

## RESEARCH ARTICLE



# Wildlife documentaries present a diverse, but biased, portrayal of the natural world

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## Abstract

1. Wildlife-documentary production has expanded over recent decades, while studies report reduced direct contact with nature. The role of documentaries and other electronic content in educating people about biodiversity is therefore likely to be growing increasingly important. This study investigated whether the content of wildlife documentaries is an accurate reflection of the natural world and whether conservation messaging in documentaries has changed over time.
2. We sampled an online film database ( $n = 105$ ) to quantify the representation of taxa and habitats over time, and compared this with actual taxonomic diversity in the natural world. We assessed whether the precision with which an organism could be identified from the way it was mentioned varied between taxa or across time, and whether mentions of conservation and anthropogenic impacts on the natural world changed over time.
3. Mentions of organisms ( $n = 374$ ) were very biased towards vertebrates (81.1% of mentions) relative to invertebrates (17.9% of mentions), despite vertebrates representing only 3.4% of described species, compared to 74.9% for invertebrates. Mentions were highly variable across groups and between time periods, particularly for insects, fish and reptiles. Plants had a consistently low representation across time periods.
4. A range of habitats was represented, the most common being tropical forest and the least common being deep ocean, but there was no change over time.
5. Mentions identifiable to species were significantly different between taxa, with 41.8% of mentions of vertebrates identifiable to species compared with just 7.5% of invertebrate mentions and 10% of plant mentions. This did not change over time.
6. Conservation was mentioned in 16.2% of documentaries overall, but in almost 50% of documentaries in the current decade. Anthropogenic impacts were mentioned in 22.1% of documentaries and never before the 1970s.
7. Our results show that documentaries provide a diverse picture of nature with an increasing focus on conservation, with likely benefits for public awareness. However, they overrepresent vertebrate species, potentially directing public

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attention towards these taxa. We suggest widening the range of taxa featured to redress this and call for a greater focus on threats to biodiversity to improve public awareness.

#### KEYWORDS

awareness, biases, conservation, documentaries, media, natural world, portrayals, public

## 1 | INTRODUCTION

The natural world is under increasing threat from accelerating habitat and biodiversity losses (Grooten & Almond, 2018; WWF, 2020), with estimated species extinction levels at 100–1000 times the background rate (De Vos et al., 2015). Despite urban areas supporting a surprisingly high diversity of species (Ives et al., 2016), disconnect between people and nature is growing, a trend which is often linked to reduced daily contact with nature (Maller et al., 2009; Miller, 2005). Frequent concerns are now raised around the 'extinction of experience', where children's opportunities to experience and develop a connection with the natural world are increasingly limited (Soga & Gaston, 2016). Contact with the natural world during childhood is positively related both to emotional connectedness to nature and to perceptions of local nature (Soga et al., 2016). Given the decline in children's daily contact with nature (Louv, 2005; Moss, 2012), public appreciation of the natural world could decrease in the near future.

In this context, technology-mediated portrayals of the natural world form an increasingly important component of people's experience of nature (Truong & Clayton, 2020). Popular media plays a key role in shaping public values and awareness (Boissat et al., 2021; Östman, 2014), and documentaries in particular have become an increasingly effective tool for social change (Whiteman, 2004), with potential to shape public perceptions of the environment (Jones et al., 2019; van Eeden et al., 2017). For example, watching nature documentaries is positively correlated with donating to pro-environmental organisations (Arendt & Matthes, 2016; Martín-López et al., 2007; Zaradic et al., 2009; Zhang et al., 2014).

However, nature documentaries have been accused of presenting a pristine view of the natural world and excluding the presence and impacts of humans (Jones et al., 2019), potentially as a result of commercial pressure to provide entertainment to viewers (Aitchison et al., 2021). This is also the case for other media designed primarily for entertainment value, such as video games, which can present the natural world as more risky and dangerous than reality (e.g. predators are often portrayed as aggressive towards humans, despite the contemporary risk they pose to humans being relatively low) (Crowley et al., 2021). Moreover, the natural world is often presented in popular media through a white, colonial lens (Humphreys, 2012)—as a pool of resources that humans should extract from or manage, rather than existing as an environment in its own right, which can be enjoyed passively or merely observed (Crowley et al., 2021). Technology-mediated nature experiences are therefore subject to

a high degree of editing and optimisation (Clayton et al., 2017); in practice, this means that scientific accuracy is sometimes compromised in favour of the primary purpose of a particular medium. As a result, a greater reliance on vicarious, indirect nature experiences than on direct experiences could produce a general bias or filter in people's expectations of the natural world (Truong & Clayton, 2020).

Given the capacity of technology-mediated nature experiences to influence people's environmental knowledge (Crowley et al., 2021), there is also substantial scope to amend or exacerbate existing biases in public awareness and appreciation of biodiversity. Current awareness of biodiversity is skewed towards vertebrate taxa, despite the fact that global animal diversity is dominated by invertebrates (Snaddon et al., 2008). Surveys conducted across children and adults show a preference for charismatic, familiar fauna, such as birds and mammals, over species perceived as less safe or less attractive, such as insects, reptiles and amphibians, and these attitudes can predict the likelihood of conservation support for these species (Liordos et al., 2017; Schlegel & Rupf, 2010). Biases towards large, charismatic species are not limited to the public; they are also apparent in scientific research, which displays a similar skew towards vertebrate over invertebrate taxa and, within vertebrates, towards mammals over other groups (Bonnet et al., 2002; Clark & May, 2002; Titley et al., 2017). This mirrors a reliance by NGOs on a relatively small number of flagship species in their fundraising campaigns: one study found that NGOs used just 80 flagship species, 58% of which were primates or carnivores (Smith et al., 2012). In general, these charismatic, flagship species are relatively large and colourful, have forward-facing eyes and are phylogenetically similar to humans (Jarić et al., 2022; Smith et al., 2012). While these species are selected to maximise monetary donations and engagement, similar levels of engagement could be achieved using other species that are less often used to head flagship campaigns while expanding the taxonomic diversity of species presented to the public (Shreedhar, 2021; Smith et al., 2012).

The selection of flagship species is dependent on the context of the particular conservation message being promoted (e.g. does it need to have local versus international appeal?) (Smith et al., 2012; Verissimo et al., 2011). As a result, children surveyed across a range of countries consistently referred to the same few mammals as deserving of priority protection, and were less good at identifying local animals and less likely to identify them as conservation priorities (Ballouard et al., 2011). This illustrates how the charisma of a species can affect its prominence in wider society (societal salience) and thus make it more or less prone to societal extinction (the loss

of collective memory of a species, through the loss of attention, knowledge and representations associated with it from cultures and societies (Jarić et al., 2022)), with knock-on effects for biological extinction (Jarić et al., 2022).

Since public perception of the natural world can influence the amount of support conservation initiatives receive and their overall success (Champ, 2002; Fischer & Young, 2007; Shunula, 2002), as well as the development of environmental policies (Martín-López et al., 2009; Renn, 2006), unbiased nature documentaries could play an important role in promoting the conservation of undervalued species. Despite portrayals being optimised for entertainment value, technology-mediated nature experiences can still hold significant educational value: for example, those playing a video game that focused on North American fauna performed significantly better in a wildlife identification quiz than gamers who had not played the same game (Crowley et al., 2021). As such, technology-mediated nature experiences, despite being standardised and less sensorially rich than direct nature experiences and therefore not a substitute for building a full connection with the natural world (Truong & Clayton, 2020), are nevertheless important avenues for ecological and environmental education (Crowley et al., 2021). Indeed, some argue that it is more useful to think not of the 'extinction of experience' but of a 'transformation of experience' (Clayton et al., 2017; Truong & Clayton, 2020), as vicarious, indirect, incidental experiences of nature start to become people's primary nature experiences (Keniger et al., 2013; Truong & Clayton, 2020). Since this transformation is unlikely to be reversed, it is important to understand the role of these vicarious interactions with the natural world in forming a connection with and awareness of nature (Crowley et al., 2021; Truong & Clayton, 2020).

In this paper, we assessed whether there are biases towards certain taxa or ecosystems within wildlife documentaries and whether conservation and anthropogenic threat messaging have changed over time. We sourced documentaries produced between 1918 and 2021 using an online movie database and assessed whether there were biases in the representation or identification level of taxonomic groups, or the representation of habitats, and whether any biases changed over time. We also assessed whether conservation messages or anthropogenic impacts on the environment were mentioned and whether this has changed over time.

## 2 | METHODS

### 2.1 | Documentary sourcing

We collated a list of nature documentaries released between 1918 and June 2021 from the Internet Movie Database (IMDb) website (IMDb, 2021), accessed in January 2019 for all releases prior to February 2019 and in July 2021 for all releases from February 2019 onwards. IMDb is popular globally and features information about productions from around the world. However, it is biased towards English-language productions, especially those produced in the

United States (Bioglio & Pensa, 2018), and production companies with the highest budgets and distributional power. Nonetheless, it provides a good overview of current production and is likely to feature those documentaries that have had the greatest influence on audiences.

We identified documentaries by searching IMDb using the genre 'documentary' with the keywords 'wildlife' or 'nature'. We considered relevant documentaries to be those that focused specifically on flora or fauna, judged holistically by considering the title, synopsis and thumbnail images. When this information was ambiguous, the inclusion of a documentary was decided by discussion between authors or by watching the documentary itself. We did not sample documentaries with a main focus on activism or animal ethics, only those with a focus on animal behaviour, conservation or ecology. We defined an individual documentary either as a stand-alone film or as one season of a documentary series. This allowed us to consider separate seasons from long-running series (e.g. *Natural World*) as separate documentaries, since we expected their content to evolve over time, while avoiding pseudo-replication of episodes within a season, which were likely to contain similar content. We treated 'specials' of a series (e.g. National Geographic specials) as individual documentaries. We only selected documentaries with background information available on IMDb to ensure that we had consistent information.

This produced a list of 945 documentaries in total, which we split into seven time periods: pre-1970s (1918–1969;  $N = 51$ ), 1970s ( $N = 43$ ), 1980s ( $N = 64$ ), 1990s ( $N = 142$ ), 2000s ( $N = 281$ ), 2010s (2010 to 2019;  $N = 318$ ) and 2020s (2020 to June 2021;  $N = 46$ ).

### 2.2 | Documentary sample selecting

From the compiled list of eligible documentaries, only 15 pre-1970 documentaries were accessible online. For every other time period, we randomly selected 15 documentaries for sampling using an online random number generator. If a selected documentary was unavailable online, or unavailable in English or with English subtitles, we repeated the selection process until we had a list of 15 accessible documentaries in each of the seven time periods, totalling 105 documentaries overall (Appendix S1). The decision to exclude documentaries that were unavailable in English was due to resource constraints of the research team and to ensure consistent information was collected.

### 2.3 | Documentary sampling

For each of the 105 documentaries selected, we generated a random start time between, and inclusive of, the documentary's start and 5 min from the documentary's end, using the same online random number generator. This was to prevent generation of a random start time between 5 min from the end and the end (e.g. 2 min from the end) since this would not allow a full 5 min to be sampled. If the selected documentary formed part of a series, we first randomly

selected an episode from that series before generating a random start time in the same way (Appendix S1). From the random start time, we then watched 5 min of the documentary.

We recorded every organism mentioned in the sample period with the word or phrase used to describe them and later identified these to the greatest possible taxonomic resolution from this phrase alone. This meant that some organisms were identifiable to species level (e.g. 'strawberry poison-dart frog', *Oophaga pumilio*), while others were only identifiable to a coarser resolution (e.g. 'corals' to the class Anthozoa). We grouped every organism into one of the following taxonomic groups: mammals, birds, reptiles, amphibians, fish, insects, arachnids, crustaceans, molluscs, other invertebrates or plants.

We recorded every habitat shown in the sample period broadly following the major (Level 1) habitats listed in the IUCN Habitats Classification Scheme (IUCN, 2021). We differed by grouping savanna and shrubland, since separating these habitats was often difficult from the available footage, and by grouping subtidal and intertidal habitats as 'coastal', since these were often shown together. We further split lentic and lotic freshwater habitats because of the substantially different conditions that these habitats provide, and recorded coral reefs separately to other coastal habitats. We recorded tundra separately to other grassland for the same reason. Forest was so frequently present that we split it into the Level 2 categories of boreal, temperate and tropical. Some Level 1 categories were not seen in any samples (e.g. caves) and so are absent from our data. In full, the categories are: boreal forest, temperate forest, tropical forest, savanna, grassland, tundra, inland rocky areas, desert, lentic wetland, lotic wetland, coastal, coral reef, oceanic, deep ocean or artificial (e.g. city centres, agriculture).

We also recorded whether there was a conservation message included in the sample period. This was defined as either mention of the need for conservation or an example of conservation in practice. We recorded anthropogenic impacts mentioned in the sample period, classified as one of the following: overexploitation, habitat degradation (including habitat loss), invasive species, extinction cascades or human-wildlife conflict (Diamond, 1989). We chose this classification system since it originates around the middle of the total time span covered by our sample of documentaries, so it is likely to provide good coverage of the anthropogenic threats considered to be key to biodiversity loss within our sample. This classification system does not include climate change, but the relatively recent shift in awareness and discourse around this threat in particular, which has accelerated over the last three decades (Anderson et al., 2021) and may be reflected in increased focus in more recent documentaries, merits its own investigation.

## 2.4 | Statistical analyses

We used RStudio Version 1.4.1717 (RStudio 1.4.1717, 'Juliet Rose', 2021) and R version 4.1.0 for all analyses.

## 2.5 | Representation of the natural world

A chi-square goodness-of-fit test was used to test for relative differences in the number of times taxa were mentioned compared to the number of described species in each taxonomic group (IUCN Red List, 2020). This allowed us to compare representation across taxa in the documentaries with actual biodiversity across taxa in the natural world. In this sense, a bias towards certain taxa constitutes an overrepresentation in comparison to that found in the natural world, and an unbiased representation is one in which taxa are represented proportionally to their actual biodiversity. While we do not expect representations of taxa to match their actual biodiversity exactly (i.e. be 'unbiased'), making this comparison allows us to contextualise our findings relative to the natural world and discuss the potential implications of current portrayals. We used chi-square tests of independence to test for differences in representation of taxa and habitats between time periods.

To investigate the taxonomic level to which organisms were identified, chi-square tests of independence were used to test for differences in the frequencies of mentions identifiable to species versus other taxonomic levels within each of our 11 taxonomic groups and within each of our seven time periods.

## 2.6 | Conservation messages and anthropogenic impacts

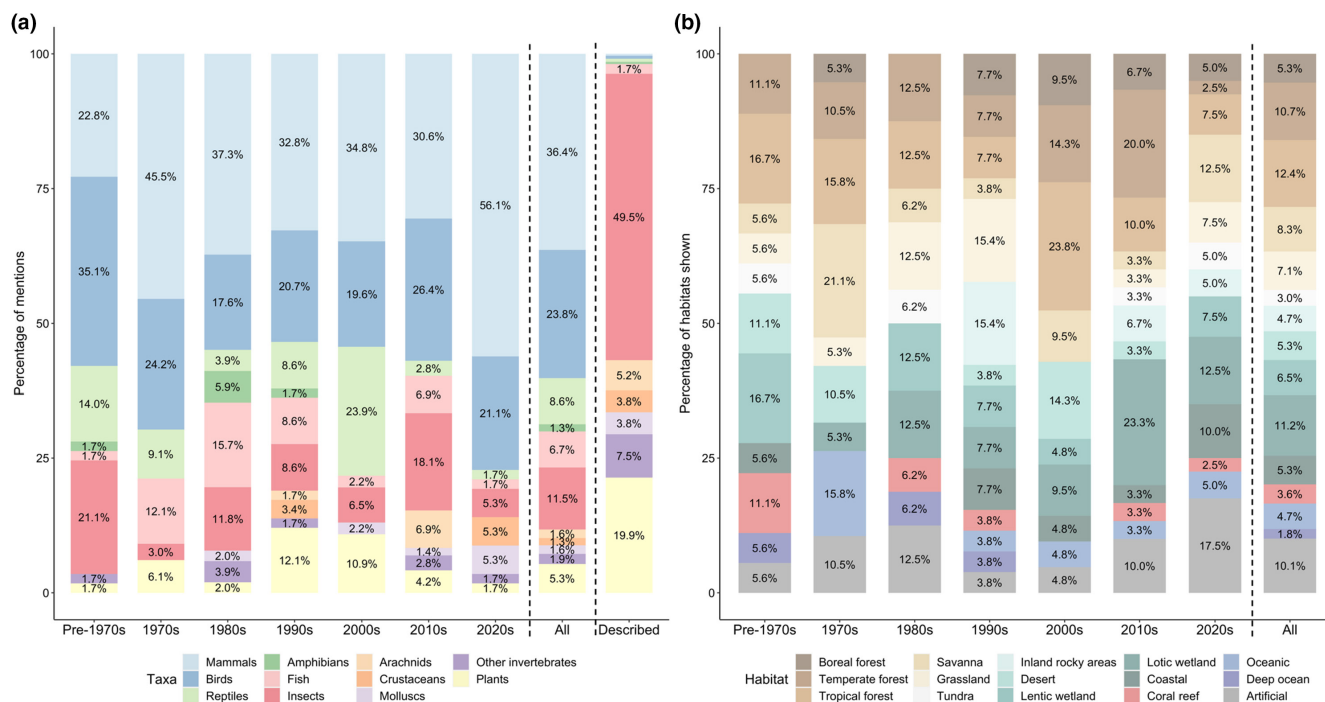
Chi-square tests of independence were again used to test for differences in the frequency of documentaries containing a conservation message between time periods, and for differences in the frequency of documentaries that mentioned different anthropogenic impacts between time periods.

We opted to use simple tests of differences between groups and across time periods rather than more complex regression analyses in order to be confident that any significant differences found are robust to biases from individual documentaries.

# 3 | RESULTS

## 3.1 | Representation of the natural world

We recorded 374 mentions of organisms across all sampled documentaries (Figure 1a). Of these, 94.7% were animals, the majority being mammals (36.4%) or birds (23.8%). Vertebrates made up 76.7% of all organisms mentioned, with insects amounting to 11.5% and all other invertebrates only 6.4% of mentions. Plants made up 19.9% of all organisms mentioned. These percentages were significantly different from the number of described species in each group ( $\chi^2 = 18,717$ ,  $df = 10$ ,  $p < 0.0001$ ) (Figure 1a). Compared to relative percentages of described species, all vertebrate taxa were overrepresented, and all invertebrate taxa were underrepresented (Figure 1a). Representation of taxonomic groups was significantly



**FIGURE 1** Representations of taxa (a) and habitats (b) in wildlife documentaries ( $n = 105$ ) across time periods. Percentages lower than 1% are not labelled. (a) Percentage of mentions within each time period and overall, coloured by taxonomic group. The total number of separate mentions of taxa was 374. The far-right column shows the total number of described species coloured by taxonomic group (IUCN Red List, 2020). (b) Percentage of habitat types shown within each time period and overall, coloured by habitat type. The total number of separate times ecosystems were shown was 169.

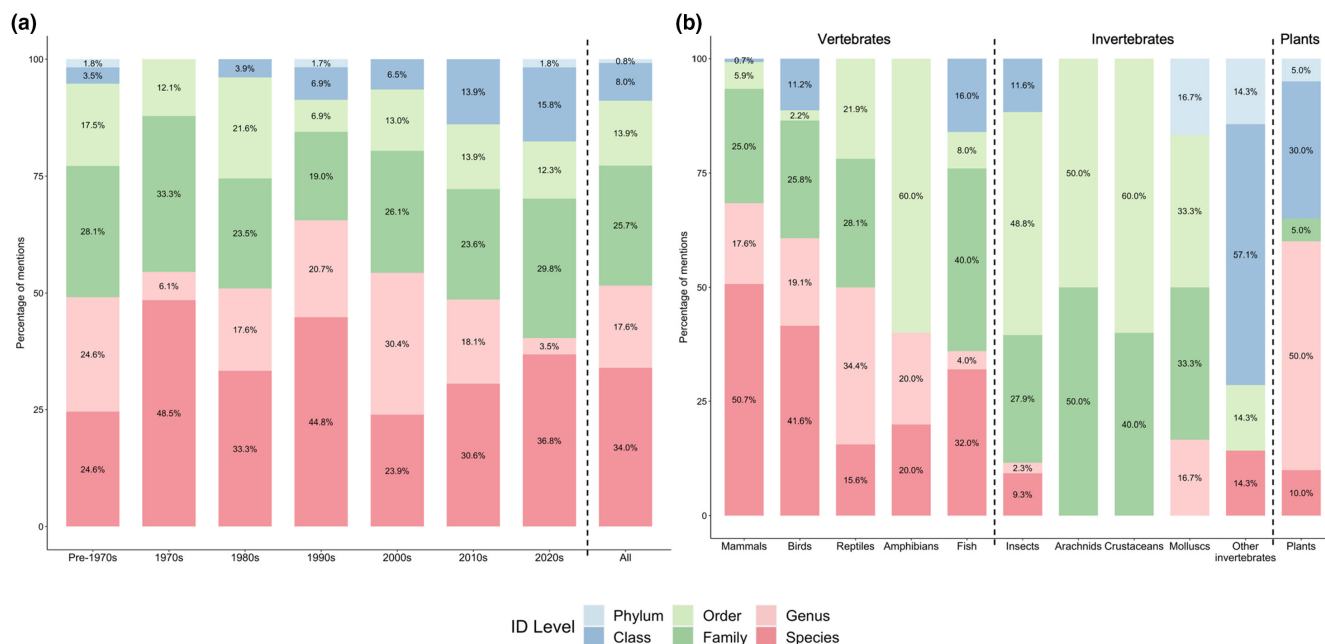
different and variable between time periods ( $\chi^2 = 124.83$ ,  $df = 60$ ,  $p < 0.0001$ ), with mammals and birds always collectively making up more than 50% of mentions, despite high variability in their respective proportions between time periods (Figure 1a). There was a distinct lack of pattern or trend across time, particularly in the representation of insects, fish and reptiles. While representations of mammals and birds remained consistently high across time, representations across these three groups showed large variations from one time period to the next. For example, representation of insects reduced from 21.1% of mentions in the pre-1970s to 3% in the 1970s; for fish, it increased from 1.7% in the pre-1970s to 12.1% in the 1970s; and for reptiles, it dropped from 23.9% in the 2000s to 2.8% in the 2010s. There was a consistently low representation of plants throughout time periods, which was highest in the 1990s at 12.1%.

A wide range of habitats was represented in the documentaries, with the three most commonly featured being tropical forest, lotic wetland and temperate forest, and the three least common being deep sea, tundra and coral reef (Figure 1b). Artificial habitats tended to be featured only rarely in documentaries, with an overall percentage occurrence of 10.1%. This appeared to increase in frequency between the 1990s and the 2020s, with the highest frequency appearing in the current decade at 17.5% (Figure 1b). However, overall representation of habitats did not differ significantly between time periods ( $\chi^2 = 88.13$ ,  $df = 84$ ,  $p = 0.358$ ) (Figure 1b).

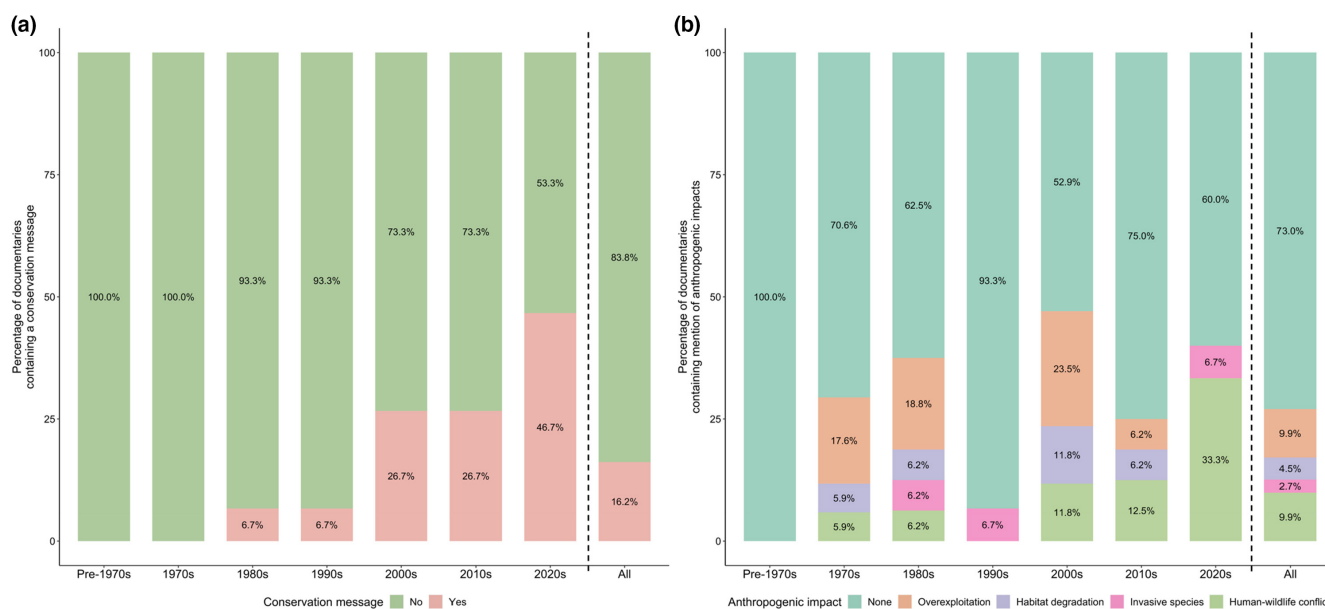
Overall, the percentages of mentions identifiable to each taxonomic level were as follows: species: 34.0%, genus: 17.7%, family: 25.7%, order: 14.0%, class: 8.0%, phylum: 0.8%. The frequency of mentions identifiable to species level was not different between time periods ( $\chi^2 = 5.36$ ,  $df = 6$ ,  $p = 0.4983$ ) (Figure 2a). However, the frequency of mentions identifiable to species level was significantly different between taxonomic groups ( $\chi^2 = 28.14$ ,  $df = 10$ ,  $p = 0.001715$ ), with 41.8% of vertebrate mentions identifiable to species compared with just 7.5% of invertebrate mentions. Mammals, birds and fish were the most identifiable to species, at 50.7%, 41.6% and 32% of mentions, respectively (Figure 2b). Just 9.3% of insect mentions were identifiable to species, while no arachnids, crustaceans or molluscs were identifiable to species (Figure 2b). Plants were poorly identified to species, at just 10% of mentions; however, plants were the group most identified to genus level, at 50% of all plant mentions.

### 3.2 | Conservation messages and anthropogenic impacts

The frequency of documentaries sampled containing a conservation message was significantly different between time periods ( $\chi^2 = 20.50$ ,  $df = 6$ ,  $p < 0.00226$ ) (Figure 3a). No documentaries before the 1980s contained a conservation message. In both the 1980s



**FIGURE 2** Percentage of mentions of taxa ( $n = 374$ ) in wildlife documentaries ( $n = 105$ ) identifiable to each taxonomic level. Bars are coloured by taxonomic group. (a) Percentage of mentions split by time period. The far-right bar shows all mentions across all time periods and taxonomic groups. (b) Percentage of mentions split by taxonomic group.



**FIGURE 3** Conservation messaging in wildlife documentaries ( $n = 105$ ) across time periods. (a) Percentage of documentaries within each time period including a conservation message. (b) Percentage of documentaries within each time period including mentions of different anthropogenic impacts.

and 1990s, 6.7% of samples contained a conservation message. This increased to >25% in each of the 2000s, 2010s and 2020s, reaching 46.7% in the current decade. Overall, conservation was mentioned in 16.2% of all documentaries sampled (Figure 3a).

Anthropogenic impacts on the natural world were mentioned in 22.1% of documentaries sampled (Figure 3b). 36.7% of mentions were of

overexploitation, 16.7% of habitat degradation, 10% of invasive species and 36.7% of human-wildlife conflict. However, extinction cascades were not mentioned at all. The frequency of types of anthropogenic impacts mentioned was not significantly different between time periods ( $\chi^2 = 24.79$ ,  $df = 18$ ,  $p = 0.131$ ), although no anthropogenic impacts were mentioned in documentaries before the 1970s (Figure 3b).



## 4 | DISCUSSION

A wide range of taxa and habitats was represented in the documentaries sampled across all time periods. However, there were large differences in the representation of different groups and habitats, with a higher frequency of vertebrate taxa and a lower frequency of invertebrates and plants compared to the numbers of described species in these groups. This is consistent with findings that conservation science has been focused more on vertebrate than invertebrate and plant groups over the last three decades (Di Marco et al., 2017). Similarly, some habitats (specifically tropical forest, lotic wetland and temperate forest) were more commonly depicted than others (specifically deep sea, tundra and coral reef), again consistent with a larger long-term focus on terrestrial than marine and freshwater systems (Di Marco et al., 2017; Miles & Kapos, 2008). In addition, the level of taxonomic identification in documentaries differed significantly between groups, being higher for vertebrate taxa than invertebrate taxa. Indeed, no arachnids, crustaceans or molluscs were identifiable to species level in our sample. Strikingly, although a low percentage of plants was identified to species level, a much higher percentage were identified to genus level, perhaps reflecting the prominence of Cultivars or Cultivar-Groups within botanical taxonomy. This is a formal category in the International Code of Nomenclature for Cultivated Plants (Brickell et al., 2009) and reflects groups of plants within the same genus that share defined characteristics (Hortax, 2013), which might explain the relative ease of identifying plants to genus. A conservation message was found in less than one in five documentaries sampled, but the frequency increased over time. Anthropogenic impacts were mentioned in 22.1% of documentaries but never before the 1970s, while the relative focus given to different anthropogenic threats did not always mirror their relative severity in the real world. Collectively, these represent clear trends despite the relatively small sample of 105 documentaries spread across a 70-year period.

The wide range of taxa and habitats depicted in documentaries highlights the current importance and future potential of this medium for increasing awareness of global biodiversity and ecosystems. With an increasing proportion of the global population living in urban environments (United Nations, 2019) and increasingly disconnected from nature (Maller et al., 2009; Miller, 2005), widening the range of taxa and habitats shown could enable people to experience wildlife and ecosystems that are not accessible in everyday life. Such a global coverage also allows people to experience wildlife in diverse and inaccessible environments, including difficult-to-reach or sensitive, high-biodiversity habitats, potentially increasing awareness of their importance and support for their conservation (Fernández-Bellón & Kane, 2020; Hynes et al., 2021; LaMarre & Landreville, 2009; Martín-López et al., 2009). This effect may be particularly important currently, with the COVID-19 pandemic still restricting international travel. Given the low but potentially increasing frequency of documentaries featuring artificial habitats, such as city centres, found here, there is also significant scope for documentaries to focus on urban wildlife that viewers are likely to be able to

see in their local area. This could prove an important pathway for inspiring people to engage more actively with local biodiversity.

The differences in representations across groups and habitats are likely to be the result of existing biases in preferences for different taxa, geographical and technological accessibility (Tittley et al., 2017), and pre-conceptions about which taxa and habitats are most appealing to target audiences (Jones et al., 2019; Martín-López et al., 2007). For example, species that are more familiar, larger, phylogenetically closer or physically similar to humans, and culturally or socially important tend to illicit more positive reactions (Martín-López et al., 2007) and so may be featured more. It is also the case that people tend to prefer groups they can identify more easily over unfamiliar groups, potentially explaining the link between the lower proportion of invertebrates and plants identifiable to species than other groups and their similarly low representation in documentaries (Lindemann-Matthies, 2005; Schlegel & Rupf, 2010). Similarly, ecosystems tend to be shown as pristine with an abundance of wildlife, devoid of negative anthropogenic impacts, since this is assumed to be more palatable (Jones et al., 2019).

Existing preferences and accessibility could also explain the high variability seen in representations of groups across time. For example, it is possible that the relatively less-advanced equipment used before the 1970s could have made taxa such as birds, in which males of many species call in predictable locations, relatively easier to film than other taxa, explaining their high frequency in this period and subsequent drop between the pre-1970s and 1970s. In contrast, as technology has advanced (including motion-activated filming technology), filming of more elusive species, such as big cats, might have become more viable, explaining the large focus on mammals in the 2020s. Similarly, the increase in focus on plants, from 2% of mentions in the 1980s to 12.1% in the 1990s, could be due to the novel use of timelapse photography, which was the focus of the series *The Private Life of Plants* in 1995 (The Private Life of Plants, 1995). Finally, the lower representation of invertebrate taxa could also be due to our sample's bias towards documentaries available in English; public perceptions of insects are more negative in western cultures, as compared with more positive cultural perceptions in Asian cultures, where insects feature more widely in culture and are more commonly eaten (Tan et al., 2015). It is therefore possible that examining the same metrics in wildlife documentaries originating from countries in Asia might reveal less of an underrepresentation of invertebrate groups.

Despite a wide range of taxa being represented in the documentaries overall, some taxa showed more consistency in their representation over time than others. In particular, birds and mammals showed consistently high representation, while molluscs and other invertebrates showed a consistently low representation. In contrast, representations of insects, reptiles and fish showed especially high variability, ranging from relatively high to relatively low representation between consecutive decades. The high representation of mammal and bird species is consistent with biases towards large vertebrate species, both within public perceptions and within conservation research (Di Marco et al., 2017; Smith et al., 2012). The

lower focus on plants also complements previous research showing that the public's identification of plants is less accurate than that of animals, while nature users also care less about plants than animals, being more likely to accept lethal chemical control methods for the former than the latter (Höbart et al., 2020; Schlegel & Rupf, 2010).

Our finding that reptiles group with insects in terms of their high variability in representation across time is consistent with findings that these groups are consistently rated as less attractive than mammals and birds and engender negative attitudes (Schlegel & Rupf, 2010). However, the finding that fish group with reptiles and insects in terms of high variability in representation is novel. Previous research shows that conservation science has consistently focused more on vertebrates than on invertebrates and plants across the last three decades (Di Marco et al., 2017), and, within vertebrates, there is a greater focus on large, colourful animals with forward-facing eyes that are phylogenetically closer to humans (Smith et al., 2012). This could explain why reptiles and fish, although vertebrates, group with insects; they are often less colourful than birds and are phylogenetically further from humans than other mammals. Our finding that marine systems (e.g. deep sea and coral reefs) were poorly represented in documentaries is consistent with the research showing a greater focus on terrestrial than aquatic systems (Di Marco et al., 2017; Miles & Kapos, 2008). This could also partly explain why fish and crustaceans are less well represented in documentaries. Finally, it should be noted as a caveat that the high variability in taxa we observed between decades could be due to our relatively small sample size per time period, which was 15 documentaries or 105 min. Therefore, large differences in study focus in one or two documentaries could have resulted in large fluctuations. However, our approach of analysing data by decade rather than documentary should have reduced this effect.

The recorded disparity in relative representation across taxa and habitats could have a large influence on public perceptions of the natural world and support for conservation (Martín-López et al., 2007, 2009), potentially directing more funds towards larger, vertebrate species, especially given current, low levels of public awareness of biodiversity and related issues (Lindemann-Matthies & Bose, 2008; Natural England, 2020). In particular, the relatively low representation of invertebrates and plants, both in terms of their appearance and level of identification, could mean that people place less value on these groups, despite their high biodiversity and important roles in ecosystem functioning (Lee & Choi, 2020; Stork, 2018). Significantly, although the relative representation of taxa varied across time periods, there was no obvious trend for less represented groups to increase over time, indicating that such differences are likely to continue in the future without concerted action, both by documentary makers and researchers studying these groups. However, there may be a trade-off between representation of different taxa and potential conservation benefit of a documentary, as the portrayal of familiar, charismatic species has been found to be particularly effective in increasing conservation donations (Shreedhar & Mourato, 2019), suggesting that showcasing less familiar species could limit the conservation benefit of a documentary.

We therefore call for more work to identify the barriers associated with showcasing less-popular groups, informing the development of strategies to reduce these long-term biases. For example, identifying 'Cinderella' mammal species (183 threatened, overlooked mammal species with socially appealing traits, Smith et al., 2012) has been suggested as a useful framework for broadening the range of flagship species currently used by NGOs in fundraising campaigns, since these share similar traits with species already used but have thus far been overlooked. Similar approaches could also be used for selecting a broader range of species to be included in wildlife documentaries. More work is also needed to understand whether focusing on non-mammal, invertebrate or plant species could increase their societal salience and thus reduce their risk of societal extinction (Jarić et al., 2022), or whether it is better to ensure a representative portrayal across all taxonomic groups, mirroring their actual diversity in the natural world. Just as flagship species are chosen by international NGOs to maximise international appeal and thus the global reach of fundraising messages, it is vital that we understand how best to improve public awareness of biodiversity and biodiversity losses, with an emphasis on ensuring scientific accuracy as well as securing support for conservation, both locally and globally.

This is especially important where biodiversity preservation depends on knowledge of local species and ecosystems (Fernández-Llamazares et al., 2015; Kai et al., 2014). Local ecological knowledge, traditional ecological knowledge or indigenous knowledge is now widely acknowledged as being central to sustainable resource use, biodiversity conservation, the capacity of societies to adapt to socio-ecological change and the formation of people's attitudes to conservation (Berkes et al., 2000; Brook & McLachlan, 2008; Gadgil et al., 1993; Gilchrist et al., 2005; Shen et al., 2012). The standardisation of nature portrayals in mass media (Truong & Clayton, 2020), including an overemphasis on species that are internationally salient at the cost of including species that are locally salient (Ballouard et al., 2011), could therefore accelerate loss of local knowledge, as well as the societal extinction of local biodiversity, with knock-on effects for its conservation and risk of biological extinction (Jarić et al., 2022). Therefore, in addition to research into why particular taxa or habitats are underrepresented, work is also needed to understand the relative emphases on species with local versus international relevance, and how local ecological knowledge can be better included in nature documentaries.

A conservation message was found in 16.2% of documentaries sampled, with the frequency increasing over time. Anthropogenic impacts were mentioned in 22.1% of documentaries, with no mentions pre-1970s. Significantly, the most recent documentaries contained conservation messages or information about anthropogenic impacts in roughly 50% of cases. This finding is likely to reflect an increasing awareness of human impacts on the natural world among the public, particularly over the last decade, and an increasing willingness for documentary makers to highlight this (Jones et al., 2019), although it is hard to unpick the directionality of this relationship. Such coverage is likely to have significant benefits for conservation, since conservation policy, scientific



research and social aspects, such as public awareness, preference and willingness to donate, are part of a complex positive feedback mechanism (Martín-López et al., 2009), in which science and public opinion foster each other. It is important that documentary makers and conservation scientists continue to assess the focus on conservation in documentaries to strike the right balance between keeping the public engaged and enthused in the natural world, while raising awareness of global issues.

There was high variability between the frequency of mentions of different anthropogenic threats. For example, invasive species and habitat degradation received less attention than other threats in all time periods. This difference in representation of threats does not necessarily reflect their relative importance globally but may instead reflect changes in media attention, public awareness or relative ease of depiction in media format. Indeed, changes in land and sea use, including habitat loss and degradation is, in reality, recorded as the current greatest threat to species worldwide, followed by species overexploitation, invasive species and climate change (WWF, 2020). Such differences in media coverage versus relative impact have also been recorded in other studies. For example, Legagneux et al. (2018) identified a discrepancy in media coverage between climate change and biodiversity loss, with the former receiving up to eight times higher coverage than the latter in the media. Since the classification system for anthropogenic threats used here was based on Diamond (1989) and did not include climate change, a useful follow-up to this study would be to assess how coverage of this specific threat has changed over the most recent three decades (Anderson et al., 2021), given the marked increase in public awareness of this issue over this period.

The changes in mentions of anthropogenic threats found here broadly mirror changes in the conservation literature over the last eight decades (Anderson et al., 2021) but with a few key differences. For example, we found that mentions of human–wildlife conflict showed a large increase over time. Conservation literature likewise shows that human–wildlife conflicts are increasing as the human population expands and natural habitats dwindle (WWF, 2008), such that they are now a top priority for wildlife management across the world (Can, 2021). Similarly, habitat degradation was one of the most commonly mentioned threats in documentaries in the 1970s and 1990s, and this increased in the 2000s. This threat included aspects of habitat loss and pollution, which also increased in the conservation literature in the 1990s and 2000s, and 1960s to the 1980s, respectively (Anderson et al., 2021). On the other hand, the changes we found in mentions of overexploitation and invasive species did not clearly reflect the wider conservation literature. For example, we found overexploitation to be one of the most commonly mentioned anthropogenic threats, particularly before the 2010s. In contrast, overexploitation has consistently been overlooked in conservation research (Anderson et al., 2021), despite being a key cause of biodiversity losses worldwide (Brondizio et al., 2019). In contrast to this, invasive species were rarely featured in documentaries, appearing in just three decades: the 1980s, 1990s and 2020s, but this threat has seen a huge increase in the conservation literature in recent

decades, reflecting invasive species' role in extinctions worldwide (Anderson et al., 2021).

In line with biases in taxonomic focus, it could also be beneficial for documentaries to broaden their coverage of anthropogenic threats, particularly of the most pressing issues, as this could raise public awareness and help to generate public support for policies to tackle these issues (Aitchison et al., 2021; Hynes et al., 2021). For example, no sampled documentary mentioned extinction cascades as an anthropogenic impact, despite models identifying coextinction as the most common form of species loss (Dunn et al., 2009). This omission is consistent with calls to better integrate coextinction within global threat assessments, which generally use threat criteria less relevant to invertebrates, which are often dependent on host species (Moir & Brennan, 2020). A concerted effort to include mention and discussion of extinction cascades as a threat to biodiversity has the potential to increase public awareness and lead to an increase in policies targeted towards this issue (Aitchison et al., 2021; Martín-López et al., 2009).

When wildlife documentaries first appeared as a medium, film and television screens were the only means of accessing their content and experiencing nature digitally. However, we now live in a world with platforms that offer diverse indirect experiences of nature, including social media and video games (Keniger et al., 2013). It is therefore important that more work is carried out to assess the relative contributions of different media to people's experiences of nature and whether alternative media differ in their nature-based content. Given the recent emphasis by YouTube and social networks on shorter videos or social media-originated content (Jaffe, 2020; Sherman, 2021; Singer, 2021), it is possible that, over time, this could alter people's interactions with and expectations of nature, potentially favouring aesthetics or excitement over the reality of the natural world (Truong & Clayton, 2020). As such, it is possible that nature documentaries now occupy a niche within media portrayals of nature, uniquely providing longer-form, nuanced content. This provides nature documentary makers with the opportunity to lean into this role, focusing on the provision of scientifically accurate content over and above that which prioritises entertainment value.

## 4.1 | Implications and conclusion

Wildlife documentaries have clear capacity for depicting a wide range of species and ecosystems, with potential to increase public awareness and appreciation of a broader range of groups and support for conservation efforts. This is especially important in the context of the COVID-19 pandemic, which has restricted international travel. However, the range of species and habitats represented has not increased over time, potentially limiting the medium's ability to engage audiences with less-familiar taxa and habitats, or to increase engagement with more familiar, local, urban areas. We call for more work to identify reasons why certain taxa and habitats are under-represented and solutions to make them more attractive to documentary makers and public audiences alike.

In contrast, the frequency of conservation messages has increased over time, and human impacts on the environment have been mentioned more since the 1970s than before. However, certain threats are mentioned more commonly than others, potentially giving a biased view of their importance. Given the current critical point in conservation and the urgency needed to tackle global biodiversity losses, this increased mention of conservation is crucial and positive, but we call for a more concerted effort to weigh mention of threats by their importance. This is likely to be facilitated by increased engagement between documentary makers and conservation researchers. It is important that the attention given to human threats to the natural world is regularly reviewed by documentary makers and conservation researchers alike. This would ensure an appropriate balance is struck between educating audiences and providing hope and tangible solutions to conservation problems, without being off-putting.

## AUTHOR CONTRIBUTIONS

Edgar C. Turner conceived the idea, and Edgar C. Turner, Ho-Yee Lee and Amelia Jaffé designed the study. Ho-Yee Lee, Amelia Jaffé and Kate Howlett collected the data. Kate Howlett analysed the data and wrote the initial draft of the manuscript. All authors commented on the manuscript and gave final approval for publication.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## DATA AVAILABILITY STATEMENT

Data are archived on the Dryad Digital Repository <https://doi.org/10.5061/dryad.vmcvdcncxg> (Howlett et al., 2022).

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

**Appendix S1.** Details of wildlife documentaries sampled in the study, together with start time of the five-minute sample period within each documentary.

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