

More exposure opportunities for promoting freshwater conservation

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Funding information

Education, Audiovisual and Culture Executive Agency of the European Union: Erasmus Mundus Joint Doctorate SMART; Leibniz Association: Freshwater Megafauna Futures; Spanish Government's María de Maeztu excellence accreditation 2018-2022, Grant/Award Number: MDM-2017-0714; German Federal Ministry of Education and Research (BMBF), Grant/Award Number: 033W034A

Abstract

1. Freshwater ecosystems have a higher percentage of threatened and extinct species than terrestrial or marine realms, but remain under-represented in conservation research and actions arguably as a consequence of less popularity and promotion.
2. Cover images of conservation journals were used as a proxy of exposure and potential promotion opportunities provided for different ecosystems and species. To examine whether articles related to cover images received more attention, citations and Altmetric scores of cover-featured articles were compared with non-featured ones within the same host journal issue.
3. Freshwater ecosystems (10.4%) were featured less often than marine (15.2%) or terrestrial (74.4%) ecosystems on covers of 18 conservation journals from 1997 to 2016. All 15 most featured species are from terrestrial or marine ecosystems.
4. In addition, cover-featured studies showed higher citations and Altmetric scores than non-featured ones within the same host journal issue, indicating that cover-featured articles received more attention. Further investigations are needed to examine the relationship (i.e. whether there is a true causality) between being featured on the cover, and citations and Altmetric scores received by articles, as well as potentially resulting in greater conservation efforts. Nevertheless, we believe that providing exposure opportunities is likely to better inform the public about the continuing degradation of freshwater ecosystems and its impacts on human well-being, including economic loss and danger to public health. Journal editors can contribute by balancing their selection of featured ecosystems and species when opportunities arise.
5. Increasing exposure opportunities for freshwater ecosystems through various channels seems a promising approach to raise public awareness and appreciation of freshwater biodiversity. Scientists can play an active role and form an alliance with journal editors, conservation organizations, and media, to increase momentum in society for fresh waters to be experienced as essential ecosystems and prevent further degradation of freshwater habitats and biodiversity loss.

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KEYWORDS

Altmetric scores, biodiversity, citation, conservation effort, cover image, flagship species, public awareness, social media

1 | INTRODUCTION

Freshwater habitats including rivers, lakes, and wetlands cover less than 3% of Earth's surface area but support approximately 9.5% of all described animals and one-third of vertebrates (Balian et al., 2008). Meanwhile, freshwater ecosystems are subject to severe and increasing pressures owing to a growing demand for water, energy, and food, leading to overexploitation of fresh water and organisms (Dudgeon et al., 2006; Vörösmarty et al., 2010; Reid et al., 2019) and to the loss of important habitats such as wetlands and free-flowing rivers (Reis et al., 2017; Grill et al., 2019). Consequently, 27% of all freshwater species assessed are considered as threatened (i.e. evaluated as Critically Endangered, Endangered, or Vulnerable) on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (Tickner et al., 2020), while global populations of freshwater vertebrates declined by 84% from 1970 to 2016 (World Wide Fund for Nature, 2020).

Although the percentages of threatened and extinct species and the rate of decline of vertebrate populations are much higher in fresh waters than those in terrestrial or marine ecosystems (Costello, 2015; McRae, Deinet & Freeman, 2017), freshwater ecosystems are largely under-represented in biodiversity and conservation research (Jucker et al., 2018; Mazor et al., 2018; Tydecks et al., 2018). Even more worryingly, gaps in conservation actions could be worse than those in research (Clark & May, 2002; Abell & Harrison, 2020). Indeed, freshwater ecosystems have received only about 3% of the environmental funding from European foundations and approximately 8% from North American foundations (Synchronicity Earth, 2018). Globally, 89% of seasonal freshwater wetlands are not covered by protected areas (Reis et al., 2017) and most of the world's largest rivers have less than 10% of their basins targeted by integrated protection, which falls short of the goal (i.e. 17%) of the Convention on Biological Diversity (Abell et al., 2017). Even within protected areas, conservation actions often focus on terrestrial ecosystems and stressors to freshwater biodiversity persist (Hermoso et al., 2016; Abell & Harrison, 2020). For example, more than 1,200 large dams and 500 proposed hydropower dams (>1 MW) are located within protected areas (Thieme et al., 2020). Dams can block migratory pathways of freshwater species, alter natural flow regimes and impede sediment movement in rivers, which reduces the effectiveness of the protection of freshwater ecosystems.

Research and conservation actions to safeguard freshwater biodiversity suffer from low popularity among the general public (Monroe et al., 2009; Cooke et al., 2013). Unlike terrestrial and marine ecosystems represented by popular megafauna such as the big cats, elephants, rhinos, polar bears, and cetaceans, freshwater life remains inconspicuous to the public eye and consequently out of sight and out

of mind (Monroe et al., 2009; Darwall et al., 2018; He & Jähnig, 2019). Indeed, information on biodiversity and studies focusing on biodiversity are currently biased towards certain species (e.g. large mammals and birds) and ecosystems (e.g. the terrestrial realm) (Clark & May, 2002; Jucker et al., 2018; Mazor et al., 2018; Tydecks et al., 2018). Consequently, the need for conservation efforts for threatened species (e.g. invertebrates) and ecosystems (e.g. fresh waters) is largely underestimated as they are consistently under-represented in the information presented to the general public and policy makers (Kalinkat et al., 2017; Eisenhauer, Bonn & Guerra, 2019). Hence, raising public awareness of the dire situation of freshwater ecosystems, its adverse impacts on human well-being, and providing ideas for solutions could increase the willingness of people to engage in protecting freshwater ecosystems and establishing more conservation actions (Kalinkat et al., 2017; Darwall et al., 2018).

One of the common practices to increase public awareness of biodiversity is promoting species or habitats that are in need of conservation (Clucas, McHugh & Caro, 2008) – for example, by using their images for conservation campaigns (e.g. featuring rhinos and elephants on billboards and popular magazines to raise awareness of illegal hunting) or promoting them on television (e.g. in nature documentaries). In addition, conservation organizations such as the World Wide Fund for Nature (WWF) and Fauna & Flora International (FFI), use threatened charismatic species such as the giant panda (*Ailuropoda melanoleuca*) and the Arabian oryx (*Oryx leucoryx*) as their logos. These actions have proved successful because images can attract people's attention, deliver messages, and provoke emotions and thoughts at a glance (Clucas, McHugh & Caro, 2008). Similarly, conservation journals use species or habitat images as journal covers to promote content, relating the cover image to one of the articles published in the same issue (e.g. *Conservation Biology, Diversity and Distributions*). This is an opportunity for journals to direct the attention of their readers not only to a study, which editors assess as particularly interesting or important, but also to species or habitats and their conservation.

This article discusses the understudied relationship between exposure opportunities and promotion of freshwater species and habitats using the example of cover images of conservation journals. We use the covers of conservation journals as an example to illustrate the opportunities for exposure given to freshwater ecosystems and compare the citation and Altmetric scores received by cover-featured articles and non-featured ones within the same host journal issue. We highlight the potential of an alliance formed by freshwater scientists, scientific journals, conservation organizations, and the media to increase exposure opportunities for freshwater ecosystems and raise public awareness of freshwater biodiversity.

2 | FRESHWATER ECOSYSTEMS ARE UNDER-REPRESENTED ON THE COVERS OF CONSERVATION JOURNALS

Information on cover images of academic conservation journals was collected for the period of 1997 to 2016. There were 56 academic journals listed under the category of 'biodiversity conservation' in Web of Science databases (27 October 2017). Among these journals, 18 were selected as they regularly changed their covers between 1997 and 2016 (i.e. these journals used different cover images for each issue or changed their cover images annually; Table 1), and information on their covers was available online or in the printed copies. For each cover image, information on the species or habitats featured was collected. In total, 1,043 images with a clear focus on species or habitats and associated ecosystems were included in the analysis. During the IUCN Red List assessments, species were assigned to one of the seven categories – freshwater; marine; terrestrial; freshwater and marine; freshwater and terrestrial; marine and terrestrial; freshwater, marine, and terrestrial – based on their life history and habitat requirements. When a cover-featured species was assessed by the IUCN Red List (IUCN, 2018), its associated ecosystem category was obtained from the IUCN Red List database. For species not evaluated by the IUCN Red List, a single ecosystem (i.e. freshwater, marine, or terrestrial) or a combination of ecosystems (e.g. marine and terrestrial) was assigned, according to their life history and habitat requirements. Similarly, covers that featured

TABLE 1 Biodiversity and conservation journals from which cover images were collected

Journal	Period of data collection
<i>Animal Conservation</i> ^a	2003–2016 ^b
<i>Biodiversity and Conservation</i>	1997–2012 ^b
<i>Conservation Biology</i> ^a	1997–2016
<i>Conservation Letters</i> ^a	2008–2016 ^b
<i>Diversity and Distributions</i> ^a	2016 ^b
<i>Ecography</i> ^a	2014–2016 ^b
<i>Global Change Biology</i> ^a	1998–2016
<i>Journal for Nature Conservation</i>	2002–2016 ^b
<i>Journal of Applied Ecology</i> ^a	1997–2016
<i>Journal of Fish and Wildlife Management</i>	2011–2016 ^b
<i>Northeastern Naturalist</i>	1997–2016
<i>Oryx</i> ^a	1997–2016
<i>Pachyderm</i>	1997–2016
<i>Southeastern Naturalist</i>	2002–2016 ^b
<i>Systematics and Biodiversity</i> ^a	2003–2016 ^b
<i>The Southwestern Naturalist</i>	1997–2016
<i>Tropical Conservation Science</i>	2008–2016 ^b
<i>Wildlife Society Bulletin</i>	1997–2006; 2011–2016 ^b

^aThese journals show Altmetric scores for each article on their websites.

^bThese journals started changing cover images regularly after 1997 or stopped changing cover images regularly before 2016. *Wildlife Society Bulletin* was paused between 2007 and 2010.

habitats only (without species) were either assigned to a single ecosystem or a combination of ecosystems. In the case of multiple ecosystems featured on the same cover, the cover count was split proportionately (e.g. 0.5 point for the terrestrial and the freshwater ecosystem count if both are shown on the cover).

In total, 74.4% of all cover images were related to terrestrial ecosystems, outnumbering the sum of cover images featuring marine (15.2%) or freshwater (10.4%) ecosystems. From 1997 to 2016, terrestrial ecosystems constantly dominated the covers of conservation journals (Figure 1), contributing at least 70% to all cover images in each year except for 2010 (64.2%). Freshwater ecosystems have been portrayed on conservation journal covers less often than marine and terrestrial ecosystems in every year since 2007.

In terms of individual species (Figure 2), the African elephant (*Loxodonta africana*, 18 times) was featured most often on the covers of journals, followed by the tiger (*Panthera tigris*, eight), the black rhinoceros (*Diceros bicornis*, eight), the polar bear (*Ursus maritimus*, seven), the puma (*Puma concolor*, seven), the grey wolf (*Canis lupus*, six), and the American black bear (*Ursus americanus*, six). All 15 most featured species (i.e. featured on journal covers at least four times) were from terrestrial or marine ecosystems. Fourteen are large vertebrate species with the monarch butterfly (*Danaus plexippus*) as the only invertebrate species, which reflects the under-representation of invertebrates in conservation efforts. Indeed, although invertebrates play key roles in various ecosystems (Kellert, 1993; Covich, Palmer & Crowl, 1999) and declines in their populations have been widely reported (Wagner et al., 2021), they remain under-represented in monitoring and conservation actions (Eisenhauer, Bonn & Guerra, 2019). This could lead to a quiet extinction of invertebrates, consequently causing the loss of ecosystem functions and vertebrate species (Eisenhauer, Bonn & Guerra, 2019).

Among the 34 species that were featured at least three times on journal covers, only three species were associated with fresh waters: the American alligator (*Alligator mississippiensis*); spotted salamander (*Ambystoma maculatum*); and sockeye salmon (*Oncorhynchus nerka*), whereas six species were associated with marine and 32 species with terrestrial ecosystems. None of the 95 species featured more than

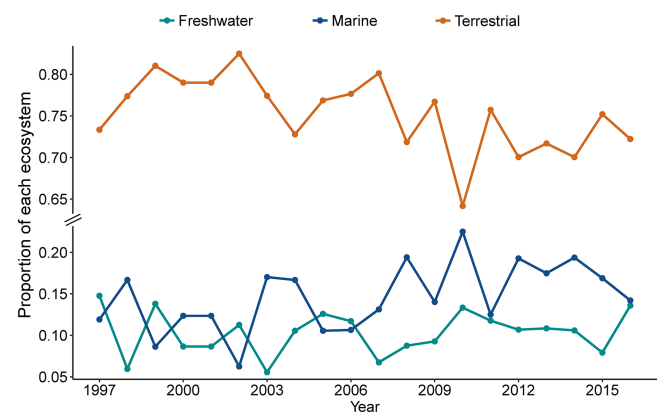
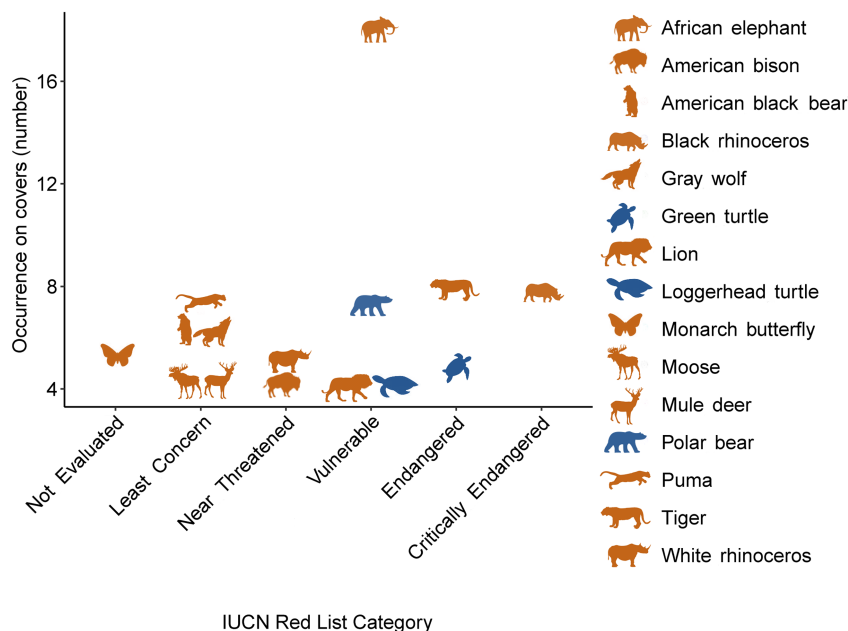


FIGURE 1 Percentage of species and habitats from each ecosystem type on the covers of 18 conservation journals between 1997 and 2016

FIGURE 2 The 15 most featured species and their IUCN Red List categories on covers of 18 conservation journals between 1997 and 2016 (IUCN, 2018; brown-coloured animals are from terrestrial ecosystems while blue-coloured animals are associated with both marine and terrestrial ecosystems)



once was solely associated with fresh waters; all of these species spend part or all of their life cycles in marine or terrestrial ecosystems. Meanwhile, six of them were associated only with marine ecosystems and 62 species were associated only with terrestrial ecosystems.

The observed patterns in species and ecosystems featured on the covers of conservation journals are in line with Clucas, McHugh & Caro (2008), who found that big cats, bears, primates, and large birds were often featured on covers of popular conservation and nature magazines in the USA, whereas freshwater species such as fish were rarely featured. Hence, the covers of conservation journals reflect the current landscape of biodiversity studies and conservation efforts: so far, most research and conservation efforts have focused on terrestrial and marine ecosystems, particularly on birds and terrestrial and marine megafauna (Clucas, McHugh & Caro, 2008; Mazor et al., 2018; Tydecks et al., 2018), whereas only 18% of all biodiversity studies published from 1945 to 2014 are associated with freshwater ecosystems (Tydecks et al., 2018). Among aquatic realms, freshwater ecosystems are less recognized and their conservation is less targeted in environmental legislation or conservation actions than marine ecosystems (e.g. Marine Protected Areas; Boon & Baxter, 2016). This is despite an urgent need for the conservation of freshwater ecosystems that was flagged almost 20 years ago (Abell, 2002) and a large body of research showing that threats to freshwater habitats and species are intense and increasing over the last few decades (Vörösmarty et al., 2010; He et al., 2018; Grill et al., 2019; Reid et al., 2019; WWF, 2020). Terrestrial and marine megafauna species, which are frequently featured on covers of conservation journals (Figure 2) and on popular conservation and nature magazines (Clucas, McHugh & Caro, 2008), are the ones that receive most research attention and conservation efforts (Donaldson et al., 2016; Ford et al., 2017). These species are also the ones perceived by the general public as the most charismatic animals

(Albert, Luque & Courchamp, 2018; Courchamp et al., 2018), while freshwater megafauna are often overlooked (Cooke et al., 2013; He & Jähnig, 2019; Moleón et al., 2020).

Several factors may have contributed to the under-representation of freshwater ecosystems on journal covers. First, there are generally fewer freshwater studies published in biodiversity and conservation journals than studies focusing on terrestrial or marine ecosystems (Mazor et al., 2018; Tydecks et al., 2018). This limits the opportunities for editors to showcase freshwater species or habitats on the cover of the host journal issue. Second, authors of these published freshwater studies might not have suitable photos to offer as cover images. Turbidity or flow makes it challenging to photograph freshwater life and underwater habitats compared with marine environments. Third, compared with terrestrial or marine species, photographers portray freshwater species in their natural habitats less often, but instead display them as 'fish out of the water' (i.e. fish species as food or trophies of angling competitions; Monroe et al., 2009). Photographs featuring freshwater organisms out of the water are likely to be less appealing to readers than those featuring species occurring in their natural habitats. Finally, it is likely that editors sometimes consciously choose to feature non-freshwater studies, and therefore species from terrestrial or marine ecosystems on the cover, because they consider them important and expect them to generate more interest.

3 | COULD MORE EXPOSURE OPPORTUNITIES LEAD TO MORE ATTENTION?

Citation was used as a proxy to measure attention received by published articles from academia. In addition, the Altmetric score was chosen as an indicator to measure attention both from scientists and

the general public. The Altmetric score is a web-driven metric that captures coverage and mentions on web-based media, including news, blogs, social media, and policy documents (Costas, Zahedi & Wouters, 2015). It is regarded as a complementary metric to citations, as it can capture attention from a more diverse readership (Piwowar, 2013; Bornmann, 2014). For nine journals – *Animal Conservation*, *Conservation Biology*, *Conservation Letters*, *Diversity and Distributions*, *Ecography*, *Global Change Biology*, *Journal of Applied Ecology*, *Oryx*, and *Systematic and Biodiversity* – cover images are usually chosen to reflect the ecosystem or species from a selected article (henceforth called a ‘cover-featured article’) within the same issue. Citations and Altmetric scores were collated for articles (excluding editorials and book reviews) published in these nine journals between 2014 and 2016. Citations were derived from the Web of Science on 27 October 2017, while the Altmetric scores were collected from journal websites. As Altmetric scores can change with time, the scores for articles published in the same issue were collected on the same day. The percentiles of cover-featured articles within the host journal issue were calculated, both for citations and Altmetric scores, and the Wilcoxon signed-rank test was used to determine whether the percentiles of citations and Altmetric scores for cover-featured articles were higher than the median (i.e. Q_{50}) of all articles.

Studies featured on the covers of conservation journals resonated well with researchers and the general public. Cover-featured studies had significantly higher citations ($P < 0.001$, effect size = 0.34) and Altmetric scores ($P < 0.001$, effect size = 0.60) than non-featured ones within the same host journal issue, indicating that articles featured on covers received more attention from scientists and the general public (Figure 3). This correlation does not necessarily imply causation, i.e. the high citations and Altmetric scores of cover-featured articles may not solely be a result of being promoted on journal covers. It is possible that these cover-featured articles would have received the same attention without being featured. For example, the frequently featured megafauna species have received much research attention from scientists and are also popular with the general public (Ford et al., 2017; Albert, Luque & Courchamp, 2018; Courchamp et al., 2018). Hence, studies focusing on these popular species are likely to receive more citations as a result of a relatively higher number of related research projects and papers, and receive more media attention on social media platforms owing to their popularity among the general public. Furthermore, many readers nowadays gain access to research articles through online portals rather than reading printed copies, so they may not come across the journals' covers.

Nevertheless, being featured on journal covers can offer more opportunities of exposure to potential readers. For example, cover images are often displayed in prominent positions on the websites of conservation journals (e.g. *Diversity and Distributions*, *Animal Conservation*, and *Journal of Applied Ecology*) and are specially mentioned by the journals' accounts on social media platforms together with the featured studies. More and more conservation journals (e.g. *Conservation Biology*, *Conservation Letters*, *Animal Conservation*, and *Ecography*) and conservation organisations (IUCN,

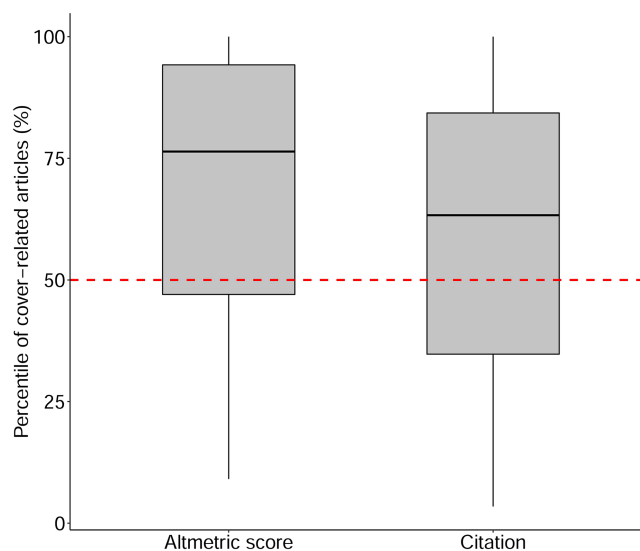


FIGURE 3 Percentiles of cover-related articles in terms of Altmetric scores and citations within host journal issues ($N = 168$). Red dashed line shows the median percentile (i.e. Q_{50}) of all articles within the same host journal issue. The whiskers above the boxes represent articles with percentiles higher than 75% of all cover-related articles while the whiskers below the boxes indicate articles with lowest 25% percentiles among all cover-related articles. The black lines within the boxes mark the medians of all cover-related articles

WWF, Conservation International and The Nature Conservancy) are active on social media platforms such as Twitter and Facebook, promoting biodiversity conservation and interacting with the general public through these channels (Parsons et al., 2014). In addition, there is a greater chance that a press release will be created by authors and their institutes for a cover story and sent to respective media outlets. Hence, studies that benefit from exposure opportunities on covers are more likely to be noticed, spread through the internet and picked up by the media, and in turn are exposed to a more diverse, non-scientific audience than non-featured articles (Lamb, Gilbert & Ford, 2018). This effect has been recognized by publishers and cover exposure is now offered to authors for a fee by some journals. For example, Wiley offers this service, stating that articles featured on their journals' covers received 30% higher Altmetric scores and 35% higher full-text views on its website (i.e. Wiley Online Library; Wiley, 2020).

4 | FUTURE RESEARCH AVENUES TO UNDERSTAND DRIVERS OF CONSERVATION EFFORTS

Although these results indicate a positive correlation between being featured on journal covers and the attention that articles receive, it does not mean that being featured on journal covers will lead directly to greater conservation efforts on the species or ecosystems featured. The impact of scientific publications on conservation practice is often

complicated and varies among regions and ecosystems (Boon & Baxter, 2020). It also depends on the evidence presented in the publications and efforts of scientists to disseminate their findings to a wider audience (Boon & Baxter, 2020). For example, articles containing comprehensive and transparent evidence and a clear management direction together with a policy brief are more likely to be understood and accepted by decision makers (Cooke & Suski, 2020). Scientific communications including popular versions of publications (e.g. feature articles in magazines, graphical illustrations, or video summaries), translations of main findings into local languages where results are meant to be implemented, participatory workshops with key actors and outreach activities in local communities emphasizing the social and cultural values of freshwater habitats and

species, can all improve recognition and acceptance of scientific findings by stakeholders and the general public (Cooke & Suski, 2020; Larocque et al., 2020; Noble & Fulton, 2020). Moreover, active engagement in follow-up monitoring and assessment programmes (e.g. LIFE programmes and Red List assessments) with related authorities after publication can also help to ensure the implementation of recommendations from scientific studies (Abeli et al., 2020; Bylak & Kukuła, 2020). Given the multiple, potential drivers behind conservation efforts, future studies need to disentangle the effect of different factors on attention received by publications from society, as well as the influence of scientific publications on conservation practice (Table 2). We believe that providing more exposure and promotion opportunities is a promising first step to

TABLE 2 Research questions that help to identify the underlying drivers of conservation efforts received for different species or habitats

Theme	Question	Aim of the question
Funding allocation	How much funding from national research funding agencies and major NGOs goes to research and conservation projects that target terrestrial, marine, or freshwater ecosystems?	Identifying gaps in funding to support persistence of freshwater biodiversity.
	What is the part of freshwater-related funding spent on actions targeting the most threatened species or regions?	Optimizing the allocation of limited available funding.
Biodiversity knowledge	Is there a bias in currently available information (e.g. on distribution, population, and threats) of terrestrial, marine, and freshwater species in commonly used online databases or websites (e.g. IUCN Red List, Global Biodiversity Information Facility, Wikipedia)?	Identifying knowledge gaps in different ecosystems.
	How does the availability of biodiversity knowledge match the level of overall biodiversity and threatened species in fresh waters spatially?	Identifying gaps in current monitoring and assessment of freshwater biodiversity.
Influence of scientific journals	How many scientists versus non-scientists follow conservation journals on social media (e.g. Twitter)?	Examining the degree of direct influence of scientific journals on public perception.
	What makes a post of scientific journals to be retweeted, liked and commented on by these followers?	Testing whether featured species or habitats selected by journals receive attention of their audience.
	Do articles featured on journal covers have higher citations and Altmetric scores than non-featured ones focusing on the same species or habitats and published in the same journal?	Testing whether the promotion through scientific journals directly contributes to the attention received by articles.
Media coverage	Is there more media coverage on terrestrial or marine ecosystems than on fresh waters regarding conservation?	Identifying potential biases in the current media coverage of different ecosystems.
	Are frequently featured species by media recognized more by the general public than those that are at similar risk of extinction but featured less often?	Examining whether exposure and promotion opportunities increase public awareness.
Public interest	What characteristics make species more appealing to people?	Identifying potential flagship species.

increase public awareness of the dire situation of freshwater ecosystems and biodiversity as well as of potential consequences for human well-being. Such efforts are likely to boost related science communication, positively influence conservation practice and benefit the future development of freshwater conservation.

5 | BUILDING AN ALLIANCE TO PROMOTE FRESHWATER BIODIVERSITY

Fresh waters are often regarded as a resource. It is not well recognized that freshwater ecosystems support high levels of biodiversity (e.g. approximately one third of all described vertebrate species and half of all described fish species; Balian et al., 2008; Fricke, Eschmeyer & van der Laan, 2020) and provide important ecosystem services to society (Postel & Carpenter, 1997). Such a biased perception probably leads to the underestimation of the importance of freshwater biodiversity and ecosystems. This may hinder young researchers to pursue a career in freshwater research and conservation and, in turn, influence the amount of research on freshwater biodiversity and ecosystems. To increase appreciation and awareness of freshwater life and to facilitate the development of freshwater research and conservation actions in the future, more exposure opportunities on various platforms are needed for fresh waters.

Freshwater scientists can play an active role in achieving this goal. For example, by submitting appealing images (e.g. Figure 4) of freshwater species and habitats to journals together with their articles, they can support editors in promoting freshwater conservation. Considering the challenges of taking photographs under water, collaborations with professional photographers can be a promising avenue to showcase freshwater life and increase public appreciation of freshwater ecosystems. These images can also be used by journals to promote articles on social media platforms. Journals themselves could seize opportunities for exposure and

promotion of fresh waters to counterbalance popular species that have already received much attention and conservation efforts. Specifically, journals could invite freshwater scientists as editors and provide more promotion for freshwater-related studies when such opportunities arise.

Scientists can also help promote fresh waters by establishing collaborations with media (e.g. newspapers, magazines, and online blogs) to disseminate information about freshwater biodiversity. For example, freshwater scientists can contact journalists and writers proactively to provide stories about their studies when focusing on species with unique biological traits and life-histories, or high economic or cultural values (see the species identified in Noble et al., 2016; Carrizo et al., 2017; Kalinkat et al., 2017). These studies are likely to be appealing to media and resonate well with the general public. Freshwater scientists can also work together with international and local conservation organizations, thereby enhancing their communications with decision makers and local communities. Such direct interaction has been suggested to boost conservation actions (Parsons et al., 2014; Papworth et al., 2015) and to lead to better uptake of science in policy (King, Schnee & White, 2017). More and more freshwater scientists have participated in these activities; for example, by promoting freshwater conservation on various channels or by engaging with policies that aim at 'bending the curve' of global freshwater biodiversity loss (Tickner et al., 2020).

Visual media are also a promising tool to raise public awareness of freshwater biodiversity, since they reach a diverse audience and stimulate public discussion (Silk et al., 2018). So far freshwater ecosystems have rarely been featured in popular films or television programmes, but terrestrial and marine-themed examples such as 'Blue Planet', 'Finding Nemo', 'Happy Feet', 'Madagascar' and 'Rio' exemplify the huge potential of such media especially, but not exclusively, to reach and inform younger generations.

Public perception and knowledge on biodiversity, including its status and importance, are influenced by available information



FIGURE 4 Examples of photographs featuring freshwater species and habitats that could increase public appreciation of freshwater ecosystems: Suwannee cooter (*Pseudemys concinna suwanniensis*, top left, courtesy of Cheyenne Alderson); Arapaima (*Arapaima gigas*, top right, courtesy of David Ausserhofer); hippopotamus (*Hippopotamus amphibius*, bottom left by Brian Snelson; CC-BY 2.0); and Yangtze finless porpoises (*Neophocaena asiaeorientalis* ssp. *asiaeorientalis*) and birds in the Poyang Lake, China (bottom right, courtesy of Huigong Yu)

(Papworth et al., 2015; Kochalski et al., 2019). Increasing public awareness of freshwater ecosystems and improving the protection of freshwater life is likely to be a long-term process (Tickner et al., 2020). As a first step, scientists can work together with scientific journals, media, and conservation organizations to form an alliance to provide more exposure opportunities and create momentum in society for fresh waters to be experienced as essential ecosystems.

ACKNOWLEDGEMENTS

This work has been carried out within the SMART Joint Doctorate (Science for the MAnagement of Rivers and their Tidal systems), funded with the support of the Erasmus Mundus programme of Education, Audiovisual and Culture Executive Agency of the European Union and is a contribution to the Leibniz Competition project 'Freshwater Megafauna Futures' funded by the Leibniz Association. S.C.J. and F.H. acknowledge the support of German Federal Ministry of Education and Research (BMBF; 033W034A). S.D.L. was supported through the Spanish Government's María de Maeztu excellence accreditation 2018-2022 (Ref. MDM-2017-0714). Gregor Kalinkat, Mark W. Schwartz, Philip J. Boon, Steve J. Ormerod and two anonymous reviewers provided constructive comments on earlier versions of this article. We also thank Jing Du and Karan Kakouei for their assistance with data collection. This manuscript contributes to the Alliance for Freshwater Life's vision to understand, value, and safeguard freshwater biodiversity.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

DATA AVAILABILITY STATEMENT

No new data were generated by the study. Information on cover images of conservation journals is available from the journals listed in the manuscript.

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How to cite this article: He, F., Jähnig, S.C., Wetzig, A. & Langhans, S.D. (2021). More exposure opportunities for promoting freshwater conservation. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 31(12), 3626–3635. <https://doi.org/10.1002/aqc.3725>