decline in people’s spontaneous outdoor activities, several possible triggers have been identified including rapid growth in the number and proportion of people living in urban areas (Turner et al. 2004; Zhang et al. 2014), technological advancement 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 overscheduling and micromanaging of children’s lives (Clements 2004; Hofferth 2009). For the majority of people today, outdoor nature experiences are vanishing and being replaced by virtual alternatives (Clements 2004; 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, he emphasized that direct, personal contact with nearby nature (even that of a “ditch”) is vital to forge a person’s emotional intimacy with nature, which is never replaced by other vicarious experiences (Pyle 1993). Nabhan and Antoine (1993) have also warned that “children’s very ability to perceive the environment may be diminished by replacement of multisensory experience richly textured
lands. With two-dimensional world of books or the audiovisual world of TV, videos, and movies.” From an evolutionary perspective, Wilson (1984, 1993) further argued that human’s have a deep and intimate emotional tendency to affiliate with nature, particularly its living biota, because it is rooted in our biology. He proposed that, as humans have for a long time evolved with (and been part of) nature, we still show inherited earlier adaptations and are likely to function well when we interact with nature, the so-called Biophilia hypothesis (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 its conception, researchers from a wide range of disciplines have provided evidence showing serious consequences of extinction of experience. Those who do not directly interact with nature are likely to lose substantial health and wellbeing advantages (Keniger et al. 2013; Shanahan et al. 2015), are less likely to perceive the benefits that it brings and positively to value it (Bixler et al. 2002; Ewert et al. 2005), and are less motivated to want to visit and protect it (Wells and Lekies 2006; Ward Thompson et al. 2008). In consequence, extinction of experience has increasingly been seen both as a major public health issue (Groenewegen et al. 2012; Shanahan et al. 2015) and one of the most fundamental obstacles to halting and reversing global environmental degradation (Miller 2005; Balmford and Cowling 2006). Despite increasing awareness of the extinction of experience, however, it is astonishing how little is known about the phenomenon. Indeed, although there is a growing literature that concerns the loss of human-nature interactions, the majority of attention to date has been paid to the health and wellbeing benefits of nature (Keniger et al. 2013; Hartig et al. 2014; Shanahan et al. 2015). A more comprehensive discussion is still wanting. Here, we present the current state of understanding (with particular emphasis on the causes and consequences of the loss of human-nature interactions), summarize key previous findings, and suggest future research directions. In so doing 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 nature, but includes, for example, urban parks (Lin et al. 2014), planted
vegetation (Kardan et al. 2015), and allotments (van den Verg et al. 2010).

Causes

Loss of opportunity. Arguably, the root driver of the loss of human-nature interactions is the loss of opportunity to experience nature (Figures 2a and 3a). Over the past half century 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). There is plenty of evidence that people living in areas with lesser amounts of, and who are further from, natural environments interact with nature less frequently (Figure 2a; e.g. Neuvonen et al. 2007; Soga et al. in press). In China, for example, a survey of more than 1,000 elementary school students clearly demonstrated that those living in rural environments more frequently visited neighborhood natural environments than did those living in city centres, and participated in a wide range of nature-based activities (Zhang et al. 2014). Impoverishment of local flora and fauna also endangers people’s opportunities to experience nature, as neighborhood environments are the only ones in which many people encounter nature in their daily lives (Turner et al. 2004; Samways 2007). Indeed, Kai et al. (2014) recently suggested that extirpation of local woodland birds in SW China eroded local people’s knowledge of these species, especially amongst younger generations who cannot experience the sights and sounds of these birds directly.

Loss of orientation. Not only the opportunity to interact with nature, but the loss of people’s positive orientation towards engaging with it - their emotional affinity with nature - is an important cause of the loss of human-nature interactions (Figures 2b and 3b). Developing a variety of methodologies and measures (e.g. The Connectedness to Nature Scale, The Nature Relatedness Scale), researchers have reported a positive relationship between levels of people’s emotional connectedness to nature and the frequency of their visits to natural environments (Mayer and Frantz 2004; Nisbet et al. 2009). Cheng and Monroe (2012), for example, observed that those with a strong emotional connectedness to nature reported being more likely to spend time in nature, suggesting
that the more one has an orientation towards nature, the greater one’s motivations and intentions to use it.

Although the relative contribution of orientation to the loss of interactions with nature is still 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, that of opportunity. For example, Hinds and Sparks (2008) and Ward Thompson et al. (2008) have demonstrated that greater frequency of exposure to nature in childhood enhances a person’s feeling of being emotionally connected with nature, which positively affects their intentions to visit nature. In Brisbane, Australia, Lin et al. (2014) also found that the frequency of people’s use of urban greenspace was driven more by levels of emotional connectedness to nature than neighborhood greenspace coverage. Since completely different measures are required to deal with the loss of opportunity and of orientation, more research should investigate their relative importance and interaction.

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

Health and wellbeing changes. The most immediate outcome of the loss of interactions with nature is the loss of the associated health and wellbeing benefits (Figures 2c and 4). Indeed, Keniger et al. (2013) and Hartig et al. (2014) have identified a remarkable range of such benefits. Studies have provided evidence showing a positive relationship between levels of exposure to nature and those of physical health and psychological wellbeing (Figure 4, a and b; van den Berg et al. 2010; Kardan et al. 2015), and social cohesion (Figure 4c; Sugiyama et al. 2008). Whilst the majority of such analyses have examined short-term health benefits, recent studies have documented long-lasting
influences, such as on diabetes (Lachowycz and Jones 2011), circulatory and heart disease (Maas et al. 2009), and longevity (Takano et al. 2002). Additionally, it has long been held that regular contact with nature is vital for children’s social, emotional, cognitive, and motor development (Keniger et al. 2013; Dadvand et al. 2015). Hence, overall, it is widely acknowledged that, much like a vitamin, a regular dose of exposure to natural environments is a necessary ingredient for a healthy life (so-called “Vitamin G”), 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 wellbeing, it also changes people’s emotions towards nature, including their affinity to, interest in, and love of nature (Figures 2d and 5a). In the U.S., Bixler et al. (2002) showed that recreational play in wild natural environments in childhood positively influenced people’s later interest in natural environments and outdoor recreation activities. In the U.K., Hinds and Sparks (2008) reported that survey respondents who had grown up in rural environments exhibited more positive emotional connections to nature than those from urban environments (Figure 5a). Zhang et al. (2014) also observed that exposure to natural environments and direct contact with nature decreased people’s *Biophobia*, i.e. the fear of and aversion to nature. Importantly, these positive emotional changes towards nature are not only triggers for environmental attitudes and behavior, but they are also closely associated with mental health and wellbeing, such as vitality and life satisfaction (Figure 2e; see also Capaldi et al. 2014).

**Attitudinal changes.** Evidence shows that loss of interactions with nature changes people’s attitudes towards nature, including the values they place on it, beliefs concerning the environment, environmental ethical norms, and their willingness to protect nature (Figures 2f and 5b). Based on an interview study of 576 university undergraduate students, Ewert et al. (2005) showed that the current beliefs of adults concerning the environment are associated with participation in early-life outdoor activities. Among 1,002 U.S. citizens, Wells and Lekies (2006) reported that childhood activities in
natural environments (e.g. hiking or playing in the woods or planting trees or seeds) had a positive effect on adult environmental attitudes (Figures 5b). In Hong Kong, Lo and Jim (2010) demonstrated that people’s willingness to pay for recovering the loss of neighborhood greenspace was significantly positively related to the frequency of their greenspace visits. Importantly, it has also been shown that not only regular contacts with nature, but even a few days of outdoor experience could have long-term effects on children’s emotional affinity with nature, ecological beliefs and knowledge, and willingness to display pro-environmental behavior (e.g. Collado et al. 2013).

Behavioral changes. Loss of interactions with nature changes people’s behavior towards nature, such as their participation in environmentally friendly activities (Figures 2g and 5b). In the U.S., Nord et al. (1998) demonstrated that participation in forest recreational activities (e.g. hiking, birdwatching, fishing) had a positive influence on a wide range of pro-environmental behaviors, including donation to nature protection, environmentally conscious consumption, and voting for a candidate who was committed to the environment. Wells and Lekies (2006) also reported that the frequency of participating in nature-related activities in childhood has a significant positive influence on current levels of participation in pro-environmental behavior (e.g. recycling) (Figure 5b). In Spain, Collado et al. (2015) showed that children who participated in environmental actions (e.g. recycling, saving water and energy) used natural environments more frequently than those who did not. These behavioral changes are mediated by the health and wellbeing, emotional, and attitudinal changes mentioned above (Figure 2h-k). Wells and Lekies (2006) and Collado et al. (2015), for example, observed that nature experience has both direct and indirect (i.e. through environmental attitudes) influences on the levels of participation in pro-environmental behavior, suggesting close associations among people’s emotional connectedness to nature, their environmentalism, and environmental friendly actions. Doubtless, complex associations exist amongst health and wellbeing, emotion, attitudes, and behavior towards nature.

Feedback loops
Unfortunately, there are likely to be several feedback pathways by which the consequences of loss of human-nature interactions cause further disaffection and apathy towards nature, through loss of orientation and opportunity (Figure 2). First, not surprisingly, changes in an individual’s emotions towards nature, such as a loss of emotional affinity to, love of, and interest in nature, may decrease their future personal orientation towards engaging with nature. It has been reported that direct experience of nature increases people’s further willingness to visit and be in nature, sometimes after several decades (e.g. Bixler et al. 2002; Ward Thompson et al. 2008). Second, erosion of an individual’s nature orientation also influences that of other individuals, especially those in younger (and ultimately future) generations. Indeed, the levels of children’s emotional affinity to and experiences of nature are likely to be influenced by the beliefs and lifestyles of other members of the society to which they belong, including family, peers, and school teachers (Milligan and Bingley 2007; Cheng and Monroe 2012). Third, changes in public attitudes towards nature, i.e. 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), “[i]f people no longer value nature or see it as relevant to their lives, will they be willing to invest in its protection?”. Dallimer et al. (2014) reported that people’s environmental attitudes (willingness to pay for biodiversity enhancement) were positively related to self-reported psychological wellbeing benefits derived from nature. Through this feedback loop, unfortunately, publically acceptable standards with regard to environmental health may also decline, as most people measure the normal state of the environment against the best that they remember from their early years (“shifting environmental and cognitive baselines”; Lozano-Montes et al. 2008). Lastly, and obviously, a decline in positive behavior to the environment, such as recycling, environmentally conscious consumption, and donation for nature protection, may also reduce opportunity of experience nature more directly.

Reducing the extinction of experience

Given the substantial benefits of interactions with nature for human health and wellbeing, it is important to limit, and reverse, the extinction of experience and the associated negative feedback
loops (Keniger et al. 2013; Hartig et al. 2014). It is also argued that if there is to be broad-based public support to overcome global anthropogenic environmental pressures it is vital to provide opportunities for people to experience nature on a daily basis so as to forge their emotional ties to nature (Miller 2005; Balmford and Cowling 2006).

**Increasing the opportunity.** Arguably the simplest approach to reduce the extinction of experience, and reconnect people to nature, is to increase their opportunity to interact directly with nature by providing more green infrastructure in the towns and cities where the majority of people live or work (Shanahan et al. 2015; Soga et al. in press). Indeed, the level of outdoor physical exercise that people take and their exposure to nature tend to be positively associated with the amount of neighborhood urban greenspace (e.g. Neuvonen et al. 2007; Soga et al. in press). Key is that these natural places must be located such that they are easily accessible from people’s homes and be designed in such a way that they can be reached on foot or by bicycle (Soga et al. in press).

Increasingly, both the amount of, and proximity to urban greenspace are reflected in public policy commitments. In the U.K., for example, Natural England (a government body) recommends that everyone should have accessible natural greenspaces of at least 2 ha within 300m from their home (available via www.naturalengland.org.uk/). In Australia, a national campaign called “The 2020 Vision” aims to increase urban greenspace in Australia by 20% by 2020 (available via 2020vision.com.au/). To frame such recommendations, campaigns and actions as optimally as possible, there is an urgent need to determine how much greenspace is sufficient to attain particular public health and wellbeing outcomes and the form of dose-response relationships between these variables (Shanahan et al. 2015).

As well as traditional parks and managed playgrounds, lightly-managed natural environments (i.e. areas managed for nature) also have an important role in reducing the extinction of experience, as such high-quality natural environments provide urban dwellers with memorable experiences, which may enhance their emotional attachment to, and further motivation to visit, nature (Bixler et al.)
253 2002). Also importantly, these natural environments in close proximity to the built environments
could provide an additional opportunity to experience nature for urban dwellers, as some wildlife
species would spill out from them into residential areas. Hence, even if in small and scattered pieces,
preserving and restoring greenspace managed for nature in urban areas would be beneficial not only
for biodiversity conservation itself, but also for rescuing the extinction of experience (Pyle 1993;
Samways 2007), although these experiences can be both positive and negative.

Increasing the orientation. Unfortunately, in many cases merely increasing the opportunity for
interacting with nature will be inadequate for redressing the extinction of experience, although city
planning has previously commonly employed area-based targets as a means to get people to visit
greenspace. A significant number of people are not likely to use neighborhood natural environments
even if these areas have a high aesthetic and recreational value and are available close to their homes
(Lin et al. 2014). This clearly highlights that to get people to interact with nature, and receive a
variety of benefits from it, we need to enhance both opportunity and orientation components in
tandem.

Both theory and evidence have suggested that an individual’s orientation towards nature is
encouraged by regular outdoor play during childhood (Kals et al. 1999; Bixler et al. 2002; Ward
Thompson et al. 2008). This first requires parents to encourage their children to spend plenty of time
in outdoor recreational activities, especially unstructured, freely-chosen play (Vadala et al. 2007).
Broader environmental and policy changes are also needed (e.g. social marketing campaigns and
educational and outreach programs). Indeed, in response to increased societal attention to
nature-deficit phenomena, and consequences thereof, public policies and agencies are today focusing
efforts toward developing children’s emotional affinity to nature. The National Environmental
Education Foundation, for example, has a national “Children in Nature Initiative”, which is aimed at
encouraging children and families to participate in outdoor recreation activities for physical and
mental health benefits (available via www.neefusa.org/). In order to make these policies more
effective, future research ought to examine in more detail how long influences of childhood experience of interacting with nature last and whether past experience of nature has cumulative effects.

Although much attention is being focused on childhood experiences, people’s orientation towards nature is also likely to be reinforced by adulthood experiences of directly interacting with nature. 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 individual pro-environmental behaviors. Falxa-Raymond et al. (2013) also pointed out that green job training can reinforce young adults’ positive attitudes and behavior to the environment. Given these potential implications, future policy should pay more attention to adult-oriented social marketing campaigns and nature-based job training programs.

**In conclusion**

This review has highlighted that interaction with nature is beneficial, and even vital, in maintaining human quality of life and in reducing the challenges of a wide range of physical and mental diseases and illnesses. Doubtless, urban nature plays a central role in reducing extinction of experience and reconnecting humans with nature (Miller 2005; Shanahan et al. 2015; Soga et al. in press). Nevertheless, the majority of people, even those participating in city planning and policy making, still often consider that urban greenspace, and other natural components in residential areas, are a luxury rather than a necessity (Groenewegen et al. 2006). In order to bridge this knowledge gap, more attention must be paid to conveying the significance of experiencing nature to a larger audience. By participating in broad-based partnerships with policy makers, city planners, educational professionals, and local citizens, researchers can further contribute greatly to reducing the extinction of experience.

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References cited (50/50 references)


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Figure legends

Figure 1. Empirical evidence demonstrating that today’s children spend less time in outdoor nature experiences, compared with the previous generation. Data from (a) the U.K. (England Marketing 2009), (b) the U.S. (Clements 2004), (c, d) the U.S. (Hofferth 2009), (e, f) Japan ((e) Report to Ministry of the Environment, available via www.env.go.jp/ and (f) Report to Cabinet Office, Government of Japan, available via www.cao.go.jp/), (g) the U.S. (Report to Minnesota Department of Natural Resources, available via www.dnr.state.mn.us/), and (h) the U.S. (Report to National Park Service, available via www.nps.gov/), respectively.

Figure 2. The causes (opportunity and orientation) and consequences (changes in health and wellbeing and emotions, attitudes, and behavior towards nature) of extinction of experience, i.e. loss of interactions with nature, and potential pathways among them. Each letter (a to k) is cited in the main text. Extinction of experience can have 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.

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

Figure 4. Health and wellbeing changes due to loss of interactions with nature. (a) Physical health (physical constraints) and (b) psychological wellbeing (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, b) participation in allotment gardening and (c) levels of neighborhood greenspace. In the panels (a) and (b),
“neighbors” means the control group (i.e. those who did not participate in allotment gardening). Higher scores of physical constraints, life satisfaction, and social coherence mean higher levels of physical constraints, life satisfaction, and emotional connectedness with neighborhood communities, respectively.

**Figure 5.** Emotional, attitudinal, and behavioral changes due to loss of interactions with nature. (a) Emotional change (affective connection with nature) reported in the U.K. (Hinds and Sparks 2008). (b) Attitudinal and behavioral change (levels of environmentalism and participation in pro-environmental behavior) reported in the U.S. (Wells and Lekies 2006). Exposure to nature was measured by (a) childhood environments and (b) participation in nature-based activities in childhood. Higher scores of affective connection mean higher levels of individual’s emotional affinity to nature. Values on panel (b) mean standardized 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).
Fig. 1

(a) Per capita recreational visits to national parks

(b) Frequency of outdoor activity

(c) Percentage of children participating in outdoors

(d) Time spent in outdoors (minutes/week)

(e) Percentage of people who have played in natural areas in childhood

(f) Percentage of children who have never experienced

(g) Per capita change in number of participants or visitors (%)

(h) Per capita recreational visits to national parks

http://www.nps.gov/index.htm

http://www.dnr.state.mn.us/conservationagenda/outdoor_rec/trend/index.html
Fig. 2

CAUSES

Opportunity

Orientation

Extinction of experience

Health and wellbeing changes

Emotional changes

Attitudinal changes

Behavioral changes

FEEDBACK LOOPS

Consequences

a

b

c

d

e

f

g

h

i

j

k

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Fig. 3

(a) Opportunity

- Frequency of visits per week
- Distance to greenspace (km)

(b) Orientation

- Nature relatedness Scale
- Level of park use
Fig. 4

Physical constraints score

Psychological life satisfaction score

Social coherence score

Respondents category

Neighbourhood greenness
Fig. 5

(a) Emotion

Childhood location

Urban  Suburban  Rural

Affective connection score

5.2  5.4  5.6  5.8  6.0

(b) Attitude and Behavior

Nature experience in childhood

Environmental attitudes in adulthood

Pro-environmental behavior in adulthood

0.21

0.10

0.26