

Considering connections between Hollywood and biodiversity conservation

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Abstract

Cinema offers a substantial opportunity to share messages with a wide audience. Given its global range and potentially high impact, there is an urgent need for research that evaluates the

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effects of this form of visual media on conservation outcomes. Cinema can influence the awareness and behaviours of non-specialist audiences, and could therefore play an important positive and/or negative role in biodiversity conservation through behavioural change and social pressure on key stakeholders and policy makers. Limited awareness about the potential benefits and limitations of cinema for conservation, as well as a lack of evidence about impacts, currently hinder our ability to learn from previous and ongoing initiatives, and to engage productively with the movie industry. We discuss the key opportunities and risks that arise from cinematic representations of conservation issues and species of concern, making use of examples and case studies where they are available. We additionally provide a framework that enables conservationists to better understand and engage with the film industry, highlighting how this can facilitate engagement with the movie industry, harness its potential, and improve work to mitigate any negative consequences. A robust evidence base is key for evaluating and planning these engagements, and for informing related policy and management decisions.

Introduction

Watching Disney's new version of *The Jungle Book* (2016) inspired us to write this article. As a growing percentage of the world's population becomes concentrated in urban areas (Wigginton et al. 2016), citizens of post-industrial nations increasingly report a sense of disconnection from the natural world (Miller 2005). Meanwhile, our ability to simulate the 'wild' has increased dramatically; here was a film featuring a spectacular depiction of a South Asian jungle and its inhabitants, mostly created by Computer Generated Imagery (CGI), that the viewer could experience from the comfort of their chair. The movie also highlighted the plight of pangolins (*Manidae* spp.) through humour, and the pangolin character has subsequently been included in associated merchandise to promote its cause (see below and Flocken 2016).

Visual media (Vivanco 2002; Sandbrook et al. 2015) and arts (Curtis et al. 2014; Verma et al. 2015) are becoming increasingly important channels, filters and mirrors of human understanding about the natural world. Their linkages to environmental engagement, attitudes, norms, policy

support and, ultimately, human behaviour – key considerations of conservation concern worldwide (St John et al. 2013) – must therefore be considered. On the one hand, evocative footage of natural spaces and rare or charismatic species has the potential to increase media consumers' interest in and support for biodiversity conservation. For example, exposure to visual depictions of charismatic flagship species has been found to be associated with people's concern for that species and conservation intentions (Smith & Sutton 2008). Alternatively, however, spectacular imagery could create or reinforce simplified, romantic ideals of nature and wildlife that some might adopt as a comfortable substitute for challenging real-world encounters. Furthermore, watching wildlife on screen may not translate into conservation action, given the often limited or unclear effectiveness of environmental education as a single tool for effective behaviour change (Holmes 2003). At worst, increased exposure could produce new, unforeseen threats to species and locations thrown into the spotlight by their starring role in a blockbuster. As a result, it is important for conservation scientists to identify the opportunities provided by visual media for achieving conservation goals (Knight & Cowling 2007), and to invest in anticipating the potential consequences of engaging with associated industries (Cook et al. 2014).

While nature documentaries might serve as sources of information about wildlife and conservation issues (Dingwall & Aldridge 2006), they are often targeted towards audiences with an existing interest in the topic. Movies, in contrast, may not offer the most direct way to highlight a specific conservation issue, but may reach larger, broader audiences. Documentaries are normally distributed via television, which makes viewing figures difficult to compare with cinema releases. However, perhaps the most successful cinema-format wildlife film, *March of the Penguins* (2005) took a lifetime box-office of \$77,437,223: the animated, animal-focused movie *Madagascar* (2005) took \$193,595,521 the same year (Box Office Mojo n.d.). Cinema is also generally considered a more immersive format and lends itself well to spectacular sound, imagery and sequences. It might therefore have greater emotional impacts on audiences than television (Visch et al. 2010; Baranowski & Hecht 2014). There is considerable variation in how the movie industry could influence

conservation impacts. Films can vary in their environmental motives from feature-length documentaries such as *March of the Penguins*, through storylines with evident environmental motives (including many examples discussed below), to movies with no conservation message that may still influence behaviour. Our question, then, is: what role(s) does, or could, Hollywood play in conservation?

Despite the long-standing tradition of the movie industry producing wildlife-focused content (the Oscar-winning *Serengeti shall not die* by Bernhard & Michael Grzimeks [1957] and Disney's *Bambi* [1942] are classic examples), surprisingly little attention has been given to critically reviewing its potential impacts (Jepson et al. 2011). Impacts, here, may be positive or negative, and may affect audiences (e.g. knowledge, perceptions and behaviour); socio-economic trends (e.g. increasing demand for a pet, visits to a location, or resource allocation to an issue); and/or, ultimately, conservation outcomes (e.g. habitat protection/disturbance, species recovery/decline). Here we discuss some of the opportunities and challenges movie fame can create for conservation. Although we recognise the presence and potential importance of international movie industries and independent filmmaking, we primarily refer to mass-market productions of the American movie industry (aka Hollywood), which continue to attract the highest level of investment and dominate global box office receipts. However, much of the discussion here also applies to movies made elsewhere and on smaller budgets, and to other visual media targeted at general audiences (e.g. YouTube, TV shows etc.). We outline a range of methodological approaches, including both qualitative and quantitative techniques, to consider how the impact of silver screen appearances might be assessed and monitored, providing a framework to guide future research (Fig. 1; Table 1), encourage engagement with the industry, and inform policy decisions. Finally, we argue that better understanding the impacts of Hollywood on conservation can only be beneficial, and potentially enables the harnessing or mitigation of these impacts as tools for biodiversity conservation.

Opportunities

Movies provide a potent means of sharing biodiverse landscapes, wildlife spectacles and exotic or rare species with a wide audience. The extent to which awareness affects pro-conservation attitudes and behaviours is often complex and unclear, given the myriad other factors at play (Howell 2014; Moorhouse et al. 2016), but there is a clear role for cinema in introducing audiences to new places, species and conservation problems. To date this has most frequently been achieved by animated features that do not require rare wildlife or inhospitable environments to be found or filmed (see Yong et al. 2011), but continuing advances in CGI and motion-capture technologies may change this. Specific reference to the conservation status of the taxa involved may be important for raising the profile of particular species (but see Colléony et al. 2016). Blue Sky Studios' *Rio* (2011), for example, features the critically endangered Spix's macaw *Cyanopsitta spixii*, and several plot points involve conservation issues, including the illegal trade in exotic birds and captive breeding of threatened species. Although a positive conservation outcome for this species might be unrealistic, the issues highlighted affect many tropical parrots.

A second, subtler, example is the inclusion of a pangolin (*Manidae* spp.) in the aforementioned Disney remake of *The Jungle Book* (2016). It makes a cameo appearance, spectating while Mowgli, the protagonist, retrieves honey from a tall cliff. Fellow observer Baloo (a sloth bear *Melursus ursinus*) threatens the pangolin with the line "*You have never been a more endangered species than you are at this moment*", a knowing comedic reference to the precarious real-world status of pangolins in southern and eastern Asia. All four Asian species are threatened by hunting and illegal trade, listed as endangered or critically endangered on the IUCN red list, and listed by the Convention on International Trade in Endangered Species (CITES) (Challender et al. 2014). *The Jungle Book* director Jon Favreau has since revealed that Los Angeles zoo staff (acting as advisors to the filmmakers) had suggested the pangolin's inclusion (Flocken 2016). Favreau had previously been unaware of pangolins, but became an advocate of featuring the species and encouraged Disney to add a pangolin to their merchandise line-up as "*a commitment to raise awareness for the pangolin*

and the overall efforts of the Disney Conservation Fund” (Flocken 2016). Even without a direct conservation message, featuring relatively little-known species can inspire public interest. The appearance of fossas (*Cryptoprocta ferox*) in Dreamworks’ animated film *Madagascar* (2005), for example, led to a substantial increase in Google.com searches for ‘fossa’ in the USA (Fig. 2).

Cinema also has the potential to substantially increase awareness of a featured area or region. The release of *Wild* (2014), based on author Cheryl Strayed’s 2009 solo hike along the Pacific Crest Trail (USA) – a route mostly through National Forest and protected wilderness – prompted a dramatic increase in footfall on the trail: the number of permits issued for hikes of >500 miles increased by 70% between 2014 and 2015 (Pacific Crest Trail Association 2014, 2015). The Pacific Coast Trail Association (PCTA) encourages fans of *Wild* to become members, thereby contributing to the upkeep and conservation of the scenic trail (<http://www.pcta.org/wild>). In conjunction with effective management, therefore, visitor increases to areas such as this could have positive outcomes by inspiring concern for – and investment in – their conservation.

A further potential advantage is the heightened emotional impact that movies can carry (Visch et al. 2010). Again, this is often associated with the use of nonhuman characters in animated or effects-driven films. *Happy Feet* (2006), for example, carries strong messages about overfishing and plastic pollution: in one scene ‘Lovelace’, a rockhopper penguin (*Eudyptes* spp.), suffers from entanglement in the plastic rings of a six-pack. Movies’ ability to portray conservation problems through the eyes of well-developed, sympathetic (albeit often anthropomorphic) animal characters could make the inclusion of such scenes an especially powerful tool. Negative conservation messages can be associated with feelings of guilt or powerlessness, emotions that animated films may not be seeking to inspire. However, optimistic messages – a better fit with animated movies – might also be more successful in achieving support and lasting behaviour change (Garnett & Lindenmayer 2011). From the earliest Disney movies to more recent animated and CGI productions, animals and the natural world are common themes of films targeting younger audiences, who will be actors in future social change, and on whom there may be greater emotional and long-term effects

(Gifford & Nilsson 2014). An excellent illustration is provided by the “*Bambi effect*” (Hastings 1996), the impact that the emotive loss of the titular character’s mother in Disney’s 1942 film is believed to have had on audiences’ attitudes towards hunting.

Director James Cameron intentionally sought emotional impact from his environmental fable *Avatar* (2009): “*I just want [people] to internalize a sense of respect and a sense of taking responsibility for the stewardship of the earth...I think the film can do that by creating an emotional reaction*” (quoted in Erbe 2011). *Avatar* has a more general environmental message that nevertheless touches on specific conservation issues, including natural resource extraction, maintaining ecosystem function, and habitat loss. Similarly, movies set in the midst or aftermath of environmental disasters can explore broader environmental issues through visions of a world devastated by climate change or food and energy crises: recent examples including *The Road* (2009), *Interstellar* (2014), and the recently reinvigorated *Mad Max* franchise.

Risks

Conservation is not, of course, the primary aim of the modern movie industry, and there are also potential negative impacts of silver-screen appearances for featured species, habitats and landscapes.

The global reach and influence of Hollywood movies enable them to ignite market trends, with challenging implications for conservation. An often-repeated example is the purported impact, on wild clownfish populations, of increased market demand for common clownfish *Amphiprion ocellaris* associated with the release of Disney/Pixar film *Finding Nemo* (2003) (Strange 2008; Yong et al. 2011; Bush et al. 2014). This is despite the film’s plot implying that wild-caught tropical fish make unsuitable pets: Nemo’s abduction from the reef, and subsequent imprisonment in a dentist surgery’s tank, is key to the storyline. The example suggests that increased interest in a species might drive market demand for its consumption and/or trade, and indicates that a movie’s key

messages may not be received or interpreted as expected. Nevertheless, to our knowledge, evidence to support ‘the Nemo effect’ is scarce or virtually non-existent, and indeed, data to support assertions about the direct impacts of cinema are generally very limited (Gomis & Bonillo n.d.; Strange 2008). This therefore represents a prime example of why research investigating the type, magnitude and direction of any impacts is required. For example, analyses of the spatial and temporal distribution of illegal trade incidents could be related to movie release dates, to determine how they may have influenced the market.

A further potential issue is how particular species or people are portrayed. Contemporary cinema acts as both a reflection and propagator of villainous stereotypes, and repeatedly negative portrayals of particular species and peoples in popular culture can have long-lasting impacts on their ‘public image’. For example, though difficult to quantify, *Jaws* (1975) is strongly implicated as responsible for an increased awareness of sharks in the Western psyche, one often accompanied by an exaggerated perception of the risks they pose, with likely consequences for their conservation (Neff 2015; Nosal et al. 2016). Stories behind human characters and cultures also risk being oversimplified, belying the real-world complexity of people’s use of, and dependency on, natural resources (e.g. Knapp et al. 2017).

Positive and romanticised depictions of wildlife can also have inadvertent conservation impacts. The ‘*Bambi* effect’ (see above), is unlikely to be solely or even primarily responsible for anti-hunting sentiments; rather, it may be indicative of broader shifts in cultural attitudes towards wildlife in the mid-20th Century (Hastings 1996). Nevertheless, the movie popularises and/or reinforces a narrative of separation between humans and wildlife, and promotes an ethic of non-intervention. This ‘hands-off’ attitude may be important in limiting the ability of conservation managers to kill deer, for example, despite the effects that substantial increases in deer populations could have on other species and forest regeneration (Chollet & Martin 2013).

Another complex and contradictory story that characterises the diversity and extent of cinema’s impacts on conservation is Warner Bros’ *Free Willy* (1993), in which a captive orca *Orcinus*

orca is returned to the wild with the help of a dedicated young boy: in the famous climactic scene, the whale leaps to freedom over a harbour wall. The movie's impact continues to resonate more than twenty years later, but is multi-faceted. First, *Free Willy's* positive depiction of previously maligned 'killer whales' has been credited with an about-turn in how this species is perceived by Western publics: compare the gentle character of Willy with the dangerous, revenge-seeking creature in *Jaws*-inspired *Orca* (1977) (Lawrence & Phillips 2004). Second, the film inspired a popular campaign to 'Free Keiko', the whale starring as the titular Willy. Keiko became the poster-child of captive orcas and millions of dollars were poured into his rehabilitation and eventual release (though he died less than a year later) (Grimm 2016). The ethics of exhibiting captive orcas, ostensibly to represent and enable the conservation of their wild cousins, remain hotly disputed, and have since also served as the topic of the provocative and influential documentary *Blackfish* (2014). Third, *Free Willy* probably contributed to larger changes in cultural attitudes to whales that created the conditions for a commercial whale-watching industry (which, in turn, has both positive and negative implications for conservation: Lawrence & Phillips 2004; Wearing et al. 2011). This case highlights the power of an animal movie star to raise the profile of both species and individual animals (like Keiko), but also the challenges created by the translation of complex, real-world conservation issues into neat, romantic Hollywood spectacles.

Cinema exposure can also have major implications for a featured region or ecosystem. Rapid changes in visitor pressure and behaviour can result from increased public awareness and media attention associated with movie appearances (Beeton 2016), a phenomenon known as 'film-induced tourism' that is sometimes incidental, but can also be orchestrated (e.g. *Australia* [2008] was publicised in collaboration with the country's tourist board). From a conservation perspective, this could create problems if increases in visitor pressure are overwhelming or ecosystems are not resilient (Sakellari 2014). Furthermore, if not managed appropriately, increased tourism can have problematic socio-economic consequences, illustrating the need to consider a wide range of potential impacts. In the detailed example outlined by Cohen (2005) pertaining to *The Beach* (2000),

modifications made by the filmmakers to a little-used beach in a Thai national park led to division between local business owners and challenges to democratic procedure, as well as environmental concerns.

Films with explicit environmental messages or subtexts may be perceived as depressing or sanctimonious, potentially limiting their effectiveness (and indeed, their popularity, as a visit to the cinema might be seen as an opportunity for escapism from the world's problems). Sensationalised depictions of environmental issues can also obfuscate or misrepresent real problems; notably, disaster movie *The Day After Tomorrow* (2004), though igniting media debates about climate change, is also noted for its scientific inaccuracy (Leiserowitz 2004).

Assessing the impact of films

We have discussed some key opportunities and challenges the movie industry presents for biodiversity conservation, which have clear implications for policy and management decision-making. However, the current lack of evidence surrounding most of these suppositions undermines our ability to effectively harness cinema as a conservation tool or adequately mitigate any negative impacts (Fig. 1). Consequently, assessing and monitoring public responses to movie appearances of species, systems and spaces of conservation concern will be imperative for understanding the impacts of Hollywood on conservation. This will require a cross-disciplinary approach, and in the following section we highlight some of the qualitative and quantitative approaches that could be used as part of our proposed research framework to assess and understand these impacts (Table 1).

Audience responses

Engagement with cinema-going audiences will be important in investigating a movie's immediate effect on viewers. A range of qualitative and quantitative social research methods (such as questionnaire surveys, interviews or discussion groups) could be used to monitor: any increased interest or awareness in conservation issues following their appearance in a movie; the kind of

messages communicated; and whether these are likely to lead to further action or behavioural change. This has often been previously studied using questionnaires that assess intention to act. For example, research surveying moviegoers before or after watching *The Day After Tomorrow* found that participants sampled after viewing were willing to allocate approximately 50% more in monetary donations to climate mitigation, when choosing between five good causes, than those questioned before (Balmford et al. 2004). However, they were no more likely to plan on taking emission-reducing actions. Other studies have additionally considered the effects of movies and documentaries on public perception of and attitude towards climate change and science by surveying the same moviegoers before *and* after watching using survey groups as well as questionnaires (Lowe et al. 2006) and/or investigating long-term impacts on perception (Reusswig & Leiserowitz 2005; Howell 2011). A similar approach could be applied to investigating awareness of more specific conservation issues, and any corresponding behavioural change. If possible, studies should address broader changes in attitude or find a way of directly measuring behaviour change in addition to assessing the intention to act, as responses to this method alone can be susceptible to social desirability biases (Chao & Lam 2011). Comparative or experimental approaches could also be used to assess responses to different films and potentially identify which aspects of ‘movie appearances’ influence viewers, and how. Responses might be affected, for instance, by the realism of a setting (Schroepfer et al. 2011) or the soundtrack (Nosal et al. 2016).

Monitoring online responses

Increasingly, it may be possible to monitor audience responses by looking to their online activity, the advantages and disadvantages of which are discussed by Arts et al. (2015). Recognising that human actions are increasingly played out in a digital realm, Roll et al. (2016) used page views of the Wikipedia online digital text archive as a metric of global interest in reptiles. Google trends statistics have also been used in relation to conservation (Proulx et al. 2014), for example, to explore factors influencing internet saliency of bird species (Correia et al. 2016). It is possible to download

Google trends data directly, or to perform and display queries with the R package *gtrendsR* (Massicotte & Eddebuettel 2016). We provide a clear example of a cinematic impact on Google trends statistics (Fig. 2), which illustrates the relationships between the release of films in the *Madagascar* (2005; 2008) and *Rio* (2011; 2014) franchises, as well as *Finding Dory* (2016), and Google searches in the USA for featured species. Currently, Google trends indicate interest in a specific attribute, without considering whether this is positive or negative for the species or ecosystem concerned. Further research is needed to understand the type of interest a film has elicited before drawing a link to possible conservation outcomes (see Table 1; Fig. 1). Search terms could subsequently be refined to explore the depth or geographic localisation of increased interest in an issue, and could help target subsequent efforts to capitalise on increases in salience or mitigate potential problems.

Media, discourse and case analyses

Beyond the initial impact of movies on their audiences, researchers should also examine the secondary response (i.e. influence on wider public discourses) and longer-term effects. Digital technology now plays a vital role in promoting both conservation and movies (Arts et al. 2015), and how movie messages are propagated and reported by news and social media will affect the power and longevity of their influence. The use of media content and discourse analyses could be especially powerful in teasing apart responses across multiple platforms, and semi-longitudinal case studies of movie impacts and legacies could also reveal important insights (see above examples of *Free Willy* and *The Beach*).

Industry-based research

Researchers should investigate the aims and motives of filmmakers, studios and others involved in producing movies featuring certain species, environments or conservation problems. This might involve, for example, interviews, focus groups or ethnographic research with writers,

producers and scientific advisors involved in developing conservation-relevant stories. Direct engagement will be central to developing an understanding of the movie industry and how to work effectively within it; fostering cinema-conservation relationships; clarifying aims and objectives with filmmakers; and identifying potential areas of engagement or collaboration. Assessing the engagement of potential stakeholders in this way has previously been demonstrated to be an effective method in conservation planning (Raymond & Knight 2013).

Biodiversity impacts

If conservationists aim to explore the potential role of movies in promoting positive conservation and environmental behaviours (e.g. enhance financial support for specific conservation projects, or decrease demand for illegally-traded species), ultimate effects must also be considered. If a specific ecosystem or species is portrayed in a movie, indicators of conservation status, such as abundance trends, could be explored, taking into account peak cinema-screening and home-release periods. However, given the time and spatial scales at which these processes can occur, the time lags between intervention (e.g. movie release) and measurement of indicator trends, and the potential difficulty in directly attributing any changes that occur to single factors, other indicators may be essential for assessing biodiversity impacts. CITES records (Challender et al. 2015) could be used to investigate changes in trade for some species, while in other situations market surveys (Harris et al. 2015) and online media (Hinsley et al. 2016) could be monitored to better assess demand for goods of conservation concern (although this will not be possible for all species). These will also provide key information on wildlife consumers and how media influences them, ultimately providing insights about how to mitigate potential negative impacts.

Harnessing the power of Hollywood: the beginning of beautiful friendship?

Andrew Stanton, writer/director of *Wall-E* (2008) – in which the last robot on earth cleans up the detritus of long-departed humans – has said: “*I don't have an ecological message to push.*”

[But] I don't mind that it supports that kind of view" (Simon 2008). While in this instance the environmental message was incidental to the story, movies might nevertheless be purposefully employed by conservationists to highlight issues of concern; brand placement is already common in big-budget movies. Productions that feature wildlife or naturalistic settings often employ scientific advisors who may have, or could form, links with interested organisations. There are therefore at least two established frameworks within which conservationists might engage with the industry (Cook et al. 2013).

The impact of movie references to a conservation issue could be enhanced by providing additional information and/or highlighting relevant campaigns and organisations in the credits and associated promotional materials (Arendt & Matthes 2014), and this may provide an excellent starting point for conservationists to engage with other forms of visual media (e.g. YouTube). A good example is the 'Home Tree Initiative', a scheme led by James Cameron and 20th Century Fox, in association with the Earth Day Network, which was launched alongside *Avatar's* home release (on Earth Day). Buyers of DVDs could register a code online and adopt a tree; the initiative achieved its goal of planting a million trees worldwide in 2010-11 (Taylor 2013).

Involving informed conservationists at the outset of a project can allow for horizon scanning for potential conservation-related issues that may arise (Cook et al. 2014), and the inclusion of additional information or existing evidence can contribute to this. For example, following the apparent but unanticipated impact of *Finding Nemo*, Disney/Pixar worked with the Association of Zoos and Aquariums for advice on mitigating the 'Nemo effect' following the sequel, *Finding Dory* (2016; starring the regal blue tang *Paracanthurus hepatus*). The collaborators encouraged responsible fish buying and ownership as part of the film's promotional campaign (e.g. a 'Selecting the Right Pet Fish' poster), and produced an educator's guide including information about marine species and their conservation. This example neatly highlights the benefits that could be obtained by using research on the conservation outcomes of previous movies to guide future engagement with the film industry.

This mitigation strategy draws some parallels with the suggestion that film studios that take advantage of particular species or ecosystems should contribute to their conservation (Jepson et al. 2011), equivalent to the idea of payments for ecosystem services (Redford & Adams 2009). However, as well as generating some controversy (Jepson & Jennings 2013; Wunder & Sheil 2013), this proposal revealed how difficult it would be to determine to what extent such an approach might work, given the lack of research and evidence surrounding movie impacts on biodiversity. Once again, this demonstrates the need to robustly assess these impacts.

If this comes across as a plea to Hollywood, we are not suggesting the movie industry become conservation campaigners. Rather, we are primarily advocating greater efforts from conservationists and researchers to understand, access, and take advantage of the opportunities cinema offers to share unsung species, key habitats and important issues. Industry engagement strategies need to be positive, collaborative and, at least initially, proposed and promoted by conservationists. In an information-saturated and screen-dominated age, it is vital that conservationists engage with the media through which they are attempting to be heard, and therefore the widest possible audiences. There are a number of possible avenues for developing partnerships and initiatives, such as using existing industry communication channels with non-governmental organisations or professional bodies within conservation to propose collaborations or offer advice; the development of voluntary certification schemes for conservation credentials (cf. the American Humane Society's 'No Animals Were Harmed' certification); and recognition or endorsement of good examples and role-models. Indeed, many filmmakers are already interested in conservation and environmental issues. Providing opportunities for industry professionals to enhance audience awareness and encourage behavioural change therefore has the potential to be a very powerful tool.

Conclusions

Hollywood offers enormous opportunities to raise broad, if shallow, awareness of a wide variety of conservation issues. Conservationists should therefore be prepared to interact with the movie industry, and filmmakers might also be encouraged to realise their potential to make a difference. Further, generating a better understanding of the impacts of cinema on conservation issues (applying the framework provided in Figure 1 and Table 1) will be integral to both harnessing the power of the silver screen in the future, and to mitigating any negative impacts it may have. A robust evidence base will be crucial for enabling these processes.

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Table 1. The potential positive and negative impacts of cinema on biodiversity conservation and suggested research questions and methods to investigate them, from the raising of audience awareness through direct conservation impact to increased industry engagement.

Potential contribution	Opportunities	Risks	Suggested research questions	Example research approaches
Engagement with film industry	<ul style="list-style-type: none"> • Collaborations between filmmakers and conservation organisations • Co-production of movie content with conservation messages 	<ul style="list-style-type: none"> • Primary interests of movie industry are commercial, which may produce conflicts of interest 	<ul style="list-style-type: none"> • What environmental awareness is there within the industry? • What common gains could industry and conservation work towards? • How to foster positive relationships between the movie industry and conservation community? 	<ul style="list-style-type: none"> • Social research into industry engagements with conservation (<i>e.g. interviews, focus groups, expert shadowing</i>) • Socioeconomic research into audience interests and market trends
Raising audience interest and awareness	<ul style="list-style-type: none"> • Disseminating information about conservation issues among wider audiences • Increasing interest in species/ecosystems/issues of conservation concern 	<ul style="list-style-type: none"> • Sensationalist or romanticised representations may be problematic by altering audience perception of the species/people involved • Reinforcement of uneven societal interest in certain species/ecosystems 	<ul style="list-style-type: none"> • How are different types of messaging around conservation understood and interpreted? • What movie characteristics are more effective at increasing public environmental awareness 	<ul style="list-style-type: none"> • Google trends analyses (<i>e.g. species or site searches</i>) • Audience surveys (<i>e.g. evaluating environmental awareness and intention to support specific conservation intervention</i>) and experimental viewings • Discourse and/or content analyses

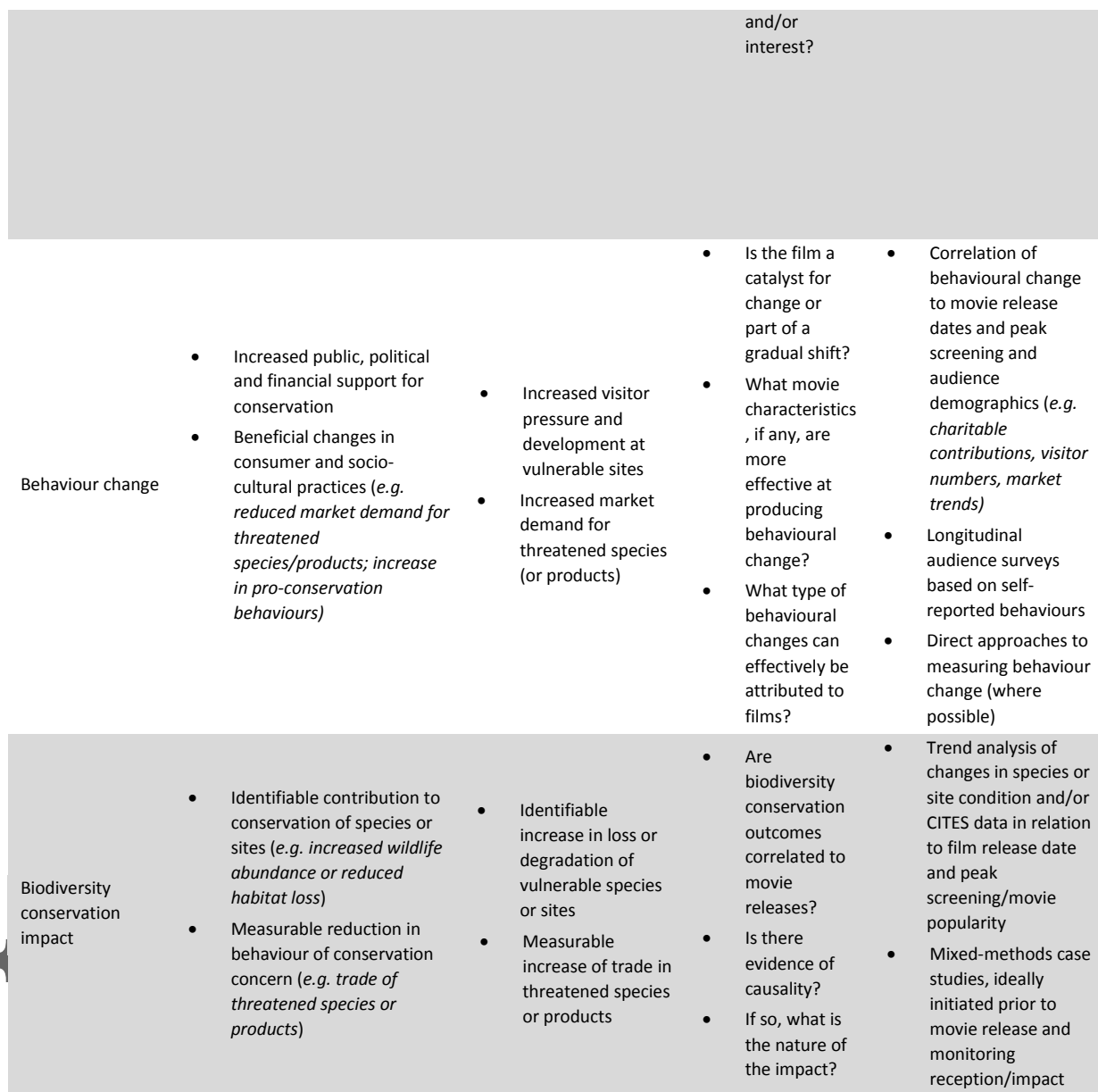


Figure Legends

Figure 1. A framework to understand the influence of cinema on biodiversity conservation, from initial engagement with the industry, through effects on audience awareness, to behaviour change and conservation outcomes. We highlight that this framework is iterative and conservation outcomes can be used to inform future engagements with the industry. Central lines (with examples) indicate potential more direct routes to conservation impact from earlier stages in the process.

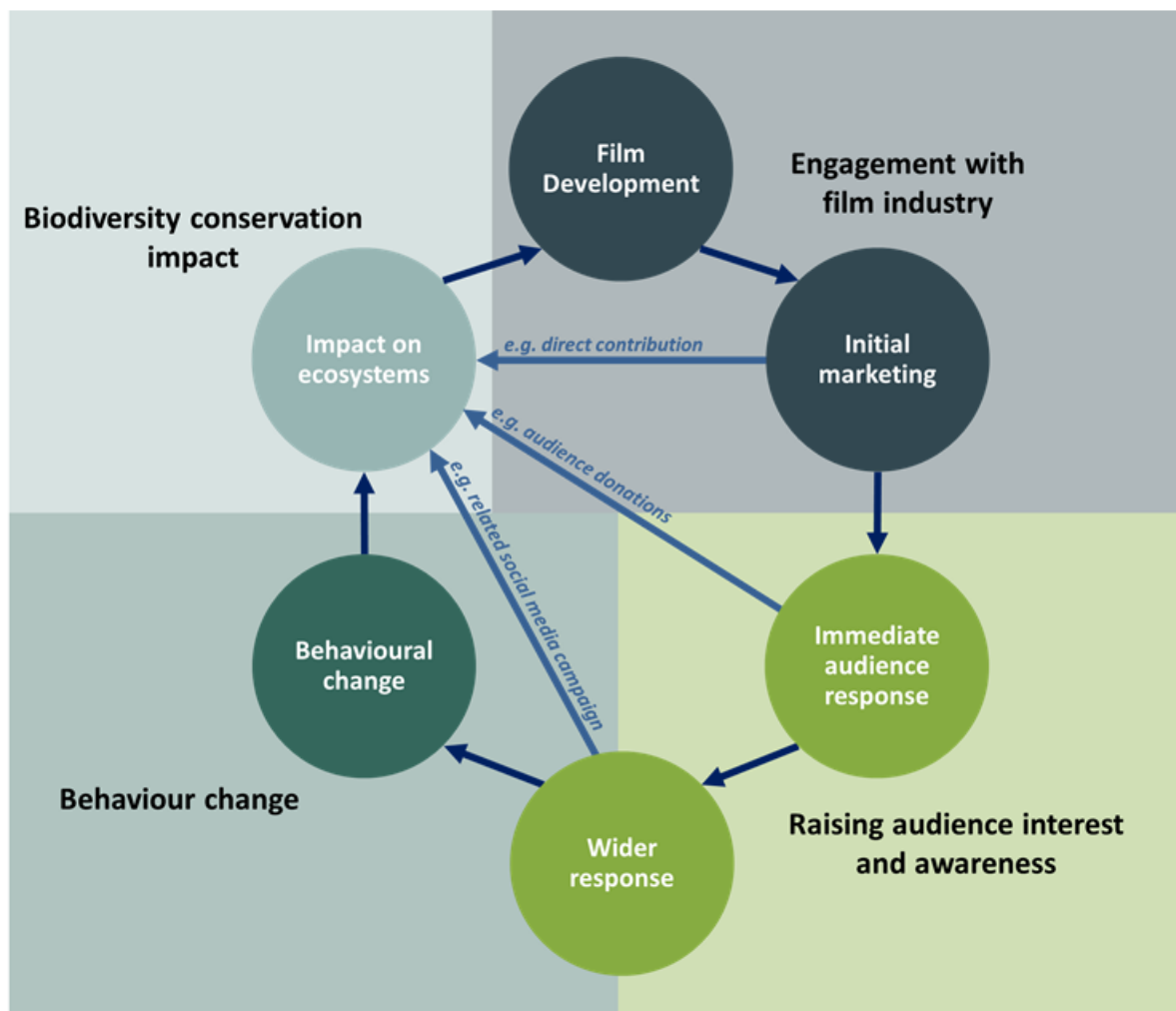


Figure 2. Google trends statistics for searches in the USA for three species featured in animated films, in relation to a timeline of relevant movie releases. The fossa (*Cryptoprocta ferox*) were the antagonists of *Madagascar* (2005) (light/blue line); the blue tang (*Paracanthurus hepatus*) is the species of the titular character in *Finding Dory* (2016) (dark/green line); and the Spix’s macaw (*Cyanopsitta spixii*), takes centre stage in the *Rio* (2011; 2014) franchise (mid/orange line). The google searches used are in the following categories: Fossa – animal, Blue Tang – search term, and Spix’s macaw – organism classification, and data was extracted directly from the google trends information online. The Google trends statistic represents relative search effort (with the time period of maximum search effort having a value of 100). Lines have been smoothed with local polynomial regression fitting (for more information and R code refer to the supplementary material).

Of note is the small peak in searches for “Fossa” related to the release of *Madagascar 2*, despite the

fact that the film did not include this character (and these additional searches therefore likely representing an increase in people watching the prequel).

