Viewing Nature-Focused Livestreams and Subjective Well-Being:

A Scoping Review

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Abstract

Engaging with nature relates to psychosocial well-being; however, some people encounter barriers to experiencing nature. Nature-focused livestreams offer a relatively new pathway for engagement with the natural world, yet little is known about their association with individual well-being. This scoping review seeks to describe the state of the knowledge regarding nature-focused livestreams and the well-being of adults. Searching 12 databases and one search engine in April 2022 and again in May 2023 and screening 1,645 unique potentially relevant evidence sources, the research team identified 10 articles that met inclusion criteria for *population* (adults over 18 years of age), *concept* (well-being), and *context* (nature-focused livestreams). Findings demonstrate emerging empirical support for the connection between viewing nature-focused livestreams and factors related to psychosocial well-being. The most commonly reported outcome related to well-being positive affect or uplifted mood (n = 7, 70%). Potential mechanisms that were identified indicated well-being was enhanced through connecting with nature or with other people. Nature-focused livesstreams should be considered as a possible way to extend the well-being benefits of engagement with nature to individuals who are unable to leave their homes or who live in urban areas with limited access to nature.

Keywords: well-being, nature, nature-focused livecam broadcasts, nature-focused webcams

Engagement with the natural world has clear benefits for humans, including improved cardiovascular, neuroendocrine, and metabolic health indicators; lower cortisol and cholesterol levels; reduced risk for a wide variety of conditions and diseases; and longevity (Twohig-Bennett & Jones, 2018; Wen et al., 2019; Yao et al., 2021). Psychological benefits associated with nature range from reduced depressive symptoms, anxiety, fatigue, anger, stress, and burnout to better quality of life and higher levels of happiness and other positive emotions (Capaldi et al., 2014; Corazon et al., 2019; Daniels et al., 2022; Farrow & Washburn, 2019; Hansen et al., 2017; McMahan & Estes, 2015; Wen et al., 2019; Yao et al., 2021). Experiences with nature are also associated with positive cognitive states, including improved attention, memory, and mental processes (Berman et al., 2012; Berto, 2005; Bratman et al., 2015; Daniels et al., 2022).

Unfortunately, for many, it is difficult to have these beneficial experiences with nature. In modern times, people are increasingly disconnected from nature (Frumkin et al., 2017; Pergams & Zaradic, 2008). This disconnection is exacerbated for people confined to indoor spaces regularly, such as those working indoors or living in prisons, nursing homes, or other institutional settings (Snell et al., 2019) or who belong to marginalized groups in urban areas with inequitable access to the natural world (Langhans et al., 2023). Health problems or disability may also restrict people's ability to enter natural environments (Colley et al., 2016; Donaldson et al., 2005). These obstacles to engaging with nature physically make exploring alternate means of experiencing nature intriguing.

Innovations allowing humans to experience nature in new ways include still photography, videos, televised broadcasts and closed-circuit television, graphics, memes, virtual reality, digital games, livestreaming, and nature-focused apps (Kahn et al., 2009; Ratz & Conk, 2010; Silk et al., 2021; Snell et al., 2019). These technologies can simulate nature and have the potential to explain, mediate, or augment it (Kahn et al., 2009). Encountering the natural world in these ways

may increase access to the benefits of nature by allowing people to experience it from a variety of settings, circumstances, perspectives, and times (Snell et al., 2019; Zabini et al., 2020) and may also be beneficial for those living in urban settings with limited access to natural settings, for people with physical or health limitations, or in times of quarantine such as the recent COVID-19 pandemic (Lee et al., 2022; van Houwelingen-Snippe, van Rompay, & Ben Allouch, 2020).

Like physical experiences with nature, virtual or online exposure to the natural world can also be beneficial. For example, people have reported happy memories, reduced stress, and feelings of optimism, hope, restoration, or joy when indirectly experiencing nature through media such as slideshows, virtual reality, or online digital images and video (Darcy et al., 2022; Lee et al., 2022; Valtchanov & Ellard, 2010). However, not all responses to online or digital exposure to nature have been positive. Kahn et al. (2009) found that although participants who looked at high-quality images of nature on a large plasma display reported feeling connected to nature and other humans, they experienced no more heart rate recovery from mild stress than those who looked at a blank wall. Other research participants have reported ambivalent feelings with exposure to digital nature such as sadness or frustration about being unable to visit locations in person or participate in sensory experiences nature provides (Darcy et al., 2022; Kjellgren & Buhrkall, 2010).

Features of Online Platforms that Affect the Experience of Viewing Nature Online

The experiences associated with interacting with nature online are likely shaped by the features of the online platform. In their neo-ecological theory, Navarro and Tudge (2022) suggest several features of online platforms and systems that influence human behaviors and experiences in virtual environments. Some of these features are (1) synchronicity/asynchronicity, (2) publicness, (3) cue absence, and (4) anonymity (Navarro & Tudge, 2022). *Synchronicity* and

asynchronicity refer to whether online content is available for consumption in real-time (e.g., livestreaming) or with a time-lag (e.g., watching prerecorded videos online or sharing photos by email). To the extent virtual spaces allow people to meet others beyond their family and close friends for social or cultural purposes, they demonstrate the feature of *publicness*, which is indicative of larger, broader, and more diverse audiences or groups of online participants. Because online interactions may be devoid of non-verbal communication cues, the extent of *cue absence* on a platform is an important consideration. Some online communications, such as video conferencing, allow individuals to give and receive non-verbal cues. Emojis or other visual symbols can also provide cues. However, to a large extent, platforms or systems where communication is solely text-based will have a high degree of cue absence. Somewhat related to cue absence is the quality of *anonymity.* When the identities of online actors are anonymous, information about personal identities is not available or is limited to what the individuals on the platform choose to disclose. In online multiplayer nature games, the players' voices could afford some degree of non-verbal cues and reveal characteristics of personal identity to other players. In contrast, on platforms where users create their usernames, do not upload their photographs in their user profiles, and are limited to text-only communications, both anonymity and cue absence would be high.

Nature-Focused Livestreaming

The technology of interest for this scoping review is livestreaming. Livestreaming entails capturing and streaming a variety of video content (e.g., entertainment, education, religion) in real-time to audiences at a distance using digital and online technologies (Chen & Lin, 2018; Qiu et al., 2021). Livestreaming audiences participate in shared, synchronous experiences and—depending on the online platform—may also be able to communicate in real-time using chat features or discussion boards (Qiu et al., 2021). Viewing livestreams has been associated with

greater social support and relationships (Lee et al., 2022; Qiu et al., 2021), yet little is known about the specific effects of viewing nature-focused livestreams.

Nature-focused livestreams are a fairly new application of technology for connecting with nature. These livestreams differ from other ways of experiencing or sharing nature online or digitally in their synchronicity; events witnessed in a nature livestream occur in real time and can range from the mundane to the surprising. Well-known examples of nature-focused livestreams include the U.S. National Parks livecams and Africam, which focuses on wildlife in Africa. There are also clearinghouse organizations, or platforms, that provide access to multiple livestreams, such as Explore.org and the nature section of Webcamtaxi.com. Nature-focused livestreams are gaining popularity. Explore.org touted an increase of 85% in viewership of their virtual livestreams over two years (Granville, 2020). As nature webcams proliferate—at least 150 were installed in U.S. national parks alone as of 2019 (Gray & Wikle, 2021)—and as viewership increases, netizens can commune virtually with nature in real-time.

Many websites and platforms devoted to nature-focused livestreams allow viewers to direct message one another or post public messages on discussion boards or include other features that facilitate social connection, such as social media links or calendars of events allowing members to coordinate their viewing activities. Some have links to curated social media communities where viewers with specialized interests can interact across broader forums. These platforms can exhibit high publicness, especially when compared to viewing photos on websites without social features. The policies and guidelines of the platforms for nature-focused livestreams can determine their degree of cue absence and anonymity. For example, viewers may have customized avatars to mask their identities or may be able to use emojis when commenting on discussion boards.

Current Study

Despite nature-focused livestreams' increasing popularity and their potential to enhance viewers' well-being and social connectedness, much remains to be learned about their effects. To our knowledge, there has not been a comprehensive literature review on nature-focused livecam broadcasts and individual well-being. Lee et al. (2022) documented well-being outcomes in their review on the effects of watching webcams for virtual travel. However, webcam travel included content unrelated to nature (e.g., historic sites, city centers, resorts). To disaggregate the specific characteristics of nature-focused livestreaming from the effects of broader webcam travel, we focus this scoping review on only nature-focused livestreams, which we define as: (a) focused on natural environments (e.g., oceans, outer space) or animals and plants in the outdoors or zoos; (b) providing real-time, live video feeds; and (c) available and accessible to the public through the internet. Our research aims to describe the state of the knowledge regarding nature-focused livestreams and adults' well-being. To this end, we pose research questions (RQs) related to nature-focused livestreams' (NFLs) viewers; broadcasters, broadcasts, and platforms; and well-being outcomes:

RQ1: What are the characteristics of the viewers of NFLs?

RQ2: What is the content of NFLs?

RQ3: What are the characteristics of the broadcasters of NFLs?

RQ4: What are the features (i.e., synchronicity/asynchronicity, publicness, cue absence, anonymity) of platforms that host NFLs?

RQ5: What are the features of NFLs (e.g., narrated, scheduled programming, round-the-clock access)?

RQ6: What well-being outcomes are associated with viewing NFLs?

RQ7: Do the article's aims include identifying specific well-being outcomes?

RQ8: What, if any, instruments are used to measure well-being and what are their documented psychometric properties?

RQ9: What, if any, mechanisms are identified to explain the effects viewing NFLs on well-being?

Methods

Scoping reviews synthesize literature synthesis by mapping key concepts and summarizing available evidence to inform future research. We used the most recent enhanced guidance on scoping review frameworks (Colquhoun et al., 2014; Peters et al., 2020) for this research. Our Preferred Reporting Items for Systematic reviews and Meta-Analyses Extension for Scoping Reviews Checklist (Tricco et al., 2018) is available in online Supplemental Materials. Scoping reviews are exploratory by nature, aiming to map or explore the breadth of evidence on a topic (Munn et al., 2022). They are useful for examining emerging evidence in an unclear landscape that does not yet lend itself to the construction of specific research questions better answered using precise, systematic review methodology. Because the intended focus is on summarizing and describing the scope, diversity, and nature of research in a specific field, rather than on critically appraising the quality of included studies, scoping reviews do not include quality assessments as a standard practice, allowing for broader evidence mapping and identification of research gaps not subject to the methodological constraints of conducting a detailed quality assessment (Wake et al., 2020). According to Wake et al. (2020), because there is no assessment of methodological limitations or bias, scoping reviews do not yield synthesized answers to questions or implications for practice. Their value lies in identifying gaps in the literature, defining key terms, and providing an overview of the existing evidence on a topic. They may include quantitative, qualitative, and mixed methods research and gray literature, the diversity of which cannot be assessed using a single set of quality criteria. As such, scoping reviews can guide future research directions, pointing to where more detailed research is needed, and laying a foundation for more focused reviews that would include quality assessments (Munn et al., 2022; Wake et al., 2020).

We conducted a preliminary search of the JBI Systematic Review Register, Campbell Collaboration, Web of Science, Google Scholar, and OSF Registries for similar or equivalent projects. Finding none, we developed an *a priori* protocol for a scoping review (Highfill et al., 2022), registered on the Open Science Framework website (https://osf.io/wb74k). The research team adapted the protocol as needed (McKenzie et al., 2022), such as adding a research question about article aims after discovering articles that reported post hoc well-being outcomes.

Inclusion/Exclusion Criteria

We structured our inquiry using JBI's PCC framework: population, concept, context (Peters et al., 2020). The *population* of interest was adults over 18 years old who viewed nature-focused livestreams. The *concept* was subjective well-being, operationalized in the broadest and most inclusive sense. From a theoretical standpoint, two different paradigms of well-being exist – the hedonic and the eudaimonic. The hedonic view posits that well-being consists of satisfaction with physical pleasure, mental pleasure, attaining goals, and achieving desired outcomes. The eudaimonic view focuses on meeting one's potential and living a virtuous and meaningful life (Diener & Sim, 2024). The *context* was nature-focused livestreams, which for this review included livestreams of nature, geographical features, animals in outdoor environments or zoos, and other non-human natural phenomena. It excluded livestreams that were human-focused, private (i.e., not intended for a public audience), and broadcasts of household pets, companion animals, or events of human creation or origin (e.g., hunting).

Search Strategy

The search strategy was designed to locate published and unpublished studies in any language without date limits. First, we conducted a limited search of PubMed, Web of Science, and Google Scholar to identify articles on the topic. From the articles found in this preliminary search, we used keywords in the titles and abstracts of relevant articles and the National Library

of Medicine's Medical Subject Headings (MeSH) describing the articles to develop full search strategies for each database. Search strategies, including all identified keywords and index terms, were adapted for the databases Scopus (Elsevier), Web of Science Core Collection (Clarivate Analytics), and CINAHL (EBSCO) using the Polyglot Search Translator (Clark, Sanders, et al., 2020). Manual translation was performed for PsycInfo (EBSCO), GenderWatch (Proquest), Ageline (EBSCO), Communication and Mass Media Complete (EBSCO), Sociology Database (Proquest), Agricola (EBSCO), Newspaper Source (EBSCO). Sources of unpublished studies/gray literature were Google Scholar and ProQuest: Dissertations & Theses. The searches were conducted in April 2022 and again in May 2023 (see Search Strategy Tables of Highfill et al., 2022). After the resulting articles and documents were screened for inclusion, the reference lists of all included sources of evidence were screened for additional studies, and the corresponding authors of all included sources were contacted for additional relevant work to consider for inclusion.

Data Management

We collated the citations identified in the database searches and exported them to EndNote 20 Citation Management Software (Team, 2013) and used the Groups function in EndNote to sort references by database. Then, we copied the EndNote library and imported it into the SR Accelerator DeDuplicator (Clark, Glasziou, et al., 2020) for deduplication. We imported the resulting file back into EndNote and used its deduplication feature to remove additional duplicates and uploaded the export to Covidence for a final deduplication effort. We retained the original citation list and the resulting deduplicated lists as records of the deduplication process. We imported the final, deduplicated list of citations into JBI SUMARI software for the selection of evidence sources. After conducting the search again in May 2023, a

member of our research team manually deleted duplicates within the search results and from the previous search.

Selection of Evidence Sources

Using the JBI SUMARI web-based application, three reviewers screened and selected evidence sources (Munn et al., 2019). Prior to screening, each reviewed the protocol's inclusion and exclusion criteria. Then, they conducted a pilot test, independently administering the criteria to a few titles and abstracts from the search results, comparing decisions, and conferring to ensure consistent application of the inclusion/exclusion criteria. Then each of the remaining citations' title and abstract were screened by two reviewers. Following the screening at the title and abstract level, potentially relevant sources were retrieved in full, and two reviewers carefully assessed the full text using the inclusion criteria.

The team resolved disagreements at each stage of the selection process through consensus among the three researchers during regular team meetings, which were held to review processes, discuss challenges, and make final inclusion determinations (Colquhoun et al., 2014). Some articles included nature-focused livestreams in a broader category, such as "nature media" (Phillips et al., 2023). If the team was able to find well-being results linked solely to livestreaming, the article was included, but otherwise excluded. Lastly, the team carefully considered the characteristics of public and live broadcasts when discussing the inclusion of articles. If the phenomenon being examined was not publicly available (as in Kahn et al.'s 2009 study of window displays) or was a videotape(s) of material that was initially livestreamed (e.g., the first study in Shively, 2023), the review team excluded the evidence source.

At each stage in the selection process, the team tracked number of articles included and excluded, documenting reasons for exclusion at the full-text review stage. See the PRISMA flow diagram (Page et al., 2021) in Figure 1 for a summary of the selection process stages.

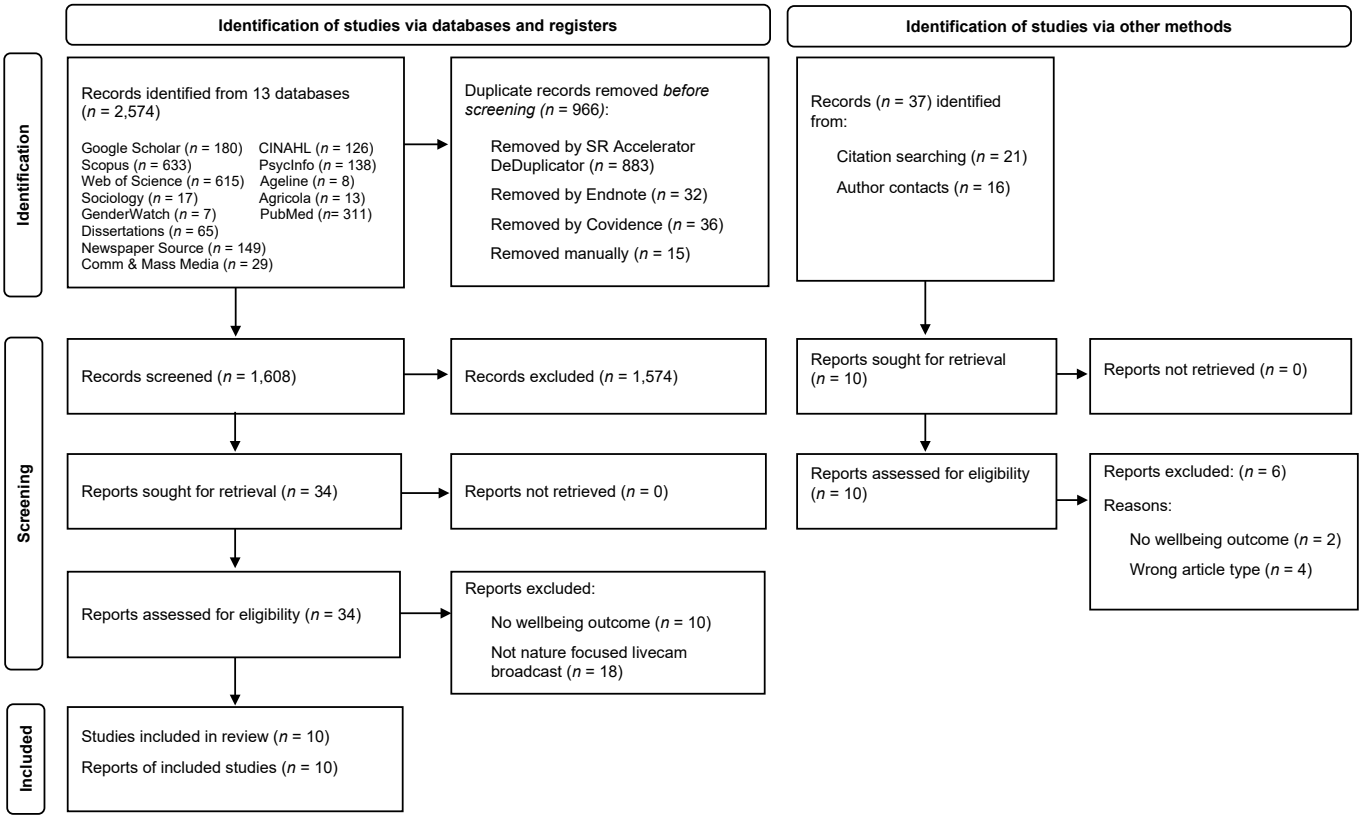

Figure 1. PRISMA flow diagram for the scoping review.

Data Extraction and Analysis

Three members of the research team created, piloted, modified, and adopted a data extraction spreadsheet for article characteristics and data charting. Original drafts of the data extraction tools were included in the published protocol (Highfill et al., 2022); the final data extraction tools are available as attached files in the *Associated Project* protocol's OSF webpage (https://osf.io/wb74k). Using the data extraction tools, two independent reviewers extracted data from each article in the sample. The reviewers resolved disagreements by consensus. Article characteristics included author name(s); date of publication; author(s) affiliation, location, and discipline; funding source(s); reported conflicts of interest; type of report (e.g., quantitative, qualitative, grey literature); and if applicable, sample size and characteristics of human subjects research. Data charted included article aims, location(s) of livecams, location(s) of broadcast

viewers, content of livestreams, characteristics of broadcasters, broadcast features, and well-being findings.

After data extraction, two researchers conducted content analysis and thematic analysis of the data as recommended by Colquhoun et al. (2014). Content analysis was used to identify frequencies of article characteristics and charted data; thematic analysis identified themes for well-being outcomes.

Results

We identified 2,574 articles through database searches. Thirty-seven additional articles were located using hand searching and citation chasing. We eliminated 1,601 irrelevant and 966 duplicate articles, reviewing 44 full texts. After excluding 34 articles, the sample included 10 reports representing 10 studies and 10 lead authors.

Sample

Article topics included exploring webcam travel; evaluating a platform; discussing nestcams; considering human boredom and animal experiences; comparing online and onsite responses of viewers; describing viewer characteristics; examining relationships among viewers, animals, and technology; investigating how humans learn about animals; exploring the effects or benefits of viewing; and examining viewers' experiences. Table 1 presents detailed article characteristics.

Viewer Characteristics *(RQ1)*

Viewer location (presented in Table 2 along with other findings) was based on information in the evidence sources related to a general description of the livestream viewers, not descriptions of the samples of the human subjects research (which are presented in Table 1). Many (n = 7, 70%) of the evidence sources described the location of the viewers, indicating a

Table 1. Characteristics of Evidence Sources Related to Nature-Focused Livecam Broadcasts and Well-Being ($N = 13$).

Author(s)	Year	Peer reviewed? If no, type	Author university affiliated? If no, type	Author Discipline(s)	Funding?	Conflicts of Interest?	Quantitative?	Quantitative sample size	Quantitative sample characteristics	Qualitative?	Qualitative sample size & description
Anderson	2019	yes	yes	Social Work	none	none	no	NA	NA	yes	Emails to broadcaster; size *n.r.*
Beddington	2020	news article	newspaper	Journalism	*n.r.*	*n.r.*	no	NA	NA	no	NA
Blaer	2023	Yes	Yes	Tourism	yes	none	yes	590	90% ♀; 67% age 40-69; 36% employed FT; 22% retired	yes	62,495 YouTube and 10,780 Facebook posts
Jarratt	2020	yes	yes	Tourism	none	none	yes	277	69% ♀	yes	3 platforms
Johnson-Pynn & Carleton	2019	yes	yes	Psychology; Biology	none	none	yes	2,930	89% ♀; 57% age 45-64; 87% ≥ college	yes	2,039 Facebook posts from 883 people
Searle	2023	yes	yes	Geography	*n.r.*	*n.r.*	yes	455	68% ♀, 29% ♂, 3% non-binary	yes	20
Skibins et al.	2022	yes	yes	Recreation	none	*n.r.*	yes	5,582	65% ♀; 61% ≥ age 50; 87% from USA; 77% ≥ college	yes	5582 respondents to open-ended questions
Shively	2022	grey literature	yes	Horticulture/ Natural Resources	*n.r.*	*n.r.*	yes	514	77% ♀; 75% ≥ age 50; 59% grad. deg.; 73% > average income	no	NA
Turnbull et al.	2020	yes	yes	Geography Conservation/ Development	*n.r.*	*n.r.*	no	NA	NA	yes	nestcam hosts; size *n.r.*
Zhang & Xiao	2023	Yes	Yes	Tourism	yes	none	no	NA	NA	yes	29, 55% female; ages 20-60; 66% from China; 93% ≥ college

Note. *n.r.* = not reported; ♀=female; ♂ = male; NA = not applicable; FT = full-time

worldwide audience for the nature-focused livestreams. Some reported a preponderance of viewers in the United States (Anderson, 2019), Australia (Blaer, 2023), or the United Kingdom (Jarratt, 2021).

Of those reporting sample descriptives from a research study (Blaer, 2023; Jarratt, 2021; Johnson-Pynn & Carleton, 2019; Searle et al., 2023; Shively, 2023; Skibins et al., 2022; Zhang & Xiao, 2023), all reported having a majority of participants who were female or who had at least a college education, and many samples skewed toward middle-aged to older adults (Blaer, 2023; Johnson-Pynn & Carleton, 2019; Shively, 2023; Skibins et al., 2022). In some of the studies, a majority of study participants watched the livestreams daily (Anderson, 2019; Johnson-Pynn & Carleton, 2019; Searle et al., 2023; Shively, 2023); however, two reported that only about 1/3 or fewer of the participants watched daily (Blaer, 2023; Jarratt, 2021). In the two evidence sources reporting the duration of viewing sessions (Johnson-Pynn & Carleton, 2019; Shively, 2023), substantial portions of participants (i.e., 40% - 72%) indicated they watched for at least an hour.

Broadcast Content and Broadcaster Characteristics *(RQ2 and RQ3)*

The broadcasts were made from locations across the globe including Australia, the United Kingdom, Kenya, the United States, Canada, and European countries. Broadcasts included a wide range of content from landscapes and curated wildlife environments (i.e., conservation center, safari park, or zoo) to views of specific animals in the wild. Specific content included the “penguin parade” from Phillip Island Nature Parks in Victoria, Australia (Blaer, 2023); peregrine falcon nests (Searle et al., 2023; Turnbull et al., 2020); African wildlife (Shively, 2022); nests from a variety of bird species (Anderson, 2019; Beddington, 2020; Johnson-Pynne & Carlton, 2019); and bears (Skibins, 2022). In general, the articles provided

Table 2. Overview of key findings for sample of evidence sources of nature-focused livestream broadcasts and well-being ($N = 13$).

						Outcomes Identified		
Author(s)	**Viewer Location**	**Livecam Location**	**Broadcast Content**	**Broadcaster Characteristics**	Aims include identifying specific well-being outcomes?	Positive affect/Uplifted mood	Relaxation/rejuvenation	Knowledge/fascination/ escape
Anderson	82% in USA	Rural Montana, USA	osprey nest, ranch activities	Private guest ranch	No		✓	
Beddington	worldwide	Varies by platform including Netherlands, UK, USA	bird nests; captive penguins, pandas, koalas, and jellyfish	varies by platform, including zoos	No	✓		
Blaer	88% in Australia	Phillip Island Nature Parks, Victoria, Australia	penguin parade	not-for-profit conservation organization	No	✓		
Jarratt	83% in UK	nature reserve and seaside in the UK	wildlife, landscapes, zoos & safari parks, aquariums, pets	varies by platform, including business improvement district	No	✓	✓	✓
Johnson-Pynne & Carlton	*n.r.*	Georgia, USA	nesting bald eagles	College	No		✓	✓
Searle et al.	worldwide	United Kingdom	peregrine falcons	varies including a church and conservationists	No	✓		✓
Shively	Worldwide	Mpala Research Center and Conservancy in Kenya	animals in natural habitat	research & conservation center	Yes**		✓	✓
Skibins et al.	worldwide	Alaska, USA	brown bears in Alaska	recipient of private foundation funding	Yes*	✓	✓	✓
Turnbull et al.	*n.r.*	United Kingdom	peregrine falcons	*n.r.*	No	✓		✓
Zhang & Xiao	*n.r.*	*n.r.*	*n.r.*	*n.r.*	Yes**	✓		

Note. *n.r.* = not reported; *outcomes = quality of life, relaxation, and reduction of stress; **outcomes = psychological well-being

scant information about the broadcasters other than the type of organization. The broadcasters (see Table 2 for details) varied and included a private for-profit business (Anderson, 2019), a private college (Johnson-Pynn & Carleton, 2019), a quasi-governmental agency (Jarratt, 2021), a research and conservation center (Shively, 2023), and zoos and aquariums (Beddington, 2020; Jarratt, 2021). Only one article (Skibins et al., 2022) reported the funding source of the broadcaster, which was a private foundation.

Platform and Broadcast Features (RQ4 and RQ5)

There was little consistency in the types of platform features that were discussed in the articles. Some (n = 4, 40%) indicated that the platforms had social media features that allowed viewers to message one another, post chats, or integrate with other social media platforms (i.e., Facebook, Instagram). One article noted that a substantial portion of the participants (28%) communicated with other viewers "outside the context of the…webcam" (Johnson-Pynn & Carleton, 2019, p. 4). Two articles (20%) reported that the platform provided additional content, including expert commentary, guest presenters, blogs, FAQs, and raffles for naming rights (Anderson, 2019; Blaer, 2023). One (10%) noted the video content was downloadable (Beddington, 2020)) or reported that the platforms provided the opportunity for viewers to make donations (Blaer, 2023).

Of those reporting on synchronicity (n = 4, 40%), all indicated the platforms had opportunities for both real-time and lagged communications (Anderson, 2019; Beddington, 2020; Blaer, 2023; Johnson-Pynn & Carleton, 2019). Articles rarely discussed cue absence, but when they did (n = 2, 20%), they reported medium to high levels of cue absence (Blaer, 2023; Johnson-Pynn & Carleton, 2019). Two (20%) reported on sites that were fully public (Blaer, 2023; Johnson-Pynn & Carleton, 2019), but others reported on sites restricted to members (Anderson, 2019) or multiple sites with varying degrees of publicness (Beddington, 2020). There

was no consensus on levels of anonymity on the platforms among the articles that addressed anonymity (Beddington, 2020; Blaer, 2023; Johnson-Pynn & Carleton, 2019).

Most articles (n = 6, 60%) indicated that multiple cameras were broadcasting on the platforms. The broadcasts typically came with sound (Anderson, 2019; Beddington, 2020; Johnson-Pynn & Carleton, 2019; Searle et al., 2023; Shively, 2023). Half (n = 5) reported round-the-clock access to the broadcasts (Anderson, 2019; Blaer, 2023; Johnson-Pynn & Carleton, 2019; Searle et al., 2023; Turnbull et al., 2020), at least during peak season for the broadcast content (Skibins et al., 2022; Turnbull et al., 2020), with scheduled programming reported in two (20%) articles (Anderson, 2019; Blaer, 2023).

Well-being (RQ6, RQ7, RQ8, and RQ9)

RQ6 asked *What well-being outcomes were associated with viewing NFLs?* Five articles (50%) had well-being findings related to relaxation and rejuvenation, and six reported findings related to novelty, fascination, escape, or increased knowledge (n = 6, 60%). Each of the article's well-being outcomes are denoted in the checklist section of Table 2.

The evidence sources reported well-being-related outcomes along three major themes: Positive Affect/Uplifted Mood; Relaxation/Rejuvenation; and Knowledge/Fascination/Escape. Only a few (n = 3, 30%) of the evidence sources (Shively, 2023; Skibins et al., 2022; Zhang & Xiao, 2023) had an explicit aim related to identifying well-being outcomes (RQ7). In these three articles, well-being was measured with single items related to happiness and levels of stress (Shively, 2022); open-ended items on a questionnaire (Skibins et al., 2022); and using a facial reader as viewers watched the livecam broadcasts (Zhang & Xiao, 2023). The other articles reported well-being findings through qualitative methods (e.g., content analysis, analysis of open-ended survey items) as a post-hoc finding, and none reported psychometric properties of their assessment instruments (RQ8).

Potential mechanisms (RQ9)

Six (60%) of the articles identified at least one mechanism for why viewing nature-focused livestreams led to well-being outcomes (Anderson, 2019; Blaer, 2023; Beddington, 2020; Jarratt, 2020; Searle et al., 2023; Turnbull et al., 2020). None of the sources used quantitative methods and statistical analyses to identify mediating variable(s) in models of well-being. All of these reported that it was through connecting with nature. Sometimes, this connection was in ways that would be impossible without the webcam. For example, Turnbull et al. noted, "nestcams…allow for interpersonal relationships to form between viewers and individual animals" (p. 6.7), and Searle et al. stated, "the cameras have the ability to break down barriers" (p. 204).

In addition, connecting to other humans through the platforms was identified in two of the articles (Anderson, 2019; Blaer, 2023) as a mechanism for enhanced well-being. Anderson (2019) reported on "a sense of rejuvenation and healing that comes from connecting with nature and connecting with each other" (p. 339). Blaer (2023)—who studied webcam travel more generally but reported specific well-being outcomes associated with viewing natural locations—wrote that changes in viewers occurred, "in part through building and engaging online communities and supporting a sense of connection to nature" (p. 47).

Discussion

This scoping review synthesized knowledge of nature-focused livestreams and their association with adults' well-being. The findings show evidence for a link between viewing nature-focused livestreams and well-being along dimensions similar to those associated with engagement with physical nature (Capaldi et al., 2014; Corazon et al., 2019; Daniels et al., 2022; Farrow & Washburn, 2019; Hansen et al., 2017; McMahan & Estes, 2015; Wen et al., 2019; Yao

et al., 2021). This suggests that nature-focused livestream viewing could be used to enhance well-being for adults, particularly when access to physical nature may be limited.

Our first research question asked about the characteristics of the broadcast viewers. We found the broadcasts had a global reach with a tendency toward Western audiences. Most lead authors were from the United States or the United Kingdom, which may have biased the results on viewership toward these two countries. Future research focusing on audiences from a broader variety of global locations is warranted. Most of the viewers tended to be well-educated and middle-aged or older. Although it is possible that other viewers could also report enhanced well-being associated with nature-focused livestreams, additional research is needed with samples containing ample participants from a broad range of demographic groups.

The next two research questions focused on the content of broadcasts and characteristics of the broadcasters. Most articles reported on the content, which tended to be specific animals in natural or zoo habitats. Because both theory and empirical support indicate that different types of natural landscapes and exposure may have different effects on humans' social and emotional responses (Bratman et al., 2019; Snell et al., 2015; van Houwelingen-Snippe, van Rompay, de Jong et al., 2020), it is possible that the content of nature-focused livestreams would also produce different social and emotional responses for viewers. As the body of evidence for well-being outcomes of nature-focused livestreams grows, researchers may be able to identify how content impacts viewers.

In contrast to information on broadcast content, details about the broadcasters themselves were less available. Because there are a variety of online content creators with differing motivations (Blank, 2013; Munar & Jacobsen, 2014), it is reasonable to hypothesize that the characteristics of livestream broadcasters could influence the motivations and outcomes of nature-focused livestream broadcasts. Providing information about broadcasters in future

research should help build knowledge about the factors associated with well-being outcomes, specifically related to broadcaster type and motivation.

Regarding our fourth and fifth research questions related to the features of the platforms and the broadcasts, it was typical for the articles to provide descriptions of the broadcasts from the viewers' perspective (e.g., 24-hour access; multiple cameras on a livestreaming website). However, less information was provided regarding the platforms on which the broadcasts were made available. Neo-ecological theory (Navarro & Tudge, 2022) suggests that the features of online platforms are important characteristics of the virtual systems in which individuals are embedded. Using the neo-ecological framework to report platform characteristics (e.g., synchronicity, publicness, anonymity, cue absence) in future research could provide valuable context for understanding and assessing how broadcasting platforms relate to viewers' experiences.

Our final three research questions concerned well-being outcomes for viewers of nature-focused livestreams. In this study, the nature-based webcams were viewed as the vehicles or mechanisms that can potentially impact viewers' hedonic and eudaimonic well-being. We only found evidence for hedonic well-being outcomes; however it is possible that eudaimonic effects exist but have not yet been examined. Regarding hedonic well-being, it is entirely plausible that individuals derive emotional benefits from engaging with the nature-based webcams, including a sense of pleasure and an emotional connection with flora and fauna and with their fellow viewers, particularly with sites with chatrooms. In terms of eudaimonic well-being, individuals may derive meaning by watching nature-based webcams, such as a sense that the world is larger than their own lives, a reckoning of their place in the world, and a better understanding of the meaning of their life within the context of the natural world.

Although each of the 10 articles in this review reported well-being outcomes, only a few (n = 3, 30%) had specific aims of examining well-being. These articles (Skibins et al., 2022; Shively, 2023; Zhang & Xiao, 2023) were published in 2020 or later, suggesting the recency of intentionally exploring how nature-focused livestreams can improve well-being. Among all the articles, we found various psychosocial well-being outcomes associated with nature-focused livestreams. None of the evidence sources explored physical benefits of viewing nature-focused livestreams, such as those linked to engaging with the physical natural world (Twohig-Bennett & Jones, 2018; Wen et al., 2019; Yao et al., 2021). Neither did any evidence source explore how platform or broadcast features were associated with the effectiveness of viewing broadcasts to influence well-being. It is clear that research on this fairly new innovation for connecting with nature is in its infancy with the potential to examine many additional well-being outcomes and viewing contexts. Additional research is needed to help interrogate a full array of potential benefits and mechanisms of nature-focused livestreams on well-being among different populations and in different contexts and circumstances. New studies using larger samples and quantitative methods could test theoretical frameworks that assert hypothesized mechanisms, including connecting with nature and others.

Limitations

Some limitations are inherent to the scoping review method, but these do not diminish its intended purpose—to map existing literature on a broad topic, identify the key concepts, the evidence available, and any gaps, as well as inform future research. For example, the lack of a quality assessment as found in systematic reviews and meta-analyses, means that scoping reviews do not evaluate the rigor of the evidence sources. We intentionally did not include an assessment of methodological rigor because our goal was to map the existing literature, not evaluate it (Tricco et al., 2018). Another example is the use of broad operational definitions in

order to gather as broad a sample of evidence sources as possible. In our case, we used a broad definition of well-being. Although our scoping review may lack some specificity, we purposely kept our definition of well-being broad to allow for the inclusion of a wide range of well-being outcomes.

Although this scoping review was conducted in a systematic and rigorous way, it is possible relevant studies may have been overlooked. Although our search strategy included articles published in any language, we found only articles in English, and most of the samples were from the English-speaking world, which likely limits generalizability. Many participants in most of the studies in this review were university-educated women who viewed nature-focused livestreams daily. These sample characteristics may further reduce the ability to generalize to other populations. Highlighting the demographic skew of the studies is an important scoping review finding pointing to the need for additional research.

Conclusion

Nature-focused livestreams have promise for bringing the benefits of the natural world to a variety of audiences and potentially improve the lives of those who cannot leave their homes or live far from natural environments. To the extent that viewing nature-focused livestreams confers positive emotional, psychological, and social benefits, access to the broadcasts should be equitable across socioeconomic and geographic groups. Additional research is needed to better understand the effects of viewing these broadcasts, especially to examine the results of diverse broadcast content and platforms among a diverse viewership and to include potential physiological benefits. As knowledge about nature-focused livestreams continues to grow, researchers, practitioners, and broadcasters alike can gain valuable insights and tools to provide the most beneficial content and delivery to a wide array of audiences worldwide.

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