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Review



Nature-focused livestreams: Connecting people to nature and to each other

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Engaging with nature has been found to have a range of benefits across the biopsychosocial and spiritual domains of well-being. Nature-focused livestreams (NFLs) offer an alternative to physically engaging with nature and serve as a window to nature as society has become more urbanized and has increasingly moved indoors. In this brief review, we examine the role of NFLs in connecting people with nature and connecting people with each other. Emerging evidence suggests that NFLs can be effective in doing so, and that feelings of connectedness can, in turn, provide similar benefits found with physical engagement with nature, most notably greater emotional well-being and a sense of community. Future research should rigorously explore the potential of this technology-enhanced platform.

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Introduction & background

The benefits of interacting and connecting with nature are well-established and range from improved psychological and emotional well-being, greater physical wellbeing, cognitive stimulation and maintenance of

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cognitive abilities, and lower risks of morbidity and mortality [1-6]. Activities that connect people with nature vary and include owning and engaging with pets, indoor and outdoor gardening, outdoor activities (e.g., walking, camping, birdwatching, forest bathing), hobby farming, and even hunting and fishing. As society has evolved with increasing urbanization, however, people have become less connected with nature due to lack of opportunity and shifts in interests with the advance of technology, such as television, cell phones, and social media [7]. This lack of exposure to nature has led to the use of the non-clinical diagnosis of "nature deficit disorder" [8]. While technology can draw us away from the natural world, we have also learned that technology can connect us with nature in unique ways. In this brief review, we focus on nature-focused livestreams (NFLs) and ways in which this technology fosters connections with nature and with each other.

Livestreams (also referred to as livecam or webcam broadcasts) are not a new phenomenon. The first live camera stream to be broadcast over the internet is thought to be the CoffeeCam. In 1993, scientists at the University of Cambridge set up a livestream to capture and monitor the status of the office coffee maker. If full, then they would make a trip to the break room. If empty, they would skip the trip. The FogCam, a single livestreaming camera in San Francisco that allows viewers to watch the fog roll in and out, was established in 1994 and bills itself as the world's oldest webcam. Commercialization quickly followed these early uses of livestreams, and this technology became widely available to the public. The use of livestreams moved from static images to active and interactive productions ranging from peoples' personal lives to cityscapes to surveillance to nature-based programming [9]. NFLs are one of the many types of programming available to the public and have grown in number and diversity of the past several decades. NFLs have been defined as having the following attributes: "(a) focused on animals, plants, and environments (e.g., oceans, outer space); (b) provide real-time, live video feeds; and (c) available and accessible to the public through the internet" [10], p. 3. Wellknown examples of NFLs include the Giant Panda Cam that captures the activities of the panda bears and other





Model of Nature-Focused Livestreams (WB = Well-Being; adapted from Gobster et al. [14]).

animals at the Smithsonian National Zoo [11], Africam that broadcasts wildlife livestreams across the African continent [12], and Explore. org that provides a platform for a plethora of NFLs around the globe [13]. In this review, we explore recent research on two particular purposes/outcomes related to NFLs – connecting people with nature and connecting people with each other (see Figure 1).

Connecting people with nature

The most obvious and most common purpose and outcome of NFLs is connecting people with nature. NFLs are designed specifically to expose people to nature and those choosing to do so have any number and focus of NFLs to choose from. The simple fact that NFLs have grown significantly over the past several decades is evidence that people are connecting to nature via this venue [15]. For example, the annual Fat Bear Week live stream from Katmai National Park in Alaska has grown from a one-day Facebook event to a weeklong binge watching by millions of viewers. In fact, over 1.3 million viewers from over 100 countries cast their votes this year for the fattest bear [16]. Researchers are also using outcome measures to quantify livestream viewers' connectedness to nature. A recent meta-analysis of research on direct and indirect contact with nature, such as livestreams, found that all forms of contact with nature showed positive effects on feeling connected to nature [17]. Other researchers have consistently found increased connectedness with nature with all forms of exposure, from NFLs to 360° images and immersive virtual nature (IVN), a form of virtual reality [18-20]. Returning our focus specifically to NFLs, these connections with nature can result in other benefits, such as improvements in mental health, higher social well-being, stress reduction, attention restoration, and greater desire for increased conservation efforts [10,21-23]. The benefits of NFLs were particularly evident during the COVID-19 pandemic when people were sequestered and separated from each other [24]. Finally, the connections with nature fostered via NFLs can also positively impact actual tourism and increase visits to national parks and other nature environments, thereby generating income and furthering conservation efforts [25].

One limitation in this research is the fact that researchers often include recorded content with live content, and it is difficult to parse out whether and to what extent livestreams are more beneficial than recorded content. Some researchers refer to "videos," but don't distinguish them as live or recorded. Only one study was found that compared live to recorded videos of nature. These researchers found that there were increases in participants' attention when the videos were perceived as live, while both formats were equally effective at reducing stress [26]. Livestreams may be

perceived as more suspenseful and engaging with the sense that anything could happen at any moment. One should also note that NFLs lack the additional sensory experience of physically interacting with nature (e.g., touch, smell) and the "je ne sais quoi" of the actual human experience of being fully engaged with nature [27,28]. However, NFLs do provide opportunities to engage with nature on a limited basis for people who otherwise might lack the ability, access, time, resources, or opportunity to do so. In this way, NFLs may represent the next best thing, and research strongly suggests that experiencing nature remotely is certainly better than not experiencing it at all. In fact, emerging research on virtual reality (VR) nature experiences has demonstrated similar benefits to actual exposure to nature on certain outcomes related to well-being, such as psychological arousal, but likely to a lesser degree [27,29]. With the growth of technologies such as VR, we are seeing people increasingly augment actual experiences with virtual experiences. In some cases, people may substitute online experiences for actual experiences with nature, particularly those who have limited access, resources, or ability to go out into nature [30]. There is no evidence to suggest that these virtual and online experiences devalue real experiences with nature. On the contrary, research has found that virtual and online experiences can increase positive attitudes toward conservation and the natural environment, and promote ecotourism [27,31].

Connecting people with each other

Shared experiences are often the basis of relationships between people, from the most intense, such as growing up in the same family, to the more casual, such as reading the same book. As technology has advanced and spread (e.g., social media sites), we have found that people can and do share experiences virtually and bond over these encounters, forming "virtual communities" [32]. There is emerging evidence that NFLs have the capacity to create these shared experiences and for people to connect with each other over these shared experiences. Online chat features provide platforms for NFL viewers to share reactions to what they are viewing and to engage others with real-time exchanges. The simple fact that these chats exist, and that people are using them is evidence of social exchange, which is the foundation for virtual communities. Researchers have also analyzed these chats to provide a deeper look at these exchanges and the community shared. An analysis of almost 130,000 comments on the Facebook group associated with NFLs in the United Kingdom found an array of well-being benefits, including bringing people together and creating a sense of community [33]. A researcher in Australia analyzed 73,000 chat entries and almost 600 survey responses surrounding Live Penguin TV that followed the evening penguin parade from the ocean to their beach burrows. Similar to other studies, participants reported a sense of virtual community with their "fellow waddle watchers" [25]. In another study, researchers examined The Great Moose Migration livestream in Sweden and found that users formed their own Facebook group that "displays intimacy and affective ties between its members" [33, p. 4]. In a recent study in the United States, researchers evaluated an activity program for older adults with cognitive impairment using NFLs and found that the participants could effectively engage with the program and that there was an increase in the positive relationship domain of wellbeing among the participants [34].

Clearly, NFLs have the capacity to bring people together and to foster virtual communities. What is less clear is whether and to what degree these virtual communities differ compared with other virtual communities, such as those built around video games, sports teams, or hobbies. It could be that NFLs offer a certain combination of entertainment, education, escape, natural rhythm, and emotional connection in a noncompetitive and innocuous format that is conducive to the building of virtual community [35]. The biophilia hypothesis, the innate drive for humans to connect with other life forms and nature, also suggests that NFLs may be better suited for fostering connections between people. Nature is viewed as a universal force that binds us together and may be more a more powerful commonality than everyday interests [36]. Additional research is warranted to fully explore this notion.

Gaps in the research exist as to whether these online relationships and communities centered on nature contribute to or detract from offline relationships and offline behavior. Recent evidence has shown that virtual groups (e.g., Meetup) with similar interests can lead to offline interactions [37]. Additional research is needed regarding NFLs and offline interactions, but there is every indication that offline interactions could be facilitated by online relationships. There are also questions as to whether NFLs can draw people away from offline interactions and relationships. The replacement argument suggests that this could be the case; however, the mirroring argument counters that online identities (and relationships) are not independent from real-life identities [38]. There is evidence to suggest that shared interactions through avenues such as NFLs is not detracting from actual shared interactions with nature. For example, attendance at National Parks in the United States has increased by 39 million visitors between 2000 and 2023 [39] and researchers have posited that online exposure to the National Parks may be one of the primary drivers behind these increased visits [40].

Promising programs & future directions

The future of NFLs is quite bright and there are emerging examples of programs that are capable of achieving both of the desirable outcomes described in this review. Days at Dunrovin (D@D) is a prime example of this approach. D@D is an online membership-based platform that centers around life on a small guest ranch in rural Montana. D@D has multiple 24/7 year-round livestream cameras on the property and features interactive programming where viewers can engage with ranch workers and content creators. Equally important, D@D intentionally offers and encourages viewers to chat with each other and views itself as "a central place of interest for people to spend time, share experiences, and form friendships" [41]. A qualitative evaluation of unsolicited emails to the owner of D@D also provides evidence that the program is indeed linking people together and serves as a "virtual care farm." Researchers found that D@D creates a sense of community among members, as one member stated, "There's a reason we're all together (D@D members), our friends in chat are special people, we all care about each other" [42], p. 339. Anecdotal evidence also suggests that D@D is effective in fulfilling this mission. In fact, one member who passed away in recent years had her funeral livestreamed on the D@D site to enable her online community to virtually attend her services.

Technology is often maligned as an isolating mechanism, yet technology-enhanced NFLs such as D@D are bringing people together all over the world through a shared connection with nature. While research strongly suggests that NFLs can connect people with nature and with each other, future research should further explore the unique specific qualities of nature that seem to unite people. Research projects with additional rigor (e.g., experimental designs) would be especially illuminating, as would projects that incorporate NFLs into structured interventions targeting key outcomes, such as socioemotional well-being. Additional research on specific groups, most notably those groups that may lack access and the ability to experience actual nature experiences, such as individuals with physical and cognitive limitations, incarcerated populations, and those living in dense, urban environments. For example, we know that older adults with dementia can experience psychosocial benefits from exposure to nature via therapeutic gardens [43]. We also know that incarcerated populations benefit from exposure to nature [44], and nascent exploratory research has found that prisoners can experience reductions in stress when engaged with recorded visual imagery and sounds associated with nature [45]. While challenging to conduct in applied settings, experimental designs and other rigorous approaches could yield a clearer understanding of how structured interventions using NFLs could be developed, implemented, and evaluated with both specific and general populations. NFLs offer a unique window to reflect on our place in the natural world, to find peace and awe in the beauty of nature, and to join

CRediT author statement

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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Further information on references of particular interest

- In this meta-analysis, researchers reviewed longitudinal quantitative studies on nature exposure published between 1990 and 2020. Analyses found small to medium effect sizes indicating improvements in mental health with exposure to nature.
- This integrative review focuses on research on the effects of garden and forest interventions (n = 25) on stress-related illnesses (e.g., exhaustion, burnout). Findings suggest that these nature-based interventions (NBIs) can promote stress reduction and balance in life.
- 10. In this scoping review (n = 10), researchers found that viewing nature-focused livestreams was related to positive affect and uplifted mood. Connections with nature and with other people were identified as potential mechanisms behind these outcomes.
- 17. Researchers conducted a meta-analytic review of quasi-experimental studies focusing on exposure to nature and feelings of nature connectedness. Results revealed medium positive effects for nature exposure and nature connectedness regardless of whether the exposure was direct or indirect (e.g., livestream exposure) or the timing of the exposure (e.g., single session or repeated sessions).
- 18. This systematic review and meta-analysis (n = 6) found that ** immersive virtual nature (i.e., virtual reality focused on naturalistic scenario) could effectively promote feelings of connectedness with nature. Research is nascent in this area and the researchers suggest exploring ways to "optimize the desired effects of this technology".
- Researchers used an online experimental design to explore differences in nature connectedness and pro-environment views when exposed to different scenery and traditional videos, 360° videos, or 360° static images. Results indicated that scenery type (e.g., coral reef, forest, urban), more so than media format, contributed to connectedness to nature.
- 20. Researchers conducted two online experiments (n = 665) to * examine whether and to what extent nature-focused videos could inspire a sense of awe leading to pro-environmental views. Results from both studies indicated that nature-focused videos, particularly videos depicting vast nature, could inspire awe, connectedness to nature, and pro-environmental views.
- In this qualitative analysis of online surveys (n = 6968), researchers evaluated the impact of viewing nature-focused livestreams on mental health and nature conservation views.
 Findings revealed positive gains in mental health, perceptions of nature, and nature conservative views.
- The researcher evaluated 73,000 social media posts and 590 survey responses related to nature-based wildlife livestreams. Findings suggest that participating in the livestreams helped to connect people with nature, build community, and promote conservation and tourism.
- 27. The researchers investigated the relationship between three ** types of nature exposure (living in a green neighborhood, visiting

nature, watching/listening to nature documentaries) and wellbeing (N = 4960). Visiting nature was found to be related to better health outcomes and pro-environmental behaviors, while watching/listening to nature documentaries was only found to be related to pro-environmental behaviors.

- 29. The researchers used an experimental design to compare actual ** exposure to nature with virtual reality exposure to nature with college students (N = 81). Findings indicated that both types of exposure were beneficial in terms of mood and physiological arousal; however, actual exposure appeared to have a greater positive impact.
- 30. In this conceptual review, the authors explore the role of technology (e.g., online nature experiences) and the ways in which it can substitute for actual nature experiences or help people reconnect with the natural environment. Guidelines for future research are introduced.
- 31. The researchers used a quasi-experimental design to compare * virtual reality marine tourism to actual marine tourism (N = 114). Findings suggested that virtual reality tourism could be equally effective in influencing positive conservation behaviors.
- 32. Researchers administered a survey to Twitch (a livestreaming ** site) viewers (n = 1944) to assess their feelings of belonging and cohesion with an online community. Results revealed that individual and community level activity on this site predicted the degree to which users felt a sense of virtual community.
- 35. Researchers presented a case study and conceptual review of ** public experiences of The Great Moose Migration, an annual livestream event based in Sweden. The researchers identify several aspects of this livestream that make it particularly engaging and capable of building community, including the annual nature of the event, the dynamic rhythm of the event, and audience participation (i.e., co-producing the event).
- 34. Researchers adapted and evaluated the impact of a naturefocused livestream intervention for older adults with cognitive and physical impairment in assisted living. Participation in the intervention was related to gains in the positive relations domain of well-being.
- An interactive website built around a system of livestreams,
 intentional programming, and viewer interactions focusing on Dunrovin Ranch, a small, working guest ranch located in rural Montana, USA.
- 42. The researcher conducted an exploratory qualitative evaluation of a virtual care farm. Findings indicated that users felt a sense of connection with nature and with others, while also feeling rejuvenation and restoration through their experiences with the virtual care farm.
- 45. Using physiological measures of stress and surveys, researchers evaluated the effects of visual imagery and sounds of nature on stress in incarcerated men. Findings indicated that both visual imagery and sounds of nature could decrease stress levels and produce beneficial mental health outcomes in this population.