The *Alliance for Freshwater Life*: A global call to unite efforts for freshwater biodiversity science and conservation

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Abstract

1. Global pressures on freshwater ecosystems are high and rising. Viewed primarily as a resource for humans, current practices of water use have led to catastrophic declines in freshwater species and the degradation of freshwater ecosystems, including their genetic and functional diversity. Approximately three-quarters of the world's inland wetlands have been lost, one-third of the 28 000 freshwater species assessed for the International Union for Conservation of Nature (IUCN)

Red List are threatened with extinction, and freshwater vertebrate populations are undergoing declines that are more rapid than those of terrestrial and marine species. This global loss continues unchecked, despite the importance of freshwater ecosystems as a source of clean water, food, livelihoods, recreation, and inspiration.

2. The causes of these declines include hydrological alterations, habitat degradation and loss, overexploitation, invasive species, pollution, and the multiple impacts of climate change. Although there are policy initiatives that aim to protect freshwater life, these are rarely implemented with sufficient conviction and enforcement. Policies that focus on the development and management of fresh waters as a resource for people almost universally neglect the biodiversity that they contain.

3. Here we introduce the *Alliance for Freshwater Life*, a global initiative, uniting specialists in research, data synthesis, conservation, education and outreach, and policymaking. This expert network aims to provide the critical mass required for the effective representation of freshwater biodiversity at policy meetings, to develop solutions balancing the needs of development and conservation, and to better convey the important role freshwater ecosystems play in human well-being. Through this united effort we hope to reverse this tide of loss and decline in freshwater biodiversity. We introduce several short- and medium-term actions as examples for making positive change, and invite individuals, organizations, authorities, and governments to join the *Alliance for Freshwater Life*.

KEYWORDS

biodiversity, conservation evaluation, endangered species, fish, invertebrates, macrophytes

1 | INTRODUCTION

Freshwater ecosystems are a fundamental resource for human life, providing clean water, food, livelihoods, and other ecosystem services, estimated to be worth over $4 trillion annually (Béné et al., 2016; Costanza et al., 2014; Lynch et al., 2016; Youn et al., 2014). The rivers, lakes, and wetlands that make up these ecosystems cover less than 1% of the Earth's surface area (Mittermeier, Farrell, Harrison, Upgren, & Brooks, 2010), and yet support over 10% of all known species (Dijkstra, Monaghan, & Pauls, 2014; Mittermeier et al., 2010), including 30% of all vertebrates.

Despite the overwhelming contribution of fresh waters to global biodiversity and human well-being, there is, simply put, a global freshwater biodiversity crisis that requires immediate attention. Freshwater vertebrate populations have declined by more than 80% over the past 50 years, a rate of decline twice that recorded for either marine or terrestrial systems (World Wide Fund for Nature, WWF, 2016). According to the International Union for Conservation of Nature (IUCN, 2017), approximately one in three of the 28 000 species dependent upon freshwater habitats thus far assessed is threatened with extinction. An estimated three-quarters of the world's inland natural wetlands were lost during the 20th century (Davidson, 2014). The World Economic Forum

(WEF) report for 2017 ranks freshwater supply at number three in a list of the top-10 global risks in terms of impact, surpassed only by weapons of mass destruction and extreme weather events (WEF, 2017).

2 | CAUSES OF THE FRESHWATER BIODIVERSITY CRISIS

The causes of this crisis have been recognized for many years (Abell, 2002; Benz & Collins, 1997; Collen et al., 2014; Dudgeon et al., 2006; Foley et al., 2005; Master, Stein, Kutner, & Hammerson, 2000; McAllister, Hamilton, & Harvey, 1997; Strayer & Dudgeon, 2010; Thieme et al., 2011; Vörösmarty et al., 2010), yet little action has been taken to address them. A fundamental driver of the decline in freshwater biodiversity is the dramatic increase in global consumption of natural resources over the last century (Garcia-Moreno et al., 2014). This has led to unsustainable water abstraction, widespread habitat loss and degradation, increased levels of pollution, and a proliferation of invasive species (Garrick et al., 2017). Many wetlands have been converted to agricultural production (Ramsar, 2017), and other fresh waters are actively used as sinks for pollutants or dumps for effluent and industrial waste, without consideration of the harm caused or the resultant loss of biodiversity and ecosystem functioning in these systems (Craig et al., 2017). Engineering-based solutions for water provisioning emphasize water infrastructure (Green et al., 2015; Tockner,

Bernhardt, Koska, & Zarfl, 2016; Vörösmarty et al., 2010). These may help meet human demands for water in the short term, but often have significant impacts on freshwater ecosystems (Harrison et al., 2016). Changes in precipitation and temperature regimes linked to climate change greatly compound these impacts (Tedesco et al., 2013).

This demand for fresh water will only increase in the current epoch of rapid environmental change, termed the Anthropocene (Crutzen & Stoermer, 2000; Waters et al., 2016). Around 750 million people still lack access to safe drinking water, and more than 1.3 billion people lack access to electricity, for which hydropower is still viewed as a solution (World Health Organization/United Nations Children's Fund (WHO/ UNICEF), 2015). Agriculture currently accounts for 70% of freshwater use globally. By 2050, agricultural production will need to increase by 60% globally, and will need to double in developing countries (Alexandratos & Bruinsma, 2012) or be exported from those parts of the world gearing up to increase their share of global markets. Water demand for manufacturing is expected to increase by 400% between 2000 and 2050 globally (United Nations World Water Assessment Programme (WWAP), 2015). It is predicted that by 2030 the average global water requirements will exceed current accessible and reliable water supplies by over 40% (Addams, Boccaletti, Kerlin, & Stuchtey, 2009).

A second fundamental cause for the freshwater biodiversity crisis is the insufficient consideration of impacts on freshwater ecosystems in decision making and policy about water and land use, leading to their degradation and loss (Cowx & Portocarrero Aya, 2011; Garrick et al., 2017; Hoekstra & Mekonnen, 2012). Safeguarding freshwater ecosystems often comes second to other development priorities that are viewed as being more directly linked to human well-being, such as the provision of drinking water, energy, and food. The result is the unnecessary and often inadvertent sacrifice of freshwater life as collateral damage in global development, which can lead to the destruction of the very ecosystems required to support these same objectives. One example is the loss of food production through the destruction of freshwater fisheries (Lynch et al., 2017). Another is the global surge in hydropower projects (Zarfl, Lumsdon, Berlekamp, Tydecks, & Tockner, 2015), viewed as a 'green' energy source despite the extensive degradation of habitat and the disruption of species migration routes (Winemiller et al., 2016). The UN High Level Panel on Water recognizes the value of the environment in delivering water-related services to people, but is (very nearly) silent on biodiversity and non-human uses of water (https://sustainabledevelopment. un.org/HLPWater). We consider this to be an example of an anachronistic approach to policymaking that can be changed through coordinated and sustained global actions.

There are a number of international agreements to conserve and support the sustainable use of freshwater species and ecosystems, including the Convention on Biological Diversity (CBD; with 168 signatory countries at the time of writing) (Leadley et al., 2014) and the Ramsar Convention on Wetlands of International Importance (www.ramsar.org). More recently agreed, the Sustainable Development Goals (SDGs) (https://sustainabledevelopment.un.org/), to which almost all countries are committed, are intended to promote prosperity while protecting the planet. The SDGs include targets to protect and restore water-related ecosystems (Target 6.1); to ensure the conservation, restoration, and sustainable use of terrestrial and inland

freshwater ecosystems, and their services (Target 15.1); and to reduce the degradation of natural habitats, halt the loss of biodiversity, and protect and prevent the extinction of threatened species (Target 15.5). The targets are for delivery in 2030 (6.1) or, alarmingly, as early as 2020 (15.1 and 15.5). If progress is not adequate, the targets risk being discounted as unrealistic or impractical. It is therefore imperative that efforts are stepped up to achieve these targets. In short, international efforts thus far lack specific actions and goals for conserving freshwater ecosystems and species, and their genetic and functional diversity. As a result, they have had little success in slowing their decline (Convention on Biological Diversity, 2014). It is only through galvanizing, massively expanding, and mobilizing the currently fragmented network of experts working to improve our understanding and conservation of freshwater ecosystems that we will gain the voice and momentum required to influence, inform, and help implement existing and new policy for the benefit of freshwater biodiversity. It is also through this alliance that we will generate a detailed road map for change to conserve and benefit from freshwater biodiversity in the future.

Although the challenges may appear insurmountable, there have been successes upon which to model a more positive future, in which human needs are met and biodiversity loss is minimized. There have been successes in restoring rivers and wetlands, improving connectivity for migrating fish, and challenging inappropriate hydropower developments and unsustainable water abstraction and pollution. We see the beginnings of a global movement to halt and reverse the current declines in freshwater biodiversity, and an increasing awareness in the global population of the need for better water and land-use practices. To date, however, these actions have been few and far between, carried out in relative isolation, and are wholly insufficient in the context of the freshwater biodiversity crisis. We feel that it is time for the global freshwater biodiversity community to unite, to coordinate our actions, and to help civil societies and governments take action on a scale appropriate to the magnitude of this crisis. We need to improve awareness of the issues, provide the necessary scientific research to inform environmental and development decision making, engage with policymakers to help set priorities for biodiversity with respect to human concerns, and effectively exchange information between science, policy, and management.

A major shift in our approach to water and land management is required to address the continuing freshwater biodiversity crisis. Dudley, Harrison, Kettunen, Madgwick, and Mauerhofer (2016) noted that key activities needed for the improved conservation of freshwater ecosystems included: the development of better partnerships across sectors to promote conservation and management; closer attention to the role of natural infrastructure in freshwater resource management; an increase in knowledge and capacity-building within the sectors addressing freshwater conservation; the improved development of policy frameworks; and a process of learning lessons from successful water management (e.g. the development of 'conservation evidence'). It is encouraging to see that the substantial value of nature-based solutions (NBSs) is becoming more widely recognized as a way to offset the rising challenges to water security while also addressing the continuing decline in freshwater biodiversity (WWAP, 2018). However, investment in NBS options is still below 1% of the total investment in water resources management infrastructure (WWAP, 2018).

3 | THE *ALLIANCE FOR FRESHWATER LIFE* AND ITS FIVE CORE AREAS FOR ACTION

In response to the present and future challenges, we introduce here the formation of a global initiative, the *Alliance for Freshwater Life* (hereafter referred to as the *Alliance*) (https://allianceforfreshwaterlife.org). The *Alliance* is a growing collaboration of national and international organizations and individuals that brings together expertise on education, outreach, research, conservation, and policymaking for the sustainable management of freshwater biodiversity. The aim of the *Alliance* is to engage with conservation professionals, civil society, government, and policymakers, and to place freshwater species and their associated ecosystems on the global agenda as legitimate targets for conservation action. Freshwater species and ecosystems are a key component of global biodiversity and provide people with a wide variety of services essential to our long-term survival and future prosperity.

Vision – A world where people better understand, value, and safeguard freshwater biodiversity

Mission – To halt and reverse the global decline of freshwater biodiversity through research, data synthesis, conservation, education, outreach, and policymaking

We have thus far identified five core areas of work as being essential to support stakeholders in halting and reversing the loss of freshwater biodiversity (Figure 1).

These areas of work will not, on their own, bring the changes required for freshwater biodiversity to be restored and conserved for the future. It is only through their integration, combined with serious consideration of freshwater biodiversity needs in the decision making by the public and private sectors, conservation non-governmental organizations (NGOs), and international conventions dedicated to nature conservation, that the necessary change will occur at a global scale. The *Alliance* has been formed to facilitate this integration of expertise and capacity, and to stimulate a new momentum to effect change.

3.1 | Research

Scientific research is essential to inform good conservation decision making and for establishing the socio-economic context for sustainable use (Bhaduri et al., 2016; Matthews, Wickel, & Freeman, 2011). The *Alliance* aims to improve our understanding of all facets of freshwater biodiversity. All too often the application of academic research to further our understanding of freshwater ecosystems, give direction on appropriate conservation action, and inform national or international policy is not realized effectively. Major gaps in knowledge need to be identified and addressed, particularly on the distribution and status of freshwater biodiversity, how freshwater biodiversity could be better integrated into the landscapes of the Anthropocene, and which data and knowledge are needed to balance human needs with sustaining biodiversity. The potential application of existing and continuing research will be identified and communicated as part of the awareness-raising activities. Support for filling knowledge gaps, resulting in large part from the, often limited, funding for freshwater biodiversity conservation and research, will be addressed through a coordinated large-scale funding drive.

The *Alliance* will engage with some of the world's largest freshwater research organizations to ensure the greater application of existing research, and to identify and fill existing gaps in knowledge essential to conservation and sustainable use of freshwater biodiversity.

3.2 | Data and synthesis

Although data and knowledge relevant to the management and conservation of freshwater biodiversity are available, they are not often easily or freely accessed, or presented in a consistent or integrated way. An objective of the *Alliance* is to make this body of existing information more readily and openly available in a suitable format for conservation decision makers, managers, researchers, and other interested parties. We will build upon and support existing global initiatives, such as the Freshwater Information Platform (www.freshwaterplatform.eu), the IUCN Red List of Threatened Species (www.iucnredlist.org), the World Database of Key Biodiversity Areas (www.keybiodiversityareas.org), the Global Lake Ecological Observatory Network (www.gleon.org), and the Freshwater Biodiversity Observation Network (FWBON, geobon.org/networks/thematic-bon/freshwater-bon), in the development and application of essential biodiversity variables for tracking change in freshwater biodiversity (Turak et al., 2017). Through these actions the *Alliance* aims for data
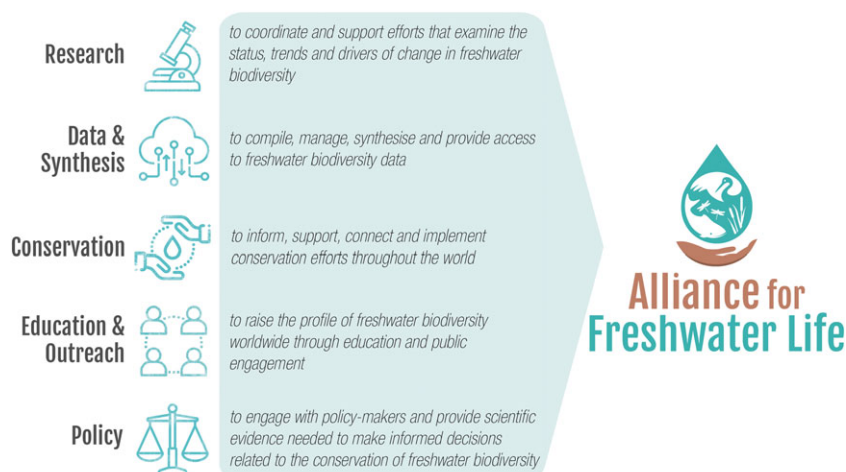

Research — *to coordinate and support efforts that examine the status, trends and drivers of change in freshwater biodiversity*

Data & Synthesis — *to compile, manage, synthesise and provide access to freshwater biodiversity data*

Conservation — *to inform, support, connect and implement conservation efforts throughout the world*

Education & Outreach — *to raise the profile of freshwater biodiversity worldwide through education and public engagement*

Policy — *to engage with policy-makers and provide scientific evidence needed to make informed decisions related to the conservation of freshwater biodiversity*

FIGURE 1 The five core areas of work under the *Alliance for Freshwater Life*

transparency and will help to expand open access to information, making it more readily available to all interested parties.

3.3 | Conservation

Conservation and the sustainable use of freshwater biodiversity is the backbone of the *Alliance*. Its policy mandate is closely linked to demands from national governments, the Ramsar and CBD conventions, and the SDGs, as well as those for delivering knowledge usable for the Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services (IPBES). Freshwater biodiversity requires conservation management on the ground, such as to restore the species and ecosystems that are already degraded, to ensure that their use is sustainable, and to identify and protect those that remain in relatively good condition.

The *Alliance* will help conservation activists, scientists, policy makers, and funding organizations to collaborate and share knowledge on conservation actions. This global social network and community of practice for freshwater biodiversity conservation includes world-renowned leaders in their fields, as well as major partner organizations working to conserve freshwater biodiversity. The global network of organizations and experts will support the sharing and dissemination of information and technology for biodiversity management, conservation, and observation. The *Alliance* will work to develop new projects and partnerships to implement large-scale conservation actions.

3.4 | Education and outreach

Levels of awareness of the biodiversity crisis in freshwater ecosystems remain pitifully low, and prompted Richter, Braun, Mendelson, and Master (1997) to refer to threats to freshwater biodiversity as the 'quiet crisis … taking place beneath the surface of the world's rivers and lakes'. This situation remains largely unchanged (Dudgeon, 2010), and thus requires large-scale initiatives that bring a focus and a voice to freshwater biodiversity. Initiatives such as Ramsar's 'World Wetland Day' (www.worldwetlandsday.org), the 'International Day of Action for Rivers' (www.internationalrivers.org/dayofactionforrivers2018), and the 'World Fish Migration Day' (www.worldfishmigrationday.com) provide a strategy that highlights important issues, but they are inevitably limited by the one-day-a-year focus. The *Alliance* will support the formation of much needed and targeted new awareness-raising activities worldwide. Many policies for the sustainable management and conservation of freshwater ecosystems already exist, but all too often remain partially, or not at all, implemented. New large-scale and professional awareness campaigns are a critical prerequisite to raise the importance of freshwater ecosystems on the political, industrial, and social agendas.

The *Alliance* will tackle the 'awareness challenge' by ensuring that the results of research and exploration on freshwater biodiversity and conservation action are disseminated via scientific publications, public education programmes, including through schools and universities, the promotion of the work of conservation NGOs on fresh waters, and public outreach through news and other media. The freshwater world will be introduced to the public through high-profile documentaries of

exploration and discovery in some of the world's most dramatic yet poorly known regions.

3.5 | Policy

Environmental policies rarely include specific targets to benefit freshwater biodiversity, which are most commonly buried within the broader category of the terrestrial or marine environment. Where there are specific policies for managing freshwater systems, the focus is primarily on the management of water resources for people, with little consideration to ensure that ecological functions are maintained, and that freshwater species are conserved (Harrison et al., 2016). Even major regional and legally binding policy initiatives such as the European Water Framework Directive that uses the biological structure of water bodies to assess quality targets does not include the conservation of ecosystems *per se* within its implementation cycles (Voulvoulis, Arpon, & Giakoumis, 2017).

The *Alliance* will address the freshwater biodiversity and conservation policy gap through its work to build awareness of the importance of freshwater species and ecosystems, helping to ensure that politicians develop and implement policies and targets benefitting freshwater biodiversity. The *Alliance* will then engage with policy makers as new policies are developed and implemented to facilitate the input of science to the policy arena. Priorities for freshwater biodiversity will be highlighted for greater attention within major global instruments such as the CBD, the Convention on the Conservation of Migratory Species of Wild Animals (CMS), the Ramsar Convention, the Convention Concerning the Protection of World Cultural and Natural Heritage, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and IPBES. Ultimately, the *Alliance* aims to facilitate science–policy meetings at the national, regional, and global scales, bringing together scientists, policy makers, conservationists, funding bodies, and campaigners. Where existing policies already exist, such as the SDGs or the water-related Nationally Determined Contributions (NDCs) that are part of the post-2020 climate actions for countries, the *Alliance* will help to make available the relevant scientific knowledge and highlight the importance of functioning freshwater ecosystems for fulfilling other related SDGs, such as for poverty alleviation.

4 | NEXT STEPS

In 2018, the Stockholm World Water Week (www.worldwaterweek.org) addresses the theme of 'Water, ecosystems and human development'. This international event represents a unique opportunity to highlight the conservation of freshwater species and ecosystems as a core component of sustainable water resource management and international freshwater policy (Moulton, 2017). World Water Week provides a platform on which the *Alliance* will be presented to the private and policy sectors that are often otherwise difficult for the science and conservation community to reach.

The core areas of work for the *Alliance*, if addressed independently, will provide important information and facilitate progress, but for effective impact at the scale required to address this global crisis,

TABLE 1 Examples of short-, mid-, and long-term goals proposed for implementation or support, under the five core areas for action in the *Alliance*. Funds are currently being sought to support this work

Core areas	Short-term goals	Mid- to long-term goals
Research	Identify poorly known areas of high predicted freshwater biodiversity (using species distribution modelling techniques) as targets for survey	Implement biodiversity assessments in poorly known regions of high predicted freshwater biodiversity
	Support the development of a global classification of freshwater ecosystems	Support the completion of a globally comprehensive assessment of the distribution and conservation status of representative freshwater taxa
	Support the development of tools to collect data on collective properties of freshwater biodiversity, e.g. species richness and compositional turnover	Achieve a better understanding of the extent and drivers of freshwater biodiversity decline, and solutions to reverse this decline
		Compile evidence (www.conservationevidence.com) for what works, or does not work, in conserving freshwater biodiversity
Data and synthesis	Collate, harmonize, analyse, and visualize existing data on freshwater biodiversity, building on the Freshwater Information Platform (FIP, www.freshwaterplatform.eu) for data management and dissemination	Support work to broaden representation of freshwater species in the Living Planet Index (http://www.livingplanetindex.org)
	Review all major existing initiatives focused on freshwater biodiversity to identify gaps and potential partners	Develop the FIP to provide open access to the majority of available freshwater biodiversity data, in suitable formats for the relevant sectors
		Globally identify freshwater Key Biodiversity Areas (www.keybiodiversityareas.org) as priority sites for conservation action
		Ensure much greater representation of freshwater biodiversity data within regional and global biodiversity analyses
		Connect studies in freshwater systems to major research concepts and hypotheses, revealing to which degree these concepts are applicable and useful
Conservation	Support the development of a new funding platform for site-based conservation action of freshwater species and ecosystems	Support efforts to expand and/or adapt the world's protected areas network to better represent freshwater biodiversity
	Complete a gap analysis of freshwater biodiversity within the world's protected areas network	Develop species conservation action plans for the world's most threatened freshwater species
Education and outreach	Develop and publicize the *Alliance* website	Support the development of high-profile documentaries to raise awareness and interest in freshwater species
	Hold a 'showcase' event to launch and promote the *Alliance* at the Stockholm World Water Week 2018	Initiate a series of articles on freshwater biodiversity for the mass media
	Hold photography competitions focused on freshwater biodiversity	Develop an online lecture series on freshwater biodiversity conservation in cooperation with the Massive Open Online Courses (www.mooc.org)
	Develop a strategy for engaging with the private sector and the general public using social and multimedia	Hold Art–Science events promoting interest in freshwater biodiversity
		Establish programmes on freshwater ecosystems in educational curricula
Policy	Promote a specific freshwater biodiversity target in the post-2020 biodiversity targets	Provide recommendations to international conventions for development of freshwater biodiversity resolutions
	Identify national and international policies relevant to conservation and the sustainable use of freshwater biodiversity	Support a review of SDG targets and the role of freshwater ecosystems
	Develop a network of freshwater biodiversity experts providing representation at relevant policy fora	Review the role of freshwater ecosystems in the Intended Nationally Determined Contributions (INDCs) relating to climate agreements
	Establish a freshwater biodiversity topic in the IPBES 2nd work programme for 2020–2030	Ensure that the interests of freshwater biodiversity are strongly represented within all relevant policies

all must be brought together in synergy through a single global initiative. This needs to be on a similar scale to that accomplished through the Census of Marine Life (www.coml.org), but with a clear pathway for influencing and informing policy that will in turn lead to conservation action and more sustainable development. In this context the objective of the *Alliance* is to unite the expertise of a diverse range of organizations, creating a coherent approach leading to effective action. Examples of priority goals for the *Alliance* within these five core areas of work are presented in Table 1.

A number of organizations, some with global membership and others playing key roles in global networks, have been involved in the initial stages of planning the *Alliance*, including IUCN, the Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB), WWF, FWBON, Conservation International, IHE Delft Institute for Water Education, the National Great Rivers Research and Education Center (NGRREC), Synchronicity Earth, and the South African Institute for Aquatic Biodiversity (NRF-SAIAB). We invite like-minded individuals, organizations, and governments to join the *Alliance* and to contribute their expertise, energy, and inspiration. In this way we aim to build a truly global representation within the *Alliance*.

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