GUEST EDITORIAL

Nature on screen: The implications of visual media for human−nature relationships

The implications of digital visual media for human−nature relationships

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1 | INTRODUCTION

Amid biodiversity and climate crises, the way we encounter and communicate about the natural world is changing. Increased technological capability, accessibility and connectivity have enabled a proliferation of content, platforms and consumption of digital visual media. Even as environmental and conservation scientists have—perhaps belatedly—begun investigating how 'traditional' forms of digital visual media (e.g. movies, television) affect the thoughts and actions of their audiences (Fernández-Bellon & Kane, 2020; Fukano et al., 2020; Silk et al., 2018; Veríssimo et al., 2020), emerging technologies such as augmented (Dunn et al., 2021) and virtual reality (Blythe et al., 2021) are enabling both the projection of digital phenomena into actual landscapes and the immersion of users in virtual ones.

This 'Nature on Screen' special feature draws attention to new research and perspectives around two key questions. First, how and why is 'nature on screen' produced, by whom and for whom? Second, how does digital visual media both reflect and inform people's relations with the natural world? We take a holistic approach to examining the role of visual media in human−nature relations, considering not only the consumption and impact of content but also its conception, development and production.

We employ broad-brush definitions of 'nature' and 'visual media'. 'Nature' here refers primarily to the biophysical world and does not necessarily exclude humans. Articles in the special feature include depictions of (more-or-less realistic) animals, landscapes, ecological processes and environmental histories. 'Visual media' can refer to all kinds of visual culture including art, photography and digital imagery. Many forms of media are also more than just visual, involving other senses such as hearing and, increasingly, touch (Mitchell, 2005), but the dominance of screens and power of imagery makes visual media a central component of an increasingly digital world. This special feature consequently focuses on 'nature on screen', that is, as represented through digital visual media, including television programmes and movies, video games, virtual reality and image-oriented social media (e.g. YouTube, Instagram)—see Table 1 for a typology.

2 | NATURE ON SCREEN: FROM PRODUCTION TO IMPACT

We provide an overview of the processes through which visual media can influence human−nature interactions (Figure 1), following a narrative from the initial production of content, through consumption of and engagement with different forms of digital visual media,

TABLE 1 Typology of digital visual media formats, with examples of content types and research investigating digital visual media and human–nature relationships

Format	Examples	Relevant research
Static image	Digital photographs, graphics, memes	Arts et al. (2021), Conti and Heldt Cassel (2020) and Tenkanen et al. (2017)
Short-form video	TikTok, YouTube, music videos	Freund et al. (2021), Blythe et al. (2021), Thomas et al. (2021) and Hautea et al. (2021)
Long-form video	Documentaries, movies	Aitchison et al. (2021), Boissat et al. (2021), Carpentier et al. (2021), McCormack et al. (2021) and Somerville et al. (2021)
Live video	Webcams, live streams	Jarratt (2021) and Verma et al. (2015)
Digital game	Console/PC games, mobile games	Crowley et al. (2021), Dunn et al. (2021), Fisher et al. (2021), Fletcher (2017) and Truong et al. (2018)
Other app	ID guides, wildlife recording, educational apps	Altrudi (2021), Santori et al. (2021) and Verma et al. (2015)

to how content can impact human–nature interactions. Throughout, we consider how researchers might best study these processes, using examples from this special issue and further afield to illustrate key ideas and approaches.
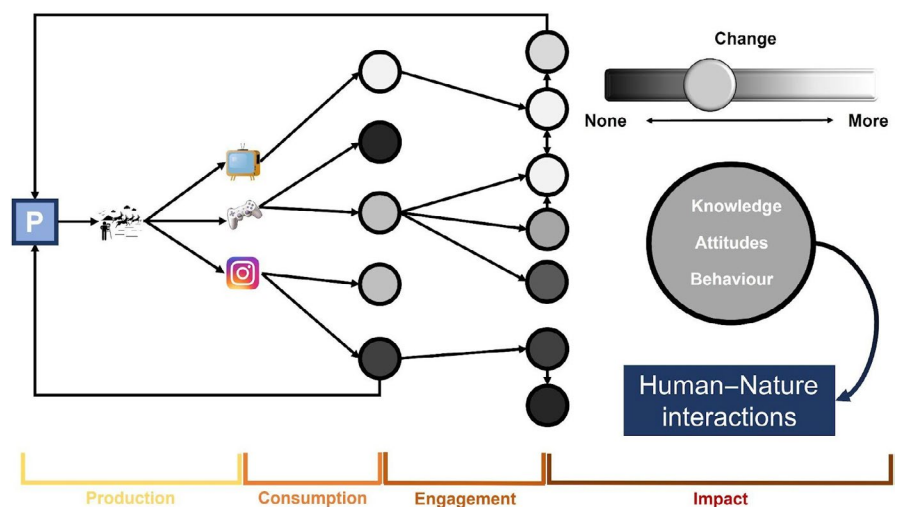
2.1 | Production

The visualisation of nature is facilitated by increasingly sophisticated techniques of observation, and contextualised by changing ideas around human–nature relationships. What happens 'behind the scenes' can be conceptualised in terms of 'production ecologies' (Cottle, 2004), provoking questions such as what tools, technologies and techniques are used for creation and dissemination?; who is responsible for representing nature, and to what end(s)?; and what wider socio-economic and cultural factors shape these depictions?

Insights into the technicalities of image-making are an increasingly conspicuous aspect of producing nature programmes, for example with supplementary segments showing audiences how the material for nature documentaries is captured (Louson, 2021). These often feature technological innovations designed to capture unpredictable or less visible wildlife, film in inaccessible terrains and extreme weather (e.g. motion-detecting cameras, macro photography, stabilisers), or generate content for mass consumption and instant circulation (e.g. web-cameras and live streams). Traditional wildlife films have tended to instruct a detached, non-intrusive 'viewership' underpinned by (and upholding) a human–nature divide, even for those behind the camera (Aitchison et al., 2021). This may explain why tensions can emerge when producers of visual nature intervene—or do not—to help wildlife in distress (as in a recent case: Mohdin, 2018). There are also material implications and tangible environmental impacts of digital media production, such as the creation of e-waste (Maffey et al., 2015). Aitchison et al. (2021) discuss, from a practitioner's perspective, some of these environmental tensions and challenges, and provide some suggestions as to how researchers and filmmakers might collaborate to address them.

The aims of formal productions (e.g. wildlife documentaries) include education, raising support for conservation and generating profit. These may not be mutually exclusive and might best be understood by considering both the creators and contexts of production. While wildlife filmmaking has been written about extensively (e.g. Blewitt, 2010; Burt, 2002; Cottle, 2004), nature documentaries are not a homogeneous category. There are, for example, standard productions and 'blue-chip' high-value productions with mass global appeal, characterised by spectacular nature imagery (Bousé, 2000; Louson, 2018). Financial backing, organisational structures (e.g. commissioning bodies) and target viewership all shape producers' choices of narrative framing and what to include. While affective storytelling and arresting aesthetics remain central (Somerville et al., 2021), motivations for choice of narrative techniques are

FIGURE 1 An illustration of the process by which visual media impacts human–nature interactions. Visual media is produced in various forms with different purposes in mind (Section 2.1). It is then consumed by an audience that may be engaged with the content and encourage consumption by peers in their social network (Section 2.2). The knowledge, attitude or behaviour of all those who interact with the content (directly or indirectly) could then be changed, potentially impacting human–nature interactions (Section 2.3)

changing, with an apparent move towards more explicit conversations around biodiversity loss and anthropogenic causes of ecological change (Aitchison et al., 2021).

Beyond wildlife films, less is known about the production ecologies or aims of digital visual nature content. There are clear research avenues in investigating the development and intent of nature-depicting short-form videos and live-streaming services. Remote camera viewing or webcams, for example, may be employed by conservation organisations to bring awareness to particular species or encourage public support through donations and patronage (Verma et al., 2015). An increasingly sophisticated but under-examined means of bringing nature to screen relates to the generation of nature content by social media users. Arts et al. (2021) take an exploratory step in this direction by investigating the motivations and practices of Instagram users producing, editing and sharing images of the outdoors.

As regards the wider social context and ethics of producing nature on screen, we have identified three interrelated concerns: authenticity of depictions, creator responsibility and representational justice. Concerns about authenticity are fundamentally about the relationship between representation and reality. There have been several high-profile instances in which producers of wildlife films have been accused of misleading or deceiving viewers with footage that appears to be 'natural' but was contrived, for example by piecing together unconnected scenes to fit a narrative (Louson, 2021). The grey areas between factual presentation and engaging storytelling are a matter of concern for Somerville et al. (2021), who argue that the dramatised depiction of wildlife in the series 'Dynasties' is a form of misinformation that confounds public understanding of science.

This raises the question: what are the ethical responsibilities of those who represent nature on screen? There are codes of practice voluntarily upheld by most wildlife film producers, which centre on animal welfare during production. Such codes do not extend, however, to social media users or organisations sharing wildlife content online. Recognising that sharing videos of charismatic species has the potential for both positive and negative impacts on their welfare and conservation, Freund et al. (2021) analysed the content of YouTube videos posted by orangutan rescue and rehabilitation organisations. They aimed to determine whether particular video features affect engagement (see below) and the sentiment of user comments, with a view to providing best practice guidelines for relevant organisations and avoiding negative consequences for orangutans (e.g. unintentionally increasing demand for orangutans as pets). More than simply protection from harm, however, there is growing consideration around what the wider purposes and social responsibility of media production are (Aitchison et al., 2021; Boissat et al., 2021), especially in the face of climate and extinction crises.

A crucial, but under-examined, aspect of producing nature on screen is representational justice, both for humans and nonhumans. There is a continuing popularity of content focusing narrowly on familiar species and 'spectacular' narratives (Igoe, 2010; Somerville et al., 2021); persistent, stereotypical representations of certain species (e.g. the use of predators as 'enemies' in video games;

Crowley et al., 2021); and often entire omissions of smaller-bodied taxa. However, arts-based collaborations (Thomas et al., 2021) and technological improvements in miniaturisation have expanded the options for depicting nature previously unfamiliar or unseen (Verma et al., 2016). Traditional wildlife films have also been critiqued for tendencies to de-people nature and exclude human impacts from meaningful visualisation, resulting in replication of (neo)colonial, racialised and gendered conservation ideologies and relationships (Adams, 2003). This is partly an issue of resources and access (e.g. uneven funding distribution), and partly a product of romantic constructions of nature as pristine wilderness, where signs of humanity, and particularly indigenous communities, are either visually erased or depicted as primitive (Castree, 2014). Other productions provide more inclusive and contextualised perspectives, however, such as environmental justice documentaries and cinema. Carpentier et al. (2021) explore how documentary film Kiruna (about the physical relocation of a town undermined by its own mining industry) visualises both the dominant, anthropocentric ideologies that have led to Kiruna's current predicament, and also how these are contested and resisted by both the town's inhabitants and, the authors argue, the soil itself.

2.2 | Consumption and engagement

How digital visual nature content is disseminated also has a defining role in both the audience it reaches and how this audience will engage with it. Some forms of visual media require specialist equipment (e.g. virtual reality) or subscriptions which may restrict accessibility based on wealth or availability (Straubhaar et al., 2019). Cultural differences may also give content particular relevance or appeal to audiences in a certain region (even if also popular elsewhere). For example, the video game Animal Crossing: New Horizons is rooted in Japanese culture and conceptions of human–nature relationships (Fisher et al., 2021). However, as Internet access becomes increasingly widespread, the (sometimes live) streaming of content through platforms such as YouTube (Freund et al., 2021; Thomas et al., 2021) and Instagram (Arts et al., 2021) greatly facilitates international access to nature-related visual media from multiple devices. While the proliferation and diversity of online content increases competition for viewers' attention, search and recommendation algorithms make content more readily accessible to interested audiences; indeed, evidence suggests most online consumption of visual content is driven by these algorithms (Zhou et al., 2010). Yet, the use of recommendation algorithms raises critical questions regarding (a) what content gets promoted, to whom and why and (b) the consequences of these algorithmic decisions. For example, recommendation systems may reinforce representational biases highlighted above, and create potential exclusions related to audience segmentation.

One way these questions might be addressed is by tracking consumption, attention and engagement with specific content. Following the incorporation of social networking capabilities into internet-based platforms, views, likes, comments and shares can be

used by content creators and broadcasters to assess which topics generate most engagement with audiences and are a priority for further investment. For example, Thomas et al. (2021) use these metrics to examine how the reach of their educational Shout Trout Workout lyric poem, comic and music video varied depending on who shared it, and on which social media platform, as well as to gauge the reaction to it. Aitchison et al. (2021) discuss how streaming services such as Netflix have an advantage over traditional broadcasters due to the wealth of information they have about their customers' viewing habits and interests. Social media can also be used to investigate how individual consumption of visual media fits within wider networks, as people are embedded within communities with whom they communicate either in person or online (Figure 1). For instance, nature recreation or citizen-science enthusiasts who coalesce around particular representations of nature can establish links and interactions that stimulate the emergence of dedicated communities (Daume & Galaz, 2016; Sbragaglia et al., 2020). These communication networks are therefore integral to shaping the reach of digital visual media by influencing who hears about particular content and what information they are exposed to. Network thinking also helps disentangle what is meant by consumption and engagement. Here, we use consumption to describe the process of how someone receives visual media content, content-related information or associated messages (Figure 1). We then use engagement to reflect how they share or disseminate this information through their networks in ways that could generate wider impacts (see below).

Information flow and behaviour change in social networks have been the subject of extensive cross-disciplinary research (see de Lange et al., 2019). In the context of visual media, the likelihood of engaging may depend on who and how many people the information is received from, as well as its content. For example, a consumer may be more likely to discuss or share something that everyone else is discussing or the likelihood of changing behaviour may depend on reinforcement from peers alongside watching a nature documentary (something that producers can directly encourage by, for example, organising group screenings; Aitchison et al., 2021).

Understanding the role of communication networks can be difficult outside carefully controlled conditions. However, digital media platforms provide a wealth of relevant data that enable new insights into consumption and engagement with both visual media and associated conservation/environmental messaging (Correia et al., 2021). Already, wildlife filmmakers extensively use such metrics to gather information on the reach of their programmes (Aitchison et al., 2021), and researchers have used video and other social media metrics to investigate how different content is received and responded to (Freund et al., 2021). People may preferentially communicate with others who share common views and values, potentially producing echo chambers (Cinelli et al., 2021; Miller et al., 2021). Consequently, reaching a large audience may not have the same impact as reaching the right audience, even if highly engaged. In the case of digital visual media related to wildlife conservation this may be especially important, as often the primary consumers will be those who already have an interest (Dunn et al., 2021).

Finding content that extends engagement with conservation or pro-environmental messages to more diverse audiences is critical to enhancing impact (see below). Social media platforms offer multiple routes to identify who is engaging with content (e.g. likes, retweets, shares etc.; Freund et al., 2021; Thomas et al., 2021), their views on the material they are engaging with (Doughty et al., 2020) and the social networks of those sharing the content (e.g. Weber et al., 2020). In our hypothetical example in Figure 1, engaged individuals (light grey) play an important role in influencing new audiences that were not initially reached, whether this be a new social 'bubble' or different demographic.

One recent area of inquiry highlighting novel means of engaging audiences with nature content focuses on video games and immersive reality technologies. Such media arguably (Fletcher, 2017) enable less prescriptive or passive modes of engaging with (simulated) natural environments than watching videos (Tait & Nelson, 2021). For example, Crowley et al. (2021) highlight how the immersive environments of Red Dead Redemption 2 require players to actively engage—often violently—with simulated wildlife, while Fisher et al. (2021) propose that interactive features of Animal Crossing: New Horizons could inspire pro-conservation behaviour.

2.3 | Impact

Impact can be defined as the positive, neutral or negative, primary or secondary effects produced by a media stimulus, directly or indirectly, whether intended or unintended. Regardless of their aims, digital depictions of nature have the potential to have 'actual world' effects on people's understanding of, and behaviour towards, the natural world. Crowley et al. (2021) identify, for example, that the big-budget video game Red Dead Redemption 2, designed primarily for entertainment rather than education, nevertheless teaches its players to better identify North American wildlife. This indicates a potential role for immersive, interactive visual media in the delivery of ecological education, a point supported by Thomas et al. (2021). Beyond knowledge transfer, the 'vicarious experiences' (Kellert, 2002) of nature provided by visual media can shape understanding and perceptions of human–nature relations. Arts et al. (2021) highlight how Instagram users' nature photography is both influenced by, and reinforces, standardised stories and representations of the outdoors, and how generating and curating these representations is an increasingly central component of outdoor experiences. Blythe et al. (2021) compared empathetic responses to environmental messaging about future ocean health scenarios, delivered through both virtual reality video and written statements. They found that the use of pessimistic or optimistic narratives was associated with increased empathy, but that medium of delivery had no apparent effect. Effective emotional engagement and storytelling, as much as degree of immersion or technological novelty, may therefore be key to the immediate impact of vicarious nature experiences. Correspondingly, McCormack et al. (2021) draw on insights from social psychology to propose a framework for studying and

enhancing the 'narrative persuasion' of environmental films, with the aim of improving their effectiveness in inspiring pro-environmental behaviours.

Given that the primary goal of biodiversity conservation is to improve the status of species and ecosystems (Veríssimo, 2019), conservationists working with digital visual media are increasingly focused not just on influencing knowledge and perceptions, but also producing measurable, positive conservation impacts. However, the relationships between visual media consumption and ultimate biodiversity impacts are multi-dimensional; here, we highlight four key challenges that must be overcome to determine and measure these impacts (both positive and negative).

The first is going beyond indicators of attention and engagement. Audience consumption and engagement can be measured with ever more ease and detail, but this wealth of information can create an illusion of comprehensiveness, with organisations focusing exclusively on metrics to the detriment of measuring the ultimate impacts of engagement. An example of this is UNEP's WildforLife campaign, a highly awarded digital conservation initiative that has focused on its extensive reach to claim impact (Hether, 2018). This claim rests on the assumption that reach is equivalent to, or at least indicative of, impact. Yet while reaching the right audience is a prerequisite for impact, it is insufficient to guarantee it, with evidence that interventions with wide reach can have limited to no impact. For example, Shreedhar (2021) used Facebook advertising to fundraise for conservation, reaching more than 300,000 Facebook users but eliciting only a single donation.

The second challenge is ensuring that the evidence base is robust enough to understand cause and effect. Recent years have brought an increase in the number of robust evaluations of digital media interventions, focusing on narrative films, documentaries and mobile games. These have included both quantitative design such as randomised control trials and synthetic controls (e.g. Dunn et al., 2021) and theory-based evaluation, which focuses explicitly on understanding causality as opposed to quantifying change, and allows for post-hoc evaluation to be carried out (e.g. Boissat et al., 2021). These evaluations suggest that mobile games such as Kakapo Run and documentaries such BlackFish were catalysts for change (Boissat et al., 2021; Dunn & Veríssimo, 2020). Yet, there remains a tendency for causal claims to emerge based on anecdotal evidence, which may still gain traction in the media. BBC documentary series Blue Planet II was widely lauded as a catalyst for the movement to reduce plastic use. While the series may have contributed to change through its impact on specific influential individuals and organisations, for example, the UK's environment minister (Aitchison et al., 2021), research by Dunn et al. (2020) identified that viewing the programme had limited impact on individual consumer behaviour, despite increasing audience knowledge. Similarly, the movie Finding Dory was initially blamed for increased demand for Blue Tang fish, the species of the protagonist, a phenomenon for which subsequent analysis found no evidence (Veríssimo et al., 2020) despite evidence of increased interest in the species (Silk et al., 2018). In other instances, causal

claims around impact are made based on evidence that is not robust enough to support them, such as direct comparisons between those exposed to a specific item of media content and those who are not (e.g. WWF, 2020). Because those consuming media are self-selected they may, for example, have a higher initial interest in wildlife and be more likely to respond to interventions, making it difficult to generalise their behaviour to wider populations (Arendt & Matthes, 2014; Veríssimo et al., 2018).

The third challenge is to link changes in human behaviour with changes in the biological indicators of interest, or at least clarify the assumptions of these links. Thomas-Walters et al. (2021) illustrate the complexities of both connecting behaviour change to biological indicators and disentangling potential drivers of a change in a population or species (e.g. limits to observational data, time-lagged response of indicators, confounding interventions). In these cases, theory-based impact evaluation may be particularly helpful, as shown by Salazar et al. (2019) when examining the role of social marketing campaigns in the recovery of a parrot population in the Caribbean Island of Bonaire.

The fourth and final challenge is to embrace failure and learning. Conservation interventions utilising visual media require innovation, which brings with it risk, and not all intended goals will be achieved. Reticence in sharing negative outcomes limits cross-institutional learning from initiatives, an already pervasive phenomenon in conservation science (Catalano et al., 2018). However, this information is critical for successful interventions to develop while maintaining the level of effectiveness, and indeed cost efficiency, that conservationists hope for. This willingness to share failure, alongside more rigorous evaluation, could enable digital visual media interventions to play a key role in impactful conservation practice.

3 | EMERGING THEMES

A clear theme throughout this special feature is the proliferation of platforms through which nature on screen is shared (Table 1). A corresponding increase in content represents a key challenge to those using digital visual media to promote conservation messages, but also offers opportunities to rethink how we depict and perceive human–nature relationships, as well as inspiring new research directions. While we have discussed visual media through a linear process of production, consumption, engagement and impact, a growth in accessible image-capturing and viewing technology (e.g. smartphones) blurs the lines between producers and consumers (Manovich, 2009) of digital nature content, to some extent 'democratising' its production. The growth of visual social media has also compressed time lags between production and consumption, enabling rapid content distribution, feedback and adaptation (e.g. through memes), but at the same time creating conditions for rapid decontextualisation and fleeting relevance. The implications of this democratisation and acceleration of content production for human understandings of nature, and the impacts of these processes, are exciting areas for future research.

Democratisation of production also returns us to the important question of who is producing what and for whom? This special feature highlights a diversity of producers, and the challenges faced in determining the purposes and audiences of their content. Even forms of digital visual media traditionally linked to representing the natural world, such as wildlife documentaries, are rapidly changing their approach to generating content and engaging with audiences (Aitchison et al., 2021). Furthermore, social media platforms increasingly enable anyone to produce nature-related visual media, and in some contexts the nature depicted may itself be virtual (e.g. Onder, 2021; see also Crowley et al., 2021). Those generating content for visual social media may change how they interact with nature in order to do so, for example, visiting particular sites or attending to wildlife and landscape features they would otherwise have ignored. Producers' goals in generating content are hence likely to be important both for their own experience, and in shaping the expectations of others vis-a-vis the nature being depicted, a potentially fruitful area of study (Arts et al., 2021).

Our discussion therefore highlights a diversity of motivations and intended outcomes for representing nature on screen. Nature content may aim to entertain, educate, promote conservation efforts, change behaviour, enhance profit or enable social engagement. Often there are tensions between the commodification of nature and environmental goals, whether this is designing content that intends (or hopes) to shape human–nature relationships (McCormack et al., 2021) or trying to anticipate and avoid unintended consequences (Freund et al., 2021). The production and consumption of visual media also has environmental impacts; finding the right balance between these negatives and influencing broader and more diverse audiences is a critical challenge to be addressed (Aitchison et al., 2021).

These emerging challenges can only be satisfactorily addressed by gaining a more robust understanding of how visual media impacts both human behaviour and outcomes for wildlife and ecosystems. The special feature explores various aspects of this, including examining how content might influence knowledge, attitudes and behaviour, both theoretically (Fisher et al., 2021; McCormack et al., 2021) and empirically (Blythe et al., 2021; Crowley et al., 2021; Dunn et al., 2021) or identifying how effects on humans translate to conservation outcomes (Boissat et al., 2021). However, it also illustrates how collaborations between producers and researchers can harness increasingly rich data available to producers to better understand what features of visual media shape their uptake and impact (Freund et al., 2021; Thomas et al., 2021).

4 | CONCLUSIONS

Research investigating the implications of digital visual media for human–nature relationships is diverse and dynamic, connecting multiple disciplines and areas of expertise. Here, we draw attention to both recent work and emerging research approaches in this field, particularly:

1. Collaborative working between content producers (e.g. filmmakers and games developers), researchers and consumers. Particularly fruitful collaborations could emerge with those groups whose perspectives have previously been marginalised, and/or who are the intended audience.
2. The use of culturomics and network analysis to better understand how content is disseminated, by whom it is shared and accessed and the extent of consumer engagement.
3. Combining empirical studies of the 'proximate' impacts of visual media on consumers' knowledge, attitudes and behaviours with theory-based evaluations of how nature-on-screen ultimately impacts human–nature interactions.

The production, dissemination, consumption and engagement of digital visual media are changing so rapidly that new opportunities and urgent challenges for research both continue to emerge. We hope that this synthesis provides a cross-disciplinary overview of progress so far, highlights the most valuable next steps, and inspires more research into the representation and impacts of 'nature on screen'.

CONFLICT OF INTERESTS
Matthew Silk and Sarah L. Crowley were Guest Editors of the 'Nature on screen: The implications of visual media for human–nature relationships' Special Feature, but were not involved in the peer review or decision-making process for this article. The authors have no other conflict of interests to declare.

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