When screens replace backyards: strategies to connect digital-media-oriented young people to nature

Rachael C. Edwards & Brendon M. H. Larson

Published online: 13 Jun 2020.

Submit your article to this journal ☑

Article views: 1124

View related articles ☑

View Crossmark data ☑

Citing articles: 3 View citing articles ☑

Routledge
Taylor & Francis Group

Check for updates

When screens replace backyards: strategies to connect digital-media-oriented young people to nature

Rachael C. Edwards[a] and Brendon M. H. Larson[b]

aSchool of Planning, Faculty of Environment, University of Waterloo, Waterloo, ON, Canada; bSchool of Environment, Resources, and Sustainability, University of Waterloo, Waterloo, ON, Canada

ABSTRACT

Children's connection to nature (CTN) is declining with each generation, a concerning trend given that CTN is positively linked to wellbeing and environmentalism. A primary cause of this decline is that twenty-first-century youth engage with screens for several hours each day, which to a large extent replaces nature-based play. Researchers have proposed that this change represents a transition in human orientation, particularly in Westernized societies, from nature (biophilia) to digital media (videophilia). Interventions promoting nature-based play must acknowledge digital-media use as a competing leisure pursuit, but the literature presents little guidance for designing programs that will attract young people who are more oriented toward digital media than nature. Drawing on a wide breadth of research, we address this gap through (1) exploring the implications of videophilia for nature-based programming and (2) summarizing recommendations from a narrative literature review for designing interventions that appeal to digital-media-oriented youth.

Introduction

Over the past decade, a growing body of research has explored the concept of Connection to Nature (CTN), which Zylstra et al. (2014, 126) define as 'a stable state of consciousness comprising symbiotic cognitive, affective, and experiential dimensions that reflect a realization of the interrelatedness between one's self and the rest of nature'.[1] Put simply, the concept refers to the sense of oneness a person feels with the natural world, which may be measured using a wide variety of instruments (Cartwright and Mitten 2018). The literature most often discusses CTN in relation to concerns about its decline, particularly in Western developed nations where most evidence supporting a decline in CTN, and exploring its causes, has emerged[2] (Imai, Nakashizuka, and Kohsaka 2018; Soga and Gaston 2016). The concerns surrounding the decline of CTN stem primarily from literature empirically linking CTN to pro-environmental attitudes and environmentally responsible behavior (Frantz and Mayer 2014). As such, researchers call for greater contact between humans and nature, particularly in urban contexts, given the significance of direct nature-based experiences for fostering CTN (Soga and Gaston 2018).

The literature relating to CTN is particularly prolific in the context of children and adolescents whose direct contact with nature and CTN is in steep decline (Larson et al. 2019; Louv 2005; Hughes, Richardson, and Lumber 2018). These data are concerning on two accounts. First,

research has empirically linked both childhood CTN and direct contact with nature to the level of CTN and environmentalism exhibited later in life (Rosa, Profice, and Collado 2018). Second, exposure to nature and a strong CTN have been identified as critical for childhood development and wellbeing (Keniger et al. 2013; Zelenski and Nisbet 2014), with a loss of childhood interactions with nature often referred to as Nature Deficit Disorder (Driessnack 2009). Thus, declining CTN in children is a worthy concern from the perspective of both sustainability and public health.

Given the value of childhood CTN to both ecological and human health, the environmental education sector has initiated a variety of interventions to increase contact between children and nature and often has measured the effect of participation on CTN (Barthel et al. 2018; Beer, Cook, and Kantor 2018; Bruni et al. 2017). The goal of connecting children to nature is cited across environmental organizations (e.g. Parks Canada 2018; The Royal Society for the Protection of Birds 2017; USDA Forest Services 2012). However, the behavioral changes that youth have undergone since the 1990s that contribute to decreasing contact with nature present a significant obstacle for such efforts. In particular, the dominant leisure activities of children and adolescents have shifted from nature-based play to electronic media (henceforth referred to as digital media given that the vast majority of contemporary electronic-media use is in a digital form, e.g. video games, social media, and video streaming) (Larson et al. 2019). This change has contributed to a generational loss of environmental knowledge, illustrated by Balmford et al.'s (2002) compelling finding that children in the UK were better able to identify Pokémon than wildlife. Researchers consider this shift in the leisure preferences of twenty-first-century youth to be a primary cause of Nature Deficit Disorder (Driessnack 2009; Soga and Gaston 2018).

Although the literature describes a wide variety of strategies for re-connecting young people to nature (Beery and Jørgensen 2018; Louv 2005; Soga and Gaston 2018; Wells and Lekies 2006), the majority of these solutions acknowledge neither that digital-media use is a competing leisure activity nor children's pre-existing levels of CTN. Given this lack of consideration for existing leisure preferences within guiding recommendations, are programs that apply such strategies likely to attract youth who are more interested in digital media than nature? Recent literature urges researchers and practitioners to embrace society's reliance on technology and give value to the changing ways through which humans experience nature (Clayton et al. 2017). A growing number of studies have also identified program elements with the potential to engage technology-oriented youth in nature-based play (e.g. nature-themed apps) (Sandbrook, Adams, and Monteferri 2015). To date, however, there exists no summary of such strategies for actively targeting and engaging this population. Here, we address this gap. The paper first explores the concept of videophilia, the shift of human orientation away from nature and toward digital media (Pergams and Zaradic 2006), and its implications for fostering CTN in youth. Drawing on a narrative literature review, we then provide a list of strategies for designing nature-based programs that will appeal to young people whose lives rely on digital media. Given that these digitally driven youth arguably represent the norm, their participation in nature-based programming is essential to (1) ensure that they receive the health and other benefits provided by nature contact and (2) instill them with an appreciation and concern for nature. Although technology and other shifts (e.g. the rapid rate of extinction) have brought about fundamental change in children's experiences of nature, meaningful direct interactions can be facilitated for digitally driven youth, both with and without the use of a screen.

From biophilia to videophilia: challenges for addressing declining connection to nature

Pergams and Zaradic (2006, 393) introduced the concept of videophilia in the mid-2000s, defining it as 'the new human tendency to focus on sedentary activities involving electronic media'.

The term makes reference to Wilson's (1984, 1) Biophilia Hypothesis, which suggests that humans have 'the innate tendency to focus on life and lifelike processes'. Zaradic and Pergams (2007) suggested that, in only one or two generations, a fundamental societal change was taking place, one that saw human orientation shift from nature to electronic media. They based this hypothesis on evidence from US National Park visitation rates which, after consistently increasing for 50 years, had been in steady decline since the late 1980s. Of the many explanatory variables tested, four electronic-media use variables were statistically significant in explaining this decline: per capita hours spent watching movies at home, theater attendance, playing video games, and engaging with the Internet. Pergams and Zaradic (2008, 2295) further supported their hypothesis that a 'fundamental shift away from people's interest in nature' was taking place through revealing a distinct downward trend in several other nature recreation variables.

Although researchers have embraced the Videophilia Hypothesis (e.g. Kareiva 2008; Larson et al. 2019), it has also been subject to some critique. In 2010, the US National Park Service sponsored a study which found that, contrary to Zaradic and Pergams (2007), the number of hours spent using electronic media was positively related to park visitation (Burkett, Tyrrell, and Virden 2010). Subsequently, in their exploration of factors explaining US National Park visitation, Stevens, More, and Markowski-Lindsay (2014, 156) suggested 'that several potential statistical problems (…) appear to be associated with Pergams and Zaradic's [2006] analysis'. Despite these critiques, research exploring digital-media use patterns, trends related to nature contact, and CTN supports the theoretical basis for the Videophilia Hypothesis (e.g. Larson et al. 2019 and see below), with the CTN literature often listing excessive use of digital media as a key causal factor in the decline of CTN in children and youth (e.g. Soga and Gaston 2018).

Data on the digital-media use of children and adolescents support the Videophilia Hypothesis in the sense that digital media is becoming an increasingly dominant component of daily leisure pursuits. For example, a 2017 study in the UK reported that children ages 8–11 and 12–15 spend 6.6 and 9.3 h per day, respectively, using electronic media, significantly higher than a decade prior (Ofcom 2017). This overall increase in screen time was largely attributed to the use of portable screen-based devices. Similar trends have been reported in many other countries, including the USA and Australia (Anderson and Jiang 2018; Rideout, Foehr, and Roberts 2010; Yu and Baxter 2015). Given the decreasing digital divide across the world, researchers also express concerns over excessive digital-media use in developing countries (Gasser, Maclay, and Palfrey 2010). For example, a study by the Pew Research Centre (2018) found that although social media use had plateaued in developed countries, it was continuing to rise in developing nations.

The prominent role that digital media plays in the leisure activities of young people is unsurprising given that it is nearly impossible in today's society to separate digital media from popular cultural consumption and communication patterns, particularly among younger generations (Chassiakos et al. 2016). Research on the subjective experiences of children and youth indicates that digital media now plays a dominant role in the lives of young people. In their metasynthesis of qualitative research on youth (ages 11–18) and screen time, Minges et al. (2015, 390) found that digital media had become routinized within the home where it was 'often used as a default activity for unstructured leisure time'. Through interviews and discussion groups with children (ages 6–12), Bassiouni and Hackley (2016) similarly found that digital media formed a key aspect of the children's individual and social identity. For example, children and adolescents often use digital media for the perceived social connections it offers (Barry et al. 2017; Bond 2016; Jacobsen and Forste 2011). As such, there are growing concerns surrounding a rise in addictive consumption patterns exhibited by young people (Griffiths and Meredith 2009; Kuss and Griffiths 2017). In one study, 45% of teenagers in the USA self-reported being online 'almost constantly', a figure that had nearly doubled since 2015 (Anderson and Jiang 2018), with other research reporting that 50% of teenagers 'feel addicted' to their phones (Felt and Robb 2016). It is this pervasive extent of digital-media consumption with which efforts to increase children's and adolescents' contact with and interest in nature must compete.

If digital-media use increasingly dominates the leisure time of children and adolescents, it follows that a declining amount of time will be devoted to other activities, including nature-based play. Indeed, qualitative evidence from the perspective of 10- to 11-year-old children suggests that if they were to decrease their use of digital media, it would be replaced by active recreation (e.g. '*If there wasn't the technology then I would probably be out everyday*' and '*I'd probably make some inventions in the back yard*') (Sebire et al. 2011, 304–305). In their systematic qualitative literature review of physical activity barriers for children (ages 0–6), Hesketh, Lakshman, and van Sluijs (2017) show that parents also perceive that children prefer digital media over active pursuits. The literature further reports a decline in adolescent direct contact with nature (Larson et al. 2019; Louv 2005; Miller 2005), a trend that has been referred to as the Extinction of Experience[3] (Pyle 1993; Soga and Gaston 2016). Both the academic and gray literature widely acknowledge the excessive time children spend using digital media as a key factor contributing to this reduced time spent in direct and engaged contact with nature and, subsequently, declining CTN (Beer, Cook, and Kantor 2018; Driessnack 2009; Kellert et al. 2017; Larson et al. 2019; Ortiz et al. 2018; Soga and Gaston 2018; Zylstra et al. 2014). Several of these studies cite the Videophilia Hypothesis directly. This acknowledgment is a necessary initial step if we are to design interventions that shift the interests of young people back to nature.

The videophilia shift: implications for nature-based program design

To address the Extinction of Experience, much research to date has turned to environmentally oriented adults to identify meaningful aspects of their childhood experiences in nature (Chawla 2007; Wells and Lekies 2006). In turn, nature-based programs frequently integrate these factors within program design (e.g. unstructured nature-play, exposure to wild environments, see Barthel et al. 2018; Beer, Cook, and Kantor 2018; Bruni et al. 2017). There are concerns, however, that the impact of nature-based programs is limited because they often fail to gain the participation of youth who do not have a pre-existing interest in nature (Miller 2005). Avoiding self-selective participation is difficult given that a prior interest in nature is a leading motivator for participation in nature-based activities (Kennedy, Jensen, and Verbeke 2018; Schuttler et al. 2018). We argue that a failure to gain a broader participation base is partially linked to a lack of consideration for pre-existing and competing interests, including digital media.

The adults from which recommended program design elements have emerged did not face the same pressures as today's youth with regard to digital media. This changing social context is not acknowledged when programs universally apply important aspects of the previous generation's interactions with nature. Indeed, it has been argued that 'global urbanization and the development of technology, in combination with new ways of working, seeing the world, and consuming, are too different today to allow the experience of earlier generations to be replicated' (Clayton et al. 2017, 648). Recent research also suggests that the qualities of meaningful interactions with nature will vary based on a child's pre-existing level of CTN. Through interviews and surveys with professionals specializing in connecting youth from a wide range of ages (0–18) to nature, Giusti et al. (2018) produced a model that frames childhood CTN as a progression in which youth begin by feeling comfortable and curious about nature, and eventually reach a point of caring about and 'being one with nature'. They explain that 'Children's ability to just enjoy and be curious about natural spaces is therefore a gateway to more profound forms of human nature relationships' (Giusti et al. 2018, 14). We suggest that the majority of today's youth exist at the beginning of this progression given their increased reliance on digital media and corresponding decline in nature-based experiences. These children, therefore, will require different types of interactions with nature than previous generations if we are to foster CTN.

We conceptualize the variation in young people's CTN and leisure preferences, and the implications of this variation for nature-based program design, as the Digital Media–Nature
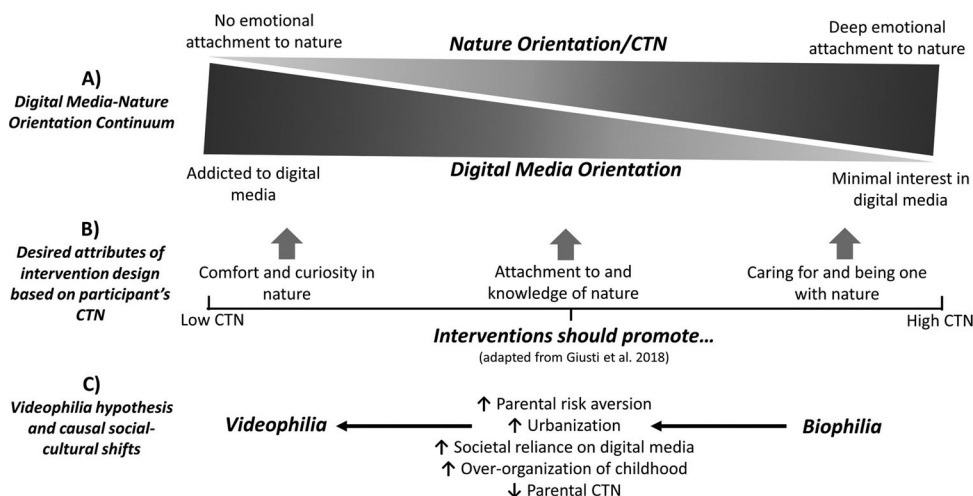
Figure 1. The three continuums considered in the composition of recommendations for fostering Connection to Nature (CTN) in digital-media-oriented youth. (A) The Digital Media–Nature Orientation Continuum, a spectrum moving from interest in/connection to digital media to interest in/connection to nature. (B) Recommended intervention attributes for different levels of childhood CTN (adapted from Giusti et al. 2018). (C) The shift from biophilia to videophilia and causal social-cultural changes.

Orientation Continuum. On this continuum, youth whose interests are more oriented toward digital media are less oriented toward nature (Figure 1A), though we emphasize that the orientation to digital media versus nature is not necessarily a trade-off because it is likely possible for a child to have a strong interest in both, particularly as technology itself continues to overlap with outdoor experiences, offering novel ways of interacting with nature (Clayton et al. 2017). However, the aforementioned quantitative and qualitative research on changing leisure preferences and declining CTN suggests that there is a general negative correlation. Indeed, in their recent research on the relationship between screen time, outdoor time, and CTN in US middle school students, Larson et al. (2019) found screen time to be a significant negative predictor of CTN. The children and adolescents who are the target of this paper are those on the left of the spectrum (i.e. generally more oriented toward digital media than nature). To successfully foster CTN in this target group, their interest in digital media needs to be acknowledged as a competing leisure activity to nature-based play and addressed through program design. The low pre-existing CTN likely to be associated with such youth must also be considered (Figure 1B). Ultimately, it is unlikely that digital-media oriented youth will participate on a sustained basis in nature-based programs unless these programs inspire curiosity and comfort in nature and can compete with digital media as a form of entertainment.

In addition to considering a child's placement on the Digital Media–Nature Orientation Continuum, interventions designed to promote childhood–nature contact should also account for the array of social-cultural factors underlying the shift from biophilia to videophilia (Figure 1C). These factors serve to push children's orientation toward digital media both indirectly (e.g. children's access to nature increasingly limited) and directly (e.g. parents actively promoting the use of digital media). For example, the literature commonly discusses urbanization as a primary contributing factor to declining CTN (Giusti et al. 2018; Imai, Nakashizuka, and Kohsaka 2018; Ives et al. 2018), a key finding being that a loss of proximate access to green space results in less incidental encounters with nature (Beery and Jørgensen 2018). With less access to green space, children must resort to other leisure pursuits, including digital media.

Research also links several lifestyle changes within the family unit indirectly and directly to declining CTN, including an increased proportion of childhood leisure time spent in organized, structured activities (often referred to as the 'over-organization of childhood'; Driessnack 2009,

74), which reduces the opportunity for unstructured nature-based play. Parents are also actively replacing their children's direct nature contact with screen time as, among other factors, outdoor play is often perceived to be risky and requiring greater supervision (Natural England 2009; Gill 2007; Karsten 2005; Louv 2005). Such risk aversion has been linked to parents themselves having low levels of confidence in nature (Pearlman Hougie 2010). A lack of enthusiasm from parents to share nature experiences with their children further reduces the inclination of young people to visit natural spaces (Beer, Cook, and Kantor 2018; Chawla 2007). Given that these interrelated social-cultural factors contribute indirectly and directly to the increased use of digital media, strategies that acknowledge and embrace these challenges alongside childhood interest in digital media could have a more pronounced effect on CTN. The remainder of this paper explores several recommendations for designing interventions that appeal to digital-media-oriented youth.

Recommendations for connecting digital-media-oriented youth to nature

To derive a list of strategies for designing interventions that appeal to digital-media-oriented youth, we performed a narrative literature review (Bourhis 2017) on research from a wide range of fields related to CTN and environmental education, including CTN in children, outdoor recreation trends and preferences, conservation marketing and engagement, and novel methods of childhood education. We considered three primary questions when reviewing this literature which emerged from the three components of the Digital Media–Nature Orientation Continuum: what strategies could an intervention employ to (1) connect with a pre-existing interest in digital media (Figure 1A), (2) foster comfort and curiosity in nature (Figure 1B), and (3) address other interconnected social-cultural challenges that contribute to videophilia (e.g. parental risk aversion) (Figure 1C)? Broadly, the recommendations that emerged from our review provide guidance for three aspects of nature-based program design: (1) initial engagement, (2) location, and (3) program attributes. The list is not intended to be a comprehensive inventory of all actions that can be taken to foster CTN in digital-media-oriented youth, but rather provide a starting point for discussion about intervention design. Although these recommendations will be of particular benefit to teachers and environmental educators designing formal programming (e.g. for nature clubs, school programs), they will be of use to anyone looking to foster CTN in youth, including parents.

The studies included in our review, as well as those which formed the evidence underlying the Digital Media–Nature Orientation Continuum, ranged widely in terms of their age group of focus. Therefore, our recommendations are generally not age-specific, but rather are intended to be general enough to apply across youth of all ages. Educators should tailor the recommendations to suit the specific age group with which they are working. Research has suggested, however, that participation in nature-based activities prior to the age of 11 is most significantly related to pro-environmental behavior as adults (Wells and Lekies 2006). Therefore, we suggest that these recommendations be considered from a young age, particularly given the fact that digital-media use may be an issue for children as young as 2 (Kabali et al. 2015).

Recommendation 1: ensure marketing and engagement strategies reach and appeal to digital-media-oriented youth

There exists a wealth of guidance on how to engage non-traditional audiences within the field of conservation marketing and engagement (e.g. Wright et al. 2015; website of the Society for Conservation Biology's working group on Conservation Marketing and Engagement, https://www.consmark.org/). One of the first steps when aiming to attract youth with little prior interest in nature is to ensure that information about the program actually reaches this target audience.

Therefore, marketing must extend beyond traditional conservation media-outlets (e.g. websites of environmental organizations, nature-based events, self-selective mailing lists). Partnering with community-based organizations (e.g. educational institutions, faith-based organizations, youth centers) would contribute to reaching a wider audience (Bickford et al. 2012). Furthermore, providing evidence linking CTN to broader public health goals (e.g. increasing levels of physical activity) would assist in attracting such organizations – as well as open access to health-based marketing and engagement initiatives. Emphasizing this link would also serve to attract parents and teachers to environmental programming, something that is key when aiming to gain the participation of younger children who have less freedom over their own time. General online news outlets also present a useful source through which to promote an intervention to a broad audience, acting as an intermediary between environmental organizations and social media platforms (Papworth et al. 2015).

It is especially important to ensure that engagement strategies reach and appeal to individuals from a diverse range of socio-economic and ethnic backgrounds. Participation in nature programming and other science-based activities has a history of being exclusionary (D'Amore and Chawla 2017; Kennedy, Jensen, and Verbeke 2018). As such, steps should be taken to facilitate equitable opportunity. An understanding of the motivations of local minority groups with regard to green spaces can help ensure programs meet the needs of this population and contribute to a more diverse participant base. For example, evidence from state parks in the USA suggests that people from minority groups tend to use green spaces for different reasons than those from white majorities (Whiting et al. 2017).

Engagement materials must also appeal to digital-media-oriented youth, particularly given that young adults have more influence over family decision making than in previous generations (Bassiouni and Hackley 2016). One method of capturing the attention of those engaged in excessive digital-media use is to identify links between nature-based programs and trending popular media (e.g. Shark Week, [O'Bryhim and Parsons 2015]). For example, the US Fish and Wildlife Service published a blog identifying links between Pokémon and real species at national wildlife refuges. Within their marketing strategies, environmental organizations could also use celebrities from television and online programs who have been vocal conservation advocates (Alexander 2013). For example, in their Wild for Life campaign (https://wildfor.life/champions) to combat illegal wildlife trade, the United Nations partnered with a wide variety of celebrities including actors and actresses, a YouTube star, and professional athletes. Through piggy-backing off such efforts (e.g. sharing on social media), even smaller environmental organizations could make use of high-profile individuals within marketing campaigns. However, organizations must carefully research the celebrity endorsement and/or media outlet of choice to maximize effectiveness and, among other potential pitfalls, ensure that the celebrity's involvement does not overshadow the primary message (Duthie et al. 2017).

Recommendation 2: select locations with unintimidating forms of nature to increase comfort levels of digital-media-oriented youth in the outdoors

When considering the location for nature-based programs, CTN scholars often advocate for the use of more naturalized settings, drawing on research that indicates such locales have a greater effect on CTN than more managed spaces (Miller 2005; Wells and Lekies 2006; Wyles et al. 2019). Giusti et al.'s (2018) research, however, suggests that 'feeling comfortable' in nature is one of the first abilities a child must master in their CTN progression. A wealth of other research supports this finding through demonstrating the importance of confidence in nature to a child's CTN (Beer, Cook, and Kantor 2018; Beery and Jørgensen 2018). Therefore, we suggest that more managed settings that are engaging, though not intimidating, present ideal initial settings for digital-

media-oriented youth. Managed environments are also more likely to appease risk-averse parents, allowing children greater freedom to explore and learn.

Research on outdoor recreation preferences further confirms the benefits of selecting more managed settings to attract those who have little previous exposure to nature. For example, Eder and Arnberger (2016) found that adolescents ages 12–19 in Austria with less previous exposure to natural settings preferred managed riverscapes with trails and recreation infrastructure. Similarly, Davis and Gatersleben (2013) showed that adult visitors of the rugged Sliabh Liag Cliffs (Ireland) with a strong CTN perceived the setting to provide a transcendent experience. Conversely, the cliffs were perceived as disturbing to individuals with a low CTN. These findings suggest that exposure to wild environments could decrease a child's interest in nature if they experience discomfort or fear. Examples of managed environments in which programs could be carried out include neighborhood parks, community gardens, zoos, and farms. Even schoolyard programming has the potential to increase comfort levels outdoors, offering the added benefit of recognizable surroundings that facilitate a more effective learning experience (Martin 2003). Such settings also allow for more frequent exposure to nature by removing feasibility constraints. Research is needed, however, to explore whether gradual exposure to more naturalized environments (e.g. pockets of unmanaged areas within parks) will eventually lead to comfort in less-managed spaces.

In addition to considering participant comfort level, environmental educators should also ensure that the location of nature-based programs is appealing to participants. Research suggests that it is the built (e.g. playparks, paths for walking and cycling, sports infrastructure) rather than natural characteristics of green spaces that are most appealing to adolescents (Van Hecke et al. 2018; Veitch et al. 2017). This preference is due, in part, to the social interaction facilitated by such infrastructure (Eder and Arnberger 2016). Therefore, programming in green spaces with well-developed recreational infrastructure is likely to appeal to digital-media-oriented youth, providing a gateway for interaction with nature. Programs that teach youth how to use and interact with a more diverse range of natural spaces could subsequently facilitate increased interest in less structured settings, particularly for those from urban environments and underrepresented minorities (Louv 2005; Gill 2011).

Recommendation 3: create role models by involving entire families and mentors

Studies have found that role models (e.g. family members) with whom to engage in nature-based experiences are highly influential in fostering childhood CTN (Cheng and Monroe 2012). This link is thought to result from an intergenerational transmission of values in which parents who are interested in nature set an example for their children (Chawla 2007). Unfortunately, as mentioned earlier, many children today do not have such a role model because parents are often uninterested in wildlife and lack confidence in nature (Pearlman Hougie 2010). Furthermore, qualitative research with parents and youth from a range of ages suggests that parents themselves often engage in excessive use of digital media and that emulating this behavior is one of the primary factors driving a child's level of sedentary activity, including digital-media use (Hesketh, Lakshman, and van Sluijs 2017; Minges et al. 2015). Therefore, interventions that engage the whole family would likely increase the opportunity and inclination of digital-media-oriented youth to engage in outdoor play through fostering curiosity and a sense of agency in their parents (D'Amore 2015). We suggest that engaging parents and other role models is in fact more important for digitally oriented youth than for those with already high levels of CTN since the latter are likely to already have role models with whom to experience nature outside of formal programming.

Family Nature Clubs exemplify one type of program that could foster parental role models; these programs bring multiple generations and families together to experience nature (see the

Children and Nature Network's website for a starter 'tool kit' on initiating Family Nature Clubs, https://www.childrenandnature.org/). D'Amore (2016) conducted one of the first empirical evaluations of Family Nature Clubs, providing evidence in support of their benefits for wellbeing and CTN. She found that participation was correlated with increased family time in nature outside of club activities, as well as increased parental CTN. This link was due primarily to increased parental knowledge of both local natural spaces and the benefits received from time spent in nature. Particularly for younger children who are more dependent on their parents for opportunities to visit nature, Family Nature Clubs offer an excellent avenue to reduce parents' risk aversion to nature-based play (D'Amore 2016; Pearlman Hougie 2010).

Role models could also be created by cultivating adolescents with high levels of CTN as peer mentors. In their review of strategies for promoting pro-environmental behavior change in youth, Chawla and Cushing (2007, 449) listed the creation of peer role models and 'opportunities for peer group exchanges' among their primary recommendations for environmental educators. Bester et al. (2017) reported positive outcomes for both learners and near-peer teachers in an outdoor environmental education program that paired first-year undergraduate students with third-year students. In the context of promoting contact with nature in youth, a program that matches young people on either side of the Digital Media–Nature Orientation Continuum would provide those with low levels of confidence in nature a peer guide to introduce them to nature-based play.

Recommendation 4: integrate gamification techniques within program design

Pre-existing interest in digital media should also be leveraged through integrating elements within program design akin to those provided by digital media. Addiction to video games, for example, emerges from a wide range of factors including the level of immersion in the game and the cooperative and competitive social interactions (Hussain, Williams, and Griffiths 2015; Ryan, Rigby, and Przybylski 2006). Traditional outdoor recreation activities might, in some cases, fail to replicate this stimulating virtual world. Indeed, research suggests that contemporary youth are now engaging in more extreme outdoor pursuits rather than traditional nature-based recreational activities (e.g. picking wildflowers, fishing) (Curry and Brown 2010; Mjaavatn 2016). Traditional activities such as camping and canoeing also tend to involve more naturalized environments, perhaps presenting a barrier to those with low levels of confidence in nature.

Traditional outdoor activities often involve a high degree of imagination and creativity. Studies of children's perceptions, however, suggest that they simply don't know what else to do with themselves other than engage in activities involving a screen (Minges et al. 2015; Sebire et al. 2011). Research also suggests that use of some forms of digital media (particularly more passive forms such as television) is associated with a loss of creativity because, among other reasons, it displaces imaginative activities (Calvert 2015; Kásler 2017). Emulating the experience provided by digital media, therefore, will likely require more entertainment-filled interactions with nature. Applying gamification techniques could facilitate this type of interaction. Gamification, 'the use of game design elements in non-game contexts', is a strategy in which attributes of game design such as competitiveness, problem-solving, and points-based achievement are applied to promote desired behaviors (Deterding et al. 2011, 10). Research suggests that gamification is more effective at promoting behavioral change than traditional educational techniques because it offers a more enjoyable and engaging learning environment (Tan and Hew 2016). Given its entertainment and motivational value, we suggest that gamification could be used to make activities promoting outdoor exploration and play more appealing to digital-media-oriented youth.

Principles of gamification have been successfully applied in a wide variety of contexts including the promotion of environmentally responsible behavior (Morganti et al. 2017; Negruşa et al.

2015). Geocaching presents an excellent application of gamification for nature exploration, an activity in which players use GPS coordinates to track down hidden caches which are most often in outdoor locations (Battista et al. 2016). Not only does geocaching offer an entertainment-filled way of experiencing natural spaces, but its self-directed qualities can also foster a sense of agency. For example, in a study of geocachers in Canada, participants described developing an increased and heightened awareness of their surroundings through the activity (Burns 2013). Although gamification is often associated with technology such as apps (see below), this is not a prerequisite (Darcy 2014), with the concept far predating the digital era (Knaving and Björk 2013). Gamification activities could be as simple as a checklist of items to collect on a beach or a city-wide scavenger hunt through urban parks. Indeed, the possibilities for incorporating gamification are limited only by one's imagination and a wide variety of general guides are available to assist with design (e.g. Farber 2014; Matera 2015). When applying gamification concepts, however, one must ensure that the emphasis remains on outdoor exploration and discovery rather than on the game (Knaving and Björk 2013).

Eventually, we would hope that youth participating in fast-paced gamification activities would see the value in slowing down to experience the rich level of sensory engagement that nature can offer (Beery and Jørgensen 2018). Therefore, as participants feel more comfortable and curious in nature, we recommend the introduction of activities that foster place attachment and require a closer interaction with nature. For example, England's National Trust published a bingo card of outdoor activities for children to complete, the majority of which involved highly sensory experiences (e.g. watch the sunset, go pond dipping) (https://www.nationaltrust.org.uk/50-things-to-do). Such activities still present a directed and entertaining outdoor experience, but through a slower, more thought-provoking interaction with one's surroundings.

Recommendation 5: use location-based, technology-enhanced learning approaches to leverage prior interest in digital media

Technology-Enhanced Learning (TEL), or the use of technology to support and enhance education, is increasingly being applied in environmental education to, among other motivations, enhance student engagement, enjoyment, and learning outcomes (Crawford, Holder, and O'Connor 2017). TEL includes anything from simply the use of a camera, all the way to an immersive augmented reality experience (i.e. the 'visualization of virtual objects in a real-world environment' [Huang, Chen, and Chou 2016, 73]) and holds particular potential for digital-media-oriented youth given their pre-existing interest in technology (McGonigal 2011; Willis, Weiser, and Kirkwood 2014). In environmental education, applications of TEL can also range in terms of the degree of physical interaction with nature they require, but even methods that limit children to an on-screen environment are thought to hold significant potential for influencing awareness, attitudes, and behaviors (Sandbrook, Adams, and Monteferri 2015). These exclusively screen-based approaches could function as a preliminary step to outdoor exploration. However, we focus this section on the potential of field-based TEL that necessitates direct human–nature contact given the importance of sensory experience for fostering CTN.

Many conservation organizations have recognized the potential of TEL for environmental education, with a large body of literature supporting its potential to foster CTN, achieve greater learning outcomes, and result in a higher level of participant enjoyment than traditional educational activities (Huang, Chen, and Chou 2016; Li et al. 2017). Schneider and Schaal (2018), for example, found that secondary students' participation in a location-based smartphone game that facilitated the exploration of a UNESCO Biosphere Reserve had a significant positive effect on their level of CTN, the effect being most pronounced for participants with initially low CTN. Similarly, Kamarainen et al. (2013) used student attitudes and teacher perceptions to explore the effectiveness of augmented reality technology to facilitate the exploration of a pond

environment for sixth graders. They found that the addition of technology resulted in improved content understanding and that the technology and its interaction with nature was one of the most favored aspects of the activity. Less technologically advanced applications have also proven effective. For example, based on test scores and reflective journaling, Anderson et al. (2015) found that students' (fourth to sixth grade) knowledge and comprehension of science content were enhanced when tablets, data loggers, and cameras were integrated within traditional programing. These findings suggest that TEL holds significant potential for fostering CTN in young people, particularly those with a strong prior interest in digital media.

Nature-based mobile applications (apps) are one TEL approach that has received particular hype in recent years as an engagement and learning tool (e.g. *Seek* developed by iNaturalist, *Nature Passport* co-developed by IslandWood and Nature Play). These apps often assist with species identification (e.g. through image recognition), provide rewards, and use gamification techniques to facilitate nature exploration. A primary instigating factor in the development of nature apps was the success of Pokémon Go, an augmented reality location-based mobile game in which players find and capture virtual Pokémon species in the real world (de Oliveira Roque 2016). Dorward et al. (2017) highlight a variety of opportunities that location-based games like Pokémon Go can offer conservation, including encouraging outdoor exploration and the potential to direct people to specific places (e.g. nature reserves). They also describe several modifications that could be made to increase the game's conservation potential, including the introduction of real species and conservation- learning content.

An abundance of resources and guidance exists to facilitate the effective application of TEL (e.g. Fauville, Lantz-Andersson, and Säljö 2014; Hougham 2016; Neustaedter, Tang, and Judge 2013). For example, Willis, Weiser, and Kirkwood (2014) suggest that, when implementing TEL, educators should use interactive rather than passive forms of technology, promote student-directed experiences, and encourage direct sensory engagement with the natural world. They also list several TEL tools (e.g. cameras, podcasts, blogs), their different uses, and related resources. In another useful resource, Hills and Thomas (2020) present a framework highlighting the pedogeological considerations that should be considered in the decision to use digital technology in environmental education. Although a detailed examination of this literature is outside the scope of this paper, TEL has great potential, so educators may wish to review available resources for additional recommendations.

Addressing critiques of technology-enhanced learning in environmental education

Despite research demonstrating the potential of TEL in environmental education, it has also been subject to critique. A primary concern is that digital technology can become a distraction, negating the potential for meaningful interactions with nature (Hills and Thomas 2020; Sandbrook, Adams, and Monteferri 2015). A second prominent argument is that the technological aspect acts as a barrier between children and nature, reducing the sensory experience (Cuthbertson, Socha, and Potter 2004). There have also been several critiques aimed specifically at the use of digital nature-themed games. In particular, there are worries that because these games tend to present a 'hyper-real and cognitively satisfying alternative to real nature', they might detract interest from this real nature which could be considered boring by comparison (Kahn, Severson, and Ruckert 2009; Sandbrook, Adams, and Monteferri 2015, 122).

To overcome these potential issues, Hills and Thomas (2020) discuss several factors that facilitators should take into consideration when deciding whether to use digital technology. These include the specific aims of the activity, the level of technological literacy of participants and facilitators, and the stage of the learning activity in which the technology is applied (i.e. whether the technology is used during the activity itself or to aid in post-experiential reflection). Facilitators should reflect on the possible unintended consequences of using or not using digital technology (Thomas and Munge 2017) and frequent evaluation should take place to monitor the

success of this decision (Hills and Thomas 2020). Environmental educators must remember that digital technology can act to help or hinder environmental education and fostering CTN depending on the circumstances and method in which it is applied (Bolliger and Shepherd 2017; Cuthbertson, Socha, and Potter 2004; Hills and Thomas 2020). Therefore, digital technology should be used purposefully rather than by default or because it is on-trend and critical thought must be put into the decision to ensure it enhances rather than distracts from experiential learning.

Conclusion

Although the changing interests of young people present a challenge for conservation, they also offer new opportunities through technology for fostering CTN. Ultimately, youth on the left of the Digital Media–Nature Orientation Continuum will require a different type of intervention from individuals with a prior interest in nature. Therefore, those designing programs aimed at fostering CTN must take digital-media use patterns and pre-existing levels of CTN into account if they are to equitably deliver nature's wellbeing benefits and cultivate meaningful experiences in the natural world for all. Organizations which fail to do so are likely to overlook a large proportion of children and adolescents and thereby reduce their potential impact.

Although interventions should ultimately include a wide range of program components to attract youth from across the Digital Media–Nature Orientation Continuum, it is also worth considering situations in which participation could be made compulsory to evade the issue of self-selection altogether. For example, the literature recommends educational institutions as ideal bodies through which to run environmental programming given their broad catchment (Schuttler et al. 2018). Outdoor schools, environmental-focused classes, and field trips present examples of commonly implemented interventions that could be made compulsory aspects of a curriculum. Ensuring that programming appeals to digital-media-oriented youth should still be a priority, however, since opportunities for implementing compulsory programming are limited and programs are unlikely to foster CTN if they are not of interest to these youth.

Regardless of the type of instrument used for fostering CTN, we recommend the implementation of an evaluation protocol to assess whether outcomes are being met over time (Frantz and Mayer 2014). A wide variety of instruments for measuring CTN exist, many of which are relatively simple and could be rapidly implemented (see Cartwright and Mitten 2018 for a comprehensive review of 34 instruments used to measure the human–nature relationship). Before- and after-measurements of CTN, along with other factors such as leisure choices outside the program, could provide a minimally resource-intensive way of assessing program impact. However, it should be noted again that the majority of CTN scales were developed in a Western context and, therefore, they should be carefully reviewed and tested for relevance within non-Western cultures before application for evaluative purposes (Zylstra et al. 2014).

Although there is an abundance of correlational evidence supporting the relationship between digital-media use and CTN, future research should focus on quantifying the link between time spent using digital media, time spent in nature, and CTN. Furthermore, given the quantitative focus of the CTN literature to date (Ives et al. 2017), a greater amount of qualitative work is needed to provide a more in-depth understanding of the factors contributing to or inhibiting a strong CTN, including the relationship between CTN and digital-media use. Further empirical research focused on identifying the type of outdoor recreation programs desirable to young people oriented toward digital media would also facilitate a more concrete understanding of the types of interventions likely to be successful.

Although opportunities for freedom and imaginative expression in nature were important for fostering an environmental ethic in prior generations (Louv 2005), today's youth are growing up in a fundamentally changed world as a result of global shifts and technological advances.

Therefore, we contend that programs designed with a romanticized ideal of what childhood–nature-based experiences should involve will fail to excite a large proportion of society. In contrast, for youth with minimal prior interest in the outdoors, incrementalism is necessary to ensure initial appeal of nature-based programs and foster a sustained interest in nature over or alongside digital-media. Of course, it is not only the responsibility of educational programmers to facilitate meaningful contact with nature for technology-oriented youth. Ultimately, it will take a combined, interdisciplinary effort from conservationists, teachers, parents, planners, policymakers, and others to pull digital-media-oriented young people into their backyards – and beyond.

Notes

1. We recognize that the definition of 'nature' is contested, including in the context of CTN. Fletcher (2017) provides a starting point for those interested in this discussion.
2. Early conceptualizations of CTN were largely grounded in Western belief systems, tending to emphasize the cognitive dimension, but recent work has presented a more holistic description of the concept, drawing significant inspiration from non-Western perspectives (Zylstra et al. 2014). Indeed, the rejection of non-Western ideologies has been identified as a driver of declining CTN (Kimmerer 2002). Despite this shifting theoretical perspective, empirical research on trends related to CTN and its importance (e.g. evidence of its decline and the related causal factors, its relationship to pro-environmental behavior) remains predominantly Western-based (Ives et al. 2017). However, the global spread of Western culture is likely to bring similar challenges to non-Western societies and preliminary research has linked CTN to environmentalism in developing countries (Rosa, Profice, and Collado 2018). Therefore, although the evidence we present that underlines the theoretical basis for this paper is drawn primarily from Western countries, the geographic relevance of our framework and recommendations is only expected to spread. Nevertheless, in the remainder of the paper, when we refer to CTN, it should be understood that we are aware of the broader context underlying its conceptual development and evidence base, and the resulting limitations.
3. The term 'Extinction of Experience' is commonly cited within the CTN literature, referring generally to a decline in direct interactions with nature. When considering the diverse ways that humans can 'experience' nature (including when human–nature interactions are mediated through digital technology), however, the term is perhaps used too casually in the literature as it could be taken to imply that non-traditional interactions with nature are not meaningful experiences. We believe that societal change, including the changing ways that humans experience nature, must be acknowledged and embraced (see Clayton et al. (2017) for an examination of how 'experience' of nature is changing).

Acknowledgements

Funding

Disclosure statement

No conflicts of interest to disclose.

Notes on contributors

Rachael C. Edwards is a PhD candidate in the School of Planning at the University of Waterloo, Canada. Previously, she completed a B.Sc. (Hons) in Biology at the University of Saskatchewan, Canada, and an M.Sc. in Conservation and Biodiversity at the University of Exeter, UK. Rachael's research explores cultural diversity in the use of parks and protected areas. Through this work, she aims to promote equity in the planning and management of public

open space to improve community health and wellbeing and engender conservation support. Rachael has published research in the *Journal of Applied Ecology* and currently manages the grassroots Community Champions program for the charity Sustainable Merton, UK. She previously served as the Program Director for the Canadian charity Waterloo Region Nature and completed research for the Smart Prosperity Institute.

Brendon M. H. Larson is a Professor in the School of Environment, Resources, and Sustainability in the Faculty of Environment at the University of Waterloo. His research concerns the social dimensions of biodiversity conservation, for example regarding how people perceive and evaluate conservation options in the current era of dramatic global change. He has published over 70 refereed journal articles and book chapters, as well as the book *Metaphors for Environmental Sustainability: Redefining Our Relationship with Nature* (Yale University Press, 2011). He has served as President of Ontario Nature and on the editorial board of the journal *Diversity and Distributions,* and he is currently the Domain Editor for 'Climate, Ecology and Conservation' for *WIREs Climate Change*.

ORCID

Rachael C. Edwards http://orcid.org/0000-0003-4717-7615
Brendon M. H. Larson http://orcid.org/0000-0001-5623-3864

References

Alexander, Jenny. 2013. "The Case of the Green Vampire: Eco-Celebrity, Twitter and Youth Engagement." *Celebrity Studies* 4 (3): 353–368. doi:10.1080/19392397.2013.831625.

Anderson, Carrie L., Brant G. Miller, Karla B. Eitel, George Veletsianos, Jan U. H. Eitel, and Robert J. Hougham. 2015. "Exploring Techniques for Integrating Mobile Technology into Field-Based Environmental Education." *Electronic Journal of Science Education* 19 (6) http://ejse.southwestern.edu/article/view/14752.

Anderson, Monica, and Jingjing Jiang. 2018. *Teens, Social Media, and Technology 2018*. Washington, DC: Pew Research Centre. https://www.pewresearch.org/internet/2018/05/31/teens-social-media-technology-2018/

Balmford, Andrew, Lizzie Clegg, Tim Coulson, and Jennie Taylor. 2002. "Why Conservationists Should Heed Pokémon." *Science* 295 (5564): 2367. doi:10.1126/science.295.5564.2367b.

Barry, Christopher T., Chloe L. Sidoti, Shanelle M. Briggs, Shari R. Reiter, and Rebecca A. Lindsey. 2017. "Adolescent Social Media Use and Mental Health from Adolescent and Parent Perspectives." *Journal of Adolescence* 61: 1–11. doi:10.1016/j.adolescence.2017.08.005.

Barthel, Stephan, Sophie Belton, Christopher M. Raymond, and Matteo Giusti. 2018. "Fostering Children's Connection to Nature through Authentic Situations: The Case of Saving Salamanders at School." *Frontiers in Psychology* 9: 928. doi:10.3389/fpsyg.2018.00928.

Bassiouni, Dina H., and Chris Hackley. 2016. "Video Games and Young Children's Evolving Sense of Identity: A Qualitative Study." *Young Consumers* 17 (2): 127–142. doi:10.1108/YC-08-2015-00551.

Battista, Rebecca A., Stephanie T. West, Susan Houge Mackenzie, and Julie Son. 2016. "Is This Exercise? No, It's Geocaching! Exploring Factors Related to Aspects of Geocaching Participation." *Journal of Park and Recreation Administration* 34 (2): 30–48. doi:10.18666/JPRA-2016-V34-I2-6495.

Beer, Tanja, Andrea Cook, and Kate Kantor. 2018. "Running Wild: Engaging and Empowering Future Custodians of Place through Creative Nature-Based Play." *Journal of Public Pedagogies* 3(3) doi:10.15209/jpp.1143.

Beery, Thomas, and Kari A. Jørgensen. 2018. "Children in Nature: Sensory Engagement and the Experience of Biodiversity." *Environmental Education Research* 24 (1): 13–25. doi:10.1080/13504622.2016.1250149.

Bester, Lucas, Gregg Muller, Brendon Munge, Marcus Morse, and Noel Meyers. 2017. "Those Who Teach Learn: Near-Peer Teaching as Outdoor Environmental Education Curriculum and Pedagogy." *Journal of Outdoor and Environmental Education* 20 (1): 35–46. doi:10.1007/BF03401001.

Bickford, David, Mary Rose C. Posa, Lan Qie, Ahimsa Campos-Arceiz, and Enoka P. Kudavidanage. 2012. "Science Communication for Biodiversity Conservation." *Biological Conservation* 151 (1): 74–76. doi:10.1016/j.biocon.2011.12.016.

Bolliger, Doris U., and Craig E. Shepherd. 2017. "An Investigation of Mobile Technologies and Web 2.0 Tools Use in Outdoor Education Programs." *Journal of Outdoor Recreation, Education, and Leadership* 9 (2): 181–196. doi:10.18666/JOREL-2017-V9-I2-8228.

Bond, Bradley J. 2016. "Following Your 'Friend': Social Media and the Strength of Adolescents' Parasocial Relationships with Media Personae." *Cyberpsychology, Behavior and Social Networking* 19 (11): 656–660. doi:10.1089/cyber.2016.0355.

Bourhis, John. 2017. "Narrative Literature Review." In *The SAGE Encyclopedia of Communication Research Methods*, edited by Mike Allen, 1076–1077. Thousand Oaks, CA: Sage.

Bruni, Coral M., Patricia L. Winter, P. Wesley Schultz, Allen M. Omoto, and Jennifer J. Tabanico. 2017. "Getting to Know Nature: Evaluating the Effects of the Get to Know Program on Children's Connectedness with Nature." *Environmental Education Research* 23 (1): 43–62. doi:10.1080/13504622.2015.1074659.

Burkett, John, Tim Tyrrell, and Randy Virden. 2010. "National Park Service Visitation Trends: Exploring the Forces That Influence Visitation." Technical Report. doi:10.13140/2.1.4833.9848.

Burns, Patrick J. 2013. "Geocaching, Learning, and Nature in a Location-Aware Sport." M.A. thesis, University of the Fraser Valley. https://viurrspace.ca/handle/10170/663

Calvert, Sandra L. 2015. "Children and Digital Media." In *Handbook of Child Psychology and Developmental Science, Ecological Settings and Processes in Developmental Systems*. 7th ed., edited by Richard M. Lerner, 375–415. Hoboken, NJ: Wiley.

Cartwright, Kelly S., and Denise Mitten. 2018. "Quantifying the Human-Nature Relationship: A User's Guide." *Research in Outdoor Education* 16 (1): 42–70. doi:10.1353/roe.2018.0004.

Chassiakos, Yolanda R., Jenny Radesky, Dimitri Christakis, Megan A. Moreno, and Corinn Cross. 2016. "Children and Adolescents and Digital Media." *Pediatrics* 138 (5): e20162593. doi:10.1542/peds.2016-2593.

Chawla, Louise. 2007. "Childhood Experiences Associated with Care for the Natural World: A Theoretical Framework for Empirical Results." *Children, Youth and Environments* 17 (4): 144–170.

Chawla, Louise, and Debra F. Cushing. 2007. "Education for Strategic Environmental Behavior." *Environmental Education Research* 13 (4): 437–452. doi:10.1080/13504620701581539.

Cheng, Judith C. H., and Martha C. Monroe. 2012. "Connection to Nature: Children's Affective Attitude toward Nature." *Environment and Behavior* 44 (1): 31–49. doi:10.1177/0013916510385082.

Clayton, Susan, Agathe Colléony, Pauline Conversy, Etienne Maclouf, Léo Martin, Ana Cristina Torres, Minh Xuan Truong, and Anne Caroline Prévot. 2017. "Transformation of Experience: Toward a New Relationship with Nature." *Conservation Letters* 10 (5): 645–651. doi:10.1111/conl.12337.

Crawford, Maxine R., Mark D. Holder, and Brian P. O'Connor. 2017. "Using Mobile Technology to Engage Children with Nature." *Environment and Behavior* 49 (9): 959–984. doi:10.1177/0013916516673870.

Curry, Nigel, and Katrina Brown. 2010. "Differentiating Outdoor Recreation: Evidence Drawn from National Surveys in Scotland." *Journal of Policy Research in Tourism, Leisure and Events* 2 (1): 29–50. doi:10.1080/19407960903542300.

Cuthbertson, Brent, Teresa L. Socha, and Tom G. Potter. 2004. "The Double-Edged Sword: Critical Reflections on Traditional and Modern Technology in Outdoor Education." *Journal of Adventure Education & Outdoor Learning* 4 (2): 133–144. doi:10.1080/14729670485200491.

D'Amore, Chiara. 2015. "Cultivating Connection and Care: The Case for Family Nature Clubs." *Journal of Sustainable Education* 9. http://www.susted.com/wordpress/content/cultivating-connection-and-care-the-case-for-family-nature-clubs_2015_03/.

D'Amore, Chiara. 2016. "Family Nature Clubs: An Intergenerational Opportunity to Foster Love of the Natural World." *Families, Relationships and Societies* 5 (3): 431–446. doi:10.1332/204674316x14758471234542.

D'Amore, Chiara, and Louise Chawla. 2017. "Many Children in the Woods: Applying Principles of Community-Based Social Marketing to a Family Nature Club." *Ecopsychology* 9 (4): 232–240. doi:10.1089/eco.2017.0019.

Darcy, Linda T. 2014. "No Technology Required to Gamify Your Class." Association for Supervision and Curriculum Development. http://www.ascd.org/ascd-express/vol9/920-darcy.aspx

Davis, Nora, and Birgitta Gatersleben. 2013. "Transcendent Experiences in Wild and Manicured Settings: The Influence of the Trait 'Connectedness to Nature'." *Ecopsychology* 5 (2): 92–102. doi:10.1089/eco.2013.0016.

de Oliveira Roque, Fabio. 2016. "Field Studies: Could Pokémon Go Boost Birding?" *Nature* 537 (7618): 34. doi:10.1038/537034e.

Deterding, Sebastian, Dan Dixon, Rilla Khaled, and Lennart Nacke. 2011. "From Game Design Elements to Gamefulness: Defining Gamification." Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments, Tampere, Finland, 9–15. doi:10.1145/2181037.2181040.

Dorward, Leejiah J., John C. Mittermeier, Chris Sandbrook, and Fiona Spooner. 2017. "Pokémon Go: Benefits, Costs, and Lessons for the Conservation Movement." *Conservation Letters* 10 (1): 160–165. doi:10.1111/conl.12326.

Driessnack, Martha. 2009. "Ask the Expert. Children and Nature-Deficit Disorder." *Journal for Specialists in Pediatric Nursing* 14 (1): 73–75. doi:10.1007/BF00861552.

Duthie, Elizabeth, Diogo Veríssimo, Aidan Keane, and Andrew T. Knight. 2017. "The Effectiveness of Celebrities in Conservation Marketing." *PLoS One* 12 (7): e0180027. doi:10.1371/journal.pone.0180027.

Eder, Renate, and Arne Arnberger. 2016. "How Heterogeneous Are Adolescents' Preferences for Natural and Semi-Natural Riverscapes as Recreational Settings?" *Landscape Research* 41 (5): 555–568. doi:10.1080/01426397.2015.1117063.

Farber, Matthew. 2014. *Gamify Your Classroom: A Field Guide to Game-Based Learning*. New York, NY: Peter Lang.

Fauville, Geraldine, Annika Lantz-Andersson, and Roger Säljö. 2014. "ICT Tools in Environmental Education: Reviewing Two Newcomers to Schools." *Environmental Education Research* 20 (2): 248–283. doi:10.1080/13504622.2013.775220.

Felt, Laurel J., and Michael B. Robb. 2016. *Technology Addiction: Concern, Controversy, and Finding a Balance*. San Francisco, CA: Common Sense Media. https://www.commonsensemedia.org/sites/default/files/uploads/research/csm_2016_technology_addiction_research_brief_0.pdf

Fletcher, Robert. 2017. "Connection with Nature is an Oxymoron: A Political Ecology of "Nature-Deficit Disorder." *The Journal of Environmental Education* 48 (4): 226–233. doi:10.1080/00958964.2016.1139534.

Frantz, Cynthia M., and Stephan F. Mayer. 2014. "The Importance of Connection to Nature in Assessing Environmental Education Programs." *Studies in Educational Evaluation* 41: 85–89. doi:10.1016/j.stueduc.2013.10.001.

Gasser, Urs, Colin M. Maclay, and John G. Palfrey. 2010. "Working towards a Deeper Understanding of Digital Safety for Children and Young People in Developing Nations." Harvard Public Law Working Paper No. 10-36. https://ssrn.com/abstract=1628276

Gill, Tim. 2007. *No Fear: Growing up in a Risk Averse Society*. London: Calouste Gulbenkian Foundation.

Gill, Tim. 2011. *Sowing the Seeds: Reconnecting London's Children with Nature*. London: Sustainable Development Commission. https://www.london.gov.uk/sites/default/files/lsdc_-_sowing_the_seeds_-_full_report_2011.pdf

Giusti, Matteo, Ulrika Svane, Christopher M. Raymond, and Thomas H. Beery. 2018. "A Framework to Assess Where and How Children Connect to Nature." *Frontiers in Psychology* 8: 2283–2221. doi:10.3389/fpsyg.2017.02283.

Griffiths, Mark D., and Alex Meredith. 2009. "Videogame Addiction and Its Treatment." *Journal of Contemporary Psychotherapy* 39 (4): 247–253. doi:10.1007/s10879-009-9118-4.

Hesketh, Kathryn R., Rajalakshmi Lakshman, and Esther M. F. van Sluijs. 2017. "Barriers and Facilitators to Young Children's Physical Activity and Sedentary Behaviour: A Systematic Review and Synthesis of Qualitative Literature." *Obesity Reviews: An Official Journal of the International Association for the Study of Obesity* 18 (9): 987–1017. doi:10.1111/obr.12562.

Hills, David, and Glyn Thomas. 2020. "Digital Technology and Outdoor Experiential Learning." *Journal of Adventure Education and Outdoor Learning* 20 (2): 155–169. doi:10.1080/14729679.2019.1604244.

Hougham, Justin R. 2016. "To unplug or plug in." *Green Teacher*, Fall 2016. http://greenteacher.com/to-unplug-or-plug-in/

Huang, Tien-Chi, Chia-Chen Chen, and Yu-Wen Chou. 2016. "Animating Eco-Education: To See, Feel, and Discover in an Augmented Reality-Based Experiential Learning Environment." *Computers & Education* 96: 72–82. doi:10.1016/j.compedu.2016.02.008.

Hughes, Joelene, Miles Richardson, and Ryan Lumber. 2018. "Evaluating Connection to Nature and the Relationship with Conservation Behaviour in Children." *Journal for Nature Conservation* 45: 11–19. doi:10.1016/j.jnc.2018.07.004.

Hussain, Zaheer, Glenn A. Williams, and Mark D. Griffiths. 2015. "An Exploratory Study of the Association between Online Gaming Addiction and Enjoyment Motivations for Playing Massively Multiplayer Online Role-Playing Games." *Computers in Human Behavior* 50: 221–230. doi:10.1016/j.chb.2015.03.075.

Imai, Haruka, Tohru Nakashizuka, and Ryo Kohsaka. 2018. "An Analysis of 15 Years of Trends in Children's Connection with Nature and Its Relationship with Residential Environment." *Ecosystem Health and Sustainability* 4 (8): 177–187. doi:10.1080/20964129.2018.1511225.

Ives, Christopher D., David J. Abson, Henrik von Wehrden, Christian Dorninger, Kathleen Klaniecki, and Joern Fischer. 2018. "Reconnecting with Nature for Sustainability." *Sustainability Science* 13 (5): 1389–1397. doi:10.1007/s11625-018-0542-9.

Ives, Christopher D., Matteo Giusti, Joern Fischer, David J. Abson, Kathleen Klaniecki, Christian Dorninger, Josefine Laudan, et al. 2017. "Human–Nature Connection: A Multidisciplinary Review." *Current Opinion in Environmental Sustainability* 26–27: 106–113. doi:10.1016/j.cosust.2017.05.005.

Jacobsen, Wade C., and Renata Forste. 2011. "The Wired Generation: Academic and Social Outcomes of Electronic Media Use among University Students." *Cyberpsychology, Behavior and Social Networking* 14 (5): 275–280. doi:10.1089/cyber.2010.0135.

Kabali, Hilda K., Matilde M. Irigoyen, Rosemary Nunez-Davis, Jennifer G. Budacki, Sweta H. Mohanty, Kristin P. Leister, and Robert L. Bonner. 2015. "Exposure and Use of Mobile Media Devices by Young Children." *Pediatrics* 136 (6): 1044–1050. doi:10.1542/peds.2015-2151.

Kahn Jr., Peter H., Rachel L. Severson, and Jolina H. Ruckert. 2009. "The Human Relation with Nature and Technological Nature." *Current Directions in Psychological Science* 18 (1): 37–42. doi:10.1111/j.1467-8721.2009.01602.x.

Kamarainen, Amy M., Shari Metcalf, Tina Grotzer, Allison Browne, Diana Mazzuca, Shane M. Tutwiler, and Chris Dede. 2013. "EcoMOBILE: Integrating Augmented Reality and Probeware with Environmental Education Field Trips." *Computers & Education* 68: 545–556. doi:10.1016/j.compedu.2013.02.018.

Kareiva, Peter. 2008. "Ominous Trends in Nature Recreation." *Proceedings of the National Academy of Sciences of the United States of America* 105 (8): 2757–2758. doi:10.1073/pnas.0800474105.

Karsten, Lee. 2005. "It All Used to Be Better? Different Generations on Continuity and Change in Urban Children's Daily Use of Space." *Children's Geographies* 3 (3): 275–290. doi:10.1080/14733280500352912.

Kásler, Tímea T. 2017. "Investigating in What Ways Television Consumption Influences Preschool Aged Children and Their Development." *Vezetéstudomány/Budapest Management Review* 48 (11): 2–11. doi:10.14267/VEZTUD.2017.11.01.

Kellert, Stephen R., David J. Case, Daniel Escher, Daniel J. Witter, Jessica Mikels-Carrasco, and Phil T. Seng. 2017. *Disconnection and Recommendation for Reconnection*. Mishawaka, IN: The Nature of Americans. https://lccnetwork.org/sites/default/files/Resources/Nature-of-Americans_National_Report_1.2_4-26-17.pdf

Keniger, Lucy E., Kevin J. Gaston, Katherine N. Irvine, and Richard A. Fuller. 2013. "What Are the Benefits of Interacting with Nature?" *International Journal of Environmental Research and Public Health* 10 (3): 913–935. doi:10.3390/ijerph10030913.

Kennedy, Eric B., Eric A. Jensen, and Monae Verbeke. 2018. "Preaching to the Scientifically Converted: Evaluating Inclusivity in Science Festival Audiences." *International Journal of Science Education* 8 (1): 14–21. doi:10.1080/21548455.2017.1371356.

Kimmerer, Robin W. 2002. "Weaving Traditional Ecological Knowledge into Biological Education: A Call to Action." *Bioscience* 52 (5): 432–438.[0432:WTEKIB]2.0.CO;2 doi:10.1641/0006-3568(2002)052.

Knaving, Kristina, and Staffan Björk. 2013. "Designing for Fun and Play: Exploring Possibilities in Design for Gamification." Gamification'13: Proceedings of the First International Conference on Gameful Design, Research, and Applications, Toronto, ON, Canada, 131–134. doi:10.1145/2583008.2583032.

Kuss, Daria, and Mark Griffiths. 2017. "Social Networking Sites and Addiction: Ten Lessons Learned." *International Journal of Environmental Research and Public Health* 14 (3): 311. doi:10.3390/ijerph14030311.

Larson, Lincoln R., Rachel Szczytko, Edmond P. Bowers, Lauren E. Stephens, Kathryn T. Stevenson, and Myron F. Floyd. 2019. "Outdoor Time, Screen Time, and Connection to Nature: Troubling Trends among Rural Youth?" *Environment and Behavior* 51 (8): 966–991. doi:10.1177/0013916518806686.

Li, Jingya, Erik D. van der Spek, Loe Feijs, Feng Wang, and Jun Hu. 2017. "Augmented Reality Games for Learning: A Literature Review." Proceedings of the 5th International Conference on Distributed, Ambient and Pervasive Interactions, Vol. 10291, Vancouver, BC, Canada, July 9–14. doi:10.1007/978-3-319-58697-7_46.

Louv, Richard. 2005. *Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder*. Chapel Hill, NC: Algonquin Books.

Martin, Sarah Carrier. 2003. "The Influence of Outdoor Schoolyard Experiences on Students' Environmental Knowledge, Attitudes, Behaviors, and Comfort Levels." *Journal of Elementary Science Education* 15 (2): 51–63. doi:10.1007/BF03173843.

Matera, Michael. 2015. *Explore like a Pirate: Gamification and Game-Inspired Course Design to Engage, Enrich, and Elevate Your Learners*. San Diego, CA: Dave Burgess Consulting.

McGonigal, Jane. 2011. *Reality is Broken: Why Games Make Us Better and How They Can Change the World*. New York, NY: Penguin Press.

Miller, James R. 2005. "Biodiversity Conservation and the Extinction of Experience." *Trends in Ecology & Evolution* 20 (8): 430–434. doi:10.1016/j.tree.2005.05.013.

Minges, Karl E., Jo Salmon, David W. Dunstan, Neville Owen, Ariana Chao, and Robin Whittemore. 2015. "Reducing Youth Screen Time: Qualitative Metasynthesis of Findings on Barriers and Facilitators." *Health Psychology: Official Journal of the Division of Health Psychology, American Psychological Association* 34 (4): 381–397. doi:10.1037/hea0000172.

Mjaavatn, Per E. 2016. "Changes in Children's Preferences for Outdoor Activities: A Longitudinal Study." *Leisure/Loisir* 40 (2): 225–244. doi:10.1080/14927713.2016.1220260.

Morganti, Luca, Federica Pallavicini, Elena Cadel, Antonio Candelieri, Francesco Archetti, and Fabrizia Mantovani. 2017. "Gaming for Earth: Serious Games and Gamification to Engage Consumers in Pro-Environmental Behaviours for Energy Efficiency." *Energy Research & Social Science* 29: 95–102. doi:10.1016/j.erss.2017.05.001.

Natural England. 2009. *Childhood and Nature: A Survey on the Changing Relationships with Nature across Generations*. Cambridgeshire: Natural England. http://publications.naturalengland.org.uk/publication/5853658314964992

Negruşa, Adina L., Toader, Valentin Aurelian Soficǎ, Mihaela, F. Tutunea, and Rozalia V. Rus. 2015. "Exploring Gamification Techniques and Applications for Sustainable Tourism." *Sustainability* 7 (8): 11160–11189. doi:10.3390/su70811160.

Neustaedter, Carman, Anthony Tang, and Tejinder K. Judge. 2013. "Creating Scalable Location-Based Games: Lessons from Geocaching." *Personal and Ubiquitous Computing* 17 (2): 335–349. doi:10.1007/s00779-011-0497-7.

O'Bryhim, Jason R., and E. C. M. Parsons. 2015. "Increased Knowledge about Sharks Increases Public Concern about Their Conservation." *Marine Policy* 56: 43–47. doi:10.1016/j.marpol.2015.02.007.

Ofcom. 2017. *Children and Parents: Media Use and Attitudes Report 2017*. London: Ofcom. https://www.ofcom.org.uk/research-and-data/media-literacy-research/childrens/children-parents-2017

Ortiz, Janel L., April A. T. Conkey, Leonard A. Brennan, La Vonne Fedynich, and Marybeth Green. 2018. "Wild Birds in the Classroom: Evaluation of Student Affinities, Perceptions, and Attitudes in Response to an Experiential Curriculum." *International Journal of Environmental & Science Education* 13 (10): 787–803.

Papworth, Sarah K., Le T. P. Nghiem, Deepthi Chimalakonda, Mary Rose C. Posa, Lahiru S. Wijedasa, David Bickford, and L. Roman Carrasco. 2015. "Quantifying the Role of Online News in Linking Conservation Research to Facebook and Twitter." *Conservation Biology: The Journal of the Society for Conservation Biology* 29 (3): 825–833. doi:10.1111/cobi.12455.

Pearlman Hougie, Debbie, J. 2010. "Can Family Outdoor Recreation Help Reconnect Children with the Outdoors? Affluent Middle Childhood Perspectives of Outdoor Recreation in the UK." *Journal of Outdoor Recreation, Education, and Leadership* 2 (3): 217–244. doi:10.7768/1948-5123.1047.

Pergams, Oliver R. W., and Patricia A. Zaradic. 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." *Journal of Environmental Management* 80 (4): 387–393. doi:10.1016/j.jenvman.2006.02.001.

Pergams, Oliver R. W., and Patricia A. Zaradic. 2008. "Evidence for a Fundamental and Pervasive Shift Away from Nature-Based Recreation." *Proceedings of the National Academy of Sciences of the United States of America* 105 (7): 2295–2300. doi:10.1073/pnas.0709893105.

Pew Research Centre. 2018. *Social Media Use Continues to Rise in Developing Countries but Plateaus Across Developed Ones*. Washington, DC: Pew Research Centre. https://www.pewresearch.org/global/2018/06/19/social-media-use-continues-to-rise-in-developing-countries-but-plateaus-across-developed-ones/

Pyle, R. M. 1993. *The Thunder Tree: Lessons from an Urban Wildland*. Boston, MA: Houghton Mifflin.

Rideout, Victoria J., Ulla G. Foehr, and Donald F. Roberts. 2010. *Generation M2: Media in the Lives of 8- to 18-Year-Olds*. Melo Park, CA: Henry J. Kaiser Family Foundation. https://files.eric.ed.gov/fulltext/ED527859.pdf

Rosa, Claudio D., Christiana C. Profice, and Silvia Collado. 2018. "Nature Experiences and Adults' Self-Reported Pro-Environmental Behaviors: The Role of Connectedness to Nature and Childhood Nature Experiences." *Frontiers in Psychology* 9: 1–10. doi:10.3389/fpsyg.2018.01055.

Ryan, Richard M., C. Scott Rigby, and Andrew Przybylski. 2006. "The Motivational Pull of Video Games: A Self-Determination Theory Approach." *Motivation and Emotion* 30 (4): 344–360. doi:10.1007/s11031-006-9051-8.

Sandbrook, Chris, William M. Adams, and Bruno Monteferri. 2015. "Digital Games and Biodiversity Conservation." *Conservation Letters* 8 (2): 118–124. doi:10.1111/conl.12113.

Schneider, Joachim, and Steffen Schaal. 2018. "Location-Based Smartphone Games in the Context of Environmental Education and Education for Sustainable Development: Fostering Connectedness to Nature with Geogames." *Environmental Education Research* 24 (11): 1597–1610. doi:10.1080/13504622.2017.1383360.

Schuttler, Stephanie G., Amanda E. Sorensen, Rebecca C. Jordan, Caren Cooper, and Assaf Shwartz. 2018. "Bridging the Nature Gap: Can Citizen Science Reverse the Extinction of Experience?" *Frontiers in Ecology and the Environment* 16 (7): 405–411. doi:10.1002/fee.1826.

Sebire, Simon J. Jago, Russell Trish Gorely, Itziar H. Cillero, and Stuart J. H. Biddle. 2011. "'If There Wasn't the Technology Then I Would Probably Be out Everyday': A Qualitative Study of Children's Strategies to Reduce Their Screen Viewing." *Preventive Medicine* 53 (4–5): 303–308. doi:10.1016/j.ypmed.2011.08.019.

Soga, Masashi, and Kevin J. Gaston. 2016. "Extinction of Experience: The Loss of Human-Nature Interactions." *Frontiers in Ecology and the Environment* 14 (2): 94–101. doi:10.1002/fee.1225.

Soga, Masashi, and Kevin J. Gaston. 2018. "Shifting Baseline Syndrome: Causes, Consequences, and Implications." *Frontiers in Ecology and the Environment* 16 (4): 222–230. doi:10.1002/fee.1794.

Stevens, Thomas H., Thomas A. More, and Marla Markowski-Lindsay. 2014. "Declining National Park Visitation: An Economic Analysis." *Journal of Leisure Research* 46 (2): 153–164. doi:10.1080/00222216.2014.11950317.

Tan, Meng, and Khe F. Hew. 2016. "Incorporating Meaningful Gamification in a Blended Learning Research Methods Class: Examining Student Learning, Engagement, and Affective Outcomes." *Australasian Journal of Educational Technology* 32 (5): 19–34. doi:10.14742/ajet.2232.

Thomas, Glyn J., and Brendan Munge. 2017. "Innovative Outdoor Fieldwork Pedagogies in the Higher Education Sector: Optimising the Use of Technology." *Journal of Outdoor and Environmental Education* 20 (1): 7–13. doi:10.1007/BF03400998.

Van Hecke, Linde, Ariane Ghekiere, Jenny Veitch, Delfien Van Dyck, Jelle Van Cauwenberg, Peter Clarys, and Benedicte Deforche. 2018. "Public Open Space Characteristics Influencing Adolescents' Use and Physical Activity: A Systematic Literature Review of Qualitative and Quantitative Studies." *Health & Place* 51: 158–173. doi:10.1016/j.healthplace.2018.03.008.

Veitch, Jenny, Jo Salmon, Benedicte Deforche, Ariane Ghekiere, Jelle Van Cauwenberg, Shaun Bangay, and Anna Timperio. 2017. "Park Attributes That Encourage Park Visitation among Adolescents: A Conjoint Analysis Institute for Physical Activity and Nutrition (IPAN)." *Landscape and Urban Planning* 161: 52–58. doi:10.1016/j.landurbplan.2016.12.004.

Wells, Nancy M., and Kristi S. Lekies. 2006. "Nature and the Life Course: Pathways from Childhood Nature Experiences." *Children, Youth and Environments* 16 (1): 1–25.

Whiting, Jason W., Lincoln R. Larson, Gary T. Green, and Chuck Kralowec. 2017. "Outdoor Recreation Motivation and Site Preferences across Diverse Racial/Ethnic Groups: A Case Study of Georgia State Parks." *Journal of Outdoor Recreation and Tourism* 18: 10–21. doi:10.1016/j.jort.2017.02.001.

Willis, Jana, Brenda Weiser, and Donna Kirkwood. 2014. "Bridging the Gap: Meeting the Needs of Early Childhood Students by Integrating Technology and Environmental Education." *International Journal of Early Childhood Environmental Education* 2 (1): 140–155.

Wilson, Edward O. 1984. *Biophilia*. Cambridge, MA: Harvard University Press.

Wright, Andrew J., Diogo Veríssimo, Kathleen Pilfold, E. C. M. Parsons, Kimberly Ventre, Jenny Cousins, Rebecca Jefferson, Heather Koldewey, Fiona Llewellyn, and Emma McKinley. 2015. "Competitive Outreach in the 21st Century: Why We Need Conservation Marketing." *Ocean & Coastal Management* 115: 41–48. doi:10.1016/j.ocecoaman.2015.06.029.

Wyles, Kayleigh J., Mathew P. White, Caroline Hattam, Sabine Pahl, Haney King, and Melanie Austen. 2019. "Are Some Natural Environments More Psychologically Beneficial than Others? The Importance of Type and Quality on Connectedness to Nature and Psychological Restoration." *Environment and Behavior* 51 (2): 111–143. doi:10.1177/0013916517738312.

Yu, Maggie, and Jennifer Baxter. 2015. "Australian Children's Screen Time and Participation in Extracurricular Activities." In The Longitudinal Study of Australian Children Annual Statistical Report 2015. 99-125. *Growing up in Australia*. https://growingupinaustralia.gov.au/research-findings/annual-statistical-report-2015/australian-childrens-screen-time-and-participation-extracurricular

Zaradic, Patricia A., and Oliver R. W. Pergams. 2007. "Videophilia: Implications for Childhood Development and Conservation." *The Journal of Developmental Processes* 2 (1): 130–144.

Zelenski, John M., and Elizabeth K. Nisbet. 2014. "Happiness and Feeling Connected: The Distinct Role of Nature Relatedness." *Environment and Behavior* 46 (1): 3–23. doi:10.1177/0013916512451901.

Zylstra, Matthew J., Andrew T. Knight, Karen J. Esler, and Lesley L. L. Le Grange. 2014. "Connectedness as a Core Conservation Concern: An Interdisciplinary Review of Theory and a Call for Practice." *Springer Science Reviews* 2 (1–2): 119–143. doi:10.1007/s40362-014-0021-3.