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SUBSIDIARY BODY ON SCIENTIFIC,  
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Twenty-third meeting  
Montreal, Canada, 25-29 November 2019  
Item 3 of the provisional agenda\*

### **BENDING THE CURVE OF GLOBAL FRESHWATER BIODIVERSITY LOSS – AN EMERGENCY RECOVERY PLAN**

*Note by the Executive Secretary*

1. The Executive Secretary circulates herewith, for the information of participants in the twenty-third meeting of the Subsidiary Body on Scientific, Technical and Technological Advice, a call to consider an Emergency Recovery Plan to “bend the curve” of global freshwater biodiversity loss.
2. Decision 14/34 requested the Subsidiary Body on Scientific, Technical and Technological Advice, at its twenty-third and twenty-fourth meetings, to contribute to the development of the post-2020 global biodiversity framework. Furthermore, it states that the process will be based on the best available science and evidence from relevant knowledge systems, including the natural and social sciences, local, traditional and indigenous knowledge, citizen science, as well as on the best practices and lessons learned from the implementation to date of the Convention and its Protocols; among other principles. In this regard, the present document has been prepared by academics in the field of freshwater biodiversity conservation to provide relevant knowledge and insight on how to address global freshwater biodiversity loss in the context of the post-2020 global biodiversity framework.
3. This document is presented in the form and language in which it was received by the Secretariat.

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\* CBD/SBSTTA/23/1.



## Submission to the twenty-third meeting of the subsidiary body on scientific, technical and technological advice (SBSTTA)- Agenda item 3: Informing the scientific and technical evidence base for the post 2020 global biodiversity framework

**23 October 2019**

### **Bending the Curve of Global Freshwater Biodiversity Loss – An Emergency Recovery Plan**

Freshwater ecosystems host remarkable biodiversity yet have to date been insufficiently considered in recommendations by the conservation community for international action. Within this context, we contend that specific attention should be paid to freshwater biodiversity.

The flora and fauna of rivers, lakes and inland wetlands are declining at rates that far exceed those seen in forests and oceans, and for distinct reasons, and there is an urgent need for action to reverse this trend. The research community has reported extensively on the reasons for this decline. But there has been no attempt that we know of to put forward recommendations for priority actions to stem and reverse this decline at the global scale.

With reference to the recent Abu Dhabi Statement which calls on governments and international agencies to “Commit to clear and ambitious targets on species conservation in the Post-2020 Global Biodiversity Framework” the signatories to this submission call on SBSTTA to consider an Emergency Recovery Plan to “bend the curve” of freshwater biodiversity loss. Priorities for action include:

1. Accelerating implementation of environmental flows;
2. Improving water quality;
3. Protecting and restoring critical habitats;
4. Managing exploitation of freshwater species and riverine aggregates;
5. Preventing and controlling non-native species invasions; and
6. Safeguarding and restoring river connectivity.

The following detailed input, which justifies the call for an emergency recovery plan, is based on an academic paper that is currently under review in *BioScience*. Entitled *Bending the Curve of Global Freshwater Biodiversity Loss – An Emergency Recovery Plan*, it is authored by some of the leading academics in the field of freshwater biodiversity conservation.

The signatories to this submission are at the disposal of SBSTTA and the associated working groups to provide any additional information pertaining to the Emergency Recovery Plan or the specific targets on freshwater biodiversity that could be considered in the post 2020 global biodiversity framework.

(List of signatories below)

1. Australian Rivers Institute- Griffith University
2. Cardiff University
3. Fish Ecology and Conservation Physiology Lab-Carleton University
4. French Water Partnership
5. Freshwater Life
6. IUCN
7. IUCN Freshwater Conservation Committee
8. IUCN Species Survival Commission
9. IUCN World Commission on Protected Areas
10. Leibniz Institute of Freshwater Ecology and Inland Fisheries
11. UK Centre for Ecology and Hydrology
12. University of Washington
13. Wildfowl & Wetlands Trust
14. Wetlands International
15. Worldwide Fund for Nature

Note that this paper is submitted without prejudice to any of the organizations final position on the Post-2020 Global Biodiversity Framework.



Submission to the twenty-third meeting of the subsidiary body on scientific, technical and technological advice (SBSTTA)- Agenda item 3: Informing the scientific and technical evidence base for the post 2020 global biodiversity framework

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# BENDING THE CURVE OF GLOBAL FRESHWATER BIODIVERSITY LOSS – AN EMERGENCY RECOVERY PLAN

*October 2019*

## Overview

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Freshwater ecosystems host remarkable biodiversity yet have to date been insufficiently considered in recommendations by the conservation community for international action. Within this context, we contend that specific attention should be paid to freshwater biodiversity.

The flora and fauna of rivers, lakes and inland wetlands are declining at rates that far exceed those seen in forests and oceans, and for distinct reasons, and there is an urgent need for action to reverse this trend. The research community has reported extensively on the reasons for this decline. But there has been no attempt that we know of to put forward recommendations for priority actions to stem and reverse this decline at the global scale.

The signatories to this submission would therefore like to call on SBSTTA to consider an Emergency Recovery Plan to “bend the curve” of freshwater biodiversity loss. Priorities for action include:

1. Accelerating implementation of environmental flows;

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## Context

In 2020, governments will review international agreements relevant to this challenge, including the Convention on Biological Diversity (CBD), the Sustainable Development Goals (SDGs) and the UN Framework Convention on Climate Change (UNFCCC). There is a brief window of opportunity now to set out recommendations that can inform these agreements and guide future policy responses.

Nowhere is the biodiversity crisis more acute than in freshwater ecosystems. Rivers lakes and inland wetlands are home to an extraordinary diversity of life. Covering less than 1% of Earth's surface, these habitats host approximately one third of vertebrate species and 10% of all species (Strayer and Dudgeon 2010), including an estimated 70 species of freshwater-adapted mammal, 5,700 dragonflies, 250 turtles (Balian et al. 2008), 17,800 fishes (Fricke et al. 2019), and 1,600 crabs (N. Cumberlidge, pers comm). Freshwater ecosystems also provide services to billions of people including impoverished and vulnerable communities (Lynch et al. 2016). However, management of freshwater ecosystems has disregarded the fact that they consist of important habitats, instead prioritizing a narrow range of services for economic benefit. Consequently, the current rate of wetland loss is three times that of forest loss (Gardner and Finlayson 2018) and populations of freshwater vertebrate species have fallen at more than twice the rate of land or ocean vertebrates (Grooten and Almond 2018). Of the 29,500 freshwater dependent species so far assessed for the IUCN Red List, 27% are threatened with extinction and among these, an estimated 62% of turtle species, 47% of gastropods, 42% of mammals, 33% of amphibians, 30% of decapod crustaceans (crabs, crayfish and shrimps), 28% of fishes and 20% of birds are threatened (IUCN 2019). Populations of freshwater megafauna, defined as animals that reach a body mass of 30kg, declined by 88% from 1970 to 2012, with the highest declines in the Indomalaya and Palearctic realms (–99% and –97%, respectively) (He et al. 2019).

Recommendations to address immediate threats to, and underlying drivers of, wider biodiversity loss have focused mainly on terrestrial ecosystems, such as forests and grasslands (e.g. Kok et al. 2018), or have emphasized conservation strategies, such as increasing protected area coverage (e.g. Visconti et al. 2019). While valuable, these proposals have either assumed, simplistically, that measures designed to improve land management will inevitably benefit freshwater ecosystems, or they have neglected to consider freshwater biodiversity at all.

Here, we present an Emergency Recovery Plan to reverse the rapid worldwide decline in freshwater biodiversity. This Plan extends the concept of species recovery plans established in legislation such as the US Endangered Species Act 1973 and the Australian Environment Protection and

Biodiversity Conservation Act 1999. The Plan is novel in this conceptual foundation, in its focus on solutions (rather than documentation of threats), and in its explicit recommendations for international agreements, especially the CBD and the SDGs.

## 1. The Emergency Recovery Plan: Priorities for Action

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The Plan is structured around six priority actions (Figure 1). Five of these focus on the major causes of freshwater biodiversity loss described by Dudgeon et al. (2006): flow alteration; pollution; habitat degradation and loss; overexploitation of species; and invasive non-native species. In the priority action on overexploitation we have considered exploitation of abiotic substrates, such as sand and gravel, alongside biota, reflecting rising concerns about the damage to freshwater ecosystems caused by rapid expansion of riverine aggregate mining (UNEP 2019). We have also defined a sixth priority action on connectivity because of the distinct and pervasive role of dams and other infrastructure in fragmenting freshwater ecosystems and disrupting movements of water, species, sediments and nutrients (Grill et al. 2019). These priority actions are inter-related; action to address one cause of biodiversity loss can, in many contexts, help address other causes too. Given the scale of the crisis, the Plan must be ambitious. But it must also be technically feasible and pragmatic in political and socio-economic terms. As we outline in Table 1, each priority action has been implemented successfully in one or more situations across the globe, providing proof of concept and lessons that can inform scaling-up of actions. Below, for each priority action, we briefly review the problem, likely policy and management solutions, and the current implementation status of these solutions.

## 2. Action 1: Accelerate Implementation of Environmental Flows

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**The problem:** Water management for power generation, flood risk reduction or to store and deliver water for agricultural, industrial or domestic uses, changes the quantity, timing and variability of water flows and levels. In doing so, it directly alters the physical availability of freshwater habitats, their ambient conditions, connectivity between habitats, and ecosystem processes such as sediment flow. These alterations, in turn, affect functional linkages between hydrological regimes and the life histories of freshwater species (Bunn and Arthington 2002) and thus contribute substantially to losses of freshwater biodiversity. Climate change exacerbates flow alteration in many situations (Döll and Bunn 2014).

**Potential solutions:** Maintaining or restoring ecologically important attributes of hydrological regimes improves biodiversity outcomes (Bunn and Arthington 2002, Olden et al. 2014). The science and practice of environmental flow (e-flow) assessment enables identification and quantification of these attributes. A sophisticated methodological toolbox now exists for developing e-flow scenarios and recommendations in a wide range of water resource management contexts, from minimally altered to heavily managed freshwater ecosystems (Acreman et al. 2014, Poff et al. 2017). Many e-flow assessment tools consider desired socio-economic and cultural objectives alongside biodiversity goals, aiding incorporation of recommendations into river basin plans, water allocation regimes, and design and operation of water infrastructure. The 2018 Brisbane Declaration and Global Action Agenda on Environmental Flows set out 35 recommendations to accelerate implementation (Arthington et al. 2018). **Implementation status.** E-flows have been incorporated into policies in many jurisdictions (Le Quesne et al. 2010). For instance, the European Union has recommended their inclusion in river basin management plans required by the EU Water Framework Directive (CIS 2015); the nine Nile Basin countries have



agreed a common e-flows assessment strategy (NBI 2016); and China has integrated e-flows into Environmental Impact Assessment laws (Chen and Wu 2019). Examples of implementation have been documented from diverse contexts (Harwood et al. 2017) but these are currently isolated successes. Human demands for water will increase in some regions making implementation more challenging (Palazzo et al. 2019).

Even so, improved water allocation planning (Speed et al. 2013) and wiser agricultural water use (Linstead 2018) can create opportunities for progress. Shifting agricultural production to less water-stressed regions could also help (Pastor et al. 2019).

### 3. Action 2. Improve Water Quality to Sustain Aquatic Life

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The problem: Pollution impacts on freshwater biodiversity can be profound and can reflect direct toxicity and/or disruption to ecosystem processes. Pollution types include, but are not limited to: 1) nutrients from sewage, fertilizers or animal wastes; 2) synthetic chemicals such as pesticides, herbicides, heavy metals, persistent organic pollutants (POPs) and a wide range of other hazardous substances from agriculture and industry; 3) pharmaceuticals and their metabolites from human and agricultural use; 4) plastics across a wide size spectrum; 5) sediments mobilized by agriculture, forestry and mining operations; 6) salinization caused by sea water incursion or over-irrigation; and 7) heat from industrial and power sector effluents (Reid et al. 2019).

Potential solutions: Policy and management options include wastewater treatment and/or re-use, regulation of polluting industries, market instruments that reflect downstream pollution costs, improved agricultural practices, and nature-based solutions such as floodplain wetland restoration or riparian buffer zones (WWAP 2017).

Implementation status. Globally, 80% of sewage enters surface waters without adequate treatment and in Latin America, Africa and Asia, approximately 15% of river lengths are severely polluted organically (UNEP 2016, WWAP 2017). Improved wastewater treatment should therefore be a priority for many countries. In the USA and Europe, the Clean Water Act 1972 and the EU Urban Wastewater Treatment Directive have helped to slow and, in some cases, reverse point-source pollution (Vaughan and Ormerod 2012). Non point-source pollution remains a problem across all regions. Better farm management, often in combination with market mechanisms, can reduce pollution loads while maintaining agricultural yields (Wu and Ma 2015) but is not yet mainstream agricultural practice. In the EU, for instance, agricultural pollution is a major reason for failure to attain ‘Good Ecological Status’ as required by the Water Framework Directive (European Environment Agency, 2018). Improved water quality monitoring is required in many contexts, utilizing existing guidelines (e.g. UN Environment 2017). Evidence is urgently needed on sources, pathways and impacts of some pollutants, including microplastics and pharmaceuticals, to inform policy (Reid et al. 2019).

### 4. Action 3. Protect and Restore Critical Habitats

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The problem: An estimated 30% of natural freshwater ecosystems have disappeared since 1970, and 87% of inland wetlands since 1700 (Davidson 2014, Dixon et al. 2016). Causes include land conversion to agriculture and reduced hydrological connectivity after dam and levee construction (Junk et al. 2013). Climate change can also alter wetland habitat distribution and extent (Acreman et al., 2009). Changes in terrestrial habitat management caused by forestry, intensive agriculture, mining, road construction and urbanization have exacerbated pollution, sediment fluxes and extreme flows, affecting freshwater habitats downstream (Dudgeon et al. 2006).

Potential solutions: A variety of interventions can mitigate impacts on freshwater biodiversity from prior degradation and reduce future risks, including formal protected area designations, land-use planning (often linked with markets for ecosystem services) and habitat restoration programs (UN Water 2018). Strategic planning of conservation and restoration investments can help to identify synergies and resolve trade-offs between biodiversity goals and other priorities. In doing so, it can increase social and political support for conservation and restoration and ensure that freshwater biodiversity and ecosystem services outcomes are more effective and resilient to future conditions (Speed et al. 2016). Systematic conservation planning tools, which combine stakeholder engagement with algorithm-based spatial assessment, can aid prioritization of habitats for efficient conservation and restoration investments (Reis et al. 2019). Implementation status. Many freshwater ecosystems are ostensibly protected by international or national designations. For instance, the Ramsar Convention on wetlands now has 168 contracting parties worldwide who have designated 2,186 Ramsar Sites, covering 2.1 million km<sup>2</sup>. Formal protection has been only patchily effective though and lessons from successful protection efforts – for instance, on involving local communities in protected area management – should be applied more widely (Acreman et al, in rev). Management of terrestrial-oriented protected areas often does not consider freshwater ecosystems, and sometimes permits activities detrimental to their health, such as the building of dams. A lack of effective basin- scale planning and failure to address exogenous threats have also limited the biodiversity benefits of protection (Reis et al. 2017). Some countries, such as Uganda, have developed national wetland policies. Others, such as South Africa, have incorporated wetland conservation into agriculture, water or other sectoral policies. River basin planning is enshrined widely in policies, including in places such as China, the EU and Brazil. The UN has recommended investment in nature-based solutions to water management challenges as cost-effective substitutes for, or augmentations to, conventional built infrastructure (UN Water 2018), although large- scale implementation is in its infancy.

## 5. Action 4. Manage Exploitation of Freshwater Species and Riverine

### Aggregates

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The problem: Exploitation of living organisms and mineral substrates impacts freshwater biodiversity directly through removal of individuals and their habitats, and indirectly through alterations to freshwater ecosystem processes. A wide range of freshwater taxa are exploited, including plants, invertebrates (such as crabs and crayfish), fish, amphibians (such as frogs), reptiles (including turtles and their eggs), birds (including geese and ducks) and mammals (including river dolphins and otters). Policy frameworks to guide such harvests are often insufficient, and enforcement is also poor, making sustainable management difficult (Cooke et al. 2016). Bycatch is a further threat, such as of river dolphins which are accidentally caught in gill nets (Iriarte and Marmontel 2013). Extraction of riverine substrates, especially sand and gravel for use in construction, is increasing very rapidly (UNEP 2019). Research into biodiversity impacts is sparse, but effects can include direct destruction of instream and riparian flora and fauna, and changes to fluvial geomorphological regimes with associated effects on downstream habitats (Koehnken and Rintoul 2018). (Abstraction of water from freshwater habitats is discussed above in relation to Action 1, on implementing environmental flows.)

Potential solutions: The 2016 Rome Declaration, convened by the UN Food and Agriculture Organization, describes steps needed for sustainable freshwater fisheries, including improved biological assessments, science-based management and development of a global freshwater



fisheries action plan (Taylor and Bartley 2016). Bycatch can be reduced by exploiting temporal and spatial differences between target species and bycatch. Mandatory bycatch reporting can also help (Cairns et al. 2013) as can technology, such as provision of air spaces to increase survival rates of animals accidentally caught in nets (Grant et al. 2004). Solutions to riverine sand and gravel extraction can include reducing demand for construction materials (such as through avoiding over-design in buildings), substituting recycled materials for new concrete, and better management of extraction rates, locations and methods, including through improved supply chain standards (UNEP 2019). Implementation status. Currently, lack of data and science-based management is a major concern for both freshwater fisheries (Bartley et al. 2015) and riverine aggregate extraction (UNEP 2019). However, there have been promising developments in fisheries policy since the Rome Declaration. These include improved planning processes in some countries (such as Cambodia), and development of international standards for biological assessment (Bonar et al. 2017). Successful community-based fisheries management, leading to biodiversity benefits, has been documented from Thailand (Koning 2018) and Brazil (Campos-Silva and Peres 2016). Riverine aggregate extraction has been brought under improved regulatory control across parts of Europe but elsewhere, and especially in Asia, it is rapidly expanding and is often unregulated or illegal (Koehnken and Rintoul 2018).

## 6. Action 5. Prevent and Control Non-native Species Invasions in Freshwater Habitats

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**The problem:** The impacts of invasive non-native species (INNS) on freshwater biodiversity range from behavioral shifts of native species to complete restructuring of food webs and extirpation of entire faunas (Gallardo et al. 2016). The economic costs are also significant, reaching billions of dollars in the US alone (Pimentel et al. 2005). However, due to insufficient information, public awareness and policy frameworks, the effects of INNS are consistently underestimated (Early et al. 2016).

**Potential solutions:** Preventing introduction of INNS is the best approach to limiting impacts. Efforts have focused on identifying major introduction pathways, such as trade in live organisms, ballast-water transfers from ships, releases of unwanted animals from aquariums, and aquaculture and horticulture escapes. Once established, control and eradication of INNS is normally possible only with considerable investments in physical removal, chemical treatment or biological control. Climate change and globalization of trade necessitate new strategies to prevent and control INNS that, currently, inhabit limited geographic ranges or have only moderate ecological or economic impacts (Rahel and Olden 2008). Implementation status. In a few instances, countries have taken steps to identify and prioritize INNS for action. In the USA, invasive species advisory councils bring together regulators, researchers and stakeholders to address research, policy, and management needs related to INNS (Lodge et al. 2006). For example, efforts are continuing to prevent non-native carp species from invading the Laurentian Great Lakes using scientific risk assessments, laws prohibiting transportation of live fish, and an innovative electrical barrier. Public or commercial hunts and harvests have been encouraged to eradicate established INNS from freshwater ecosystems, such as in the removal of nutria (*Myocastor coypus*) from the UK (Pasko et al. 2014).

Although policies and strategies often target specific INNS (Early et al. 2016), the European Union (EU) recently adopted a regulation (2016/1141) which requires member states to prevent, control or eradicate a suite of INNS including several freshwater plant and animal species.

## 7. Action 6. Safeguard and Restore Freshwater Connectivity

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The problem: The flows of water, nutrients and sediment through freshwater ecosystems are important processes regulating biodiversity. Many species depend on periodic connectivity between upstream and downstream river reaches, or between river channels and floodplain habitats, for their migration and reproduction (McIntyre et al. 2016). Dams and weirs fragment longitudinal (upstream-to- downstream) connectivity and, through flow alterations, also affect lateral (river-to-floodplain), vertical (surface-to-groundwater) and temporal (season-to-season) approach led to the removal of two dams, and refurbishment of others, resulting in increased populations of migratory fish species (Hogg et al. 2015). Dam removal has gathered pace in recent years with more than 1,600 barriers removed in the USA alone (American Rivers, 2019). On rivers such as the Mississippi, Rhine and the Yangtze, floodplains have been reconnected with rivers through levee repositioning and re-operation of sluice gates as part of flood management system upgrades (Opperman et al. 2017, Sayers et al. 2014).

## 8. Using the Emergency Recovery Plan to Develop Global Targets and Indicators for Freshwater Biodiversity

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If these priority actions are to be progressed widely and rapidly, a coordinated international effort will be needed to: 1) Transform underlying socio-economic drivers of freshwater biodiversity declines, stemming from food, energy, industrial and infrastructure sectors, and economic planning paradigms; and 2) Promote recovery of freshwater biodiversity through improved conservation practice and better management of water resources (including improved integration of water and nature conservation policies). International agreements can facilitate this co-ordination, galvanize national policy development and guide investments by state and non-state actors. We have prioritized thirteen existing or potential targets and indicators within the CBD and SDGs that can most substantially advance implementation of, the Emergency Recovery Plan (Table 2). The recommendations focus on CBD and the SDGs as these international agreements are due to be reviewed and revised in 2020. Other agreements will also have an important role to play, including those that specifically address freshwater conservation challenges, such as the Ramsar Convention; and those primarily focused on other issues such as the UNFCCC, implementation of which could accelerate nature-based climate solutions that might also promote freshwater biodiversity recovery. Improved coordination and mutual reinforcement between all such agreements will be important (Bunn 2016). Several of our recommendations suggest maintaining existing elements of these agreements which are already aligned to the Plan. For instance, while it does not specifically mention freshwater biodiversity, CBD Aichi Target 9 on invasive species is well aligned to priority action 5. Similarly, SDG 6 (“Clean water and sanitation”) already sets out a target for improving water quality (SDG 6.3) which links directly with priority action 2. In principle, SDG 6.4, on sustainable water withdrawals, is aligned with priority action 1 from the Plan on implementing environmental flows, although there is scope within this target to improve assessment of how e-flows are being implemented and to encourage use of an explicit indicator on this aspect (FAO, 2019).

A second category includes recommendations for amending or extending existing targets and/or indicators such that they align more strongly with the Plan. For example, CBD Aichi Target 11 and SDG 15.1 both aim to increase the extent of habitats that are conserved, restored or sustainably

managed, and both specifically reference “inland waters”. However, these targets, and their associated indicators, are currently described in terms of the area of ecosystems to be protected. Much freshwater biodiversity is found in linear river systems and associated headwater, riparian and floodplain habitats. A global target and associated indicator for freshwater biodiversity conservation and restoration would therefore be better framed in terms of length of riverine (and associated riparian and wetland) habitat protected and sustainably managed. This target should also be explicit about the need to protect or sustainably manage a wide range of different habitat types including, for instance, headwater streams and ponds which are important for biodiversity (Biggs et al. 2017).

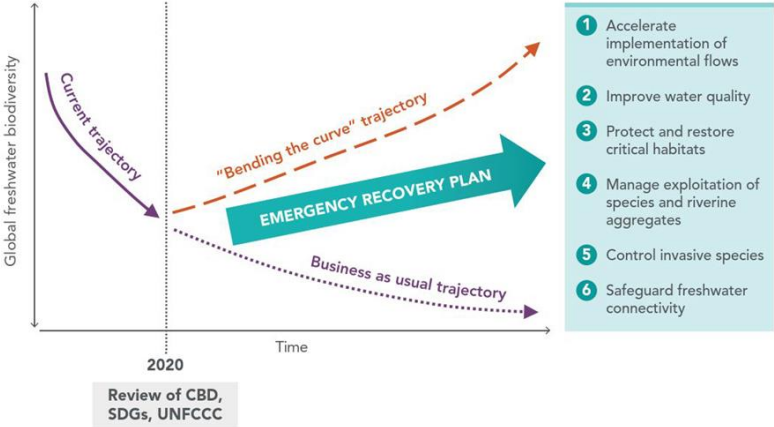
A third group of recommendations concerns the need for new targets or indicators to fill major gaps. Currently, there is no recognition of alterations in water flows and levels within the CBD Aichi Targets. This is a significant shortcoming, so a new target on implementing e-flows is needed. Riverine sand and gravel extraction are another notable omission from both CBD and SDG targets and indicators. We recommend inclusion within SDG 9.4 (sustainable infrastructure) of an indicator on the proportion of construction materials that are made from sustainably sourced aggregates and cross-referencing to a new CBD target. Freshwater fisheries are also poorly served by current targets and indicators. SDG 14 includes targets for regulation of overfishing (SDG 14.4) but this goal only covers marine fisheries even though wild caught freshwater fish provide critical protein for hundreds of millions of people (Funge-Smith 2018). Thus, we recommend addition of a specific indicator on freshwater fisheries and reframing of this target to cover all aquatic habitats. To support these targets, and to help governments and others to gauge the extent to which action is leading to recovery of freshwater ecosystems, an improved suite of indicators of global freshwater biodiversity is urgently needed. These indicators should be relevant (i.e. they should provide information salient to each of the six actions in the Plan), repeatable and affordable, scientifically robust, scalable (e.g. to countries or river basins, as well as to the globe) and sufficiently sensitive to show the impacts of different policy measures. This can build on, and strengthen, existing indicators including the Living Planet Index (McRae et al. 2017), the Red List Index (Butchart et al. 2007), and the Connectivity Status Index for rivers (Grill et al. 2019). Priorities for effort include accurate, high resolution data on hydrology, water infrastructure, water quality and exploitation and extraction of freshwater species and materials. There remain substantial gaps in data on freshwater taxa (e.g. approximately 30% of freshwater mollusc species, and 40% of decapod crustaceans, are currently classified as Data Deficient) and for some freshwater ecosystems (e.g. many of those in Sub Saharan Africa). The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), whose remit includes evidence assessment and policy advice to inform international agreements, can play a stronger role in supporting monitoring of freshwater biodiversity, including through a global thematic assessment of freshwater biodiversity and its contributions to people (D. Beard, USGS, pers. comm.).

## 9. Conclusion

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The Emergency Recovery Plan presented here should guide urgent and concerted global action for freshwater biodiversity. The Plan is rooted in practical experience across developed and emerging economies; all the actions we highlight have already been implemented somewhere in the world. The challenge now is to transition from ad hoc freshwater conservation successes to a strategic approach to recovery that achieves results at a far larger scale. Measures will only be effective if they are based on an understanding of the processes that underpin freshwater ecosystems and the

distinct threats to them, such as flow modification and connectivity loss. Simply regarding freshwater habitats as a subset of terrestrial ecosystems obscures those distinct threats and precludes effective action. Conversely, carefully designed portfolios of conservation and restoration actions addressing the most critical direct and indirect threats can stimulate rapid improvements in the condition of freshwater ecosystems. The development of a post-2020 global biodiversity framework provides a once-in-a-generation opportunity to promote such improvements. For freshwater biodiversity across the globe, the next decade will be critical.



*Figure 1: The Emergency Recovery Plan for Freshwater Biodiversity: Six priorities for global action to bend the curve of freshwater biodiversity loss that should be reflected in the post-2020 biodiversity framework*

# Implementation of priority actions in the Emergency Recovery Plan

**Table 1. Examples of implementation of priority actions in the Emergency Recovery Plan for Freshwater Biodiversity**

<b>1. Accelerate implementation of environmental flows</b>
<p><b>River basin planning:</b> E-flows have been incorporated into water legislation in South Africa and implemented through legally mandated Catchment Management Agencies, e.g. on the Crocodile River</p> <p><b>Water allocation:</b> Mexico's Water Reserves initiative sets sustainable water allocation limits for 189 rivers across the country, taking account of e-flows</p> <p><b>Infrastructure design and operation:</b> E-flows to benefit downstream fisheries are now part of the operational regime of the Three Gorges Dam, China</p>
<b>2. Improve water quality to sustain aquatic life</b>
<p><b>Wastewater treatment:</b> The EU Urban Wastewater Treatment Directive has led to widespread reduction in sewage pollution</p> <p><b>Regulation of polluting industries:</b> In Singapore, a large-scale project was launched in the 1970s to clean up the Singapore River and restore aquatic life, including through removal and relocation of pollution from pig and duck farms and from industry, while encouraging business and residential development along the waterfront.</p> <p><b>Market instruments:</b> Around Lake Taupo, New Zealand, catchment scale nitrogen caps combined with farm-based permits and trading and establishment of a Trust Fund to help reduce costs of nitrogen-reducing practices for farmers, has helped to tackle persistent diffuse pollution problems linked to pastoral agriculture.</p> <p><b>Improved agricultural practices:</b> Better management practices on cotton and sugarcane farms in India and Pakistan, encouraged by market-based initiatives such as the Better Cotton Initiative and Bonsucro, have led to reductions in pesticides and fertilizers reaching watercourses</p> <p><b>Nature-based solutions:</b> In China, restoration efforts for floodplain lakes along the central Yangtze River have resulted in improvements in lake water quality with consequent enhancement of fisheries and floodplain biodiversity</p>
<b>3. Protect and restore critical habitats</b>
<p><b>Protected areas:</b> Among many examples of successful protected area designation and management, the gazettelement by the Government of Colombia of the entire 825,000 ha Bita River basin (a sub-basin of the Orinoco) as a Ramsar site is a rare example of a free-flowing river and its entire basin being protected through an international designation</p> <p><b>Land-use planning/markets for ecosystem services:</b> The New York City Watershed Agreement has stimulated improved land use planning and management to protect and restore ecosystem processes in the Castkills-Delaware watersheds, safeguarding urban water supplies in a cost-effective way in the process</p> <p><b>Habitat restoration:</b> Approximately 60,000 ha of floodplain wetlands have been restored along the lower Danube River as a result of an international agreement signed by ministers from Bulgaria, Romania, Moldova and Ukraine</p>
<b>4. Manage exploitation of freshwater species and riverine aggregates</b>
<p><b>Science-based fisheries management:</b> In Malawi, the Ecosystem Approach to Fisheries management has been enshrined in legislation since the 1990s, with implementation efforts incorporating co-management with fishery communities, a focus on sustainable harvest of high-value Chambo (<i>Oreochromis lidole</i>) and breeding/nursery sanctuaries for commercial species.</p>

**Community fisheries management:** A community protection and resource management programme within oxbow lakes on the Juruá River within the Western Brazilian Amazon resulted in a thirty-fold increase in Arapaima, *Arapaima gigas*

**Bycatch reduction:** A combination of closures and modified traps have been demonstrated to minimize platypus bycatch within commercial eel and carp fisheries in New South Wales, Australia

**Reducing aggregates demand:** Germany recycles 87% of its waste aggregates, and in India non-toxic municipal waste is used as an aggregates substitute in roadbuilding

**Improved regulation of riverine aggregate extraction:** In the UK, an effective regulatory regime to determine the acceptability (or otherwise) of riverine aggregate extraction has been complemented by the Aggregates Levy, a tax placed on sales of primary aggregates in the UK (sand, gravels & crushed rock), which has funded research to develop understanding and improve practices to minimize environmental effects of extraction.

#### 5. Prevent and control non-native species invasions in freshwater habitats

**Identification and control of introduction pathways:** Prevention of non-native carp species invasions in the Great Lakes (US and Canada) has successfully used a combination of scientific risk assessments, prohibition of live fish transport, and an electrical barrier

**Control and eradication of established invasive non-native species:** The spread of invasive non-native weeds such as *Mimosa pigra* was limited due to management measures implemented within the Kakadu National Park, Australia, at a cost of AUS \$500,000 per year. Management measures were found to avoid an increase in *Mimosa pigra* coverage of 2.7% or higher (58 km<sup>2</sup>) compared to areas that were not managed.

#### 6. Safeguard and restore freshwater connectivity

**System-scale infrastructure planning:** A Strategic Environmental Assessment for hydropower planning has been undertaken in Myanmar that has recommended keeping the mainstems of the Irrawaddy and Salween Rivers free-flowing.

**Dam re-operation and removal:** On the Penobscot River, USA, re-operation and removal of dams along 1,500km of river resulted in increased populations of 11 migratory fish species while maintaining electricity generation capacity.

**Levee repositioning:** The Room for the Rivers program in the Netherlands has stimulated large scale levee removal and restoration of lateral connectivity along the Rhine to enhance flood storage and conveyance while also providing expanded and enhanced habitat for freshwater biodiversity.

## Advancing the Emergency Recovery Plan for Freshwater Biodiversity

**Table 2. Advancing the Emergency Recovery Plan for Freshwater Biodiversity through international agreements: Recommendations for global targets and indicators to be incorporated into the Convention on Biological Diversity and Sustainable Development Goals. Note: For simplicity and ease of reference, we have followed the existing architecture of CBD Aichi Targets and SDGs. If governments agree to restructure these targets and indicators in 2020, it will be important that the recommendations here are integrated appropriately into the new architecture.**

Existing target	Recommendation, including whether to maintain, amend or devise new targets and/or indicators	Alignment with Emergency Recovery Plan
<b>Convention on Biological Diversity targets and indicators</b>		
CBD Aichi Target 5: Habitat loss	<i>Amend:</i> i) Explicitly emphasize freshwater ecosystems, alongside forests; ii) Use Connectivity Status Index (Grill et al. 2019) and an indicator of wetland extent for indicators.	Priority Action 3. Protect and restore critical habitats Priority Action 6. Safeguard and restore freshwater connectivity
CBD Aichi Target 6: Fisheries management	<i>Amend/New:</i> i) Explicitly reference inland fisheries; ii) Add new indicators and align with SDG 14.4 (see recommendations below).	Priority Action 4. Manage exploitation of species and riverine aggregates



CBD Aichi Target 8: Pollution reduction	<i>Amend:</i> i) Expand text and indicators to explicitly focus attention on the full range of pollution, including emerging contaminants such as Pharmaceuticals and plastics, and to emphasize addressing pollution at source rather than through end-of-pipe fixes; ii) Include freshwater eutrophication alongside coastal eutrophication in indicators.	Priority Action 2. Improve water quality
CBD Target 9: Invasive species	<i>Maintain/Amend:</i> i) Existing target is aligned with Emergency Recovery Plan; ii) Amend wording and indicators to reflect the particular vulnerability and sensitivity of freshwater ecosystems to invasions.	Priority Action 5. Control invasive species
CBD Target 11: Protected areas	<i>Amend/New:</i> i) Define a distinct sub-target for proportion of Inland Waters under protection by 2030. ii) Add new indicator of length (km) of riverine habitat that is protected and connected, including riparian Habitats, headwater streams, etc. iii) Use Connectivity Status Index (Grill et al. 2019) as an indicator to track connectivity for freshwater species.	Priority Action 3. Protect and restore critical habitats Priority Action 6. Safeguard and restore freshwater connectivity
CBD Target 14: Ecosystem services	<i>Amend:</i> Revise wording to emphasize the full range of services that freshwater ecosystems provide, rather than only mentioning water supply, and to emphasize the need to balance ecosystem service provision with maintenance and/or restoration of ecosystem structure and processes.	Priority Action 1. Accelerate implementation of environmental flows Priority Action 3. Protect and restore critical habitats Priority Action 4. Manage exploitation of species and riverine aggregates Priority Action 6. Safeguard and restore freshwater connectivity
No current target	<i>New:</i> Define new targets, relevant to CBD Strategic Goal B (Reduce direct pressures on biodiversity), for i) maintaining and restoring e-flows, and ii) managing extraction of riverine substrates, as distinct and essential measures to bend the curve on freshwater biodiversity loss; align these targets with, respectively, SDG 6.4 and SDG 9.4 (see below)	Priority Action 1. Accelerate implementation of environmental flows

#### **Sustainable Development Goal targets and indicators**

SDG 6.3: Water quality	<i>Maintain:</i> Existing target and indicators are aligned with Emergency Recovery Plan, as long as the definition of “ambient water quality” in indicator 6.3.2 incorporates the full range of pollution, and its sources, affecting freshwater ecosystems.	Priority Action 2. Improve water quality
SDG 6.4: Sustainable water withdrawals	<i>Maintain/New:</i> Existing target is aligned with Emergency Recovery Plan, but a new indicator is needed on the proportion of water bodies with e-flows implemented.	Priority Action 1. Accelerate implementation of environmental flows
SDG 6.6: Water-related ecosystems	<i>Amend:</i> i) Extend target timeline to 2030 to encourage continued effort; ii) Improve indicator 6.6.1 so that it tracks the extent of only natural inland water ecosystems, i.e. excluding artificial water bodies such as reservoirs; iii) Strengthen links with SDG 15 by explicit cross-reference to indicator 15.1.2 (Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas).	Priority Action 3. Protect and restore critical habitats
SDG 9.4: Sustainable Infrastructure	<i>New:</i> Include new indicator of sustainability of sand and gravel sources used in concrete for construction.	Priority Action 4. Manage exploitation of species and riverine aggregates
SDG 14.4: Overfishing	<i>Amend/New:</i> i) Extend target to cover all aquatic ecosystems, not just marine and extend timeline to 2030 to encourage continued effort; ii) Include new indicator(s) to track separately the status of inland fisheries, e.g. proportion of fish stocks within biologically sustainable levels within inland waters.	Priority Action 4. Manage exploitation of species and riverine aggregates
SDG 15.1: Terrestrial and inland freshwater ecosystems	<i>Amend:</i> Strengthen links with SDG 6 by explicit cross-reference to indicators 6.3.2 (Water quality), SDG 6.4.2 (Water stress) and 6.6.1 (Extent of water-related ecosystems, amended as above).	Priority Action 1. Accelerate implementation of environmental flows. Priority Action 3. Protect and restore critical habitats

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